

CHEMICAL TECHNOLOGY DIVISION

NUCLEAR FUEL CYCLE RESEARCH IN RUSSIA:  
A LITERATURE SURVEY

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## ABSTRACT

A rather general literature survey of Soviet nuclear fuel cycle research is presented, along with compilations of contributing scientists, their institutes, several thousand of their publications or articles which have appeared in the open literature, and several representative abstracts of these articles. The publication period covered is mostly the interval between 1955 and mid-1963, however, a few papers extending back to the early 1940's are listed because of their historical interest. Though primary attention is given to the chemical or chemical engineering aspects of the fuel cycle, a considerable number of the selected articles deal with related aspects of metallurgy and solid state physics, as well as reactor physics, high energy physics, health physics, biology and medicine, isotope separations, radioisotope utilization, and so forth.

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## INTRODUCTION

According to recent news accounts, the fields of chemistry and chemical technology are destined, in the immediate future, for a big push in the Soviet Union. It is reported that Premier Nikita Krushchev, in a five-hour speech in Moscow on December 9, called for a three-fold expansion of Russia's chemical industry in seven years, at an estimated overall cost of \$23,000,000,000. Such an expansion is expected to place the chemical industry in first place, significantly ahead of the steel industry, in the Soviet economy.

Though the primary long-range interests in this great leap forward are presumably the fertilizer and organic chemical industries, along with those producing plastics, synthetic fibers and fabrics, it may be expected that developments in all the material resource industries (including rare metals and alloys) are in the offing. In many of these cases it can be anticipated that "spin-off" from research in nuclear and radiation chemistry will play a significant role in their ambitious program.

As evidenced in the foregoing "Contents" and "Index of Authors," this report attempts to summarize and correlate articles from the Soviet literature on a variety of subjects that are pertinent to the nuclear fuel cycle, and/or the related areas of nuclear chemistry and chemical technology. Hopefully this summary and the various associated compilations will be of help to U.S. chemists in the nuclear program as a means for acquainting them with the research and development efforts of their rather competitive USSR counterparts. It may at least help to create a degree of awareness of the steadily improving quantity and quality of those efforts, as well as to point out that, in recent years, a growing number of increasingly expansive Russian journals are being issued and, in turn, being translated by very competent and efficient U.S. organizations. Brief descriptions of some of these Journals appear in Section XI. It is believed that an unprejudiced inspection of the scientific and technical reports published therein will show, in general, that the Russian scientists are quite current and well-informed in regard to the work and progress going on in the U.S. and the other Western nations. Such knowledge and information, rather freely available since the 1955 Geneva Conference, has undoubtedly been quite helpful to them, as ordinarily evidenced by frequent references and occasional generous acknowledgments; however, especially in the last few years, it becomes rather clear that a great amount of quite original work is being accomplished - and, unquestionably modern theories, techniques and equipment are being employed, though in the latter case certain costly frills and refinements are not always in evidence. A considerable number of articles being published appear to deal rather heavily with theoretical treatment, as well as attention to broadly-based experimentation and subject-analysis; and they often reflect an apparent intent to broaden, extend or amplify efforts which may have originated in Western laboratories or plants.

The parallels in the character of the USSR work and that of Western nations, particularly since 1955, is possibly a reasonable reflection of

certain facts implied in Academician Vikt I. Spitsyn's book, Soviet Chemistry Today, a compilation of a series of six lectures, published by the U.S. National Academy of Sciences - National Research Council, in 1961. In the discussions he pointed out the dismally-low levels of their chemical industry during the 1913-1930 period (no more than a thousand chemists with higher education in 1913), the slow but determined growth after 1917, and the marked upsurge in the early thirties (the level of its gross output had topped the chemical output in pre-revolutionary Russia by more than 4.5 times by 1932, and 112 times by 1957, with expectations that this factor would climb to over 300 by 1965). He reported that, by 1961, the Soviet Union had about 800 research institutions in the field of chemistry, not counting the factory laboratories.

G. A. Modelski of the Australian National University, in his book Atomic Energy in the Communist Bloc (1959), commented on the USSR's manpower needs for their atomic program. He pointed out that "the atomic industry requires a higher proportion of scientific engineering and technical manpower than the older industries that rely on a large supply of unskilled and skilled labor. Nuclear power stations, for instance, need less manual labor than conventional stations, but that labor must be technically qualified, and must be supported by a larger staff of engineers and research scientists.

"The Soviet Union has already demonstrated its ability to mobilize the large numbers of scientists and technicians required for such projects and the Soviet Union has at present a 'stock' of trained engineers and a steadily rising annual intake of new graduates fully sufficient to meet her needs for industrial atomic expansion. The size and quality of Russia's corps of technical specialists has become a matter of general knowledge and the USSR is capable of producing quantitatively a corps of scientific and technological specialists at least similar to (if not slightly stronger than) the U.S.A., where the population is somewhat smaller.

"Today Soviet science is a large and vigorous community of at least 150,000 members (the statistical report for 1956 gives 229,000 as the total of Soviet scientific workers in all fields of knowledge; at least two-thirds of these are likely to be scientists). Visitors are impressed by the large number of extremely well-trained, able and enthusiastic young scientists and technologists in Russia. They are familiar with scientific thought, and are unlikely to under-estimate the value of scientific inquiry. Soviet science probably still needs a larger proportion of its effort to be devoted to pure research, but this will lessen as time goes on and resources expand.

"The Soviet educational plant for the production of engineering and technical specialists includes three types of establishments: the universities, of which there are about thirty-five, and which offer general and theoretical preparation in a field of knowledge; the teaching institutes, of which there are some 800 providing specialized and applied training; and certain research institutes (about 200), which conduct training programs leading to advanced degrees, but which do not offer tuition at the first degree level. Furthermore, there is a large network of several thousand

technical colleges (technicums), specializing in secondary education for students between the ages of fifteen and eighteen, and in training sub-professional and semi-professional personnel. At all these institutions, scientific, engineering and technological subjects receive the major emphasis. In 1954, some 40 per cent of all divisions of Soviet universities had specialities in mathematics and the natural sciences, and about 50 per cent of the students graduated with a science major; in the same year, 30.6 per cent of the students graduated in engineering and industry, in which 177 of the 758 teaching institutes specialized. A large proportion (up to 75 per cent) of advanced degrees were awarded in the field of natural sciences. The Soviet educational system is exceptionally well suited to provide manpower for a project such as atomic energy development, precisely because of its heavy emphasis on science and engineering. Annual graduation figures in the Soviet compare favorably with the U.S.A., where some 40,000 engineers were trained in 1950, and some 24,000 in both 1953 and 1954; the figure is expected to rise again to about 40,000 in 1960. (However, reported USSR figures for 1956 were 71,000 and, for 1960, they were expected to rise to approximately 90,000.) The Soviet economy as a whole had a fairly large pool of engineers (approximately 600,000 in 1956, roughly the same number as the USA).

"The Soviet position, secure in engineering and in applied technologies, is not so strong in the field of pure science. It has been estimated that, in 1954, the USSR was graduating about 26,250 research scientists, compared with an estimate of 24,000 graduating from American universities. Thus, although comparisons in this field are very tricky, it is plain that the obvious Soviet advantage in the engineering field is not paralleled in the pure science field, especially in the light of the greater total number of trained scientists in the U.S.A. But in pure science, too, Soviet numbers are rising."

Table 1 provides an indication of the distribution and qualifications of scientific workers in the USSR in 1960. In 1959, statistics indicated the following age distribution (percentages) of scientific workers: under 30, 20.8; 30 to 40, 34.6; 40 to 50, 22.5; 50-55, 10.5; 55-60, 6.9; 60-and-over, 4.7. A significant increase in percentage (33.7-44.6%) in the 40-and-above group, and a corresponding decrease in the under-40 group, occurred in the twenty-year interval, 1939-59.

These discussions suggest generally that Russia seems to have enough trained manpower, along with the increasing number of new technical graduates, to mount the proposed seven-year push in chemical industries - and probably to still maintain the present research and development levels in the nuclear fields. However, it can be expected that some of the scientists may be diverted for training or management, and shifting emphasis in programs may occur, with priorities being given, perhaps, to technologic efforts involving such areas as raw materials utilization (including low-grade ores), improved high-decontamination chemical separations techniques (as applied to the full spectrum of the rarer elements), radioisotope and radiation utilization in industry, development of improved alloys, and so forth, i.e. areas which may have a more immediate impact on consumer production and the total economy.

Table 1. Qualifications of Scientific Workers, 1960\*

	Total	In Higher Educational Institutions	In Scientific Institutions
<b>Total Number of Scientific Workers:</b>	354,158	146,915	200,071
<b>Doctors of Science</b>	10,945	5,967	4,656
Professors	8,410	5,425	2,809
Senior Scientific Associates	1,512	34	1,461
<b>Candidates of Science</b>	98,262	51,911	40,097
Professors	661	347	272
Senior Scientific Associates	17,509	704	16,485
Docents	32,505	29,597	2,226
Junior Scientific Associates and Assistants	5,969	2,036	3,775
<b>Without Academic Degree</b>	244,951	89,037	155,318
Professors	836	599	141
Senior Scientific Associates	1,238	190	1,014
Docents	2,971	2,485	238
Junior Scientific Associates and Assistants	20,710	5,254	15,238

\* From "Higher Education in the USSR," Central Statistical Administration of the Council of Ministers USSR, Gosstatizdat TsSu SSSR, Moscow 1961.

In the recent past there was a rather marked increase in the number of technical articles dealing with solvent extraction techniques for chemical separations in the nuclear and other somewhat-related fields, e.g. in the three-year period 1956-9 the number apparently quadrupled. In more recent years, though the primary interest seems to have centered on TBP, considerable theoretic and technologic interest has been shown in a wide variety of organophosphorus extractants, as well as in a variety of amines, carboxylic acids, alcohols, ethers, and others. The publications noted in this survey have dealt mostly with applications in the nuclear field (raw materials, feed materials, spent fuel processing, transuranium element separations, etc.); however, several systematic studies of a range of conditions, solvents, elements and periodic groups might suggest interests in broader applications of solvent extraction as a recovery and separation technique. Parallel interests, though somewhat less-extensive, have also been indicated in ion exchange and various chromatographic techniques. Whereas USSR scientists have historically or traditionally shown strong interests in crystallization, precipitation and adsorption techniques, and still do, it is apparent that they fully appreciate the advantages and flexibilities of the newer continuous-multistage methods that have arisen from developments in nuclear technology, e.g. the potentials for recovery of trace concentrations of materials from low grade ores, or the very high purification of specific materials from impurities, even when in concentrations of parts per million, or even parts per billion. Modern needs for improved alloys, ceramics, or cermets in nuclear-, space-, electronic-, and other industries, along with the associated needs for highly purified elements and compounds, may be expected to generate especial interests in the latter potential. Also, desires for greater exploitation of mineral resources, especially in the case of low-grade reserves of the rarer and more valuable metals, might similarly generate interests in the former potential.

Whether a variety of scientific and technologic "breakthroughs" in nuclear and space developments have figured strongly in the decision for pushing chemical industries at this time can only be a speculative question; however, it can be readily judged that the "spin-off" from such developments will be quite helpful in the overall task of implementing their expected large-scale (and low unit cost) endeavors in the chemical field. Among such breakthroughs of the nuclear and space age, in addition to the above-mentioned cases, can be included (1) radioactive tracer and analytical techniques (e.g. neutron-activation) in research, development and industry, (2) radiation utilization in processing or testing materials, (3) improved instrumentation, computer systems, and automation, (4) improved knowledge of metallurgy, solid-state physics, etc.

In this general literature survey, varying degrees of attention have been given to these various areas of interest. An attempt has been made to categorize the list of selected articles in the last section of this report and the previous Contents and Index of Author Lists reflect the general nature of such categorization. The attempt is granted to be of questionable accuracy and value because of a variety of uncontrollable factors; however, in the overall picture, it does permit some degree of understanding in relating a great many authors to their primary areas of

endeavor. Perhaps this will have some value to U.S. scientists in similar areas who desire to survey the technical reporting of their counterparts in the Soviet Union, or in the East European nations of the Communist Bloc.

Much is being discussed and written these days about the rapidly-growing problems and difficulties of information retrieval in all the disciplines of Science. The individual effort involved in this particular study of the literature has served to make the author more acutely aware of what those discussions and writings are all about. Feelings of inadequacy and frustration grow continually more intense as one digs ever-deeper into the volumes of publication and the increasing stores of scientific and technical knowledge, even in the more-restricted sub-levels of the broader disciplines. It becomes an humbling experience comparable to that one gets in browsing through the extensively-stocked modern-day technical libraries. One concludes that it is indeed time to get started on objective solutions to the retrieval problem. With the rate of growth of foreign literature as well as our own already-voluminous output, it is a bit staggering to the imagination to speculate on the character of the problem that will exist fifty years from now, or even five, unless realistic steps are taken to alleviate the situation.

Considering the scope and the somewhat-limited period of the study, this report has been rather hastily prepared, so it is expected that several errors and deficiencies exist. In any event, it is hoped that it can serve its intended purpose of acquainting U.S. researchers, at least to a limited extent, with USSR studies of the nuclear fuel cycle, i.e. as reported in the open literature.

I. Raw Materials and Geology: Uranium, Thorium, etc.

(from "Atomic Energy in the Communist Bloc," by G. A. Modelski, 1959)

This program appears to be carried out by a variety of agencies including affiliates of the Ministry of Geology and Conservation of Mineral Resources and the Academies of Science of the USSR and the Eastern European nations.

At the end of the war the uranium and thorium resources known to exist in the USSR were inferior to those of Canada and the Belgian Congo. The whole of Eastern Europe is rich in uranium ore, and even before the end of the war uranium was known to have been mined for many years from the famous Jachymov (Joachimsthal) deposits in Czechoslovakia and from an area in Eastern Germany. Anxious to expand its uranium production rapidly, the USSR immediately took over both these crucial workings, and in the course of the next twelve years gradually spread the prospecting for, and the mining of, uranium throughout Eastern Europe. Uranium-bearing ore is now mined in East Germany, Czechoslovakia, Romania, Hungary, Poland and Bulgaria, making these countries vital sources of materials for the Soviet atomic program.

The Soviet stake in the well-known Czechoslovak deposits dates from a 1945 treaty that gave the Soviet Union the right to share Czechoslovak uranium for a period of twenty years; the terms of this may have since been altered to give greater control to Czechoslovakia. In inter-war years the annual output of uranium oxide from Jachymov pitchblende averaged nearly twenty tons, but between 1939 and 1944 this figure fell, despite German efforts to step up production, to an average of less than six tons per annum. This led observers to conclude that the deposit was largely exhausted, but more recent activity in the area does not support this conclusion. Recently there were, in this region alone, a score of mines. The Jachymov miners are now housed in a new town called Ostrov. In 1956 its population numbered over 13,000 inhabitants, and this number is expected to double. Thanks to large-scale geological prospecting carried out mostly by Soviet geologists, important new deposits were also uncovered outside the Jachymov area. Not neglecting areas outside the Ore Mountains (Erzgebirge) Soviet geologists have been exploring, since 1951, in Slovakia and north-east Bohemia. Until about 1960 the ore was crushed, washed and graded in Czechoslovakia and dispatched to the USSR for processing into uranium metal; but by 1960 a Czechoslovak uranium processing plant was to be constructed. There is ample evidence that Czechoslovakia's uranium reserves are good and are being fully exploited.

During the last war, uranium was extracted from complex ores mined in what today is East Germany. At the end of the war the value of the East German deposits (situated principally in the Ore Mountains in the Aue regions and in the Thuringian Forest) was not generally realized, yet by 1946-7 Soviet geologists had begun to prospect the area, and mining soon started on a large scale. East German uranium added greatly to the Soviet potential; today East Germany claims to be the biggest uranium ore producer in Europe and truly one of the world's largest producers of nuclear fuel. It's output

is shipped to the USSR in the form of concentrates. Uranium is also extracted from the ash of the coal mined in the Dresden region.

Enough is known about uranium mining and milling in Romania, Hungary, Poland and Bulgaria to show that these also constitute a large and crucial source of supply for the USSR.

Less is known about uranium mining in the USSR itself. At the Geneva conference of 1955, two Soviet papers gave some details of the bio- and hydro-geochemical and "aero-radiometric" techniques developed for prospecting purposes; and they stated that these methods had helped achieve some considerable success. The hydro-geochemical method was asserted to have led to the discovery of new ore-bearing districts and deposits, as well as of new ore bodies in deposits already mined or prospected, and brought to light several deposits of industrial significance (i.e., containing ores with tenths or hundredths of one per cent of uranium).

Some of these newly discovered deposits were not necessarily in the Soviet Union, for Soviet geologists have conducted extensive searches all over Eastern Europe, and in China.

In 1956 Antropov, the Minister for Geology, gave some details about actual and potential sources. According to him the most promising areas are: Uzbekistan, Northern Areas (Kola Peninsula, Pechora, etc.), Chita Region (Lake Baikal area), Yakutia (Siberia), and West Siberian Lowlands (Ob River area).

This information confirmed earlier suppositions that the Central Asian deposits of Uzbekistan remained the chief source of Soviet ore; but prospecting has also been pushed ahead vigorously in other areas, though chiefly in the eastern part of the country; however, the geographic isolation and economic conditions of these areas would probably impose considerable difficulties on a rapid expansion of mining operations.

A London paper estimated Soviet-bloc uranium metal output at 3-4,000 tons in 1956 (rising to 5-6,000 tons in 1957 and 10,000 tons in 1958-9), thus forming in each of these years about one quarter of world production. These figures are no more than guesses, but the published figure for the 1956-60 nuclear programs in the Soviet bloc gave a rough idea of the minimal requirements of nuclear fuel that must be met for civilian uses. These programs provided for the installation of nearly 3,000 MW of nuclear capacity by 1960-1; if it is calculated very roughly that up to one ton of natural uranium metal is required for one MW of installed capacity as initial fuel charge and some current consumption, then the Soviet bloc needed up to 3,000 tons of uranium metal in the years 1956-60 for its civilian nuclear power program alone.

Apart from the Czechoslovak pitchblende deposits whose uranium content can reach several per cent, and perhaps some other deposits, the Soviet bloc seems to rely to an important extent on lower grade ore - as does the USA, whose carnotite deposits in the Colorado basin are also low-grade ore. Reliance on low-grade ores does not necessarily imply that Soviet supplies are inadequate; on the contrary, it is in agreement with modern trends in

in mining (e.g., gold or copper) where the small-scale exploitation of rich veins has now definitely shifted in favour of large-scale metal production from poor-quality ores with the help of effective separation processes. Compound processing of poly-metallic ores, too, makes it possible to win even small amounts of radioactive materials from the hitherto discarded waste products of extraction of such materials as chromium, copper, silver, vanadium, etc., and attention is now being paid to this in the USSR. Since large areas of the USSR are geologically favorable to the occurrence of low-grade uranium, it is not to be expected that in the foreseeable future the Soviet Union is likely to suffer from uranium shortages, even if supplies from Eastern Europe diminished.

The following brief abstracts of published articles help to illustrate continuing efforts in the raw materials field.

SODIUM AUTUNITE, Chernikov, A. A., et al., 1957. -- A newly discovered mineral is described, i.e., sodium autunite (a sodium uranyl phosphate hydrate), which occurs in one of the granodiorite massives of the USSR and was originally found in 1953. This mineral belongs to the group of mica-like uranium minerals and resembles ordinary autunite (calcium uranyl phosphate) in its properties.

FLOTATION OF PITCHBLEND FROM SYNTHETIC MIXTURES AND ORES, Eigeles, M. A., et al., 1958. -- Studies were made of methods for selective flotation of uranium ores involving the use of fatty acids in softened water together with selective gangue depressants and the use of acid esters of phosphoric acids or alkali salts as collectors and D-SH reagent as modifying agent.

DATA ON CHEMICAL TREATMENT OF HUNGARIAN URANIUM ORES, Szabo, A., et al., 1958. -- Studies were made of (1) a carbonate method of leaching domestic uranium ores, (2) on the effect of various factors on the leaching yield, and (3) on data for application of resins in the leaching process. Investigations were carried out on ion exchange of uranium tricarbonate complexes with resins of different types in mother and artificial solutions. The capacity of domestic ion exchange resins was investigated with respect to the carbonate concentration, uranium content and grain size. The parameters of a countercurrent, multistage system operated on a basket principle were determined. Some problems of hydrodynamic and ion exchange were investigated for resin use in a suspended layer or bed.

THE PRESENT-DAY STATUS OF THE PRODUCTION AND CONSUMPTION OF THORIUM, Kaplan, G. Ye., et al., 1958. -- The subject of the production and applications of thorium is reviewed on the basis of USSR and foreign publications (a bibliography consisting of 8 USSR references and 32 non-USSR references is appended to the article). It is brought out that prospects of the application of thorium in the nuclear energy industry and in other fields, for instance, in the manufacture of high-melting magnesium alloys, induced an intensive development of the thorium industry and of research in this field. During recent years, several enterprises at which raw material containing thorium is converted have been built in the US, India, Brazil, and other countries. The extraction of thorium and of rare-earth elements from

monazite is carried out mainly by alkaline methods. To produce pure thorium compounds, solvent extraction methods are used extensively. Metallic thorium is produced by the metal-thermic method as well as by the electrolysis of chloride-fluoride or fluoride melts. Compact metallic thorium is produced by the metal-ceramic method or by the method of melting.

EXTRACTION OF URANIUM BY MEANS OF ANION EXCHANGE FROM SULPHATE SOLUTIONS AFTER LEACHING, Arden, T. V., 1962. -- A flow sheet for the extraction of uranium and other elements from their sulphate liquors after leaching uranium-containing ores by means of ion exchange resins is described. Properties of uranyl anionic sulphate complexes and the influence of pH on their stability were studied. Results of washing out uranium from the resins by means of nitric acid solution of ammonium nitrate in a 3-column plant are given. Difficulties occurring during the factory exploitation of the anion exchange plant are noted.

RADIOMETRIC EXPRESS-ORE ANALYSIS, Posik, L. N., et al., 1960. -- A fast,  $\gamma$ -analysis, based on the ratio between the  $\gamma$  intensity and the quantity or weight concentration of active elements in an ore, is described. The analysis is especially suitable for sampling ore concentrates. The equipment is described, and the order of error is analyzed.

EXTRACTION OF URANIUM FROM PHOSPHORIC ACID SOLUTION, Laskorin, B. N., et al., 1960. -- One of the methods of ore treatment is extraction with organic compounds, preferably with the ester of phosphoric acid. The suggested use of mono- and dibutylphosphoric acid was followed by dialkylphosphoric acids and alkylamines -- (i.e. dialkylphosphoric acids, in particular di(2-ethylhexyl) phosphoric acid, and trialkylphosphinoxide, and also di- and trialkylamines, whose different structures were investigated). After treating the ore with phosphoric acid, the acid retains a quantity of uranium which could be extracted by the alkyl product of orthophosphoric, pyrophosphoric, dithiophosphoric acid and also alkylphosphinoxides.

APPLICATION OF ION-EXCHANGE MEMBRANES IN THE HYDROMETALLURGY OF URANIUM, Laskorin, B. N., et al., 1961. -- Since large amounts of acids and alkaline solutions are consumed in standard processes of uranium sorption and extraction, the authors have applied electrodialysis with ion-exchange membranes for neutralization of acid or alkaline uranium solutions. This method has also been successfully applied to reduce U(VI) (from hydrochloric solutions of borate having up to 300 g/l of uranium) electrochemically to U(IV). Such ion-exchange membranes (ionite membranes) promote either anion or cation diffusion (anionites, cationites). The membranes used by the authors have been delivered from the Scientific Research Institute of Plastics of the State Committee for Chemistry and the Moscow Institute of Chemical Technology imeni D. I. Mendeleev.

PRECIPITATION OF URANOVANADATES IN THE PRESENCE OF SALTS OF SOME METALS, Gulia, V. G., et al., 1961. -- The authors investigated the precipitation of uranium by solutions of metavanadates in the presence of NaCl, RbCl, CsCl,  $\text{NH}_4\text{Cl}$ ,  $\text{CaCl}_2$  and  $\text{Cu}(\text{NO}_3)_2$ . The freshly precipitated uranovanadates form colloidal solutions, but dense, easily filterable precipitates are produced in the presence of the metal salts. The precipitation of  $\text{Na}_2\text{O} \cdot 2\text{UO}_3 \cdot 3\text{V}_2\text{O}_5$  was carried out by adding a solution of  $\text{NaVO}_3$  to a solution of

uranyl nitrate in 0.1 N  $\text{NH}_4\text{Cl}$ .  $\text{CaO}\cdot\text{UO}_3\cdot 3\text{V}_2\text{O}_5$  was precipitated by the solution of  $\text{Ca}(\text{VO}_3)_2$  from solution of  $\text{UO}_2(\text{NO}_3)_2$  in 0.1 N  $\text{CaCl}_2$ . The concentration of  $\text{UO}_2(\text{NO}_3)_2$  was 0.0386 N and those of the soluble vanadates - 0.04 N. The quantities of the solutions added to each other were chosen so as to obtain uranovanadates with U to V ratio of 1:3.

CHARACTERISTICS OF URANINITE DISSOLUTION IN SULFURIC ACID SOLUTIONS WITH OXIDIZING AGENTS, Alkhashvili, G. M., et al., 1962. -- Uraninite, one of the most important minerals present in uranium ores, always contains various impurities, which have an important influence on uranium extraction. The iron compounds in uraninite are of special importance. Their influence on the extractability of uranium depends on the oxidizing agent used: Manganese dioxide has an accelerating effect whereas nitric acid may exert an inhibitory effect. Eight uraninites of different origin were used to study the effect of impurities on the extraction process. They contained up to 70% U with  $\text{SiO}_2$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{FeO}$ ,  $\text{Al}_2\text{O}_3\text{P}_2\text{O}_5$ ,  $\text{CaO}$ ,  $\text{MgO}$ ,  $\text{MnO}$ ,  $\text{V}_2\text{O}_5$  and  $\text{CuO}$  as impurities; some of the specimens contained no  $\text{FeO}$ ,  $\text{P}_2\text{O}_5$ ,  $\text{MnO}$ ,  $\text{V}_2\text{O}_5$  or  $\text{CuO}$ . In each case the effect of solution concentration, temperature, and test period on the extraction process was studied by using either manganese dioxide or nitric acid as oxidizing agents.

INVESTIGATION ON THE OBTAINING OF URANIUM FROM THE URANIUM ORE, Domanus, S., et al., 1962. -- The parameters of the process of sulfuric-acid leaching of Polish uranium ore were investigated. Tests were made in laboratory to determine optimum conditions of processing. It was found that the highest output (97 to 98% U) was obtained by using 70 g  $\text{H}_2\text{SO}_4$  and 10 g  $\text{MnO}_2$  for 1 kg of uranium ore, while leaching for 6 hours in ambient temperature. Experiments on a pilot-plant scale confirmed the results obtained in laboratory experiments with regard to the output of leaching.

STUDIES ON THE NEUTRALIZATION OF WASTES FORMING AS THE RESULT OF THE SULFURIC ACID TREATMENT ON URANIUM ORES, Wlodarski, Rafal, 1962. -- Wastes obtained as a result of treatment of uranium ores by 10% sulfuric acid were extracted with amine solution. They were then treated by lime milk and barium carbonate to neutralize and precipitate radium together with other products of uranium decay. The clear solution obtained was evaporated to dryness and the  $\alpha$  activity of the sediment was measured. The measures showed lowering of  $\alpha$  activity by about two orders. Finally the solutions contained about  $6 \times 10^{-7}$   $\mu\text{C}/\text{ml}$  of  $\alpha$  activity and  $10^{-7}$   $\mu\text{C}/\text{ml}$  of  $\beta$  activity. Gamma activity was not detected.

INTERACTION BETWEEN FATTY-ACID COLLECTOR AND URANINITE DURING FLOTATION, Grekulova, L. A., 1962. -- The sorption of sodium oleate on the surface of uraninite, the electrical properties of the surface, and the process of extracting uraninite from mono- and bimineral slimes by flotation were studied and the solubility of uranyl acetate was determined for aqueous media. The following uraninite and quartz specimens were used: 1) Minerals with natural ferruginized surface similar to that of metalliferous ores in flotation pulps. 2) Minerals with a cleaned surface (treated with HCl and then washed with distilled water).

**GEOCHEMISTRY OF URANIUM IN THE ZONE OF HYPERGENESIS**, Evseeva, L. S., et al., 1962. -- A review is given of uranium geochemistry. An analysis is made of the basic migration of U in the upper earth crust and of the dissolution and leaching of U by ground water. Geochemistry of uranium deposit oxidation and secondary distribution are also discussed.

**DECANTATION METHODS USED IN THE HYDROMETALLURGY OF URANIUM**, Yakubovich, I. A., 1963. -- Extraction, sorption, and electrochemical methods for leaching out the desired components may be employed both for clarified solutions and for technical suspensions or pulps. Decantation processes involving strong flocculating agents for accelerating the sedimentation have acquired importance; they are used primarily for the hydrometallurgical separation of the soluble materials from the deposits in the pulps. The applicability of a specific method can be determined only by detailed cost calculations; the results of such calculations are often used to determine whether to start the process directly with the pulp or carry out a preliminary clarification first. Equations were derived for solving problems presented by the design of countercurrent washing processes for the separation of an industrial scale of the soluble materials from the deposits. The quantities of industrial solvents required for optimum efficiency may be obtained by solving analytically or graphically the stage equations. Construction of nomograms from the equations given will greatly simplify the necessary calculations.

The following list of authors (of papers listed at the end of this report) may be helpful to readers who wish to perform specific surveys of the Soviet literature in the areas of "raw materials, geology, or mineralogy." Though undoubtedly incomplete, this list (and/or the titles and references given in Section XII) may provide some insight into the scope and progress of efforts in the Institutes of the USSR and the East European nations of the Communist Bloc.

Raw Materials, Geology and Mineralogy

- Agamirov, S. Sh. (1963) - 1 - U, geochem., ppt'n in Black Sea
- Aleksandruk, V. M. (1961) - 1 - geol. age det'n, Re meth.
- Alkhazashvili, G. M. (1962) - 1 - U, uraninite,  $H_2SO_4$  dissol.,  $MnO_2$  oxid.
- Alyamovskii, S. I. (1958) - 1 - Nb, lower oxides
- Amirkhanov, Kh. I. (1955) - 1 - geol., age det'ns, K-40 meth.
- Arden, T. V. (1960) - 1 - IX, sulfate leach
- Botova, M. M. (1963) - 1 - U
- Cherdyntsev, V. V. (1960-63) - 3 - geol., U, Th
- Chernikov, A. A. (1957) - 1 - autunite
- Chipanin, I. V. (1961) - 1 - ores, placers
- Danchev, V. I. (1963) - 1 - geol., U
- Domanus, S. (1962) - 1 - U, ores
- Dziunikowski, B. (1962) - 1 - ore anal., radiom.
- Eigeles, M. A. (1962) - 2 - Be, flotation, sol'n-air interfaces
- Eremenko, G. K. (1963) - 1 - Zr
- Evseeva, L. S. (1962) - 1 - geochem., U
- Feklichev, V. G. (1963) - 1 - Be, mineral., cryst.
- Gel'd, P. V. (1959-62) - 3 - Nb, O, reduct.
- \*Gerling, E. K. (1951-62) - 8 - U minerals, radiomet., A, Xe, He
- Grekulova, L. A. (1962) - 1 - U, fatty acids, flotation
- Gulia, V. G. (1961) - 3 - U, vanadates
- Isabaev, Ye. A. (1960) - 2 - U, isot. comp., Ac
- Ivanov, V. Ye. (1960-62) - 2 - Be, Mg-Be alloys
- Ivanova, K. S. (1961) - 1 - Th, monazites
- Kaplan, G. Ye. (1958-62) - 4 - Th, monazite, Zr, Hf, SX

Raw Materials, Geology and Mineralogy, continued

- Karajovic, D. (1962) - 1 - mining, rad. safety
- Katsnel'son, B. A. (1963) - 1 - mining, rad. safety
- Komlev, L. V. (1961) - 1 - radiogeology
- Kotlyar, V. N. (1961) - 1 - U, geol., genet. types of dep.
- Kupriyanova, I. I. (1963) - 1 - minerals, britholites
- \*Laskorin, B. N. (1960-62) - 7 - SX, IX, PO<sub>4</sub>, organophos.
- Lazarev, K. F. (1959-61) - 4 - Th, monazite, leaching, ppt'n
- Lyubimova, L. N. (1962) - 1 - U, analyt., polarog.
- Manskaya, S. M. (1963) - 1 - U, Ge, V, in lignites
- Meerson, G. A. (1957-62) - 1 - Th, monazite; Nb, O, reduc.
- Moroshkina, T. M. (1957-62) - 2 - analyt., IX, spectrogr.
- Nesmeyanova, G. M. (1961) - 2 - U-ore dissol., U oxidation
- Nevskiy, B. V. (1959) - 1 - U ores, combined use (?)
- Nikitin, A. A. (1963) - 1 - Zr, Ti, Th, sea sands
- Petriaev, E. P. (1959) - 1 - minerals, surf. area, radio. meth.
- \*Plaksin, I. N. (1956-62) - 5 - analyt., radiom.,  $\alpha$ -n, ores, U, Th, Be, B, Al, F, RE's, ext'n
- Posik, L. N. (1960) - 1 - analyt.,  $\gamma$ -radiomet., ore sampling
- Prokof'yeva, V. K. (1958) - 2 - analyt., U, V, spectrochem.
- Savitskii, I. D. (1963) - 1 - instr., radio-logging, etc.
- \*Savvin, S. B. (1959-63) - 6 - analyt., Th, U, arsenazo, photom.
- Serikov, Yu. I. (1963) - 1 - oil well logging, U-org. matter
- Sevast'yanov, Yu. G. (1963) - 1 - polyphenyls, org. react. coolants
- Shashkin, V. L. (1962) - 1 - U, Th ores, instr., logging
- Shcherbina, V. V. (1962) - 1 - mineral formations
- Smirnov, V. A. (1962) - 1 - U, Th, ores, geol., geochem.

Raw Materials, Geology and Mineralogy, continued

- Sokova, K. P. (1962) - 1 - analyt., Th, monazite, RE's, Si.
- Syritso, L. F. (1962) - 1 - U minerals, pegmatite deposits
- Syromyatnikov, N. G. (1962) - 1 - U, phosphate-Zr ores, 235/238 ratio, geol.,  
genesis
- Timofeyev, A. N. (1959) - 1 - ore prospecting,  $\gamma$ -field, Rn eff.
- Tugarinov, A. I. (1963) - 1 - minerals, age det'n, Pb-U meth.
- Upor, E. (1962-63) - 2 - U, Th, analyt., carbonate sep'n
- \*Vinogradov, A. P. (1955-63) - 6 - analyt., U, RE s, radiogenic gases, S  
isot., C-14, etc.
- Vol'fson, F. I. (1962) - 1 - U depos., geol., mineralization
- Wang, S. (1962) - 1 - uranyl vanadates, reduct. by  $H_2$
- Wlodarski, R. (1962) - 1 - U-ore,  $H_2SO_4$  treat., waste disp., removal of Ra  
and other U-daughters
- Yakubovich, I. A. (1963) - 1 - U ores, hydromet., leaching, ext'n
- Yerzhabek, V. (1958) - 1 - U ores, RE ext'n by TBP
- See also Almarin, Barabas, Davankova, Galkin, Geerson, Gordiyevskiy, Ippolitova,  
Kanevskiy, Khlebnikov, Morachevskiy, Murav'yeva, Muromskiy, Rafalskiy,  
Satunovskiy, Shankar, Sokova, Starik, Tolmachov, Vetrov, Yefremov.

## II. Feed Materials, Chemical Conversions, etc.

(from "Atomic Energy in the Communist Bloc," G. A. Modelski, 1959)

Until about 1960 the USSR was the only Soviet-bloc country with the facilities to process uranium ore and to manufacture uranium metal of nuclear purity; however, several other Eastern European countries are now entering this field too. The required production methods have been developed, and at Geneva Soviet speakers stressed the extent to which Soviet-devised methods were being used in this fairly intricate branch of metallurgy. Physico-chemical control methods evolved in the Soviet Union, according to A. P. Vinogradov, ensured satisfactory control over uranium production.

Soviet sources show that thorium has played at least a minor role in the Soviet atomic program. At Geneva, the USSR presented two papers on thorium treatment: "Metallurgy of thorium" by G. E. Kaplan, and "Powder metallurgy of thorium" by G. A. Meyerson, which describes up-to-date methods of gaining the metal and treating it by sintering. In February 1956 Kurchatov announced that a thorium reactor was to be built before 1961, and specified later that this would be an experimental 50-70 MW heavy water homogeneous power reactor to be set up as part of the test station of the Central Atomic Energy Authority. A thorium breeding system using ordinary water was also being investigated. This indicates that Soviet planners are confident of having sufficient thorium to justify an effort required to develop thorium reactors.

The following abstracts of articles from USSR and Eastern European authors help to illustrate continuing work in the feed materials effort.

FACTORS AFFECTING THE URANIUM TETRAFLUORIDE REDUCTION WITH MAGNESIUM, Kharper, Dzh., et al., 1960. -- The reaction of  $UF_4$  with Mg begins at  $560^\circ C$ ; a sharp increase of the temperature takes place within the  $600-650^\circ C$  range. A great effect on the U yield in the ingot is exerted by the heating rate at  $>400^\circ C$ . At slow heating the yield is low due to the entanglement of U reguli in the slag. It is supposed that some products of side reactions as e.g.  $UO_2$ , prevented their fusion. When using a charge of low density, "preliminary" reactions take place to a considerable degree, such as for instance, the interaction of Mg and  $UF_4$  vapors, resulting in the formation of hard-to-reduce  $UF_3$ . High yields are obtained at rapid heating of a sufficiently dense charge. It is recommended to line the reactor with graphite and to fill the space between the lining and the body of the reactor with a heat-insulating material. The lining withstands up to 12 heats.

THERMAL DECOMPOSITION OF AMMONIUM URANIUM PENTAFLUORIDE, Galkin, N. P., et al., 1961. -- This report is a continuation of the authors' studies on the reaction of  $UF_6$  with  $NH_3$ . The  $UF_6$  is partly reduced by  $NH_3$  at  $100-200^\circ C$ , with  $NH_4UF_5$  being formed (which contains up to 10% of free  $NH_4F$ ). Thermographic analysis rendered three endothermic effects: at  $220-280^\circ C$  (loss in weight 9.4%),  $320-360^\circ C$  (loss in weight 5.9%), and  $420-450^\circ C$  (loss

in weight 4.2%). The product calcined above  $450^{\circ}\text{C}$  is  $\text{UF}_4$ . This gradual separation of  $\text{NH}_4\text{F}$  was now investigated by analysis of the gases formed in thermal dissociation. Calcination was conducted 2 hr in an argon flow at 280, 360, and  $460^{\circ}\text{C}$ . Results: free  $\text{NH}_4\text{F}$  is quantitatively eliminated at  $280^{\circ}\text{C}$  accompanied by partial  $\text{NH}_4\text{UF}_5$  decomposition,  $\text{NH}_3$  being liberated predominantly. At  $360^{\circ}\text{C}$ , almost no F but only  $\text{NH}_3$  is liberated. At  $460^{\circ}\text{C}$ , mainly liberation of F can be observed. Thus,  $\text{HUF}_5$ , which is unknown in aqueous solution, should be stable between  $280$ - $460^{\circ}\text{C}$ .

PRODUCTION OF URANIUM DIOXIDE FOR NUCLEAR REACTOR FUEL, Pacovic, Nikola, 1961. -- This review article describes briefly the methods of uranium dioxide production and the advantages of uranium dioxide as a reactor fuel. The properties of uranium dioxide as a reactor fuel are, in some ways, superior to those of metallic uranium since at higher temperatures, imperative for the increase in reactor efficiency, metallic uranium accumulates fission gases and expands in volume. Uranium dioxide ( $\text{UO}_2$ , 000) has a high melting point of about  $2,800^{\circ}\text{C}$ , chemical stability in an inert and reductive gaseous atmosphere up to the melting point, is stable to the bombardment of neutrons at high temperatures, and does not change its crystal structure under the influence of fission products. Its negative properties, i.e. low thermal conductivity, especially above  $1,500^{\circ}\text{C}$ , and a low uranium content of 9.66 gr/cu. cm, are offset by the increase in reactor efficiency.

SPECTROSCOPIC INVESTIGATION OF THE STABILITY OF COMPLEX URANIUM(VI) COMPOUND WITH FLUORINE, Kuteynikov, A. F., 1961. -- A brief review of previously reported data for the stability of uranyl fluoride compounds indicated that all such studies were carried out by the potentiometric methods and that no comparative results are available from other investigations. For this reason a spectroscopic examination was made of the stability of uranyl fluoride as judged in terms of variation of the intensity of colour of the uranyl complex produced by reaction with arsenazo reagent. Optical density measurements were made in a (SF-4) spectrophotometer using a cell layer with a thickness of 1 cm at  $20^{\circ}\text{C}$ . The arsenazo reagent forms with uranyl ions a complex, blue compound, which is easily soluble in water. Solutions of this complex have a maximum spectral absorption at the wavelength of 600 m $\mu$ . Changes in the absorption spectra of the complex formed by uranyl ions with arsenazo reagent on addition of sodium fluoride are of the same basic pattern for various sodium chloride concentrations; the optical density at the wavelength of 600 m $\mu$  diminishes because of decomposition of a part of the coloured complex in consequence of the formation of colourless uranyl fluoride. In the presence of fluoride, on the other hand, the optical density rises at 500 m $\mu$  because the maximum of the absorption spectra of arsenazo solutions corresponds to this wavelength. The quantity of fluoride necessary for the decomposition of the coloured complex rises with the pH of the medium. Data for the equilibrium constants and instability constants of the complex uranyl fluoride ions for the pH range from 3.0 to 5.0 at the total uranium concentration of  $2 \times 10^{-5}\text{M}$  and  $3.4 \times 10^{-5}\text{M}$  concentration of the arsenazo reagent indicated the formation of a complex uranyl fluoride ion ( $\text{UO}_2\text{F}^-$ ) with an instability constant of  $1.7 \times 10^{-5}$ .

**POWDER METALLURGY OF THORIUM, Zelikman, A. N., 1961.** -- A review is presented on the powder metallurgy of compact thorium. The compositions and mechanical properties of Th produced by various methods are compared, and the properties of compact Th produced by powder metallurgy from electrolytic and calcium-thermal reduction are tabulated.

**LOW-TEMPERATURE CARBOTHERMAL REDUCTION OF  $U_3O_8$ , Vlasov, V. G., et al., 1962.** -- A study of the kinetics of the reduction of  $U_3O_8$  with solid carbon. The authors carried out experiments in a temperature range 625-725°C in an installation and by a method described in a previous publication and studied the effect of  $Na_2CO_3$  added to the oxide or to the reducing agent. It was found that the addition of  $Na_2CO_3$  to the carbon slows down the reduction; the addition of the latter to the oxide accelerates the process markedly. The rate of reaction does not depend on the degree of oxygen elimination until  $U_3O_8$  is fully converted to  $U_4O_9$ , but afterwards diminishes proportionally to the degree of reduction. This dependence may be expressed by  $\log a/a-q = k\tau$  where  $a$  is the degree of reduction (%) corresponding to  $UO_2$ ,  $q$  - the actual degree of reduction (%),  $k$  - a temperature constant and  $\tau$  - time. Activation energy for the reduction is 56-58 kcal/mol.

**MECHANISM WHEREBY OXYGEN-CONTAINING URANIUM COMPOUNDS EXERT A NEGATIVE INFLUENCE ON THE PROCESS AND RESULTS OF REDUCING URANIUM TETRAFLUORIDE BY METALLOTHERMAL MEANS, Reshetnikov, F. G., et al., 1962.** -- An attempt is made to discover why oxygen-containing uranium compounds  $UO_2$  and  $UO_2F_2$ , if included in the mixture, exert a negative effect on uranium reduction by the use of magnesium or calcium. According to the initial composition and the method of  $UF_4$  production, the final product contains more or less of  $UO_2$  or uranyl fluoride, the latter being formed according to the equation  $UF_4 + H_2O + 1/2 O_2 = UO_2F_2 + 2HF$ . The presence of these oxides considerably reduces the uranium yield and favors the formation of heavy slags. This effect is shown to be related to the formation of "secondary"  $UO_2$  during the reduction process. For the reduction with  $CaO$  the course of reduction is assumed to be given by (1)  $UF_4 + CaO = UOF_2 + CaF_2$ , (2)  $UOF_2 + CaO = UO_2 + CaF_2$ , and (3)  $UF_4 + 2CaO = UO_2 + 2CaF_2$  (the same holds for  $MgO$ ). The oxyfluoride  $UOF_2$  which is formed has hitherto been unknown and the existence of this new phase was proved by x-ray study of the reaction product from (2).

**DECONTAMINATION OF WASTE WATERS IN METALLURGY, Lainer, V. I., 1962.** -- Metallurgical plant and flotation mill waste decontamination is discussed, and rapid monitoring and disposal methods for poisonous and radioactive materials are evaluated.

**ELECTRIC PROPERTIES OF URANIUM OXIDES FROM  $U_3O_8$ - $UO_2$ , Zhukovskii, V. M., et al., 1962.** -- Studies of electric conductivity of oxides from  $U_3O_8$  to  $UO_2$  at 25 to 600°C showed that the conductivity increases with temperature and can be expressed by the equation  $X = A \exp(-\Delta E/2kT)$ . Removal of oxygen from the lattices of  $UO_{2.67}$  to  $UO_{2.56}$  increases the conductivity by an order of magnitude. The crystal structures from  $UO_2$  to  $U_4O_9$  are similar, but the density of  $U_4O_9$  is higher. The conductivity measurements confirmed the formation of  $U_3O_8$ ,  $U_3O_{8-x}$ ,  $U_4O_9$ ,  $UO_{2+x}$ , and  $UO_2$ .

URANIUM DIOXIDE AS A NUCLEAR FUEL, Seidl, Karel; 1963. -- Uranium dioxide is the most important and the most utilized high-temperature reactor fuel. The properties of this material are presented. The fabrication process and behavior of  $UO_2$  during irradiation are discussed.

REDUCTION OF URANIUM TRIOXIDE BY NITROGEN-HYDROGEN MIXTURE, Vlasov, V. G., et al., 1963. -- Kinetics of uranium trioxide reduction by nitrogen-hydrogen mixture at 350 to 500°C and 25 to 600 mm Hg was investigated. The activation energy of the process was 26.5 to 31.7 kcal/mole. The data were compared with the uranium trioxide reduction by pure hydrogen and ammonia.

ON THE PROBLEMS OF PHASE TRANSFORMATIONS IN THE REDUCTION OF  $U_4O_9$ , Zhukovskii, V. M., et al., 1963. -- Contradictory opinions on the state and structural characteristics of the phase components of the U-O system in the composition range  $UO_2-UO_{2.25}$  are discussed. The reduction of  $U_4O_9$  with decomposed ammonia and solid C was studied. The dependence of the lattice parameter of  $UO_2$  on the amount of O introduced into it is presented. In all cases the only end product of the reduction in the experiments was the oxide  $UO_{2+x}$ , where the values of x varied, depending on the temperature and time of reduction, from 0.08 to 0.01. It was indicated that the phase  $UO_{2+x}$  actually has a cubic lattice of the fluorite type with a randomly introduced excess of O and four atoms of U in the elementary cell.

Uranium and Thorium Feed Materials, Chemical Conversions, etc.

- \*\*Galkin, N. P. (1957-62) - 14 - U, O, F, reduct, ext'n, ppt'n
- Ivanov, M. I. (1958-62) - 3 - U, Al, Be, Fe
- Karalova, Z. K. (1962-63) - 2 - analyt., B, Be, U, O, F
- Kharper, D. (1960) - 1 -  $UF_4$  red. by Mg
- Kovtun, S. F. (1962) - 1 - U, dimens. changes, therm. cycling
- Kolesov, V. P. (1959) - 2 -  $BeF_3$ , Li oxide
- Kudintseva, G. A. (1962) - 1 - La boride coating, plasma jet
- Kutaitsev, V. I. (1962) - 1 - U, Th, Pu alloys
- Kuteynikov, A. F. (1961) - 1 - analyt.,  $UF_6$ , stability
- Lainer, V. I. (1962) - 1 - waste water decontamin.
- Maltsev, V. A. (1960) - 1 -  $UF_4$ , ht. of form.
- Pacovic, N. (1961) - 1 -  $UO_2$  prod., properties, react. fuel
- Popov, M. M. (1957-59) - 4 -  $UF_4$ ,  $UCl_4$ ,  $UI_4$ ,  $PuO_2$ , U-oxides, heat. capac.
- Reshetnikov, F. G. (1962) - 1 -  $UF_4$  red., Mg, Ca, slag form.
- Seidl, K. (1963) - 1 -  $UO_2$ , fabric., irradi. behavior
- \*Vlasov, V. G. (1962-63) - 5 - U oxide reduct., C,  $NH_3$ , N-H
- Yevstyukhin, A. I. (1959) - 1 - Th, electrolytic prep. from fused halide salts
- Yushina, L. D. (1957) - 1 - Th, elect. prep. from fused salt melts
- Zelikman, A. N. (1961) - 1 - Th, powder met., electrolyt, Ca-therm. red.
- Zhukovskii, V. M. (1962-63) - 4 - U-oxides, red., props., phase transf.
- Z, G. (initials only) (1957) - 2 - U,  $\alpha$ - $\beta$  transf., pure  $UO_2$  powders, U-233  
U-235.
- See also Bessonov, Dashkovskiy, Fischer, Gagarinskiy, Ivanov, Kidin, Kovacevic.

Hydrofluoric Acid, Fluorine, etc.

Boguslavskiy, I. M. (1961) - 1 - from  $\text{SiF}_4$

Buslaev, Yu. A. (1959-63) - 2 - Ta, U, Hf

\*Nikolaev, N. S. (1950-1962) - 6 - Nb, Zr, Hf, Ta, Mo

Talakin, O. G. (1962) - 1 - complex comp'ds, fluonitrate,  $\text{NO}_3\text{F}$ , ht. of form.

\*\*\*Tananayev, I. V. (1956-63) - 29 - complex comp'ds, F, Cl, ferrocyanides, EDTA, alk. mets., Zr, Th, U, Tl, Ge, RE's, Ag, Mo, Fe, Ni, Be, Sc, Sr, etc.

See also Tsitsishvili, Varshavskiy.

### III. Heavy Water, Isotope Separations, etc.

(from "Atomic Energy in the Communist Bloc," G. A. Modelski, 1959)

In 1956, the Head of the Atomic Energy Authority remarked confidently that the USSR would be able, by the use of new and exact techniques of ion exchange, mass spectrography, diffusion and others to produce deuterium and stable isotopes of other elements in sufficient quantities to meet their needs.

Heavy Water, a convenient though costly reactor moderator, is one of the crucial materials of a nuclear and thermonuclear program. The USSR is among the few industrial producers of heavy water. Soon after its discovery by Urey (USA) in 1931, heavy water was first produced in gram quantities in the Soviet Union at the Institute of Physical Chemistry at Dnepropetrovsk (under A. Brodsky). The Dneprostroi hydro-electric plant supplied the cheap power used for the electrolysis process. When, in 1939, the discovery of uranium fission directed attention to the role of heavy water, its production became the concern of the Commission for Isotopes of the USSR Academy of Sciences. At the first conference on isotopes in April 1940 papers on the production of heavy water were presented and plans discussed for using the electrolysis process to achieve a production rate of 33 lb per year at the electro-chemical plant in Chirchik (Uzbekistan). Other methods were also explored, in particular at the Karpov Institute of Physical Chemistry in Moscow. At that time Soviet research was not inferior to American, and despite the interruption caused by the war it proved to be a fully sufficient foundation for undertaking large-scale production. The first known Soviet heavy water reactor was designed in 1947 and put into operation in 1949. At present the USSR possesses a large heavy water industry built basically on indigenous knowledge and resources.

Calculations showed that Soviet-bloc nuclear power plans would require between 97 and 194 tons of heavy water to be available by the end of 1960. Additional similar quantities would be needed for research reactors. These are considerable quantities calling for the consumption of very substantial amounts of electric power, and they do not include heavy water production for military purposes.

For the time being, the USSR is supplying other Soviet-bloc countries with heavy water and tritium in quantities sufficient for research and radiochemical purposes; however, Czechoslovakia planned to build a heavy water plant by 1960 as part of its nuclear power program. East Germany, too, was expected to embark on heavy water manufacture, as indicated by her large chemical engineering capacity and pre-1945 experience in this field.

Diffusion of uranium hexafluoride is the common method of separating U-235, and references in Soviet publications imply that this method is used in the USSR. The effectiveness of the diffusion method was emphasized at a Soviet conference of April 1940, some months before it actually received serious consideration in the USA. At the war's end some German specialists in the diffusion method (Hertz, Barwich) went to work in the USSR, and the

establishment of Soviet diffusion plants may thus have been speeded through their technical assistance.

The credit for having made the decisive contribution to the kinetic theory of the diffusion process in electro-chemistry in the Soviet Union is given to V. R. Levich.

The location of the huge diffusion plants used for U-235 separation is unknown, but it may be supposed that when their building was begun after the war (between 1946 and 1952) there were not many areas in the Soviet Union that had the large supplies of cheap power required for this process; Southern Ukraine with its hydro-electric schemes and the Donbas coal; the Kuznetsk basin behind the Urals (Tomsk-Novosibirsk area) and Central Asia with its hydro-power schemes were some of the most likely places. Important atomic production establishments (including also heavy water plants) may recently have been built in the newly developing East Siberian hydro-electric centre of the Angara, Yenisei and Lena rivers, but since the first of the Siberian hydro-electric plants, the Irkutsk scheme, came into operation only in 1956, atomic establishments in this area could not have commenced production and contributed to the Soviet stockpile of fissile materials prior to that date. Soviet diffusion plants are thus probably situated elsewhere in the Soviet Union, perhaps along the chain of the new Volga stations, or on the upper Kama River in the Urals.

The considerable number of enriched fuel power reactors under development in the USSR suggest that U-235 is fairly plentiful, certainly more so than, for example, in Britain. Soviet authors have claimed (reviewing foreign literature on this subject) that U-235 has become a relatively inexpensive fuel and enriched uranium (when converted into energy by power reactors) is approximately equivalent in cost to coal.

The following abstracts illustrate some of the continuing studies of isotope separations by Soviet scientists.

ON THE SEPARATION OF BORON ISOTOPES BY CHEMICAL EXCHANGE, Panchenkov, G. M., et al., 1957. -- Descriptions are given of B isotope separation by chemical exchange based on the reaction of  $B^{10}F_3 + A \cdot B^{11}F_3 = B^{11}F_3 + A \cdot B^{10}F_3$ ; where A is the anisole  $C_6H_5OCH_3$  and  $A \cdot BF_3$  is the liquid complex compound of anisole with boron fluoride. It has been shown that the isotope exchange reaction, as shown above, really exists with the equilibrium constant  $\alpha = 1.013 \pm 0.005$  and the isotope  $B^{10}$  concentrated in the anisole-fluorine boron complex, i.e. in the liquid phase. Results of the experiments are shown in tabular and graphical forms.

THE SEPARATION OF THE ISOTOPES OF HELIUM BY RECTIFICATION AND THERMO-OSMOSIS, Kuznetsov, V. M., 1957 -- This paper describes the main results of an experimental study of the processes of rectification and thermoosmosis which are necessary for the computation and for the effective use of the rectification column and of the filter.

The rectification: The experiments with respect to the rectification were conducted with an adiabatic column, the construction of which is shown in a sketch.

The thermosmosis: Another sketch illustrates the device used for the thermosmosis. If the performance of the instrument and the temperature of the condenser are given, the enrichment is the stronger the greater the decline in temperature at the ends of the filter. It does not serve any purpose to apply the thermosmosis at concentrations above 4-5%.

The mass spectrometric gas analyzer: This gas analyzer has been constructed on the basis of a helium leak detector PTI-4. It makes possible an uninterrupted analysis of the gas mixture in the interval of the concentrations  $0.2\% \text{ He}^3/(\text{He}^3 + \text{He}^4)$  to  $0.2\% \text{ He}^4/(\text{He}^3 + \text{He}^4)$  with an accuracy of  $\pm 5\%$ .

Some conclusions: The combination of thermosmosis and rectification is a simple and effective method for the extraction of  $\text{He}^3$  from the mixture. It is easily possible to connect the filter for the thermosmosis with a rectification column, and the entire instrument can be housed in a cryostat. According to the results obtained in the paper under review it is possible with the aid of a column of a length of 8-10 cm to obtain virtually pure  $\text{He}^3$ , if the mixture under consideration contains 1-2% of the light isotope. The total coefficient of enrichment of column with filter is of the order of magnitude of  $10^5$ - $10^6$ . The author obtained some mathematical interrelationships for the computation of the processes of rectification at a turbulent motion of the vapor in the column. Also the dependence of the performance of the filter upon the concentration of the mixture to be enriched was determined.

INVESTIGATION AND CALCULATION OF ABSORPTION AND RECTIFYING COLUMNS WITH REGULAR FILLING MATERIAL= Zhavoronkov, N. M., et al., 1958. -- As is well known, the columns mentioned in the title have the features of high throughput rate and low hydraulic resistance. Their investigation, as well as the development of an economical design, would therefore be of great practical interest. A survey of literature is given. In cooperation with Malofeyev, Umnik, Babkov and Uvarov the authors have concerned themselves with designing distribution equipment of low hydraulic resistance. Among this equipment, 4 types (and 3 subtypes) of vertical columns were studied. One figure gives the schematic design of a column (500 mm diam., 18 m height) filled with packings of sheet filling material. In order that all sheets may be moistened, special grate distributors were arranged on the top packing. The main advantage of the filling material, its low hydraulic resistance, is illustrated in another figure. The maximum load of the regular filling bodies can be computed from a graph. A table gives some rectification results obtained with the columns described. All experiments were made at pseudo-turbulent conditions ( $Re_p = 500 - 2000$ ). For these, the height that would be equivalent to the theoretical plate was found to be almost independent of the load. For individual cases where the concentration of the component to be extracted is small (as, for instance, in producing the heavy oxygen and hydrogen isotopes) the use of the column will in fact permit installation of a multistage rectification. The condenser of the preceding column is used as an evaporating still for the next column whereby much steam is saved. The capacity of these columns was studied for the absorption of  $\text{CO}_2$ , and  $\text{NH}_3$ , respectively, in water, and of  $\text{NH}_3$  in  $\text{HCl}$ . From this the partition coefficients in the liquid and gaseous phases could be determined

By studying packings of filling material of quite different values of equivalent diameter (the gaps between sheets being 5, 10, 20 and 30 mm) formulae for determining the partition coefficients of mass transfer were derived.

ON A NEW METHOD OF ISOTOPE SEPARATION, Panchenkov, G. M., *et al.*, 1959. -- Contrary to previous assumptions it was shown that the isotopes of various elements (such as hydrogen, lithium, and mercury isotopes) have unequal molar volumes. In this paper the authors described the separation of oxygen isotopes by means of bis-(N,N'-disalicylal ethylenediamine)- $\mu$ -aquo-dicobalt, which strongly absorbs oxygen at 40°C and loses it again at 60°C. In order to determine a "screening effect" of this substance for isotope molecules of oxygen, the authors computed the distribution coefficient  $\alpha$  in glass-bulbs of a capacity of 2,000, 1,000, 500, 250, and 125 ml at a pressure of between  $\approx 760$  and  $\approx 380$  torr and a temperature of  $20 \pm 3^\circ\text{C}$ . The results of measurement are listed. They indicate that isotopes may be separated in the gas and liquid phase according to the aforesaid method. Corresponding investigations are presently being made by the authors.

PHYSIOCHEMICAL CONSTANTS OF HEAVY-OXYGEN WATER, Uvarov, O. V., *et al.*, 1962. -- The separation factor  $\alpha$  of the system  $\text{H}_2\text{O}^{16}\text{-H}_2\text{O}^{18}$  was determined in the range 20 to 210° by a differential method. At 100°,  $\alpha = 1.0038$ . The difference in vapor pressures of standard water and water enriched with  $\text{H}_2\text{O}^{18}$  to 43.6 mole % was measured. From the values of  $\alpha$ , calculations were made of the difference in the heats of vaporization, of the vapor pressure of 100%  $\text{H}_2\text{O}^{18}$  in the range of 20 to 210°C and of its boiling point at 760 mm Hg. With the aid of an interferometer, the dependence of the difference in refractive indexes for  $\text{H}_2\text{O}^{18}\text{-H}_2\text{O}^{16}$  upon the  $\text{H}_2\text{O}^{18}$  concentration in water at 20° was determined. It was found that this dependence is of linear character. The temperature coefficient of the refractive index difference  $\text{H}_2\text{O}^{18}\text{-H}_2\text{O}^{16}$  in the range 10 to 30° was determined. The density and its dependence upon the  $\text{H}_2\text{O}^{18}$  concentration were determined by a quartz pycnometer at 25, 30 and 40°. The dependence is in the form of a straight line. On the basis of the relationship obtained, it was calculated that 100%  $\text{H}_2\text{O}^{18}$  at 25° has a density 1.10723 times that of river water. The temperature dependence of the density of heavy oxygen water in the range 25 to 40° was also determined. The accuracy of the density determination was  $\pm 0.00001 \text{ g/cm}^3$ . The  $\text{H}_2\text{O}^{18}$ -enriched water was purged of deuterium by the iron-steam method. Isotopic analysis of the purified water was carried out by mass spectrometer and the drop method.

THE EXISTENCE OF A "NEGATIVE" ENRICHMENT EFFECT DURING THE THERMO-DIFFUSION OF A GAS IN A POROUS MEDIUM, Goshchitskii, *et al.*, 1962. -- A negative enrichment effect consisting of an increase in the concentration of the light component at the cold end of a capillary was observed in studying the thermo-diffusion of gases in capillaries at low value of  $d/\lambda$ , where  $d$  is the diameter of the capillary, and  $\lambda$  is the mean free path of the molecule. Gaseous mixtures of  $\text{H}_2$  and Ar,  $\text{H}_2$  and Kr, and He with Kr were allowed to diffuse through a porous membrane from a volume  $V_1$  at temperature  $T_1$  to a volume  $V_2$  at a temperature  $T_2$ . A positive separation effect was noted at low hydraulic resistance (the light component was enriched in the 'hot' vessel). The composition of the mixtures was obtained from thermal conductivity measurements. It was shown that a positive enrichment effect is always obtained, when pressure and temperature gradients are

simultaneously present in the porous medium. It was concluded that the negative enrichment effect is due to "parasitic," inverse temperature gradients existing in the vessels. As long as the porous medium was connected directly to the working volumes of gas, which were held at a definite temperature by carefully thermostating the entire vessel, only a positive enrichment effect was obtained. The negative enrichment effect was observed experimentally only on removing the thermostats from the vessels.

DISTRIBUTION OF LI ISOTOPES IN IMMISCIBLE SOLVENTS, Kolombirkin, V. M., et al., 1962. -- Distribution coefficients of Li isotopes equilibrated between the lithium salts in aqueous solutions and Li salts in acetone, isoamyl, alcohol, diethyl ether, and amyl acetate were determined. Additions of a light petroleum fraction to lithium chloride solution in mixed methylamine and isoamyl alcohol in contact with aqueous solution of lithium chloride promote the movement of the light Li isotope to the opposite direction.

ON THE POSSIBILITY OF USING NO-H<sub>2</sub>O ISOTOPE EXCHANGE IN NITRIC ACID SOLUTIONS FOR CONCENTRATING <sup>18</sup>O, Oziashvili, E. D., et al., 1962. -- During isotope exchange between NO and H<sub>2</sub>O in 8 M HNO<sub>3</sub>, <sup>15</sup>N was concentrated in the liquid phase and <sup>18</sup>O in the gaseous phase. An apparatus was constructed in which NO was decomposed into N and O above 700°C using a catalyst and the O recombined with additional NO to form NO<sub>2</sub>. Simultaneous operation of <sup>15</sup>N and <sup>18</sup>O concentrators yielded highly concentrated <sup>15</sup>N (>99%) and O containing ~15% <sup>18</sup>O.

SOME FEATURES OF THE DUAL-TEMPERATURE METHOD OF SEPARATION OF HYDROGEN ISOTOPES, Vaisberg, S. E., et al., 1963. -- The two-temperature isotopic hydrogen exchange between liquid water and countercurrent gas which forms the basis of the most economical method to produce heavy water is effected not between pure substances but between two-component phases: the saturated gas solution in water and the gas mixture with saturated water vapors. The effect of the bi-componency of phases on the process of two-temperature isotopic hydrogen exchange was analyzed and equations worked out for the exchange between the gas-vapor mixture and the gas solution when the exchange rate in the solution is sufficiently fast. The enrichment curves were calculated as exemplified by the scheme of the two-temperature exchange in the system water-hydrogen chloride (where the effect of the bi-componency of phases is rather strong). The process of the enrichment of deuterium in this system (hydrochloric acid-gas vapor mixture of hydrogen chloride with water) at  $t_1 = 17^\circ\text{C}$ ,  $t_2 = 90^\circ\text{C}$ ,  $P = 1 \text{ atm}$  was experimentally investigated. It was shown that the bi-componency of phases may lead to a shift of the enrichment maximum beyond the ratio of currents, equal to the value of the distribution coefficient ( $\alpha$ ) of deuterium. The enrichment maximum in the system under study lies in the range 2.8 to 2.9, whereas the highest value (for a cold column) at  $17^\circ\text{C}$  is 2.53. The ratio of the height equivalent to a theoretical plate (HETP) for rectification of water and HETP for the two-temperature exchange was determined and found to be, for the system under study, about 0.4.

CASCADE APPARATUS TO SEPARATE BORON ISOTOPES BY CHEMICAL EXCHANGE USING THE THERMAL PHASE-ROTATION METHOD, Makarov, A. V., et al., 1963. -- In isotope separation single separation coefficients usually are close to unity.

Thus, to obtain a highly concentrated product, "cascade" apparatus consisting of a number of cascades must be constructed. Description is given of a two-stage cascade apparatus consisting of six capped columns which was used in the chemical exchange separation of boron isotopes. The boron isotopes were fractionated between gaseous boron trifluoride and its liquid anisole complex. The cascade may be used for other  $\text{BF}_3$  complexes and in the chemical exchange separation of isotopes of other elements using the thermal phase rotation method.

SEPARATION OF STABLE ISOTOPES BY CHEMICAL AND ION-EXCHANGE METHODS, Panchenkov, G. M., 1963. -- Methods are described for separating stable isotopes by the use of various types of molecular compounds. Isotopes of boron, sulfur and oxygen were separated by this method. Isotopic exchange reactions occurred in the electric discharges. Calculations of single stage separation factors for exchange reactions are given. Potentials of the isotope separation process using ion exchange are discussed. The use of ion exchange for separating lithium isotopes is described. Synthetic zeolites (molecular sieves) were used as ion exchangers. Principles and applications of the continuous countercurrent ion exchange method are outlined.

SOLUTION OF THE EQUATIONS FOR THE OPERATION OF A COUNTER-CURRENT ION-EXCHANGE COLUMN FOR THE CASE OF ISOTOPE SEPARATION, Nikolaev, N. I., 1963. -- The derivation and solution of an equation for the operation of a countercurrent ion exchange column were achieved for stationary state conditions under the assumption of internal diffusion and external diffusion exchange kinetics. Expressions were obtained for the HETP. Satisfactory agreement was found between experimental and theoretical HETP values.

Heavy Water, Deuterium, Tritium, etc.

- Bargaftik, N. B. (1962) - 1 - therm. conduct.,  $D_2O$
- Borodin, P. M. (1963) - 1 - F-19
- Broude, V. L. (1962) - 1 - monodeuterobenzene
- Kotov, Yu. I. (1962) - 1 -  $D_2O$ ,  $N_2D_4$ , Raman and IR spectr.
- Markevich, S. V. (1962) - 1 - alloys, B, Be
- Nakhmanovich, M. L. (1963) - 1 -  $D_2O$ ,  $D_2$ ,  $H_2$  catalyt. exch., met. surf.
- Radich, L. (1962) - 1 - isot. exch., free radicals, org. comp'ds
- Rivkin, L. S. (1963) - 2 -  $D_2O$ , therm. capacity, hi-temp., press.
- Sakodynskii, K. I. (1962) - 1 - D, isot. exch.,  $H_2O$ -thiols
- Sheka, E. F. (1963) - 1 -  $D_2$ , deuterated naphthalenes, spectra
- Sidorov, A. N. (1962) - 1 - isot. exch.,  $H_2O$ -chlorophyll, IR spectra
- Sverdlov, L. M. (1962) - 1 - D, T, isot. polyatom. molecules, unharmonicity constants,  $H_2O$ , org. comps, spect.
- Tupitsyn, I. F. (1961) - 1 - D, T, prep., prop., tracers, indust., med.
- Vaisberg, S. E. (1963) - 1 - D enrich., dual temp. meth., rectific.
- Varshavskii, Ya. M. (1957) - 1 - H exch. in liq. HF,  $BF_3$  catalysis
- Zhavoronkov, N. M. (1958) - 1 - D, rectifying columns

Isotope Separation, Exchange Reactions, etc.

- Amirkhanova, I. B. (1963) - 1 - B-10, B-11,  $\text{BF}_3$ , vap. press.
- Frolov, Y. S. (1962) - 1 - isot. prod., in USSR
- Goshchitskii, B. N. (1962) - 1 - gas. diff., porous media
- Kuznetsov, V. M. (1957) - 1 - He, rectific., thermo osmosis
- Makarov, A. V. (1963) - 1 - B, Chem. exch. cascade
- Nikolaev, N. I. (1963) - 1 - IX, diffus. exch. kinetics
- Oziashvili, E. D. (1962) - 1 - O-18, N-15; NO,  $700^\circ\text{C}$
- \*Panchenkov, G. M. (1957-63) - 9 - Li, B,  $\text{BF}_3$ ; O, S, org. isot. exch., IX, zeolites, molecular sieves
- Sevryugova, N. N. (1959) - 1 - B-10, B-11,  $\text{BCl}_3$  rectific.
- Sinel'nikov, K. O. (1958) - 1 - Hg-198, Hg-204, non-stat. molec. flow
- \*\*\*Spitsyn, V. I. (1955-63) - 24 - O-18, isot. exch.; Tc-99, Pa-231, IX, AV-16, 17, AN-2F, Dowex-1, KU-2; Pa-233,  $\text{MnO}_2$
- Tatevskii, V. M. (1951) - 1 - isot. exch. reactions, calc. of equilib.
- Tikhomirov, I. A. (1962) - 1 - O-18, isot. exch., ozone, Th. decomp.
- Torchenkova, E. A. (1958) - 1 - isot. exch., heteropoly acids
- Uvarov, O. V. (1962) - 1 - O-18,  $\text{H}_2\text{O}$ , physicochem. consts.
- See also Baranov, Bresler, Gonikberg, Kolombirkin, Shushunov, Zhavoronkov.

#### IV. Rare Metals, "Nuclear" Materials, etc.

(from "Atomic Energy in the Communist Bloc," G. A. Modelski, 1959)

A characteristic feature of modern technological development is the growing use of such "rare" metals and elements as zirconium or beryllium. The atomic industry consumes large quantities of these because materials used in reactor construction or fuel element fabrication must have special nuclear characteristics (high or low neutron capture, or capacity to withstand radiation) or else must be able to withstand the high temperatures, stresses and corrosive conditions encountered within the reactor. Commonly used structural materials such as steel lack most of these properties.

Soviet economic planning recognized the crucial role of rare metals in modern industry and their Five Year Plans called for an all-round extension of geological search and for large production increases of all rare metals. Soviet-bloc reserves of these materials are large, both actually and potentially, because the vastness of its territory - much of it not yet surveyed - makes large new finds probable. Most of the new deposits, however, are probably in the relatively undeveloped areas of Soviet Asia, and their exploitation poses many problems. Considerable technological development has been required in the non-ferrous industry, even though much research on methods of making new heat-resistant and other alloys had been in progress for several years. In the Ukraine, in particular, successful work on producing materials capable of withstanding high pressures and temperatures has been undertaken by a number of research organizations. Similar work is also going on in other Soviet-bloc countries. The scope of the work is large, and the sights are set high. A 1956 Pravda article on the significance of rare metals in industry called upon Soviet engineers and technicians to establish the USSR as the world's biggest and most advanced rare metal industry.

A detailed comparison of the availability of nuclear materials in the USA and the USSR is impossible because of the total absence of production or other statistics from the Soviet. In general terms, the mineral resources of the Soviet Union are known to approximate those of the USA, but since, by contrast with the USA, a large part of Soviet territory is still unexplored, the probability of finding rich new deposits is higher in the USSR. In about 1950 it could be said that the Soviet Union, although then well provided with most of the important minerals, was deficient in such materials as uranium, boron, bismuth, cadmium and molybdenum, and had to repair these deficiencies by imports from the satellite area; but by 1955-6 the find of new deposits of uranium, boron, molybdenum, titanium and zirconium had markedly improved the Soviet position. In the next several years Soviet-bloc production and the further search for minerals will continue at a substantial rate, and Soviet resources may soon in certain respects equal US standards and be able to fulfil the demands of the atomic industry.

The production targets contemplated for most of the rare metals important to atomic development make it clear that the Soviet atomic energy program is being supported by a large planned expansion in the output of all

these materials. A broad survey of Soviet resources, is presented in the following discussions:

Cadmium is a material used to regulate the speed of nuclear reactions. The USSR output is small - perhaps in the region of 150 tons a year - and domestic reserves (one-half of which are in Kazakhstan) are considered inadequate for long-term sufficiency. Soviet resources are, however, greatly strengthened by cadmium production in Poland, a large part of which is exported to the USSR. In Poland, output doubled between 1949 and 1955 and by 1959 was the third highest in the world, following the USA and Belgium. East Germany, too, is producing cadmium.

Bismuth is mined in association with uranium (hence presumably the name "Wismut" for the uranium mining organization) in East Germany, and because uranium mining has greatly increased, bismuth production in this area must have increased too. In the USSR proper, bismuth has been mined in the Transbaikal area and in Central Asia. Methods for producing high-purity metallic bismuth for power reactors were described at the Geneva conference, but little is known about Soviet production capacity.

Titanium is useful as a steel alloy and is important as a construction material because of its good nuclear and corrosion properties. Shimkin thought that the development of an important titanium industry in the USSR was not likely due to poor-grade Soviet reserves and absence of East European production; however, steps are being taken to boost it. Judging by past experience in other metals, within a few years an important titanium industry will be operating in the USSR, with supporting industries in the satellites. Known low-grade reserves of Soviet titanium were concentrated in the Urals, but during 1954-5 some of the biggest Soviet deposits were found in Kazakhstan in the Ukraine. Chemically pure titanium has been produced, but the first Soviet titanium section was made at a Moscow rolling mill only in 1956. In the Five Year Plan for 1956-60 output was expected to increase several times. Production was to be developed in particular on the basis that abundant supplies of cheap power would soon become available from the Siberian hydro-electric power developments. In this connection, the prospected reserves of titanium were expected to increase by 40-45 per cent by 1960. Search for rich ores was greatly intensified in the Transbaikal and Pacific areas, and detailed surveys were made in the Ukraine. Other Soviet-bloc countries, too, are producing titanium from their own deposits, and have been actively investigating methods of titanium metallurgy.

Molybdenum is an important element in steel alloys. In the past, Soviet production was small, especially in relation to steel output, and surveyed reserves were considered meagre. During 1956-60 molybdenum output was expected to double, and the prospected reserves were to be increased by 65-70 per cent, by intensified research in Kazakhstan (which has the biggest Soviet deposits), in promising areas of Siberia, where large deposits have been found, in the Far East and in Armenia. Recently molybdenum ores were found in Bulgaria, and they are being sought in other countries. Energetic prospecting and mining throughout the Soviet bloc may alleviate earlier deficiencies.

Sodium in its metallic form, together with bismuth, is one of the two items chiefly used for liquid metal reactor coolants. Little is known about Soviet production, but in Poland the production of metallic sodium started in 1956 at a Soviet-designed plant in Silesia, and part of the output is exported to the USSR.

Lithium is important in electrical engineering and in thermonuclear reactions. Soviet output was unknown in 1959 but was believed to be large because output was expected to rise several times between 1956 and 1960. A large deposit discovered in the Kola Peninsula increased known reserves a thousandfold. Prospecting for lithium was to be greatly intensified in the Transbaikal and Pacific (maritime) areas.

The following abstracts illustrate the continuing studies of lithium (and sodium) by USSR scientists.

DETERMINATION OF THE TOTAL CONTENT OF RARE-EARTH ELEMENTS, AND MANGANESE, NICKEL, COPPER, ANTIMONY, ARSENIC, MOLYBDENUM, CADMIUM AND GOLD IN LITHIUM COMPOUNDS BY THE RADIOACTIVE METHOD, Nagina, V. R., et al., 1961. -- A method was developed for the simultaneous determination of the total rare-earth elements (with respect to  $^{165}\text{Dy}$ ), manganese, nickel, copper, molybdenum, antimony, cadmium, arsenic and gold in lithium salts, using the same sample. The proposed method for separating dysprosium ensures the purification of  $^{165}\text{Dy}$  from foreign radioactive impurities and to some extent from admixtures of the remaining rare-earth radioactive isotopes. This makes it possible to obtain the radioactive  $^{165}\text{Dy}$  with a radiochemical purity exceeding 99%. The total content of rare-earth elements, manganese, nickel, copper, antimony, molybdenum, cadmium, arsenic and gold in samples of lithium nitrate was determined by the radioactivation method.

PURIFICATION OF MOLTEN SODIUM BY CERMET FILTERS, Fedorchenko, I. M., et al., 1961. -- The use of cermet filters affects an improvement in the degree of purification of liquid sodium, and their use permits the development of a convenient and reliable apparatus for this filtration process. Tubular filters of iron, nickel, and titanium permits many advantageous uses as filtering elements. The use of iron, nickel, and stainless steel powder for filtering elements allows the use of welding when installing filters, and simplifies their manufacture and increases operational reliability.

DETERMINATION OF THE SELF-DIFFUSION COEFFICIENT OF LITHIUM ION IN AQUEOUS LiCl SOLUTIONS, Bakulin, E. A., et al., 1962. The coefficient of Li ion diffusion in LiCl solutions at 1.94 up to 11.56 g-equiv/1000 g  $\text{H}_2\text{O}$  was measured by a free diffusion method.

MIGRATION AND MOBILITY OF Li IONS IN AQUEOUS  $\text{LiNO}_3$  SOLUTIONS, Bakulin, E. A., 1962. -- Lithium ion migrations were measured in  $\text{LiNO}_3$  solutions of 6.5 to 22.6 M at 20 to 40°C. Li migration increased with electrolyte concentration. Temperature concentration data are tabulated.

PHOTODISINTEGRATION OF  $\text{Li}^7$ , Kulchitskii, L. A., et al., 1963. -- The energy spectra and angular distributions of protons and tritons produced in the photodisintegration of  $\text{Li}^7$  are investigated. In the energy spectra of phototritons produced at  $E_{\gamma\text{max}} = 30$  Mev, groups are observed that correspond to excitation energies of 14.1, 16.2, 18.0, 19.6, 21.5, 23.5 Mev. In most of the energy ranges the triton angular distributions have the form  $\sim \sin^2$ . Pronounced peaks were also found in the  $\text{Li}^7$  photoproton spectra. However, for  $E_{\gamma\text{max}} = 25$  and 30 Mev the majority of the observed protons correspond to transitions to the excited states of the  $\text{He}^6$  nucleus.

Lithium Chemistry, etc.

- Andreev, G. A. (1961-63) - 2 - oxalate;  $H_2O$ -HDO.
- Bakulin, E. A. (1962) - 2 - Cr,  $NO_3$ .
- Bosik, I. I. (1960-61) - 3 - Be,  $SO_4$ .
- Evseev, A. M. (1959) - 2 - Al, F, vap. press.
- Fedneva, E. M. (1959) - 2 - H, B, F
- \*Klochko, M. A. (1958-60) - 7 - nitrate, acetamide, F, I, hydrazine
- Kolombirlin, V. M. (1962) - 1 - isot. dist. in immisc. solvents
- Krivtsov, N. V. (1963) - 1 - melt diagrams,  $ClO_4$ , Li, Ca, Na
- Kulchitskii, L. A. (1963) - 1 - Li-7 photodisint.
- Malkin, V. I. (1958) - 1 - molten oxides, Li, Na, Si
- Negina, V. R. (1961) - 1 - analyt. n-activ., res, Mn, Au, Cu, Mo, Ni, etc.
- Ravich, M. I. (1963) - 1 - Cl,  $H_2O$ , equilib., 556°
- Volkov, G. I. (1958) - 1 - sol. of carbonate in LiCl sol'ns
- Vol'nov, I. I. (1959) - 2 - superoxide  $Li_2O_2 \cdot 2H_2O_2$ ; also Ca, Sr
- Vorob'eva, O. I. (1958) - 1 - fluoroberyllate, from aq. sol'ns

Sodium Purification

- Fedorchenko, I. M. (1961) - 1 - Na, molten, purification

### Beryllium and Boron

(from "Atomic Energy in the Communist Bloc," G. A. Modelski, 1959)

**Beryllium** is an efficient reactor moderator and fuel casing material. Metallic beryllium has been produced in the USSR since before the war, and methods of manufacturing reactor-grade items of pure beryllium and beryllium oxide by several powder metallurgy techniques have now been devised. The chief known Soviet beryllium sources are in the Urals and the Transbaikal area. There are also big deposits in Kazakhstan. During 1956-60 Soviet beryllium production was expected to increase many times. Prospecting was to be increased in Kazakhstan, in the East Transbaikal and the Pacific (maritime) regions. Outside the USSR, North Korea was believed to be the sole producer of beryllium in 1959.

**Boron** is used in reactor control rods, neutron shields, and also as a rocket fuel. Shimkin (1953) described borax, the source of boron, as a material in which USSR deficiency was moderate to acute. Since then, large deposits have been discovered in Siberia and in the Far East, and Yakutia is also being prospected. By 1960, surveyed reserves of boron materials were to be increased by 40-45 per cent, and prospecting was to be intensified in Kazakhstan and the Pacific areas.

The following abstracts illustrate continuing Soviet studies of beryllium and boron.

COMPARATIVE ASSESSMENT OF METHODS OF PREPARING RADIUM-BERYLLIUM SOURCES, Permiakov, V. M., 1960. -- Four methods are described for the preparation of neutron sources; with the exception of the chemical method (4-6 times less), they give practically the same number of neutrons, converted to 1 g Ra. In the wet method a solution of a radium salt is mixed with a neutral solution of  $\text{BeCl}_2$  and with finely ground metallic Be. The mixture is then treated with a solution of  $\text{NH}_4\text{OH}$  and  $\text{Na}_2\text{SO}_4$ . The  $\text{Be}(\text{OH})_2$  formed is converted to  $\text{BeO}$  by heating at  $300-350^\circ$  in a crucible furnace. The dry method of mixing consists in the preparation of finely ground, dry radium-barium sulphate and careful mixing with finely ground dry metallic beryllium. Other methods are the addition of an aqueous solution of radium-barium bromide to powdered metallic beryllium (wetted with ethyl alcohol) in a platinum dish, and the "briquetting" method (pressure  $300 \text{ kg/cm}^2$ ). Special safety precautions are required if the wet method is used. The dry method is not recommended.

BORON, ITS COMPOUNDS AND ALLOYS, Samsonov, G. V., et al., 1960. -- Chemical and metallurgical studies of boron and its compounds are discussed in this book. Topics covered include: the bases of the geochemistry of boron; boron raw materials and their processing; the production, properties, and uses of elementary boron, boranes, and boron halides; and the properties, methods of production, metallography, and crystallochemistry of alloys of boron with metals and non-metals. A description is given of the known systems in which boron participates. The problems of the use of alloys of boron in the production of heat-resistant alloys are outlined. Radiotechnology, electrotechnology, machine construction, metallurgy, and chemistry are discussed.

THE DETERMINATION OF THE HEAT OF VAPORIZATION OF BORON OXIDE BY A MASS SPECTROMETRIC METHOD, Nikitin, O. T., et al., 1962. -- In determining the heat of vaporization ( $\Delta H_T$ ) of  $B_2O_3$ , special precautions must be taken to avoid reaction of  $B_2O_3$  with traces of water vapor. The  $B_2O_3$  charge was outgassed in vacuum for 1 to 3 hours at a temperature of  $1200^\circ C$ . The evaporation of the boron oxide was carried out from a molybdenum effusion chamber. The ion source of a mass spectrometer was placed in the effusion chamber, and the  $B_2O_3$  was subjected to additional dehydration at  $1100^\circ C$  directly in the mass spectrometer. The ion current of  $B_2O_3^+$  ion was determined as a function of the temperature of the effusion chamber in order to obtain the heat of vaporization. The vapor pressure of  $B_2O_3$  is given by the following equation:  $1 \text{ g Pa}_{\text{atm}} = (7.44 \pm 0.16) - (84,500/4.576 T)$ . The heat of vaporization  $\Delta H_T (B_2O_3) = 84.5 \pm 0.5 \text{ kcal/mol}$  in the interval of temperatures from 1315 to  $1529^\circ K$ .

SOLUBILITY OF ADMIXTURES IN BERYLLIUM, Amonenko, V. M., et al., 1962. -- Thermal expansion of pure Be with small admixtures of C and O was analyzed at up to  $1200^\circ C$ . The c/a ratio for 99.98% purity is 1.547 and for 99% it is 1.567. The maximum solubility of diffused admixtures is 1.0 to 1.5%

X-RAY STUDY OF SOLUBILITY OF IMPURITIES IN BERYLLIUM, Amonenko, V. M., et al., 1962. -- The solubility of Ti, Zr, Y, and Ni in Be was studied by x-ray structural analysis of tempered samples. It was found that at room temperature only Ni has an appreciable solubility in Be. For a range of values of crystalline lattice parameters of Be saturated with gases by high-temperature exposure to air, and Be highly purified by distillation in vacuum, the saturation solubility of N and O was 2 to 3% at  $900^\circ C$ . Solid solution gases are not fixed in Be tempered at room temperature. It is indicated that Ni lowers the solubility of O and N in Be at high temperatures.

BERYLLIUM OXYBENZOATE COMPOUNDS WITH AROMATIC HYDROCARBONS, Kurdyumov, G. M., et al., 1962. -- Preparations and properties of equilibrium compounds of  $Be_4O(C_6H_5COO)_6 \cdot 3x$ -liquid hydrocarbon and  $Be_4O(C_6H_5COO)_6 \cdot 3x$ -gaseous hydrocarbon (where x is benzene, toluene, or styrene) were studied, and the heats of dissociation of respective inclusions in these compounds were determined.

ON BROMINE AND IODINE BERYLLIUM COMPLEXES WITH SIMPLE ETHERS, Turova, N. Ya., et al., 1963. -- Properties of complex compounds of beryllium bromides and iodides with aliphatic, tetrahydrofuran, and dioxane ethers were studied and their melting points found.

EXTERNAL PHOTOEFFECTS AND SECONDARY ELECTRON EMISSION OF BERYLLIUM OXIDE COATING ON BERYLLIUM BRONZE, Tyutikov, A. M., 1963. -- Spectral characteristics of the external photo effects on a beryllium oxide coating on various beryllium bronze preparations are described. Effects of beryllium and oxygen on the secondary electron emissions from beryllium bronze were analyzed, and the lack of correlation between the concentration of admixtures in the emitter and the maximum electron emission coefficient was noted.

Beryllium Chemistry, Metallurgy, etc.

- Amonenko, V. M. (1962) - 3 - cryst., solid state
- Beus, A. A. (1963) - 1 - raw mats.
- Belyaev, R. A. (1962) - 1 - oxide
- Bobovich, Ya. S. (1962) - 1 - aq. chem.
- Govorov, I. N. (1963) - 1 - alk. metasomatose
- Grigor'ev, A. I. (1958-60) - 3 - oxyacetates, amines
- Kalinchenko, L. P. (1962) - 1 - analyt.
- Khandamirova, N. E. (1959) - 1 -  $\text{BeF}_3$  vap. press.
- Korenev, Yu. M. (1962) - 1 -  $\text{BeF}_3$ , rhomb. modif.
- Kurdyumov, G. M. (1962) - 1 - oxybenzoate, aromatic hydrocarbons
- Permiakov, V. M. (1960) - 1 - Ra, Ba, O,  $\text{SO}_4$ , prep. of Ra-Be n-sources
- \*Semenenko, K. N. (1959-61) - 5 - acetates, benzoates, oxide,  $\text{LiAlH}_4$
- \*Turova, N. Ya. (1959-63) - 6 - complex comp'ds, ethers, alcs.
- Tyutikov, A. M. (1963) - 2 - BeO coat. in Be-bronze, sec. electron emiss.
- See also Alimarin.

Boron Chemistry, Production, etc.

- Khachishvili, V. I. (1961) - 1 -  $\text{BF}_3$  reduct. to B by Na
- Nikitin, O. T. (1961-62) - 2 - Be, ht. of vapor., vapor comp., mass spec.
- Nikitina, E. A. (1958) - 1 - W, Cu,  $\text{H}_2\text{O}$
- Ryss, I. G. (1959-60) - 4 -  $\text{BF}_3$ , aniline, amines
- Vinnik, M. I. (1956) - 1 -  $\text{BF}_3$ , therm. decomp. of  $\text{KBF}_3$ ,  $\text{BaCl}_2$  pres.

Graphite, Carbides, Nitrides, etc.

(from "Atomic Energy in the Communist Bloc," G. A. Modelski, 1959)

Graphite is an excellent moderator and reflector for nuclear reactors. In the USA nuclear graphite is made from petroleum coke. Little is known about the Soviet graphite industry, except that before the war synthetic-graphite production was low, and that the USSR is one of the largest producers of natural graphite. The first Soviet reactor was moderated by 100 tons of graphite blocks, and a Soviet author states that this was supplied by a new Soviet 'industry'. Work to produce nuclear graphite on an industrial scale was started in Poland. Experiments and development work on nuclear graphite have also been conducted in Czechoslovakia and in East Germany.

The following abstracts illustrate some recent studies related to graphite, carbides, and various refractory compounds of probable interest in nuclear fuel research.

THE ELECTRICAL RESISTANCE OF POLYCRYSTALLINE GRAPHITE AS A FUNCTION OF TEMPERATURE AT PRESSURES UP TO 250,000 KG/CM<sup>2</sup>, Semerchan, A. A., et al., 1962. -- The initial sample consisted of spectrographically pure, polycrystalline graphite having a specific electrical resistance  $\rho = 26 \times 10^{-4}$  ohm-cm. The sample was heated with direct current, and voltage and current readings were taken at a fixed pressure value. The temperature of the sample was directly proportional to the power expended in the sample. Since the linear dimensions of the sample do not change with pressure from ~30,000 kg/cm<sup>2</sup> (except for a very small amount of compression), the change in the electrical resistance of the graphite sample is directly proportional to the change in the specific electrical resistance of the graphite. The electrical resistance of graphite at a definite pressure decreases with increasing temperature. At any definite temperature, the electrical resistance of graphite decreases with increasing pressure. The electrical resistance of graphite was investigated over a temperature range of 20 to 200°C.

VANADIUM AND NIOBIUM CARBIDES IN STEEL, Belyakov, A. M., et al., 1962. -- During thermal treatment of niobium steel (1.35 to 1.50% Nb, 0.67 to 0.70% C) at 650 to 1300°C and annealing and tempering of vanadium steel (0.97% V and 0.71% C) the content of carbon bonded, VC<sub>1-x</sub> and NbC<sub>1-x</sub>, remained unchanged.

PHYSICAL PROPERTIES OF METAL-CERAMIC SPECIMENS OF HfC, Paderno, V. N., 1962. -- Physical properties of HfC powders of 93.68% Hf with 6.3% C (bonded) and 0.02 C (free) sintered at 2900 to 3000°C and 180 kg/mm<sup>2</sup> pressure were studied. Comparisons were made with Ti and Zr carbides.

KINETICS OF NIOBIUM CARBIDES AND NIOBIUM OXIDES REACTION IN A VACUUM, Shveikin, G. P., et al., 1963. -- Kinetic characteristics of niobium oxide and carbide reactions ( $\text{NbC} + 2\text{NbO}_2 = 3\text{NbO} + \text{CO}$ ,  $\text{Nb}_2\text{C} + \text{NbO} = 3\text{Nb} + \text{CO}$ , and  $5\text{NbC} + \text{NbO}_2 = 3\text{Nb}_2\text{C} + 2\text{CO}$  at 1400 to 1700°C) showed that the rate of the process is a function of the size of components, compression, and gas evacuation rate. Kinetic difficulties were encountered during metallic niobium formation. Sintering and gas evacuation play an important part along with the diffusion process.

VELOCITY AND PRODUCTS OF THORIUM CARBIDE THERMOCATHODE EVAPORATION, Mikhailovskii, B. I., et al., 1963. -- Contact potential and mass spectrometric analysis indicate that the  $\text{ThC}_2$  evaporation rate is subordinate to the formula  $N = Ae^{-Q/kT}$  at cathode temperatures from 1800 to 2050°K. Thermal dissociation of  $\text{ThC}_2$  molecules was not observed at  $A = 5.4 \times 10^{25}$  mol/cm<sup>2</sup>sec =  $2.3 \times 10^4$  g/cm<sup>2</sup>sec and  $Q = 4.8$  ev.

INVESTIGATION OF CONDITIONS FOR PREPARING NIOBIUM CARBIDE, Paderno, V. N., et al., 1963. -- Conditions for the formation of niobium carbide by the reduction of niobium pentoxide with soot in a hydrogen atmosphere and in a vacuum were investigated. The optimal conditions for obtaining niobium carbide were: heating a charge containing 97% of the calculated quantity of soot at 1700°C for one hour; and heating a stoichiometric charge twice at 1700°C in vacuum for one hour with intermediate grinding and screen-sizing of the product. The maximum bound carbon content in the resulting carbide samples corresponds to the formula  $\text{NbC}_{0.98}$ .

RATE OF EVAPORATION AND VAPOR PRESSURE OF CARBIDES, SILICIDES, NITRIDES, AND BORIDES, Fesenko, V. V., et al., 1963. -- The results of investigations by Langmuir's method on the rate of evaporation and the vapor pressure of carbides, borides, silicides, and nitrides are presented. It was noted that all the refractory compounds investigated were dissociated on heating in vacuum and the pressure of the vapor over the compounds was determined by both the metal vapor and the metalloid vapor pressure. It was found that for a metal the rate of evaporation increases as a rule from carbides to borides, silicides, and nitrides.

Carbides (or Nitrides), Refractory Materials, etc.

- Avarbe, R. G. (1962) - 1 - alloys, C, Hf, phase diag.
- Baskin, M. L. (1962) - 1 - W, Ta, Ti
- Belyakov, A. M. (1962) - 1 - V, Nb, steel
- Bittner, H. (1962) - 1 - Ti, Zr, Hf, V, Nb, Ta
- Bondarenko, B. V. (1962) - 1 - groups IV, V
- Fesenko, V. V. (1963) - 1 - borides, silicides, nitrides
- Gorelik, S. S. (1962) - 1 - Ti, W; borides, Ti, Zr, Mo
- Kornilov, A. N. (1962) - 1 - Nb, Ta
- Kotlyar, E. E. (1963) - 1 - Nb, Analyt.
- Kugai, L. N. (1962) - 1 - Mo, nitrides, borides, silicides, analyt.
- Kul'varskaya, B. S. (1963) - 1 - U, Zr, sol. sol'ns
- Kurnakov, N. N. (1961) - 1 - C-Ti, up to 5% C
- Lvov, S. N. (1962) - 1 - trans. met., refract. comp'ds
- Mikhailovskii, B. I. (1963) - 1 - Th, evap., therm. dissoc.
- Muratov, F. Sh. (1961) - 1 - alloys, Be-C in Cu-Be
- Nazarchuk, T. N. (1959) - 1 - B, chem. stab.
- Paderno, V. N. (1962-63) - 2 - Nb, Hf
- Popova, O. I. (1960) - 1 - (nitrides), Zr, Nb, Ta, Ti
- Rudenko, V. N. (1961) - 1 - Si, Cr, hi temp. cermets
- Semerchan, A. A. (1962) - 1 - (graphite), polycryst. elect. resist., hi-  
press., temp.
- Shveikin, G. P. (1963) - 1 - Nb, oxides, kinetics, etc.
- Zhelankin, V. I. (1958-62) - 1 - Zr, Hf, H-red. of oxides

### Zirconium and Niobium

(from "Atomic Energy in the Communist Bloc," G. A. Modelski, 1959)

Niobium, usually found together with tantalum, is needed in reactor fuel element manufacture and as an alloy in stainless steels, to be used at high pressures and temperatures. Tantalum is used for high-temperature fuel elements. Soviet laboratory experiments on niobium and tantalum began before World War II, for the USSR is well-provided with these metals, the chief deposits being in the Kola Peninsula (northern areas), and in the Urals. Some of the biggest deposits are also found in Kazakhstan. Under the 1956-60 Five Year Plan niobium and tantalum production was expected to increase many times. Prospected reserves are to be raised by 50-55 per cent, chiefly by extensive prospecting in Kazakhstan and the East Transbaikal and Pacific areas. Poland, too, is engaged in extracting niobium from poly-metallic ores and scrap.

Zirconium is a valuable material in electronics and the fabrication of reactor fuel elements. Since the war zirconium has been produced in the USSR chiefly in the Ukraine near Zhdanov, in the Azov Sea area, but the size of production and state of technology are unknown. A number of methods for producing hafnium-free zirconium have been devised since 1950. In the 1956-60 period zirconium production was to be greatly increased, and much work directed to improving the refining of the metal. In 1954-5 large zirconium deposits were found in the Ukraine, and are being prospected in detail. Other finds have been reported from north Kazakhstan and from Romania.

The following abstracts illustrate recent USSR efforts in connection with zirconium and niobium.

THE PRODUCTION OF ZIRCONIUM, Safronov, Ye. K., et al., 1956. -- Referring several times to the importance of zirconium in nuclear energy technology, the authors list data on its neutron absorption cross-section and review its anticorrosion properties and physical and chemical behavior in general. They then discuss in considerable detail the methods for the production of zirconium, the separation of zirconium from hafnium (pointing out that zirconium cannot be used at nuclear energy installations unless it is free of hafnium), and applications of zirconium other than those in nuclear energy work (e.g., the use of  $ZrO_2$  as a refractory material). USSR work on the removal of hafnium from zirconium by the fractional crystallization on an industrial scale of potassium fluorozirconate containing potassium fluorohafniate is described.

CORRECTED  $L_{\beta_2}$  EMISSION BAND OF NIOBIUM AND THE BINDING FORCES IN THE NIOBIUM-NITROGEN SYSTEM, Korsunskii, M. I., et al., 1962. -- Corrected  $L_{\beta_2}$  emission bands of niobium in the niobium-nitrogen system made it possible to ascertain the nature of the interatomic binding precisely together with electric and magnetic measurements. The  $L_{\beta_2}$  emission bands of niobium in compounds of niobium with nitrogen consist of two parts, corresponding to collectivized and bound electrons. It is shown that in compounds of niobium with nitrogen in concentrations of 6.32, 6.8, 8.1, 11.9, and 13% by weight of nitrogen the concentration of the collectivized electrons is considerably

less than in niobium. In these compounds electrons occupy less than half of the Brillouin zone, which results in the primarily electronic nature of conductance in the compounds. The share of the covalent and metallic binding in niobium nitrides is lowered in comparison with pure solid niobium.

DEFORMATION TEXTURES IN ROLLED NIOBIUM, Lainer, D. I., *et al.*, 1962. -- Preliminary technological treatment did not affect the deformation texture, but a final rolling gave some improvement. Admixtures of O, N, and C did not interfere with the fine rolling structure. The deformation axes in rolled Nb are  $(112)\overline{[110]} + (100)\overline{[110]}$ .

ELECTROCONDUCTIVITY OF BINARY OXIDES WITH  $Nb_2O_5$ , Manakov, A. I., *et al.*, 1962. -- Electric conductivity of  $K_2O-Nb_2O_5$ ,  $Li_2O-Nb_2O_5$ ,  $CaO-Nb_2O_5$ ,  $Al_2O_3-Nb_2O_5$ ,  $Fe_2O_3-Nb_2O_5$  and  $V_2O_5$  systems at 0 to 50 mole % and 700 to 1600°C was studied. Electric conductivity polytherms of liquidus and solidus phases were evaluated and constitution diagrams were constructed. All compositions of  $Fe_2O_3-Nb_2O_5$  and  $U_2O_5-Nb_2O_5$  retain their conductivity, while in the other compounds, with increased  $Me_2O_p$  the conductivity becomes ionic.

EXTRACTION OF ZIRCONIUM IN THE PRESENCE OF HYDROFLUORIC ACID, Korovin, S. S., *et al.*, 1962. -- The extraction of zirconium (0.54 moles/liter) from nitrous solutions (6 moles/liter) in the presence of HF was studied. A 50% solution of tributyl phosphate in o-xylene was used. Results: (1) Up to the ratio F:Zr = 0.5:1, the distribution coefficient  $\alpha_{Zr}$  increases to 0.92. (2) At 1:1, the distribution coefficient corresponds to that of the extraction from solutions free of fluorine. (3) At 3:1, the distribution coefficient decreases to the constant value 0.04. As the extraction rose when the F ion concentration dropped it is supposed that some mixed zirconium nitrate-fluoride complexes may be extractable also. Optimum extraction occurs when the complex contains one F ion.

EXTRACTION OF ZIRCONIUM AND HAFNIUM WITH TRIBUTYLPHOSPHATE, Korovin, S. S., *et al.*, 1962. -- The object of the work was to investigate distribution of Zr and Hf between nitric acid solutions and tributylphosphate (TBP). A 50% solution of TBP in o-xylene saturated with nitric acid was used as the extractant. Nitric acid concentration in the metal solutions was 6 mole/liter. Distribution of Zr and Hf was studied for the solutions containing 2.4, 16.2, 50.0, 70.0, 95.8 and 100% Hf. It was established that the behaviour of Zr and Hf is interconnected during the extraction but the influence of Zr on the extraction of Hf is more marked than the reverse influence. When a solution contains a predominant quantity of one of the metals, the extraction of the other metal is retarded. The maximum distribution coefficients (20.9) were obtained for the solutions containing the smallest quantity of Hf (2.4%  $HfO_2$ ). The coefficient decreases with the increasing concentration of Hf. When the concentration of the metals in the solution increases, the distribution coefficient increases and then decreases; thus, for Hf concentration of 50%, the coefficients are 5.8, 18.5 and 15.8 for the summed concentrations of the oxides in the solutions of 14.5, 73.6 and 92.1 g/liter, respectively. It is concluded that the method can be used not only for the purification of Zr from Hf but also for the preparation of pure Hf.

MATHEMATICAL METHODS IN ORGANIZING EXPERIMENT STUDYING ZIRCONIUM EXTRACTION MECHANISMS, Komissarova, L. N., et al., 1963. -- Mathematical statistics were used to verify three competing equations suggested a priori for describing the process of zirconium extraction from nitric acid solutions by tributylphosphate.

DETERMINATION OF OPTIMUM CONDITIONS IN THE EXTRACTION OF MICROQUANTITIES OF Hf WITH TRIBUTYL PHOSPHATE, Komissarova, L. N., et al., 1963. -- The distribution coefficient for Hf extraction from nitric acid solutions by TBP was increased by an order of 4 in tests using a sharp ascension method.

Zirconium Chemistry, Metallurgy, etc.

- Deich, A. Ya. (1961) - 1 - org. acids
- Grizik, A. A. (1961-62) - 3 - Hf, Li, K
- Khalezova, E. G. (1963) - 1 - Hf, oxides, Zr/Hf ratio in zircons
- Kirakosyan, A. K. (1959-61) - 3 - complexes, IX, Cu
- \*Komissarova, L. N. (1956-63) - 6 - Hf, comp'ds, TBP ext'n
- Korovin, S. S. (1960-62) - 4 - Hf, ext'n, TBP
- Nabivanets, B. I. (1961) - 2 - electromigr.,  $\text{ClO}_4$ , Cl,  $\text{NO}_3$ ,  $\text{SO}_4$
- Plotnikov, V. A. (1946) - 1 - fused salts, F, Cl, electrolyt. sep'n proc.
- Safronov, Ye. K. (1956) - 1 - production, Hf-free, fract. cryst. of fluorides,  
rev. of prop.
- Shatskii, V. M. (1962) - 1 - Hf, Sc, oxalate
- \*Sheka, I. A. (1957-62) - 8 - Hf, Cl, O, OH,  $\text{NO}_3$ , TBP, adsorp.
- Sheronov, L. N. (1959) - 1 - citrate complex
- Sinel'nikov, K. D. (1958) - 1 - purification, iodide method
- Solov'ev, A. S. (1962) - 1 - salts, complex comp'ds
- Stepanova, G. I. (1957) - 1 - refining,  $\text{ZrI}_4$  meth.
- Sukharevskii, B. Ya. (1962) - 1 - refract.  $\text{ZrO}_2$ ,  $1155^\circ\text{C}$ , polymorph. tranf.
- Sviridova, A. I. (1962) - 2 -  $\text{ZrO}_2$  films, opt. properties, temp. treat.,;  
 $\text{ZrCl}_2$ ,  $\text{ThCl}_4$
- Tikhomirov, V. I. (1962) - 1 - peroxides,  $\text{SO}_4$
- Trofimov, A. M. (1959) - 1 - ionic charge, IX meth.
- Tsirel'nikov, V. I. (1962) - 1 - Hf, decomp. of halides to met. on Mo foil,  
hi temp
- Yagodin, G. A. (1958-62) - 3 - Hf, Cl, F, therm. stab., ext'n, TOA
- Yelinson, S. V. (1962) - 1 - analyt., ores, minerals
- Yemel'yanov, V. S. (1962) - 1 - Hf; plastic Hf, iodide method,  $1350^\circ\text{C}$

Zirconium Chemistry, Metallurgy, etc., continued

Zaitsev, L. M. (1958-62) - 2 - complex comp'ds, orgs.

Zvara, I. (1962-63) - 2 - Hf, Nb, Ta, Zr-97, chlorides, KCl reacts., gas phase

See also Astanina, Babko, Balashova, Delimarskiy, Emel'yanov, Gusyatskaya, Kryuger, Marov, Morosov, Patsek, Resnik, Ruzinov, Ryabchikov, Starik, Tananayev, Vainshtein.

Niobium Chemistry, Metallurgy, etc.

Chizhikov, D. M. (1959) - 2 - iodides, purif.

Korsunskii, M. I. (1962-63) - 2 - emission spect., N

Lainer, D. I. (1962) - 2 - met., rolled

Manakov, A. I. (1962) - 2 - molten oxides, K, Li, Ca, Al, Fe, V

Polyakov, Ya. M. (1963) - 1 - Ta, H-reduct. of fluorides, 700-2000°K

Seifer, G. B. (1963) - 1 - Ta, orthophosphates

Shemyakina, T. S. (1962) - 1 - oxytrichloride, alk. halides

Solov'ev, S. I. (1958) - 1 - V, HCl sol'n

\*Vlasov, L. G. (1961-62) - 2 - oxalates, K metaniobate

See also Balashova, Gel'd, Goroshenko, Starik, Troitskiy.

Rare Earth Chemistry, Geology, etc.

- Aksel'rud, N. V. (1960-63) - 8 - hydroxides, chlorides, hydroxychlorides
- Alekseenko, L.A. (1959) - 1 - sulfates, H<sub>2</sub>O of cryst.
- Ambrezhii, M. N. (1958) - 2 - Ce, formates, citrates
- Babayan, S. G. (1961-62) - 3 - co-precip. and co-cryst.
- Balashov, Yu. A. (1963) - 1 - regular distrib. in earth's crust
- Batsanova, L. R. (1963) - 1 - IR spectra
- Batyaev, I. M. (1961) - 2 - org. complexes
- Bykhovskii, D. N. (1960-61) - 2 - Ce, co-ppt'n with U and Th oxalates
- Chechernikov, V. I. (1962-63) - 3 - Sc, ferrates, properties
- Chupakhina, R. A. (1961-62) - 2 - amines, cyanoargentates
- Chuveleva, E. A. (1962) - 1 - chromat., sep'n
- Dain, B. Ya. (1949) - 1 - Ce(IV), photored.
- Davidenko, N. K. (1959-62) - 2 - org. complexes
- Dodonov, Ya. Ya. (1949-56) - 2 - camphorates
- Drokin, A. I. (1962) - 1 - ferrites, cryst. str.
- Ivanov-Emin, B. N. (1960-61) - 2 - Yb, Lu, Y, hydroxides
- Iveronova, V. I. (1951-55) - 2 - struct. of comp'ds
- Kamenev, A. I. (1961) - 1 - lactic acid
- Karapetyan, V. E. (1963) - 1 - Sm, luminesc. and ads.
- Karelin, V. V. (1962) - 1 - metall. Y, vap. pr.
- Khomyakov, A. P. (1963) - 1 - mineral compos.
- Konenko, L. I. (1962) - 1 - phenanthroline compl.
- Korenman, I. M. (1954-55) - 2 - oxalates, sulfates, hydrox.
- Korpusov, G. V. (1961-62) - 4 - TBP ext'n, sep'n Sr
- Kuz'menko, A. A. (1958) - 1 - hexamethylene-DTA
- Makarov, S. Z. (1962) - 1 - Ce, perox., activ. oxygen

Rare Earth Chemistry, Geology, etc.

Malyarov, K. L. (1961) - 1 - cit. and tart. complexes

Makarenaya, A. A. (1962) - 1 - U, Th, Be, W, Mo, Ru, etc., conference

Martynenko, L. I. (1959-61) - 3 - TBP, EDTA

Medoks, G. V. (1950-56) - 2 - double salts, phenylbenzylphosphonium nit.

\*Mironov, N. N. (1957-61) - 6 - La, Cl, OH, Cl, SO<sub>4</sub>

Mitrofanova, N. D. (1958) - 1 - EDTA

Musayev, Sh. A. (1962) - 1 - Y, La, iodates, ppt'n

Panova, M. G. (1960-61) - 4 - yttrium

Pashinkin, A. S. (1962) - 1 - Y, Sm, Cl, vap. press.

Patrusheva, Ye. N. (1960) - 1 - ext'n, diamyl phosphoric acid

Plyushchev, V. E. (1962-63) - 3 - perrhenates; Cs, org.; Zr, Li, O

Pominov, I. S. (1957) - 1 - Nd, solvolysis, alc.-H<sub>2</sub>O

Popov, N. P. (1960) - 1 - analyt., raw mats., book

Pyatenko, Yu. A. (1962) - 1 - Na, Ca, F, gagarinite, struct.

Sakharova, N. N. (1957-58) - 2 - complexes, thiourea, Cl, trimethylamine chloride

Savits'kaya, Ya. S. (1962) - 1 - oxalates, Sc, therm. decomp.

Serebrennikov, V. V. (1958-59) - 3 - actinide chemistry (book)

Shevtsova, Z. N. (1962) - 1 - Pr, ores, fused salts, Cl, alk. met.

Shvei, I. V. (1962) - 1 - geology, properties, etc., book

Stepanov, A. V. (1959) - 2 - lanthanides, citrate complex

Terent'eva, E. A. (1957) - 1 - complex comp'ds, org. and inorg. reags.

Trofimov, A. K. (1957-62) - 2 - zircons, diff. into crystals, luminesc. spect.

Ulianov, A. I. (1962-63) - 2 - Ce, SO<sub>4</sub>, PO<sub>4</sub>, ppt's, highly insol.

Vagina, N. S. (1957-61) - 4 - complex comp'ds, acetate, oxalate, F

Vasilenko, N. A. (1957) - 1 - PO<sub>4</sub>, sep'n from Khibinsk apatite

Vasil'ev, G. I. (1961) - 1 - Y, arsenites

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Virts, G. (1954) - 1 - doub. Mg nitrates, fract. cryst.

Voronkov, A. A. (1962) - 1 - geol., gagarinite,  $\text{Na}_2\text{Ca}_2(\text{RE})_3\text{F}_{15}$

Yeremin, G. K. (1961) - 1 - ext'n by alkyl phosphates

Zaozerskii, I. N. (1956) - 1 - sep'n methods

Zvereva, N. P. (1957) - 1 - sulfide, LaS, 2100°C

See also Babko, Balashova, Bondareva, Erzhabek, Goniksberg, Grebenshikova, Hojman, Kirgintsev, Kuznetsov, Kriss, Kryuger, Makarov, Mikhaylov, Mirgalovskaya, Onosova, Pasternak, Peshkova, Pozdnyakov, Preobrazhenski, Razbitnaya, Rotshtein, Ryabchikov, Samsonov, Sedletskiy, Shvedov, Sinitsyna, Sklyarenko, Stary, Tunitskiy, Vainshtein, Zverev.

## V. Fuel Elements, Metallurgy, Alloys, Etc.

Work in these areas is probably active in many institutes within the Communist Bloc. Four of these can be described briefly:

The Institute of Atomic Energy imeni I. V. Kurchatov has presumably developed the fuels for many of the Soviet reactors, but it does not itself manufacture fuel elements in quantity. This institute was originally called the Laboratory of Measuring Instruments. After 1953, it was renamed the Moscow Physical Institute. It next became known as the Institute of Atomic Energy and was headed by Academician I. V. Kurchatov. Upon his death, the Institute was given his name.

Soviet thermonuclear research had its beginning here, and much of the Soviet work in the field is still centered at this institute, which has the Ogra and Orekh plasma installations. The IRT-1000 nuclear reactor is also located here; it has enabled the Institute to undertake projects such as studies of the effects of radiation on materials and the development of radiation shielding for the atomic icebreaker Lenin. The Institute assisted in the design and construction of the nuclear reactor for the Georgian S.S.R. and the atomic power plant for Czechoslovakia.

The Institute of Metallurgy imeni A. A. Baykov, also in Moscow, is quite active in the field of rare metals and alloys. The scientific staff of the Baykov Institute, numbering approximately 1,100, has broad metallurgical interests. In the tradition of I. P. Bardin, its late Director, the Institute is oriented toward industrial research, but there is also a strong emphasis on theoretical research. The research activity of its 20 laboratories includes:

- (1) Investigations in the field of the physics of metals and alloys
  - (a) Plastic deformation
  - (b) Mechanical working
  - (c) Phase diagrams, particularly of rare-metal systems
  - (d) Nickel-base and high-temperature alloys
  - (e) Titanium alloys
  - (f) Refractory metals
- (2) Determination of physical-chemical constants of metals, their alloys, and compounds
  - (a) Corrosion resistance
  - (b) Physical properties
  - (c) Super-strong metals (whiskers and metal foil)
- (3) Theories of metallurgical processes, including development of new processes
  - (a) Powder metallurgy
  - (b) Steelmaking
  - (c) Ultrasonic and electric-arc welding, and the development of welding equipment
  - (d) Drawing of glass-insulated, iron microgage wire
  - (e) Extractive metallurgy, particularly of pure metals

- (4) New methods of investigation and the development of new apparatus
- (a) Ultrasonic apparatus for quality control of production
  - (b) Electron microscopy
  - (c) Spectroscopy.

The Krasnoyarsk Institute of Non-Ferrous Metals imeni M. I. Kalinin. Until 1959, this institute was situated in Moscow and was known as the Moscow Institute of Nonferrous Metals and Gold imeni M. I. Kalinin. Currently, it operates a branch in the city of Noril'sk.

For an educational institution, this institute conducts an unusually large amount of research. Its staff has investigated aluminum, magnesium, and titanium alloys, thin ferromagnetic films, welding-electrode alloys, electrolytic refining of light alloys, high purity lead, high-purity aluminum (99.99999 per cent), the automation of zinc production, molybdenum disulfide, purification of thallium, thermoelectric properties, carbothermic reduction of refractory oxides, die design, pressure forming of metals, electrodeposition of metals, powder metallurgy, separation of rare-earth metals, semi-conductors, wire drawing, metal rolling and the chlorination of metals.

In 1957-1958, while the Institute was still in Moscow, an Experimental Laboratory of Pure Metals, Metallic Compounds, and Semi-conductor Materials was founded. The Laboratory is equipped with vacuum, induction, and arc furnaces, installations for monocrystal pulling, electron-optical equipment, X-ray and radiographic spectral equipment, and equipment for zone melting and the study of electrical resistance. It has studied the extraction of metal compounds with organic solvents, fractional distillation of volatile metals, and the technology of preparing pure germanium.

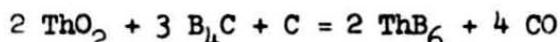
The Ural Polytechnic Institute imeni S. M. Kirov, located in Sverdlovsk, was founded in 1926. Then known as the Sverdlovsk Industrial Institute, its name was changed to the present one in 1948.

The Institute is particularly strong in both ferrous and nonferrous metallurgical research, cooperating greatly with the industries of the Ural region.

The Physical-Mathematical Faculty has a 15-mev betatron. Studies of radiation effects on living organisms, on semiconductors, and on new medicines have been conducted. A 27-mev (alpha-particle energy) cyclotron is used for studies in radiobiology, radiation chemistry, solid-state physics, and neutron dosimetry. An EM-3 electron microscope is used to investigate ferrites, crystal growth, structure of copper and nickel sulfide films, etc. Research in plasma physics is being conducted. In addition, it has developed new extracting methods for noble metals and rare and dispersed metals. It has studied vacuum-metallurgy procedures for the production of vanadium and columbium.

The following abstracts will help to illustrate the nature of Soviet work in the fields of metallurgy, alloys, ceramics, fuel elements, etc.

PREPARATION AND SOME PROPERTIES OF THORIUM HEXABORIDE, Samsonov, G. V., et al., 1956. -- Thorium hexaboride was prepared by heating a mixture of thorium, boron carbide, and carbon black in a vacuum. The reaction took place in accordance with the equation



The properties of thorium hexaboride were investigated and correlated with the structure of the electron levels of thorium. The conclusion was drawn that the physical properties of the borides of other actinides must be similar because of the absence of a deep 5 f-electron level in other actinides as well as in thorium.

PROBLEMS ON THE THEORY OF THE PROCESS OF PRESSING METAL POWDERS AND THEIR MIXTURES, Zhdanovich, G. M., 1960. -- A method of mathematical analysis of the main quantitative aspects of compaction of metal powders and their mixtures is presented. The theory is based on a method of determining the mathematical criterion of the effective hardening of an arbitrary massive metal model. Experiments were carried out that confirmed the accuracy of the formulas derived.

INTERNAL FRICTION OF URANIUM, Dashkovskiy, A. I., et al., 1960. -- The internal friction and, thus, the modulus of rigidity of uranium as dependent on temperature was measured by means of a relaxator which recorded the damping of the free torsional oscillations of a sample. A uranium wire of a length of 320 mm (diameter 0.98 mm) and a purity of 99.9% was used as a sample. The frequency of oscillations of the wire in a vacuum of  $5 \times 10^{-5}$  torr was  $\sim 2$ /sec. The rate of heating or cooling varied in the range 5 to  $0.5^\circ\text{C}/\text{min}$ . The accuracy of temperature measurement was  $\pm 1.5^\circ\text{C}$ . According to the three phases of uranium, the samples were annealed at 630, 645, 670, 720, 755, 768, 850, and  $960^\circ\text{C}$ . The course of the measured parameters is represented for the various temperatures in five figures. The results of measurement lead to the following conclusions: (1) The bend in the internal friction curve in the temperature range  $450\text{--}500^\circ\text{C}$  is caused by the tenacity of the grain boundaries. This tenacity disappears after annealing in the  $\beta$ - and  $\gamma$ -phases. This is the result of the recrystallization of phases due to lower mobility of the boundaries. (2) In temperature changes, the polymorphous transformations of uranium are accompanied by an isothermal change in internal friction. The changes take place during heating as well as during cooling in both direction. (3) The most plastic  $\gamma$ -domain, which has a body-centered cubic lattice, is characterized by a high internal friction. The tetragonal  $\beta$ -modification which tends to brittleness, has the lowest internal friction. It is generally true that the internal friction is related directly to the crystal lattice and to its capability of plastic deformation.

REACTION OF METALLIC URANIUM WITH CARBON DIOXIDE, Bessonov, A. F., et al., 1961. -- Data are reported from a study of the kinetics of the reaction of metallic uranium with carbon dioxide, which is of extreme practical and theoretical interest in modern gas-cooled atomic reactors. The kinetics of the reaction were investigated in a high-vacuum, circulation-type apparatus under the following conditions: 1. at 500 to  $900^\circ\text{C}$  under

CO<sub>2</sub> pressure of 420 mm Hg; 2. in the range of CO<sub>2</sub> pressures of 20 to 700 mm Hg at 750°C; 3. with and without circulation of CO<sub>2</sub> in the reactor volume at various temperatures and pressures. Properties of the metallic uranium used in the tests were described previously. It was found that in the initial stage of the reaction the oxidation of uranium proceeds according to a parabolic time law and, after some time, obeys a linear law. In the range of CO<sub>2</sub> pressures investigated, the velocity of the reaction is proportional to the fourth root of pressure and is independent of the carbon dioxide circulation in the reaction vessel. The apparent activation energy of the reaction at temperatures lower than 780°C was found to be 17 kcal/mol. X-ray examination showed that the oxidation of metallic uranium by CO<sub>2</sub> at 900°C proceeds to the α-UO<sub>2</sub> stage only. Microscopic analysis of the scale formed on the surface of uranium specimens showed it to consist of two layers of uranium dioxide: an inner dense layer and a porous external one. Detailed results are reported of an investigation of the diffusion processes in the above layer of oxidized uranium. The authors conclude that the rate of the diffusion-dependent oxidation in the scale formed on the surface of uranium in contact with CO<sub>2</sub> gas at elevated temperatures is a function of the CO<sub>2</sub> pressure  $\sqrt[4]{p}$ ,  $n = 4$  in the authors' tests.

REFRACTORY COMPOUNDS, THEIR PROPERTIES, PRODUCTION, AND PART IN MODERN ENGINEERING, Samsonov, G. V., 1960. -- The most promising materials are hard and refractory metal-like compounds of rare and rare-earth metals (Ti, Zr, Hf, V, Nb, Ta, Mo, W, La, Ce, Y) with B and C, Si, N, S (borides, carbides, silicides, nitrides, sulfides). The materials offer high hardness, wear resistance, strength and refractoriness, and a series of specific physical properties. The basic physical and mechanical properties of the technically most important refractory compounds are given. A detailed description is given of the fields where the materials are to be used according to their basic properties (ultra-heat-resistant materials, chemically stable alloys, heat and scale resistant alloys, hard, and electric-and-radio-engineering materials).

URANIUM DIFFUSION INTO ZIRCONIUM FROM URANIUM-MOLYBDENUM ALLOYS, Fedorov, G. B., et al., 1961. -- The diffusion of U in iodide Zr from U-Mo alloys containing 3 and 9% Mo was studied. Diffusion pairs were obtained by wedging U-Mo alloy plates into Zr specimens. The specimens were annealed in evacuated quartz ampoules at 900 to 1050°C for 160 hr. Then thin layers were taken off the contact surface and the integrated α activity of the remaining specimen portion was measured. At 950, 1000, and 1050°C diffusion coefficients of 3% Mo alloys were calculated and found to be equal to  $4 \times 10^{-12}$ ,  $1.3 \times 10^{-11}$ , and  $9 \times 10^{-11}$  cm<sup>2</sup>/sec, respectively. At 900, 950, 1000, and 1050°C the diffusion coefficients of 9% Mo alloys were equal to  $5.6 \times 10^{-12}$ ,  $1.5 \times 10^{-11}$ ,  $5.8 \times 10^{-11}$  and  $2.5 \times 10^{-10}$ , respectively. The pre-exponential factors for U, 3% Mo and 9% Mo were 0.46,  $5.7 \times 10^2$  and  $2.8 \times 10^2$  cm<sup>2</sup>/sec, respectively; the activation energies determined were equal to 47,300, 76,000 and 95,000 cal/g-atom, respectively. It was concluded that the effect of inhibited U diffusion in Zr can manifest itself in the hardening of U during its alloying with Mo rather than as a result of alloying Zr with another element.

SOME FEATURES OF THE SINTERING OF POWDERS OF REFRACTORY COMPOUNDS, Samsonov, G. V., et al., 1961. -- Two methods of preparing refractory compound parts comprise (1) pressing bars from powder and then sintering

them and (2) hot pressing (simultaneous pressing and sintering). These two methods are studied and compared with similar processes used in sintering metal powders.  $TiB_2$ ,  $CrB_2$ , and  $TiB_2-CrB_2$  were studied in the first method, while WG and  $Mo_2C$  were used in the second method.

CONSTITUTION DIAGRAM OF Hf-Re ALLOY, Savitskii, E. M., et al., 1962. -- Microstructure, microhardness, and x-ray diffraction analyses were made, and the constitution diagram for Hf-Re, demonstrating three metallic compounds, was constructed. The solubility of Re in  $\alpha$  Hf is less than 3 wt % at  $1250^\circ C$  (with 3 wt % Hf it is a two-phase alloy). Additions of Re to Hf partially stabilize the  $\beta$  phase and reduce the temperature of polymorphous transformation to  $1250^\circ C$ . A second intermetallic compound,  $HfRe_2$  is  $1000 \text{ kg/mm}^2$ .

THERMAL EXPANSION OF ZIRCONIUM-HAFNIUM ALLOYS, Pridantseva, K. S., 1962. -- Zirconium alloys with Hf contents of 1.1, 2.6, 7.6, and 18% were tested in order to find alloys with a coefficient of thermal expansion close to that of aluminosilicate ceramic materials. The tests were made with cast, vacuum-annealed specimens. The alloy with 7.6% Hf was also tested in forged condition. At all contents, Hf was found to extend the range of the roughly linear dependence of thermal expansion on temperature by raising the temperature of the  $\alpha \rightarrow \beta$  transformation of Zr. This transformation causes a sharp change in the magnitude of the thermal-expansion coefficient of Zr. Alloys with 7.6 and 18% Hf retain the linear temperature dependence of thermal expansion up to  $900^\circ C$ .

THE PROPERTIES OF RHENIUM, RHENIUM-TUNGSTEN AND RHENIUM-MOLYBDENUM ALLOYS, Savitskii, E. M., et al., 1962. -- The mechanical properties and microstructure of Re-W and Re-Mo alloys were investigated at room temperature and at 2600 to  $3400^\circ C$ . Methods of casting and of plastic deformation of W-Re, Mo-Re, and W-Mo-Re alloys were developed. It was shown that when W and Mo are alloyed with Re there is an increase in plasticity, in machinability, in weldability, and in strength, and the temperature of recrystallization increases by 400 to  $500^\circ C$ .

PRODUCTION OF BORON CARBIDES IN CARBON REDUCTION OF RARE EARTH MIXTURES WITH BORON, Markovskii, L. Ya., et al., 1962. -- Carbon reduction of  $CeO_2$  or  $La_2O_3$  mixtures with B at 1900 to  $2000^\circ C$  produced borocarbides similar to Ca, Sr, and Ba borocarbides. The synthesized products contained considerable amounts of chemically unstable compounds that in hydrolytic disintegration transform into a boron-metal solution and carbon.

THE PHASE DIAGRAM OF THE NIOBIUM-TUNGSTEN-ZIRCONIUM TERNARY SYSTEM, Savitskii, E. M., et al., 1962. -- Although the binaries Nb-W, Nb-Zr, and W-Zr are known, there are no data available on the ternary system Nb-W-Zr and therefore the system was investigated by means of melting point determination, x-ray diffraction, and microhardness measurements, limiting the field of study to portions of the ternary system with W:Zr ratios of 4:1, 1:1, and 1:3 and examining the isothermal cross sections at 2000, 1600, and  $1100^\circ C$ . The peritectic and eutectic points at 2260 and  $1660^\circ C$ , respectively, agree well with data reported by R. F. Domagala et al. W and Zr are jointly soluble in Nb in the solid state only to a limited

extent; this solubility decreases strongly with temperature. The compound  $W_2Zr$  was found to be in equilibrium with the  $\alpha$ -Nb solid solution; this compound had the highest microhardness of the system, amounting to 778 to 804 kg/mm<sup>2</sup> of the system.

THE FIRST SEMINAR OF THE DIVISION OF TECHNICAL SCIENCES OF THE UKRAINIAN ACADEMY OF SCIENCES OF SUPERFICIAL DIFFUSION SATURATION OF METALS, Epik, A. P., 1962. -- A special meeting was held in Kiev in March 1962 for reviewing the problem of diffusion saturation of metals and of refractory coatings applied on metallic and nonmetallic objects. G. V. Zemskov described the methods used for enhancing the effects of chemical and thermal treatments by means of ultrasonic waves. Results indicated that the rate of nitride treatment is accelerated by this treatment; properties such as adherence and hardness of the protective layer were improved. G. N. Dubinin reviewed the complex diffusing layers of Fe-Cr-Si, Fe-Cr-Al, Fe-Al-Si, Cr-Al-Si, etc., applied on Mo and Nb by thermal diffusion saturation. The method offers good possibilities of protecting these metals against high-temperature oxidation. Yu. N. Gribeodov found that heat-treated electrodeposited Cr layers saturated with N possess increased wear, scratch, and corrosion resistance. The electrodeposition of the Cr layer on austenitic steels followed by a nitriding treatment found industrial application. A. P. Epik described the diffusion parameters in the case of boride and carbide treatment of W and Mo in the solid phase; the diffusion rates of B and C into the base metal thickness of the protective layer were determined.

EFFECT OF TEMPERATURE ON MECHANICAL PROPERTIES OF URANIUM, Savitskii, E. M., et al., 1962. -- Mechanical properties of hot-rolled U (99.7% U and 0.26 to 0.25% C) were tested at -196 to 1100°C. Uranium hardness was found to drop from 332 kg/mm<sup>2</sup> at -196°C to 21 kg/mm<sup>2</sup> at 800°C. The temperature coefficient of hardness for  $\alpha$ -uranium was found to be  $0.9 \times 10^{-3}$ . Cold working with 50% reduction increased the room temperature hardness by 70 kg/mm<sup>2</sup>. The ductility of U increased and its resistance to deformation decreased with increasing temperature. In upsetting at 50 mm/min, cylindrical specimens 9.8 mm in dia and 15 mm long can withstand 33% reduction at 20°C, 60 to 75% at 500 to 600°C, and 97% at 850°C. To obtain a reduction of 10% at 100°C a stress of 90 kg/mm<sup>2</sup> is needed, but only 1 kg/mm<sup>2</sup> at 800°C. The tensile strength at room temperature was found to be 82 kg/mm<sup>2</sup>; elongation, 2%; and reduction of area, 4%. With increasing temperature the tensile strength decreased continuously; elongation and reduction first increase, drop somewhat at 760°C, reach a maximum (~35% elongation, and 100% reduction of area) at ~1000°C, and then drop sharply. The notch toughness of U at room temperature is low (1.7 kg·m/cm<sup>2</sup>); it rises to 7.3 at 600°C, drops to 0.5 at 750°C, and increases to ~12 kg·m/cm<sup>2</sup> at ~850°C. The same temperature dependence was observed in impact upsetting.

REACTION OF URANIUM WITH NITROGEN, Bessonov, A. F., et al., 1962. -- Studies of U reactions with nitrogen at 400 to 920°C and 200 mm Hg nitrogen pressure indicated no nitriding below 400°C. The reaction rate at 590 and 710°C and 20 to 600 mm Hg pressure is directly proportional to the square root of the pressure and is not influenced by nitrogen circulation. The similarity of the obtained data with data on U oxidation by air suggested a nitriding mechanism in which a dense nitride layer appears under a UO<sub>2</sub> film produced in preliminary treatment. Then the UO<sub>2</sub> layer separates from nonoxidized metal and cracks while the dense nitride layer grows into a porous, cracked surface.

THE EFFECT OF OVERALL PRESSURE ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF  $Nb_3Sn$ , Lazarev, B. G., et al., 1962. -- It was previously discovered that there is no evidence of an isotopic effect on the superconducting transition temperature,  $T_c$ , for isotopes of ruthenium 99 to 104, and that there is a small isotopic effect in  $Nb_3Sn$  in which  $T_c$  does not change as  $1/\sqrt{M}$  as is demanded by the mechanism of the electron-phonon interaction but rather as  $M^{-1/12}$ . A study was made of the effect of pressure on  $T_c$  for  $Nb_3Sn$ . A pressure of  $1730 \text{ kg/cm}^2$  was applied to a system containing a specially prepared sample of  $Nb_3Sn$ . The change in  $T_c$  at this pressure was  $0.045^\circ\text{K}$ , that is  $dT_c/dp = -2.5 \times 10^{-5} \text{ }^\circ\text{K/atmosphere}$ . This result is compared with those of such good superconductors as tin and mercury where  $dT_c/dp = -4.6 \times 10^{-5}$  and  $-3.6 \times 10^{-5} \text{ }^\circ\text{K/atmosphere}$ , respectively. In all three cases, the change in  $T_c$  approaches the proportionality  $1/\sqrt{M}$  as is required by the mechanism of the electron-phonon interaction. It was also determined that the variation of the magnetic field strength  $(dH_c/dt)_{T_c} = 15,500 \text{ kilogauss/degree}$ , a value which is in good agreement with the data of Kunzler. The coefficient of thermal expansion ( $\Delta\alpha$ ) and of specific heat ( $\Delta C$ ) in the transition calculated by well-known thermodynamic expressions give extremely exaggerated values ( $\Delta\alpha \approx 5 \times 10^{-4}/\text{degree}$ ,  $\Delta C \approx 100 \text{ cal/degree}$ ), thus indicating that the values of  $dH_c/dT$  and  $dT_c/dp$  are related only in a very low degree with the volume of  $Nb_3Sn$ . These results also correspond with the measurements of other properties of this superconductor, confirming that  $Nb_3Sn$  and similar superconductors retain the property of superconductivity in magnetic fields of very great intensity.

ELECTRICAL RESISTANCE OF REFRACTORY COMPOUNDS AT HIGH TEMPERATURES, Samsonov, G. V., et al., 1962. -- The temperature dependence of the electrical resistance of carbides of titanium, zirconium, hafnium, niobium, molybdenum, tungsten and borides of titanium and zirconium was measured. The thermal coefficients of the electrical resistance were calculated for the measured carbides and borides. Attempts were made to correlate the values of the electrical resistances with the electron structure of the compounds.

EFFECT OF IMPURITIES AND RARE EARTH ELEMENTS ON PROPERTIES OF ALLOYS, Pridantsev, M. V., 1962. -- The effects of low melting impurities and special mixtures of alkaline earth and rare earth metals on the technological, mechanical, and other related properties of steel and alloys were presented in this book. Characteristics of specified impurity elements and the mechanism of their effects were presented systematically. Properties such as ductility, ohmic resistance, thermal stability, corrosion, and heat fracture were considered.

CYCLIC OXIDATION-REDUCTION OF URANIUM OXIDES, Bessonov, A. F., et al., 1962. -- The subject of this study was the elucidation of the following questions: 1) Which phases are formed during the oxidation and reduction processes of active uranium dioxide and urano-uranium oxide? 2) Can the tetragonal phase be obtained at temperatures below  $400\text{-}500^\circ\text{C}$ ? 3) The oxidation kinetics of active uranium dioxide, unstable at room temperature. The work is a repetition of investigations previously published by Western scientists. The authors state that their results are in good agreement with those given in Western literature. The following phases were found during the cyclic oxidation and reduction of uranium oxides in the temperature

range from 20 to 500°C:  $UO_2$ ,  $UO_{2+x}$ ,  $UO_{2.25}$ ,  $UO_{2.36+x}$ ,  $UO_{2.6+x}$ ,  $UO_{2.67}$ . The tetragonal phase does exist as a stable one at some definite temperature range between 500°C and room temperature.

THE TEMPERATURE FIELD IN A REACTOR CYLINDRICAL FUEL ELEMENT COOLED BY A TURBULENT LIQUID FLOW, Ermakov, V. S., et al., 1962. -- A method is proposed for numerical solution of a system of equations describing stationary heat transfer between a rod with internal heat sources and a liquid flow cooling it.

FUEL ELEMENTS IN NUCLEAR REACTORS, Zaimovskii, A. S., et al., 1962. -- In this book a survey is made of various nuclear fuels and their reactions with structural materials and of structural materials' reactions with coolants. An analysis is made of the combined effects of thermal, mechanical, and radiation reactions on the fuel and construction materials.

DETERMINATION OF LOCAL AND AVERAGE HEAT-TRANSFER COEFFICIENTS FOR FUEL ELEMENTS OF THE RESEARCH REACTOR IRT, Gomelauri, V. I., et al., 1962. -- A number of laws defining the processes of heat exchange in cassettes of a nuclear reactor of the IRT type was established on the basis of the analysis of the published data and as a result of experimental investigations.

DETERMINATION OF THE FUEL ELEMENT BURNUP BY MEANS OF A MAGNETIC  $\gamma$ -SPECTROMETER, Groshev, L. V., et al., 1962. Methods previously employed for determining the  $U^{235}$  burnup of fuel elements required the use of a mass spectroscope with hot fuel, therefore necessitating extended waiting periods. This situation was improved by the use of a non-destructive method based on a magnetic Compton spectrometer which allowed the burnup to be determined by the intensity of the  $\gamma$  lines of the fission products formed in the element. The 2.19-Mev  $\gamma$  line of  $Nd^{144}$  was found to be useful for this purpose. The measurements may be undertaken within a few days after the termination of the exposure, requiring only that more than 0.1 g  $U^{235}$  be burned up for improving the statistical accuracy. If the fuel is exposed for periods exceeding the 284-day half life of  $Nd^{144}$  the conditions of the burning-up must be also taken into account. The 661-keV  $\gamma$  line of  $Ba^{137}$ , the half life of which is 26 years, may be used for the study of fuels exposed for several years.

THERMAL MODELING OF ATOMIC REACTOR FUEL ELEMENTS, Baum, V. A., 1963. -- Results of a study concerning the distribution of temperature in cylindrical reactor fuel elements are presented. It was found that the temperature distribution in the element and the absolute temperature values are strong functions of the contact between the shell and the material enclosed within the shell.

SOME FEATURES OF THE BEHAVIOR OF THE SUPERCONDUCTION TEMPERATURE TRANSITION IN THALLIUM UNDER HIGH PRESSURE, Lazarev, B. G., et al., 1963. -- The shift of the superconduction transition temperature in annealed single crystals of pure thallium ( $R_{4.20K}/R_K \sim 2 \times 10^{-4}$ ) is measured in detail at various pressures up to 1730 kg/cm<sup>2</sup>. A complex dependence of  $T_K$  on  $p$  is found in this pressure range. The effect of small electron groups is estimated by taking into account the difference of the electron-phonon interaction constant.

VACUUM COATING OF HIGH-MELTING METALS. Ul'yanov, R. A., et al., 1963. -- Experiments on Nb, Mo, and Ta coating with stainless steel (1X18H9T), Nichrome, Cr-Ni alloy (EI602), and Zr showed that increased compression improves cohesion and that higher temperatures require less compression for identical results. The structures and strengths of nickel-chromium coated Mo and Ni were not affected by 2-hour annealings at 1200°C; 10-hour annealings improved cohesion 15 to 20%.

SINTERING OF NITRIDES OF TRANSITION METALS, Samsonov, G. V., et al., 1963. -- The conditions of the sintering of nitrides of the transition metals Ti, Zr, Hf, V, Nb, Ta, Cr, and Mo are investigated in a vacuum by the method of hot pressing and reactive sintering. The optimal sintering conditions are established by each of these methods, and the advantages of the reactive sintering process and the nature of the electron density distribution in the nitride phase lattices is also shown.

PREPARATION OF A HIGH MAGNETIC FIELD USING Nb-Zr ALLOY, Savitskii, E. M., et al., 1963. -- Studies of the superconducting properties of a Nb-25% Zr wire showed that with a 1-cm ID winding and a volume of 80 cm<sup>3</sup> the maximum magnetic field intensity in the center of a solenoid is ~60 k gauss at 4.2°K.

Fuel Element Studies, Preparation, etc.

- Baum, V. A. (1963) - 1 - Thermal modeling  
 Ermakov, V. S. (1962) - 1 - liq. cooling  
 Gomeauri, V. I. (1962) - 1 - ht. trans.  
 Groshev, L. V. (1962) - 1 - burnup analysis

Metallurgy, Ceramics, etc.

- Berezin, I. A. (1962) - 1 - U met., analyt., H, O  
 Bessanov, A. F. (1961-62) - 3 - U, O<sub>2</sub>, CO<sub>2</sub>, N<sub>2</sub>  
 Chekhovskoi, V. Y. (1962) - 3 - W, Mo, corundum, thermo.  
 Dashkorskiy, A. I. (1960) - 1 - properties, U, internal friction  
 Lashko, N. F. (1959) - 1 - alloys, brazing, soldering  
 Lazarev, V. B. (1962) - 1 - RE's, molten Nd  
 Lyubchenko, A. P. (1962) - 2 - cast iron, C, Ce  
 Pisarenko, G. S. (1962) - 2 - W, Mo, 20-2700°C, prop. meas.  
 Yakovlev, J. V. (1955) - 1 - hi-purity metals, anal. by n-activation  
 Zaimovskii, A. S. (1962) - 1 - react. fuel elements, props., book  
 Zhabrova, G. M. (1962) - 1 - hi-dispersion mats. and oxides, rad. meth.  
 Zhdanovich, G. M. (1960) - 1 - met. powder pressing, theory

Solid State Physics, Properties, etc.

The following abstracts illustrate the nature of recent work in these areas by scientists in the USSR and the Communist Bloc nations.

THE EFFECT OF EXPOSURE TO THE RADIATION OF THE INSTITUTE FOR ATOMIC PHYSICS REACTOR ON THE MAGNETIC PROPERTIES OF SOME FERRITES USED IN AUTOMATIC DEVICES, Andreescu, N., et al., 1962. -- Literature data indicate that the magnetic properties of various materials are differently affected by  $\gamma$  radiation; Ni ferrites and Si-Fe alloys are hardly affected and may be used for the construction of devices exposed to radiation while the properties of Mo Permalloy and others are greatly influenced. This problem was further studied exposing ferrites having a rectangular hysteresis loop of high magnetic permeability, prepared from complex core materials containing  $\text{Fe}_2\text{O}_3$ ; ZnO; and Ni, Mg, or Mn oxides, to the neutron flux of the Institute's reactor. First tests with an integral flux of  $4.3 \times 10^{17}$  n/cm<sup>2</sup> resulted in insignificant changes in the properties; the exposures were therefore extended to integrated fluxes of  $1.7 \times 10^{18}$  and  $2.8 \times 10^{18}$  n/cm<sup>2</sup>. The results showed that the limiting hysteresis loop changed only slightly, if at all; on the other hand the magnetic permeability decreased by 20 to 30%. It is assumed that exposure to such neutron fluxes results in changes of the ferrite grain structure; this may be due to dislocations or major crystal defects or may be caused by disturbances in the homogeneous character of the material by precipitation of certain phases.

EFFECT OF NON-METALLIC ATOMS ON THE ELECTRICAL PROPERTIES OF REFRACTORY COMPOUNDS OF TRANSITION METALS, Lvov, S. N., et al., 1962. -- Data on the electrophysical properties of borides, carbides, and nitrides of Hf, Ti, Zr, U, Nb, Ta, Cr, Mo, and W are generalized. The principal regularities of the changes in the properties with a change in the acceptor capacity of d-electron shells of the atoms of transition metals and the ionizing potentials of the non-metals are pointed out.

RADIATION EFFECTS ON METALS AND OTHER HIGH MELTING MATERIALS, Pen'kovskii, V. V., 1962. -- Radiation effects of neutrons and other elementary particles on various metals and high-melting materials are described. Structural changes; phase transformation; and electric, optic, magnetic, and other changes taking place in the irradiated materials are discussed. A survey is made of high melting point materials with high resistance to irradiation for use in reactors. The book was designed for specialists in solid state physics, metal physics, and technology of high-melting compounds. 500 references are included.

NEUTRON IRRADIATION OF SILICON p-n JUNCTIONS, Nosov, Yu. R., 1963. -- An attempt was made to establish a practical limit to the use of neutron bombardment of Si for reducing the lifetime of nonequilibrium carriers in Si devices. P-n junctions prepared by fusing Al wire into n-type Si crystals were irradiated (some were subsequently quenched from 1200°C), and the diodes

so formed were subjected to current and voltage reversals. The charge carried by the transient reverse current was measured, as were the forward and reverse resistances for the junctions. Results indicate that lifetime reduction in the base of a Si diode by neutron bombardment is applicable only to about  $0.1 \mu$  sec.

BINARY URANIUM, TANTALUM, AND TIN OXIDES, Trunov, V. K., et al., 1963. -- Structures of binary U, Ta, and Sn oxides were studied at  $1200$  to  $1800^\circ\text{C}$ . The results of x-ray phase analysis of annealed specimens were tabulated. The results of indexed x-ray pictures of  $\text{UTa}_3\text{O}_{10.7}$  showed a structural similarity to  $\text{UV}_3\text{O}_{10}$ . The intensity lines of  $\text{UTaO}_5$  are indexed assuming a rhombic (pseudohexagonal) subnucleus with  $a = 6.450$ ,  $b = 3.772$ , and  $c = 3.972$  kX. The superstructure lines indicated the U and Ta atom distribution order. The  $\text{SnO}_2\text{-Ta}_2\text{O}_5$  and  $\text{SnO}_2\text{-WO}_3$  systems did not form compounds at temperatures to  $1200^\circ\text{C}$ . A variable composition  $2\text{SnO}\cdot\text{Ta}_2\text{O}_5 - 3\text{SnO}\cdot\text{Ta}_2\text{O}_5$  with pyrochlore structure and elementary nucleus with  $a = 10.542 \pm 0.003$  kX for the  $\text{Sn}_2\text{Ta}_2\text{O}_7$  and  $a = 10.586 \pm 0.003$  kX for the  $\text{Sn}_3\text{Ta}_2\text{O}_8$  were observed. A phase resembling the composition  $\text{SnTa}_4\text{O}_{11}$  was observed with larger contents of  $\text{Ta}_2\text{O}_5$ .

DISTRIBUTION OF DISPLACED ATOMS IN A SOLID DUE TO A PRIMARY ATOM GENERATED BY IRRADIATION, Korchovei, A., et al., 1963. -- A study is made of the spatial distribution of atoms displaced by a primary atom generated by radiation and having a fixed energy and a known initial direction. Mean values are calculated for the products of the different powers of the components of the final position of the primary atom. For this purpose a correlation function is introduced for the distribution of the successive displacements of the primary atom that takes into account the possibility of the atom stopping in case its energy becomes less than  $E_d$ . Further, an elegant matrix method is used to find the recurrence formulas for the quantities corresponding with the  $n$ th displacement with respect to the  $(n-1)$ st displacement, which are expressions leading to Volterra integral equations in the case where  $n$  taken on very large mean values. These values are used to calculate the distribution function of the atoms displaced by a primary atom, that in the third order of approximation differs somewhat from a three-dimensional Gaussian function.

DETERMINATION OF THE CRITICAL TEMPERATURE OF A SUPERCONDUCTOR, Moskalenko, V. A., 1963. -- The critical temperature  $T_c$  is considered to be the point at which the bound state of a particle or hole pair occurs in superconducting metals. From the condition that the binding energy of the pair is equal to zero,  $T_c$  is found by solving the Bethe-Salpeter equation. The calculation is made on Frolich's model, enlarged by including the Coulomb interaction between electrons. A relation is found between the criteria for superconductivity and the stability of the lattice to one-phonon excitations.

Solid State Physics

- Abroyan, I. A. (1963) - 1 - rad. eff., Ge, conductivity
- Agranovich, V. M. (1962) - 1 - n-irrad. eff. on reactor mats., swelling, kinetics
- Alekseevskii, N. E. (1963) - 1 - Ga-nitrides, supercond.
- Andreesev, N. (1962) - 1 -  $\gamma$ -rad. effs., magn. props. of ferrites
- Arzhanyi, P. M. (1961-63) - 3 - Nb, W-Be, Nb-Be
- Avgustinik, A. I. (1963) - 1 - refractory mats., correlations of props.
- Badayeva, T. A. (1959-61) - 2 - Th-Zr, Th-U-Bi
- Fan, F. (1963) - 1 - Y, Zr, O
- Galchenko, G. L. (1960) - 3 - U, B, F, N, Cl
- Godina, N. A. (1959-60) - 2 - Hf, Ti, O
- Gor'kov, L. P. (1963) - 1 - superconductors, evaluation
- Gubkin, A. N. (1963) - 1 - Sr, Bi, Ti, O
- Ibragimov, Sh. Sh. (1962) - 1 - n-irrad. steel, C
- Iskhakov, Kh. Sh. (1962-63) - 3 - Sr, Ti, Zr, B, oxides
- Isupova, E. N. (1960) - 1 - Be, Si, O
- Keler, E. K. (1960) - 2 - Be, Ti, Zr, O
- Khlebnikov, G. I. (1958-61) - 3 - U, Th, Np, Pu, Am, elect. depos.
- Komkov, A. I. (1962-63) - 3 - Nb, RE s, Ti, O
- Korchovei, A. (1963) - 1 - at. displ. by irrad.
- Kovba, L. M. (1958-63) - 3 - U, Nb, W, Ta, alk. met., O
- Krivov, M. A. (1963) - 1 - Ga arsenide,  $\gamma$  rad. eff.
- \*Krylov, E. I. (1957-61) - 6 - U, Th, Se, Nb, Ta, H, RE's, O
- Kushnir, Yu. M. (1963) - 1 - elect. microsc., x-ray microanalyzer
- Kuz'menko, P. P. (1963) - 2 - diffusion, Ag-110 in Mg, Sb-125 in Ni
- Kuznetsov, A. K. (1958) - 1 - Zr, Ca, O, effect of boric anhydride
- Lakharov, A. I. (1962) - 1 - n-irrad. eff. on Cu

Solid State Physics, continued

- Leonov, A. I. (1962-63) - 2 - minerals, Ce, Al, O, Si
- Lotkova, E. N. (1962) - 1 - n-irrad., silicon, IR spect.
- Lvov, S. N. (1962) - 1 - trans. mets., refract. comp'ds
- Lyubimov, V. N. (1963) - 1 - Zr, Pb, O, elect. prop.
- Lyutaya, M. D. (1962) - 1 - nitrides, Al, Ga, In, Sc
- Malyuchkov, O. T. (1962) - 3 - borides, Zr, Nb, Ta, Mo, Cr, La
- \*Mikheyeva, V. I. (1958-62) - 6 - hydrides, B, Li, RE's
- Mochalov, K. H. (1962) - 1 - borohydrides, alk. metals
- Moskalenko, V. A. (1963) - 1 - supercond., crit. temp.
- Naymov, V. A. (1962) - 1 - x-ray diffr., vanadates, RE's, Sc
- Nesterov, V. M. (1963) - 1 - dielectrics, rad. eff.
- Nosov, Yu. R. (1963) - 1 - n-irrad., Si p-n junctions
- Ormont, B. F. (1959) - 1 - semi-conductors, cryst. chem.
- Pal'guev, S. F. (1961) - 1 - Ce, Be, Mg, Sr, O, sintering, elect. cond.
- Pen'kovskii, V. V. (1962) - 1 - react. mats., irrad. eff., n's, hi-melting metals, alloys.
- Rashba, E. I. (1963) - 1 - semiconduct. imp. eff.
- Sarkisov, E. S. (1963) - 1 - co-valent cryst., coordin. no., struct.
- Sazonov, L. A. (1962) - 1 - catalysis, RE oxides, temp. depend.
- Shub, D. M. (1962) - 1 - rad. eff., oxide semiconductors
- Sinyakov, E. V. (1963) - 1 - Nb, Sr, Yb, Fe, O, ferromag. prop.
- Smolyaninov, N. P. (1962) - 1 - B, W, Pb, O, cryst. diag.
- Spitsyn, A. V. (1963) - 1 - rad. eff., semiconduct. defects
- Talbi, M. A. (1957) - 1 - rad. eff., Cd S-Se, semi-conductors
- \*Toropov, N. A. (1962-63) - 5 - RE's, Sr, Sc, Ca, Mg, Al, Si, O, const. diags., props.

Solid State Physics, continued

- Tret'yachenko, G. N. (1961) - 1 - cermets, therm. fatigue, SiC stab.
- Trunov, V. K. (1963) - 1 - U, Ta, Sn, O, struct, 1200-1800°C
- Tsarev, B. M. (1963) - 1 - LaB<sub>6</sub>, CeB<sub>6</sub>, opt. consts., props.
- Vavilov, V. S. (1962-63) - 2 - SiO<sub>2</sub> cryst., rad. eff., interact. with Li
- Veberov, A. A. (1962) - 1 - coherent rad. of phonons, ultrasonics
- Vitovskii, N. A. (1962-63) - 2 -  $\gamma$ -rad. defects in silicon
- Vlasenko, N. A. (1962) - 1 - ZnS-Cu phosphor, luminesc., impur. eff.
- Yurkov, B. Ya. (1962) - 1 - rad. eff., silicon cryst
- Zarechnyuk, O. S. (1963) - 1 - cryst., Ce, Al, transit. mets.
- Zubov, V. G. (1962) - 1 - rad. eff., fast-n's, quartz, dielect. const., Rl

Liquid Metals, Properties, etc.

The following abstracts illustrate recent Soviet work in this area.

JOINT SOLUBILITY OF THORIUM AND URANIUM IN LIQUID BISMUTH, Badayeva, T. A., et al., 1961. -- The authors studied the joint solubility of Th and U in liquid Bi in a 300 to 1,000°C temperature range. Bi 99.99%, Th 99.7% and U 99.83% were used as initial materials. In the method employed to determine solubility, the liquid and solid phases, being in equilibrium at a given temperature, were separated by pouring-off the liquid phase under the experimental conditions; the liquid phase was then chemically analyzed. A schematic diagram is presented of a device to determine Th and U solubility in liquid Bi. A microscopic analysis of the residue of the solid phase was carried out after pouring-off the liquid phase. At 300°C only traces of Th and about 0.1 at. % U were detected in liquid Bi. With elevated temperature the joint solubility of Th and U in liquid Bi increased and at 1,000°C was equal to 4.1 at. % Th and 7.5 at. % U. In the 300-1,000°C temperature range, ternary liquid solutions of Bi with Th and U are in equilibrium with solid phases:  $\text{ThBi}_2$ ,  $\text{ThBi}_2 + \text{UBi}_2$ ,  $\text{UBi}_2$ .

GENERALIZATION OF EXPERIMENTAL DATA ON THE VISCOSITY AND THERMAL CONDUCTIVITY OF LIQUID METALS, Usmanov, A. G., 1961. -- A generalization of the experimental data on heat transfer from liquid metals through walls and transfer processes in gas phases is discussed. Data are included concerning generalization of results obtained with a metallic group which includes Na and K, and another group which includes Sn, Pb, Bi, and Hg.

GENERALIZATION OF HEAT TRANSFER DATA IN LIQUID METALS, Kirillov, P. L., 1962. -- Reliable heat transfer data in liquid metals may be obtained only by temperature measurements within the liquid. On the basis of published data on temperature measurements in turbulently flowing liquid metals, such as Hg, Na, NaK alloy, and Pb-Bi alloy, certain general conclusions may be drawn. Results of these calculations are tabulated; similar values were obtained within a divergence of 8% by a formula which was found to be valid in the Pectet number (Pe) range from 100 to 20000:  $\text{Nu} = 5 + 0.25 \text{Pe}^{0.8}$ , where Nu designates the Nusselt number. However, the formula does not apply to boundary transition to the Laminar region where Nu must be equal to 4.3. In re-calculation of the data in  $\text{Nu} = f(\text{Pe}^*)$  coordinates by the least square method the following formula was obtained:  $\text{Nu} = 4.36 + 0.343 \text{Pe}^{*0.8}$  which is valid with an average deviation of  $\pm 2\%$ . This formula may be used to  $\text{Pe}^*$  numbers up to 1000, excluding the Laminar region where  $\text{Nu} = 4.36$ .

EXPERIMENTAL DETERMINATION OF THE ELECTROCONDUCTIVITY OF LIQUID SODIUM, POTASSIUM, AND LITHIUM, Solov'ev, A. N., 1963. -- Results are presented concerning the measurement of the electroconductivity of molten lithium, sodium, and potassium as a function of the temperature. The measurements for lithium and sodium were carried out from 100 to 1000°C, while the potassium determinations were made only up to 730°C. The data obtained, as well

as results from other investigators, are displayed on a graph of conductivity plotted versus temperature. In some temperature intervals agreement with earlier results is noted; in other temperature ranges there is disagreement. The error involved in these measurements is estimated to be 2.5%. The average scatter of the experimental points was found to be 0.3% for sodium, 0.5% for potassium, and 0.8% for lithium. The greatest number of determinations were carried out for sodium and using the method of least squares, an interpolation formula was derived for the electroconductivity of sodium as a function of temperature.

Liquid Metal Properties, Applications, etc.

Badayeva, T. A. (1959-61) - 2 - Th-U-Bi

Boiko, B. T. (1962) - 1 - In, Sn

Dutchak, Ya. I. (1962) - 1 - In, Bi

Kirillov, P. L. (1962) - 1 - ht. trans.

Shokol, A. A. (1962) - 1 - Ga, In, Tl purif. by vac. distill.

Solov'ev, A. N. (1963) - 1 - Na, Li, K. elect. conduct.

Usmanov, A. G. (1961) - 1 - Na, K, Sn, Pb, Bi, Hg, visc., th. cond.

Zadumkin, S. N. (1962) - 1 - theory, surf. tension

Fused Salts in Chemistry, Metallurgy, etc.

- Amosov, V. M. (1962) - 1 - electrolysis, pure Nb, fluorides of Ta, alk. met.
- Arabadzhan, A. S. (1962) - 1 - Cl, Br, Li, Na
- Batslavik, E. (1958) - 1 - F, Na, Al, Mg
- Belov, S. F. (1961) - 1 - Cl, K, Ti
- Belozerskiy, N. A. (1940) - 1 - Cl, Zr, Ta, Na, Ca
- \*Berezhnaya, V. T. (1959-61) - 5 - F, alk. met., alk. earths
- Bergman, A. G. (1962-63) - 3 -  $PO_4$ , Cl, F, alk. met., Cd
- \*Bukhalova, G. A. (1959-62) - 8 - F, Cl, alk. met., alk. earths
- Chernov, R. V. (1961) - 1 - Cl, alk. met., Ti
- Ch'ih-Tsu, Hu (1961) - 1 - F, K, Be, La
- Delimarskii, Yu. K. (1958-62) - 4 - F, S, Sn, Bi, Sb, Ni, Ti, Na, Zr, Hf
- \*Emel'yanov, V. S. (1956-61) - 5 - F, Cl, I, Th, Na, K, Zr, Nb
- Fridman, Ya. D. (1962) - 1 - Tl-In, halides
- Gorodyskii, A. V. (1962) - 1 - phys. prop.
- \*Ilyasov, I. I. (1959-62) - 5 - Br, Cl, I, alk. met., Cd, Pb, Tl
- In'chzhu, S. (1958-59) - 2 - Cl, RE s, Hf, alk. met., alk. earths
- Ivanovskii, L. E. (1961) - 3 - F, Cl, Nb, Zr, RE's, electrolyt. dissol.
- \*\*Klokman, V. R. (1958-61) - 11 - F, Cl, Ra, La, Pb, Sr, Cd, Ba
- Korshunov, B. G. (1961-62) - 3 - Cl, Nb, W, Al, Fe, Na, K
- Li, C. (1962) - 1 - Cl, Sn, RE, Fe, Na
- Makhon'ko, K. P. (1963) - 1 - radioact. aerosols
- Mateiko, Z. A. (1961-63) - 2 - F, Cl, Li, Ca, Sr, weld. flux
- \*Morosov, I. S. (1958-63) - 8 - Cl, Zr, Nb, Hf, Ta, Ti, etc.
- Naumann, D. (1963) - 1 - Na, K. Cl; chloride volat. process for irradi. U-oxides
- Nichkov, I. F. (1960) - 1 - Cl, U, Bi, alk. mets., Ca
- Nikitin, Yu. P. (1963) - 1 - F, O, Ca, Pt, electrochem.

Fused Salts in Chemistry, Metallurgy, etc., continued

- \*Nisel'son, L. A. (1958-62) - 5 - Cl, Zr, Nb, Ta, Hf, Bi, Zn, etc.
- Novikov, G. I. (1961) - 1 - Cl, W
- Novoselova, A. V. (1962) - 1 - F, Be, Sr
- Palkin, A. P. (1959-62) - 3 - Cl, Nb, Ta, Cd, Zn, Tl, Al, alk. met.
- Raspopin, S. P. (1962) - 1 - Cl, U, alk. met., electrolysis
- Ruzinov, L. P. (1962) - 1 - Cl, Zr, Hf, ht. of dissoc.
- Safanov, V. V. (1962) - 1 - Cl, Nb in Rb, Cs
- Sheiko, I. N. (1962) - 1 - Cl, Be, alk. met.
- Tsiovkina, L. A. (1959) - 1 -  $TiCl_4$  solub. in melts
- Ukshe, A. A. (1962) - 1 - alk. chlorides, met. elect. double layers
- Vaks, S. A. (1961) - 1 - Cl, Ti, Si, C.
- Val'tsev, V. K. (1961) - 1 -  $NO_3$ ,  $NH_4$ , U, Th, RE's, alk. earths, ppt'ns
- Zverev, G. L. (1955) - 1 - Ce, Ca, Cl
- See also Emel'yanov, Gautsch, Katsnel'son, Plotnikov, Smirnov, Yushina.

Electrochemistry, Electrolysis, etc.

Balashova, N. A. (1955-60) - 3 - Pt, Zr, Nb, Ce, Pr

Budov, G. M. (1963) - 1 - amalgams

Gautsch, O. (1962) - 1 - U

Gochaliev, G. Z. (1962) - 1 - Pt, Au

Gokhshtein, Ya. P. (1961) - 1 - U, H<sub>2</sub>SO<sub>4</sub>

Konstantinov, B. P. (1960-62) - 3 - Ra, Ba, amalgams, Li, Na, K, Ca

Pastukhova, Z. V. (1959-62) - 2 - electrolyt. ppt'n, Ag, Co, Cu, In

Shatalov, A. A. (1956-63) - 4 - Nb, V, HNO<sub>3</sub>, HCl, H<sub>2</sub>SO<sub>4</sub>, etc.

See also Khlebnikov, Plotnikov, Raspopin, Sheka, Sinitsyna, Smirnov, Yushina.

Alloys

- \*\*Ageyev, N. V. (1958-63) - 13 - Ti, Mo, Fe, Si, Ge, Si, Ni, Mn, V, Cr, Al, Nb
- Arbusov, M. P. (1962) - 1 - Nb, Ni, Al
- Artsishevskii, M. A. (1959) - 1 - deut. rad. eff., Ni, Fe, Al, elect. resist.
- Baikova, A. A. (1958) - 1 - metals, process metall., res. meths., book
- Bannykh, O. A. (1962) - 1 - eutectic carbon steels, annealing
- Borodich, V. D. (1962) - 1 - Nb-Zr
- Braun, M. P. (1962) - 1 - Nb, Zr, steel
- Bychkov, Yu. F. (1959) - 1 - Zr, Nb
- Dekhtyar, I. Ya. (1962) - 1 - sol. st., Ni, RE s
- Dokukina, N. V. (1962) - 1 - W, Nb, Si
- Drits, M. E. (1962) - 1 - Mg, Nd, Mn
- Dyubua, B. Ch. (1962) - 1 - W, Hf, Ti, Thermoelect.
- Epelbaum, V. A. (1958-59) - 3 - Cr-B, B-C, B-Si
- Epik, A. P. (1962) - 1 - therm. diffus. sat., Mo, Nb
- Eremenko, V. N. (1962) - 1 - Sn-Ti
- Ermenko, V. N. (1962) - 1 - molten, surf. tens.
- Fedorov, G. B. (1961) - 2 - Zr, U, Mo
- Fedorov, T. F. (1960-62) - 2 B, Ti, Cr
- Fedotov, S. G. (1962) - 1 - Ti, Al
- Gertsriken, S. D. (1955-62) - 3 - Co, Al, Ni, Mn, Fe, Hf
- Glazov, V. M. (1959) - 1 - Nb, Al
- Glazov, V. V. (1962) - 1 - Ti, Sn, Zr
- Golik, V. R. (1962) - 1 - steel, C, Nb, Mn
- Goman'kov, V. I. (1963) - 1 - Fe, Co, neutron diff.
- Gomozov, L. I. (1962) - 1 - heat resist.
- Gridnev, V. N. (1962) - 1 - Hf-base
- Grigor'ev, A. T. (1960) - 1 - Pd, Cu, Cr

Alloys, continued

- \*Grum-Grzhimaylo, N. V. (1958-61) - 6 - Mo, W, Cr, Ti, Nb  
 Grushina, U. V. (1963) - 1 - Ti, Zr, Mo  
 Gurevich, A. B. (1963) - 1 - steels, Ce  
 Ivanov, C. S. (1959) - 2 - Zr, Sn, Mo  
 Kiselev, N. A. (1962) - 1 - mets., phy. meas.  
 Kishtin, S. T. (1955) - 1 - radiography  
 Kocherov, P. V. - 1 - Al, Ca  
 Kolchin, A. M. (1963) - 1 - Nb-Zr, superconduct.  
 Konstantinov, V. I. (1962) - 1 - electrolyt., Ta, Nb  
 Kopersak, N. I. (1962) - 1 - steels, embrittlement  
 Kornilov, I. I. (1958-63) - 3 - Ti, Nb, Mo, V, Al  
 \*Krip'yakevich, P. I. (1962-63) - 5 - Th, Nb, W, Ta, Ni, Fe, RE s, Al  
 Lazarev, B. G. (1962-63) - 4 - Nb<sub>3</sub>Sn, Tl, super-conductivity  
 Levitin, V. V. (1960) - 1 - steels, B analysis, n-activ.  
 Marchenko, V. I. (1963) - 1 - Ce, S, phys. prop.  
 Marina, L. I. (1962) - 1 - Ga, P, zone melting, dissoci.  
 Markevich, G. S. (1960) - 1 - B, Be  
 Markovskii, L. Ya. (1962) - 2 - borides, carbides, RE's, alk. met.  
 Matyushenko, N. N. (1963) - 1 - Be, Mo, W, Re  
 Mikheev, V. S. (1961) - 1 - Nb, Ti, Zr  
 Mints, R. S. (1960-62) - 2 - Ni, Nb, Al  
 Mirgalovskaya, M. S. (1957) - 1 - Mn, Ce  
 Osipov, K. A. (1960-63) - 2 - Ti-Zr, creep prop., metals  
 Petrova, L. A. (1962-63) - 2 - Zr, Mo, Fe, Re,  $\beta$  solid stabil.  
 Pozharskaya, G. V. (1962) - 1 - Cd, In, thermodyn., 543-583°K  
 Pridantsev, M. V. (1962) - 1 - steels, eff. of impurities, book  
 Pridantseva, K. S. (1962) - 1 - Zr, Hf, therm. expans., varying Hf cont.

Alloys, continued

- Prokoshkin, D. A. (1962) - 2 - Mo, Nb, eff. of additive metals, salts
- Pylaeva, E. N. (1958) - 1 - Ni, Nb, Ta
- Rogachevskaya, Z. M. (1962) - 1 - metals, const. diag., book
- Romanova, A. V. (1962) - 1 - In, Pb, Sn
- Rubel', I. S. (1962) - 1 - steels, N-containing ht. treat
- \*Rudnitskii, A. A. (1959-61) - 5 - Ag, Ru, Au, Pd, Rh, Pt, thermocoup.
- \*\*\*Samsonov, G. V. (1954-63) - 27 - B, Si, N, S, Nb, Th, RE's, rare metals; IX
- \*\*\*Savitskiy, Ye. M. (1958-63) - 20 - RE's, Nb, U, C, Zr, W, Hf, Mo, Al, Ti, Cr, Mn, Ru, Re, etc.
- Shakhova, K. I. (1962) - 1 - Nb, Ti, Cr
- Shveykin, V. V. (1959) - 1 - Ti, VT-1, OT-4, pierced tube billet product.
- Sklyarenko, S. I. (1962) - 1 - Sn, Sb, Ge, electro-depos.
- Slavnova, G. K. (1963) - 1 - In, Se
- Sorokhina, N. N. (1963) - 1 - analyt., steel, RE s, spectr.
- \*Svechnikov, V. N. (1962) - 7 - hi-temp., Ni, Cr, Ti, Fe, C, Hf, Zr
- Terekhova, V. F. (1960-61) - 2 - Cr, Y, Mg, equil. diag.
- Tylkina, M. A. (1959) - 1 - Ti, Hf, phase diag.
- Ul'yanov, R. A. (1963) - 1 - met. coatings, Cr-Ni, Zr, Nb, Mo, Ta, S.S.
- Vigdorovich, V. N. (1963) - 1 - In As-InP, fragile, meas. of microhardness
- Volodarskaya, R. S. (1963) - 1 - Mg, Cu, Al, analyt., Th, Zr in alloys, complexomet.
- Vorontsova, T. V. (1962) - 1 - Mo, Ti, Zr, W, forging, plasticity
- Zakharova, G. V. (1961) - 1 - Nb powder met.; Be, B, Si, Cr, V, Ti, W, C, Mo
- Zakharova, M. I. (1962) - 1 - Be, Cu,  $\beta$ -phase transform.
- Zhuravlev, N. N. (1958-63) - 4 - Bi, Pt, Y, Sb, Sc, props., supercond.; Cs met. prep. from CsF

Corrosion of Metals, Alloys, etc.

The following abstracts illustrate the nature of recent corrosion studies by scientists in the USSR and Communist Bloc nations.

**CORROSION AND ELECTROCHEMICAL PROPERTIES OF TITANIUM-ZIRCONIUM ALLOYS IN ACID SOLUTIONS**, Andreeva, V. V., *et al.*, 1962. -- The corrosion and electrochemical behavior of titanium, zirconium, and titanium-zirconium alloys in solutions of sulfuric, nitric, and phosphoric acids and also in mixtures of nitric and phosphoric acids, were investigated. Alloying titanium with zirconium increases the titanium corrosion-resistance in sulfuric acid solutions at 100° when the concentration of the latter is 80%. At concentrations higher than that neither of the metals nor titanium-zirconium alloys are stable. In phosphoric and nitric acid solutions, titanium-zirconium alloys have no advantage over titanium and zirconium.

**THE MECHANISM OF CARBON TRANSFER IN LIQUID SODIUM**, Lyushenko, V. S., *et al.*, 1962. -- Results of investigations concerning C transfer from Fe, carbon steel, perlite steel, and chrome steel to austenitic steel and Ni alloys in oxygenated liquid Na at temperatures up to 650°C are presented. The probable mechanism of C transfer involves the formation of CO on surfaces as the result of reaction between C and O ions and the diffusion of CO through the volume of the reaction followed by adsorption of CO on the surface of steels and alloys. Adsorption is accompanied by catalytic relaxation of the bonds in the CO molecules by detachment of the O atoms on their chemical interaction with the medium.

**THE ELECTRODE POTENTIALS OF RADIOACTIVE SAMPLES OF "ARMCO" STEEL AND OF LOW-CARBON STEEL IN DISTILLED WATER AND IN AQUEOUS SOLUTIONS OF VARIOUS INHIBITORS**, Yandushkin, K. N., *et al.*, 1962. -- Samples of Armco steel and low-carbon steel were irradiated at a flux of  $0.87 \times 10^{13}$  n/cm<sup>2</sup>/sec. The specific activity of Fe<sup>59</sup> in the sample was 0.5 mc/g or 5 mc per sample. The electrode potential of the sample was measured at 25°C against a reference calomel half-cell at 10 and 30 seconds, 1, 5, 10, and 30 minutes, 1, 2, 3, 6, 10, and 18 hours, and 1, 2, 3, and 4 days in 100 ml of solution. The potential E of the radioactive samples was plotted versus lg t and was significantly more negative than the potential of the control samples. The difference in potential between the radioactive and control samples was 50 to 200 mv for Armco steel and 40 to 175 mv for carbon steel. This difference became smaller with time. The addition of NaNO<sub>2</sub> and C<sub>6</sub>H<sub>5</sub>COONa as inhibitors slows down the corrosion process, but significantly more inhibitor is required for the radioactive samples than for the control samples.

**CORROSION RESISTANCE OF CHROMIUM STEEL IN WATER AND STEAM AT CRITICAL PARAMETERS**, Gerasimov, V. V., *et al.*, 1963. -- Effects of water composition (oxygen, chloride, and sulfate), pH, and welding on the corrosion and electrochemical behavior of stainless steel alloyed with 3 to 25% Cr and up to 2% Mo and Ni were investigated.

**CORROSION RESISTANCE OF CHROMIUM-NICKEL STAINLESS STEELS IN SODIUM, AS A FUNCTION OF THE LATTER'S OXYGEN CONTENT**, Ilineev, Georgi; 1963. -- The action of liquid alkali metals, such as sodium, used as heat transfer agents, on structural materials at high temperatures, is considerably enhanced by the presence of impurities, such as oxygen or carbon. The solubility and the mass transfer processes are greatly accelerated by even very small amounts of O. This problem was studied in dynamic corrosion tests, attempting to determine the changes in the corrosion resistance of Cr-Ni stainless steels as a function of the O content of the Na while simulating the conditions which prevail in nuclear power stations. The tests were carried out in a pilot-plant scale loop, using 1 Cr-18 Ni-9 Ti type stainless steel for fabricating all the portions of the system coming in contact with the liquid metal. The high-temperature portion of the system was operated at  $550 \pm 5^\circ\text{C}$ ; the low-temperature portion at  $400$  to  $420^\circ\text{C}$ . Six different stainless steel specimens were placed in the sodium, the O content of which was kept at  $3 \times 10^{-3}$  and  $(4 \text{ to } 5) \times 10^{-2}\%$ , maintaining a flow rate of 1.5 m/sec. The results indicated that the corrosion rate of the 18-8 type stainless steels in Na with the higher O content does not exceed  $21.3 \text{ mg/dm}^2/\text{month}$ ; this type of steel was found not to be subject to intergranular corrosion and its mechanical properties were only slightly affected.

**MECHANICAL PROPERTIES AND CORROSION RESISTANCE OF HAFNIUM-ZIRCONIUM ALLOYS IN STEAM-WATER MEDIA**, Grebennikov, R. V., et al., 1963. -- Because of its excellent corrosion resistance in water up to  $360^\circ\text{C}$  and in superheated steam up to  $400^\circ\text{C}$ , Hf found uses as structural material in reactor technology; e.g., it was used in the Nautilus control rods. In order to reduce the cost of fabricating these components, the corrosion resistance of Hf alloys containing up to 50% Zr was investigated. The corrosion tests were carried out in a  $6\text{-cm}^3$  stainless steel container with water at  $350^\circ\text{C}$  and with water-steam mixtures at temperatures ranging from  $400$  to  $450^\circ\text{C}$ . The Hf alloys, containing 2 to 5, 25, 30, and 50% Zr were tested both in the annealed and the cold-worked condition. The mechanical properties of alloys were determined at  $20^\circ\text{C}$  before and after the corrosion testing. The results indicated that the alloys containing up to 30% Zr possess high corrosion resistance against water at  $350^\circ\text{C}$ . The mechanical strength decreased somewhat as the Zr content was raised from 3 to 25%. Extended exposure to water-steam mixture at  $400^\circ$  did not cause a marked deterioration of the physical properties of the Hf-3% Zr alloy. Thus, Hf alloys containing up to 30% Zr are recommended for use in contact with water at  $350^\circ\text{C}$ .

Corrosion of Metals, Alloys, etc.

- Andreeva, V. V. (1962) - 1 - electrochem. props. Ti, Zr, Ti-Zr alloys
- Byalobzheskiy, A. V. (1958) - 1 - rad. eff.
- Gerasimov, V. V. (1963) - 1 - steel
- Gratsianskii, N. N. (1963) - 1 - In-Pb, Fe-Ni
- Grebennikov, R. V. (1962-63) - 2 - Hf-Zr alloys
- Ilineev, G. (1963) - 1 - Cr-Ni steels in Na
- Kiselev, A. A. (1962) - 1 - Zr alloys in H<sub>2</sub>O, steam
- Krasnoyarskii, V. V. (1961) - 1 - protection of mats.
- Lyushenko, V. S. (1962) - 1 - steels, liq. Na, C
- Nikitin, V. I. (1963) - 1 - steel, liq. Na, 1000°C
- Ryabchenkov, A. V. (1962) - 1 - steels, steam, Ni-coating, Ni-hypophosphate
- Yandushkin, K. N. (1962) - 1 - steels, eff. of n-irrad., chg. in electrode potents.

VI. Nuclear Reactors, Accelerators, High Energy Physics,  
Transuranium Elements, Etc.

(from "Atomic Energy in the Soviet Bloc," George A. Modelski)

Between 1953 and 1956 the USSR Academy of Sciences and the Ministry of Medium Engineering shared responsibility for work in the atomic field, but technological development and the shifting emphasis (from military to peaceful uses, and from basic research to engineering development and industrial application) made it necessary to reconsider the administrative structure of nuclear affairs. In April 1956 power reactor research was transferred from the Academy of Sciences and the atomic industry to a new body, the Central Atomic Energy Authority.

The Authority was charged with the task of designing atomic reactors for power stations and other power installations, as well as with the supervision of scientific research work into the discovery of new ways of utilizing atomic energy. E. P. Slavsky was appointed as the first Head of the Authority, under the USSR Council of Ministers.

Although the functions of the Central Authority cover the civilian applications of atomic energy, they should not be regarded as equivalent to those of similar bodies in the U.S. and England (the USAEC or the UKAEA)—i.e., in contrast, they do not include nuclear weapons manufacture. The considerations that induced the Soviet leaders not to put under a single administrative roof the military and civilian aspects of Soviet atomic development may therefore be worth consideration.

The need to preserve atomic military secrecy was probably one reason. In the Soviet Union the development of atomic weapons has always been shrouded in absolute secrecy (the only official information is the announcement of tests), and secrecy could not be maintained so thoroughly if the organization in charge of the military uses of atomic energy was also supposed both to direct a far-flung program of industrial expansion and to remain in contact with atomic energy authorities of other countries. But the separation of the two organizations not only enhances the security of the military program and permits a relaxation of security and greater freedom in the civilian sector—freedom that is indispensable to vigorous large-scale national development; it also highlighted the 'peaceful' aspects of the Soviet program.

Also, by 1956, a division of functions began to emerge within the field: military aspects called for strict central control of all operations, while civilian functions demanded decentralization, nation-wide operations and the sharing of tasks among many and varied institutions. With the required production facilities constructed, the military program had become a routine manufacturing process, its problems not unlike those of ordnance production. But the uses of atomic energy for power, transport, and the countless fields where radio-isotopes find application, though only just emerging, were already promising far-reaching changes in all fields of national life.

It was not believed that two such very diverse fields of military and civilian technology, belonged within one common organization, even if

historically the one gave birth to the other. The implementation of a major industrial atomic program could not be entrusted to an organization already burdened with a task of equal national importance. An organ charged with vital national defense functions could not be expected to give full attention to industrial development; nor could it safely be left to determine the allocation of resources and the distribution of effort.

The Authority remains in touch with military requirements in two ways. First, it is a rival for scarce supplies of fissile materials, which have to be rationed between military and civilian uses. Second, it conducts or sponsors research on a number of projects of military application, such as the development of atomic ships and submarines, the design of small mobile power reactors, etc.

The Central Authority is by no means the only organization in the civilian atomic field. It is the chief driving force for industrial atomic growth, but its status--an Authority working directly under the USSR Council of Ministers--indicates that it is more a directing and co-ordinating body than an ordinary Soviet industrial ministry. In association with the central planning authorities, the State Scientific and Technical Commission and the Academy of Sciences, the Authority works on long-term plans for nuclear development; it co-ordinates annual departmental and other plans in the atomic field and assists production and research organizations (such as industrial ministries, the regional economic councils or the Academy). These efforts have been implemented by 'atoms for peace' exhibitions, the publication of an 'Atomic Energy' journal, and the opening of a number of research installations to visitors. In foreign relations the Authority advises the government on matters relating to the co-ordination of nuclear development throughout the Soviet bloc. It remains in close contact with the Soviet-bloc Institute of Nuclear Research in Dubna, with Atomic Energy Commissions elsewhere in the Soviet bloc and in the world, negotiates atomic assistance agreements, and controls international visits and other exchanges.

The Authority conducts its own research and development work, but, rather like the U.S. Atomic Energy Commission, it also farms out contracts to universities, research institutes, and other organizations, stimulating and broadening interest in atomic work. Pilot power reactors are built and operated by the Authority itself, but the large-scale industrial atomic power stations become the sole responsibility of the Ministry of Power Stations which, together with the regional councils, administers all non-industrial coal-fired or hydro-electric power plants in the Soviet Union. This practice paralleled the British and French experience, in which, after the development of prototype power reactors by the atomic energy authorities, the operating responsibilities for the large plants were given to the nationalized electricity undertakings. The preliminary testing, the selection of new types, and the development of power reactors in order to discover their handling characteristics and economic feasibility is, with the costs and risks inherent in this process, thought to be a task more suitable for a national research organization than for a body that operates power stations and distributes electric power.

Papers in basic nuclear and reactor physics presented at the Geneva conferences of 1955 and 1958 show that in their experiments the Soviet scientists have covered roughly the same ground and have arrived broadly at the same results as scientists in American and British laboratories. The Russians had performed excellent measurements of neutron beam density and studies of neutron decay. Although the Russians covered nearly all the types of neutron cross-section experiments that had been attempted in the West, their experiments were on the whole less elaborate. They were considered to be good on reactor theory, though less so on certain refinements. Although the quality and range of scientific information presented at the conference showed that the U.S.A. was ahead of the USSR, it also showed that the Russians had made rapid progress in the previous ten years, and that their efforts were being accelerated.

Since the completion of the first Soviet reactor in about 1947, an entire range of research and development reactors has been completed in the USSR. The number of reactor systems developed there is believed to be smaller than in the US, and although it represents quite a well-rounded range of reactor types it is by no means as extensive as that explored by research in the US.

The first Soviet reactor, a uranium-graphite experimental pile, became the starting-point for an important series of Soviet reactor projects. The first Soviet reactors to produce weapon-quality plutonium were, presumably, developments of the uranium-graphite system, most probably with light water cooling, thus following the United States precedent. The other important development of the original uranium-graphite pile was a powerful enriched uranium-graphite and water-moderated reactor for physical experiments and fuel element tests called 'RFT'. This reactor showed the early Soviet concern for obtaining a tool to investigate fuel elements; it was an essential foundation of the Soviet nuclear power program. Design work on it started soon after the completion of the first pile, probably in 1948, and a water-cooled and water-moderated model was operated in the spring of 1950, but because it was then decided to provide better facilities for fuel elements tests, the reactor was enlarged and a new design completed in September 1950; operation began in April 1952.

A further development of the RFT reactor and of the experience gained in operating the uranium-graphite-water reactors for weapon production was the Atomic Power Station (APS) of the USSR Academy of Sciences. This reactor was constructed in order to accumulate technical and economic experience with atomic power plants, to serve as a basis for wider nuclear power development. Completed in 1954, it used pressurized water as coolant, 5 per cent enriched uranium as fuel and graphite as moderator; a much larger station using the same system was expected to be completed by 1960. A further variant of this basic uranium-graphite system was to be a pilot power reactor in which the water-coolant of the APS would be replaced by sodium, a liquid metal.

When it was decided to redesign the RFT reactor to give greater emphasis to fuel element testing, work on a water-cooled and water-moderated research reactor was continued separately at the USSR Academy of Sciences and, after the completion of a zero-energy version, led to the design of a 300 kW experimental reactor that used 10 per cent enriched uranium as fuel. This

reactor was probably completed by 1953, and it is presently employed at the Moscow University for shielding studies, radio-isotope production and various physics investigations. Using the experience gained in building and operating this reactor, the engineers designed another, more powerful, pile, also water-cooled and water-moderated, equipped with good experimental facilities and also suited for radio-isotope production. During 1955 and 1956 seven of these reactors were sold to other Soviet-bloc states and to Egypt for installation at their research institutes.

The Kurchatov Institute devoted a great deal of time to water-cooled reactors. With experience gained in the operation of water-cooled plutonium production piles and of the water-cooled and water-moderated (P-621) experimental reactor, and, presumably, in some zero-energy experiments, two large water-cooled, water-moderated power plants were to be built in the USSR. The reactor of the atomic ice-breaker, the first Soviet nuclear propulsion unit, is water cooled.

Studies carried out since the early fifties on the plutonium breeder experimental reactor provide the data required for building the fast plutonium breeder power reactor planned for 1960.

The other important Soviet reactor family is based on heavy water. The first Soviet heavy water reactor was designed under A. I. Alikhanov and V. V. Vladimirovsky as early as 1947 and went into operation in April 1949. In conception it is close to the Chicago CP-5 and the Canadian NRX pile, though it is smaller than the NRX. The fuel originally used was natural uranium, but after the reconstruction carried out in 1956 this was replaced by 2 per cent enriched uranium, with the result that the reactor's power was raised from 0.5 to 3 MW.

A heavy water nuclear power station of large capacity was to be built in the USSR by 1961; but since a large plant of this kind could not easily be developed without previous experience with pilot reactors of the same system built for a different purpose, it may be assumed that in building this power station the USSR would be drawing on her experience in designing and operating powerful production reactors.

The completion of a homogeneous thorium breeder pilot power reactor using heavy water as moderator was scheduled for 1960. At Geneva, plans for homogeneous reactors of this type were described by a team led by Alikhanov, and although heterogeneous thorium breeder systems using ordinary water are under investigation at Kurchatov's institute, the homogeneous heavy water project stems from earlier work on the Alikhanov-Vladimirovsky heavy water reactors and can be regarded as part of the 'heavy water' family.

In 1955-6 the USSR sold two heavy water research reactors of a new design, one to Communist China and one to Yugoslavia. Basically they were developments arising from the first heavy water research reactor, but their thermal power was higher (6.5 MW), and could be raised to still higher levels. Heavy water was used as coolant and moderator, and uranium rods containing 2 per cent U-235 served as fuel. Other Soviet research establishments may also be equipped with this reactor designed for the simultaneous carrying out of a large number of experiments.

The most up-to-date among new Soviet reactors is a high-flux reactor described in recent Soviet reports as the 'impulse' reactor. The first of these was commissioned at the neutron physics laboratory of the Joint Institute of Nuclear Research at the end of 1958. Slavsky, then head of the Atomic Energy Authority, said that, of the various types of reactors designed in the Soviet Union, the 'impulse' reactor was the most interesting. 'This reactor' he said 'is most compact and economical. Its average capacity is not great, but at the moment of the impulse it produces a tremendous flux of neutrons and during this period it develops the power of tens of millions Kw.' The design of this reactor was to be further elaborated, and there were indications that it might be developed as a power unit.

Research workers in the Soviet Union have thus been provided with a basic range of research reactors and have developed with their help a number of further reactor types. As far as is known (and a number of Soviet zero-energy and pilot reactor projects have certainly remained secret), the Soviet Union is not as well provided with research reactors as the United States. Nonetheless, in the absolute number of reactors and in the number of reactor systems developed it was considered second only to the USA, and its weapon program and export commitments of nine research reactors for 1956-8 indicate a considerable reactor production capacity.

Reactor research was originally concentrated in or around Moscow, with perhaps another center in a weapon research establishment east of Moscow. Efforts were then made to disperse reactor-based research throughout the USSR. The building of reactors at Tashkent, Tomsk and Alma Ata will bring reactor technology to Soviet Asia and to territories that are the chief producers of nuclear materials; the provision of a reactor at Tbilisi was planned to further nuclear techniques in the Caucasus region. The experimental reactors of research institutes were intended to serve the development of technologies; the reactors to be newly installed at Moscow University and the Moscow and Tomsk technical institutes were used primarily for instruction and demonstration purposes, and secondarily for research; their numbers, though, were considered modest in comparison with upwards of 20 reactors to be installed at United States universities.

(Soviet High-Energy Machines)

For the past thirty years accelerators have been the basic research tool of nuclear physicists and they remain the chief instruments whereby basic nuclear physics research is carried into ever new regions. Soviet institutes are well supplied with a variety of large accelerators. They also have quite a number of the smaller accelerators, and in 1957 they put into operation a 10,000 MeV machine they call the 'synchrophasotron', which developed somewhat higher power than the Berkeley bevatron, and which for the next few years was the world's most powerful machine of its type.

The 'international' Joint Institute of Nuclear Research in Dubna formed by the merger of two Academy research establishments, is now assuming the role of the major Soviet high-energy physics centre, the Soviet equivalent of the Radiation Laboratory in Berkeley, California. Under Skobeltsyn,

the Lebedev Physical Institute in Moscow has become the other major nuclear physics centre; its members have pioneered the design of new accelerators. Since 1950 the Institute of Chemical Physics, also in Moscow, has been working on linacs in which high beam currents of the order of a hundred milliamperes could be accelerated; this work pursues a line of development started by N. N. Semenov, and parallels similar work carried out at Berkeley. At Kharkov, scientists were also specializing in the construction of linacs: under Sineinikov and Valter the Physico-Technical Institute has designed a 30 MeV linear accelerator and has proposed a new idea for a heavy ion accelerator. To improve research and teaching facilities at universities throughout the country, nuclear laboratories with cyclotrons and betatrons are being established at provincial universities, and in Georgia and Armenia.

The steady building of ever new types of large particle accelerators in the Soviet Union is evidence of recent massive government support for high energy physics research. It also indicates the up-to-date experimental facilities available in the Soviet Union, the engineering standards of Soviet industry, and the technical ingenuity of its scientists. Among the more ingenious projects being pursued was A. A. Naumov's 200 MeV model of a powerful 1,000 Mev electron synchrotron of very small dimensions, based on an exceedingly simple magnetic system, and G. I. Budker's theoretical and experimental work which would hopefully enable magnetic fields of unusually high strength to be realized. These strong magnetic fields may contain the clue to the unprecedentedly powerful and yet much less costly accelerators of the future, and the interest aroused by Budker's papers at the Moscow and Geneva conferences of 1956 showed how valuable such machines might be. Experiments designed to confirm theory are still at an early stage but the enthusiasm of the theoreticians and the scale of the effort being put into the problem indicate that notable advances might be forthcoming. In 1958 Naumov's and Budker's research teams were transferred to the new Novosibirsk research center to form the hard core of the Nuclear Physics Institute and to continue work on new types of accelerators and on ways of controlling thermonuclear reactions.

In the general availability of accelerating machines (and ignoring the respective degree of their utilization) U.S. sources have been considered as unquestionably superior. In 1956-7 the United States' 15 synchrocyclotrons compared with approximately 4 Soviet machines, and its total of nearly 20 cyclotrons compared well with the 7 cyclotrons built or planned in the USSR. The U.S. had 6 betatrons of large capacity (20 MeV and over) while the USSR had over 20 of all capacities. In linacs the relation was about 7:2 or 7:3, and in heavy particle linacs, 3:1. Soviet figures for Van der Graaff accelerators were not available, but the general ratio of 3:1 was unlikely to be different—there were approximately thirty such research machines in the United States.

Though U.S. superiority seemed clear on the score of the general availability of these machines, the race for the construction of the 'biggest yet' accelerator has at times favored the USSR. In 1939, having just completed the 60-inch cyclotron, Berkeley had in operation the biggest machine of this type in the world, but in 1940 the Russians had already begun to lay plans for a machine producing 50 MeV, this is, three times the energy of the

60-inch cyclotron. Owing to the war nothing came of these plans and after the end of the war Berkeley produced an even larger cyclotron, the 185-inch machine giving beam energies ranging from 200 to 400 MeV. But it was not long before a yet bigger machine was produced in the Soviet Union: the 6-metre proton synchrotron at Dubna was capable of accelerating protons to energies of 680 Mev. Commissioned in 1949, it was the world's most powerful particle accelerator until the Brookhaven cosmotron was put into operation in 1953. Its design embodied for the first time the principle of phase stability formulated by Veksler in 1944, but it was built by a team led by D. M. Efremov, M. G. Mescheriakov and A. L. Mints. The existence of this machine was not known until late in 1954 when a scientific journal published six papers describing experiments conducted with it. New and interesting data, including studies of the transuranium elements, were obtained about processes in the previously unexplored energy region between 380 and 660 Mev. Published work has also indicated considerable interest and theoretical work in searches for a unified field theory, the development of which might be expected to have far-reaching fundamental value in the understanding of nuclear media, "new particle" physics, solid-state physics, etc.

In 1955 Berkeley's leading position was once again re-established with the commissioning of the world's biggest proton synchrotron, the 6-7 GeV bevatron; and interesting results were soon produced in the shape of a new particle, the anti-proton, discovered with its help. But again the Russians were already building something bigger, a 10 GeV proton synchrotron at Dubna, called the 'synchrophasotron'. Problems involved in building it were first studied on a 180 MeV model; the full-scale machine was then built by a team under Veksler, Mints and Efremov. The magnet of this giant weighed 36,000 tons (as compared with 7,000 tons of the 6-metre synchrocyclotron) and had a radius of 30 metres. The design was conventional, but Western visitors who inspected the machine spoke highly of the quality of its engineering and observed that in the building of this machine, more attention had been paid to ensuring its normal working than to economizing of materials. After trials lasting for nearly a year the first proton beam, whose speed practically equals that of light, was obtained in April 1957, and the designed power of 10 GeV was ultimately reached. The synchrophasotron enabled Soviet scientists to carry out research in the GeV range and to repeat some of the American experiments with the bevatron; it was expected to remain the world's most powerful accelerating machine only until the completion in the early 1960's of the 15 GeV proton synchrotron at the Argonne National Laboratory, Chicago, the 10 GeV proton synchrotron of a novel design at Canberra, and also of the 25 GeV machine at Geneva.

Even higher energies are being sought by means of more powerful machines now on the drawing boards. In the USSR, a team under Vladimirovsky, E. G. Komar and A. L. Mints were working on the preliminary design of a 50-60 GeV machine. As a pilot-study for the bigger machine, a 7 GeV proton synchrotron was designed to test the working of the new principle of 'strong focusing' to be applied in the bigger machine. The big accelerator would consist of a ring, nearly 5,000 feet in circumference, made up of about 120 magnets. Thanks to the use of the new method, the magnet would weigh only 22,000 tons, thus requiring less steel, and consuming less electric power than the 10 GeV model.

The stimulus to build ever more powerful accelerating machines usually comes from cosmic radiation research. For the higher energy ranges reliance still has to be placed on field observations of cosmic radiation with various kinds of instruments. Skobeltsyn early distinguished himself in cosmic ray research and, ever since, considerable practical and theoretical work in this field has been carried on in the USSR. The fundamental theoretical objective of this research is to discover new elementary particles and to study their interactions, but knowledge of cosmic radiation is also crucial for work on long-range missiles and space rockets. Cosmic ray research was continued even during the most critical years of the war; towards the end of it the Academy of Sciences established under Alikhanov a Commission on Cosmic Rays. A series of cosmic ray stations now carry out observations throughout the Soviet Union. Through the Commission on Cosmic Rays, the USSR Academy of Sciences co-ordinates the cosmic radiation research of all the Soviet-bloc research institutes, ensuring that cosmic ray research in the Soviet bloc is extensive and well equipped.

The Three Major Reactor Types for Large-Scale Development  
by the USSR

(from Atomic Energy in the Communist Bloc, George A. Modelski, 1959)

- 1) Blokhintsev (water-cooled, graphite-moderated, slightly enriched U)
- 2) Kurchatov (water-cooled, water-moderated, natural and enriched U)
- 3) Alikhanov-Vladimirsky (gas-cooled, heavy water-moderated, natural U)

Some Soviet Reactors and Fuel Types

(from Jaderna Energie 5, 1959)

FIRST SOVIET (1 Mw), 1944

Thermal, heterogeneous, graphite, cooled with pressurized water;  
FUEL: 45 t natural U in rods with diameter of 30 to 40 mm and small quantities of U-oxide pellets.

TR, TVR (2.5 Mw) 1949

Moscow (Institute of Heat Technology); therm., hetero., heavy water;  
flux,  $2.5 \times 10^{13}$ ; FUEL: 2% U-235 (275 kg), Al-clad elements.

RFT (15-20 Mw) 1952

Moscow, Atomic Energy Institute; therm., hetero., graphite, cooled with pressurized water; flux,  $2-4 \times 10^{14}$ ; FUEL: 90% U-235, cermet elements.

IR (50 Mw) 1952

radioisotope production; therm., hetero., graphite; flux,  $3-4.5 \times 10^{13}$ ;  
FUEL: U enriched to 2% U-235 (3t).

X-2\* (30 Mw) 1954

Obninsk (near Moscow); therm., hetero., graphite, water cooled, with pressure tubes; flux,  $5 \times 10^{13}$  average; FUEL: fuel elements are stainless steel clad tubes.

VVR-2 (3 Mw) 1957

Moscow; therm., hetero., pressurized water; flux,  $4 \times 10^{13}$ ; FUEL: 10% U-235 (4.5 kg U-235).

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\*writer's designation

VVR-S (2 Mw) 1957-8

Rumania, Czechoslovakia (in Rezi at Prague), East Germany (Rossendorf at Dresden), Poland (Swierk at Warsaw), Hungary (Budapest), Egypt; therm., hetero., pressurized water; flux,  $2 \times 10^{13}$ ; FUEL: 10% U-235 (60 kg).

IRT-2000 (2-2.5 Mw) 1957-8

Moscow (Atomic Energy Institute), Tbilisi, Sverdlovsk, Minsk, Tomsk, etc., therm., hetero., pressurized water, pool; flux,  $3.2 \times 10^{13}$ ; FUEL: 10% U-235, UO<sub>2</sub> with Mg, Al-clad elements.

X-4\* (~100 Mwe) 1958

Siberia; therm., hetero., graphite, water-cooled, high power output; FUEL: natural U (200 t), Al-clad.

BN-50 (50 Mwe) 1958

Ulyanosk region (on the Volga); fast, Na cooled; fast flux,  $9 \times 10^{15}$ ; FUEL: Pu.

KS-150 (590 Mw) 1958

Slovakia (Bohunice, district of Trnava); therm., hetero., heavy water, CO<sub>2</sub> cooled; FUEL: natural U fuel pins of 4 mm diam., clad with Mg-Be alloy.

BR-5 (5 Mw) 1958

fast, hetero., Na, experimental power; flux,  $10^{15}$ ; FUEL: (a) PuO<sub>2</sub> pellets in stainless steel tubes, diam. 5 x 0.4 mm; (b) U rods, wrapped with Mo wire and inside stainless steel tubes, coated with Na-K alloy.

X-6\* (2 Mwe) 1958

Obninsk (Moscow region); power prototype of low output for portable central station; therm., hetero., pressurized water, pressure vessel; FUEL:

X-5\* (50 Mwe) 1958-9

Ulyanosk region (on the Volga); therm., hetero., graphite, Na cooled; FUEL: U, slightly enriched, stainless steel cladding.

VVER-210 (760 Mw) 1958-9

Voronezh region (2), Leningrad region (2); therm., hetero., pressurized water, pressure vessel; FUEL: UO<sub>2</sub> enriched to 1.5% U-235 (40 t), UO<sub>2</sub> pellets clad with Zr alloy.

TVR-S (7-10 Mw) 1958-9

China (Peking), Yugoslavia; therm., hetero., heavy water; flux,  $5.5 \times 10^{13}$ ; FUEL: 2% U-235 (340 kg).

VVR-M (10 Mw) 1959

Leningrad; therm., hetero., pressurized water; flux,  $1 \times 10^{14}$ ; FUEL: 20% U-235 (UO<sub>2</sub> and Al, cermet elements in hexagonal and cylindrical tubes.

X-7\* (50 Mwe) 1959

Ulyanosk region (on the Volga); therm., hetero., pressurized water, boiling water; FUEL: UO<sub>2</sub> enriched to 1.5% U-235, UO<sub>2</sub> pellets clad with Zr alloy.

X-8\* (35 Mw) 1959

Ulyanosk region (on the Volga), power testing of low output; therm., homogeneous, D<sub>2</sub>O coolant, boiling water; FUEL: UO<sub>2</sub> suspension, Th.

VVR-C (10-20 Mw) 1959

therm., hetero., pressurized water; flux,  $1 \times 10^{14}$ ; FUEL: 20% U-235, UO<sub>2</sub> and Al, cermet elements.

IRT-1000 (1-1.7 Mw) 1959

Bulgaria; therm., hetero., pressurized water, pool; flux,  $1.2 \times 10^{13}$ ; FUEL: 10% U-235 (60 kg).

X-1\* (50 Mw) 1959

intermediate, hetero., pressurized water, press. vessel; flux,  $2.2 \times 10^{15}$ ; FUEL: 90% U-235, in box sub-assembly containing 54 flats of 0.5 mm thickness and spaced at 1.65 mm.

Lenin Ice-Breaker (90 Mw) 1959

Built in Leningrad; therm., hetero., pressurized water, pressure vessel; FUEL: UO<sub>2</sub> enriched to 5% U-235 (85 kg U-235), UO<sub>2</sub> pellets clad with Zr alloy.

X-3\* (285 Mw) 1959-60

Beloyarsk (in the Urals), power plant with 4 reactors; therm., hetero., graphite, cooled by water and steam, pressure tubes; FUEL: 1.3% U-235 (90 t), tubular elements.

VVER-70 (70 Mwe) 1961

East Germany (north of Berlin); therm., hetero., pressurized water, pressure vessel; FUEL: UO<sub>2</sub> enriched to 1.4-1.7% U-235, UO<sub>2</sub> pellets clad with Zr alloy.

SM-2 (40-50 Mw) 1961

New Melekes, Institute of Atomic Energy Reactors, high-flux reactor; therm., hetero., beryllium oxide reflector, cooled with pressurized water; flux (unperturbed),  $2.2 \times 10^{15}$ ; FUEL: 90% U-235, 35 vol % UO<sub>2</sub>, 65 vol % Ni, plates, Ni-clad; each element contains 650 g U-235.

Physics, Reactor Studies, etc.

The following abstracts illustrate briefly some of the Soviet work in physics and related areas.

SHOCK WAVE INTERACTIONS WITH SHIFTING BOUNDARY IN ELASTIC-PLASTIC MEDIUM, Lyakhov, G. M., et al., 1962. -- Data on shock wave interaction with shifting elastic-plastic boundaries ( $\sigma = \sigma(\epsilon)$ ) at small intensities were used for analyzing the problem of plane shock wave interactions with shifting obstructions or boundaries at high energies.

NEUTRON PULSE FORM AND TRANSMISSION FUNCTION OF TWO-ROTOR NEUTRON CHOPPER. I. THE NEUTRON CHOPPER WITH FLAT SLITS, Vertebni, V. P., et al., 1962. -- A method is described for calculating the neutron pulse and the transmission function of a two-rotor neutron chopper. Transmission-function formulas are presented for cases of different distances between the rotor and different angular phase shifts.

PLANE DETONATION WAVES IN GROUND EXPLOSIONS, Lyakhov, G. M., et al., 1962. -- Detonation waves near ground explosions were studied and correlations were made of plane and spherical wave parameters. The relation between wave parameters and water and air contents in the ground was determined.

ISOTOPIC EFFECTS IN THE STRUCTURAL PROPERTIES OF SOLIDS, Kogan, V. S., 1962. -- In general, the lattice parameter of a compound decreases when hydrogen is replaced by deuterium. Lattice parameters are given and compared for the following pairs:  $\text{HfH}_2$  and  $\text{HfD}_2$ ,  $\text{NH}_4\text{Cl}$ ,  $\text{NH}_4\text{Br}$  and  $\text{ND}_4\text{Br}$ ,  $\text{NH}_4\text{I}$  and  $\text{ND}_4\text{I}$ ,  $\text{KH}_2\text{PO}_4$  and  $\text{KD}_2\text{PO}_4$ ,  $\text{KHF}_2$  and  $\text{KDF}_2$ ,  $\text{CO}(\text{NH}_2)_2$  and  $\text{CO}(\text{ND}_2)_2$ , and various carboxylic and hydroxy compounds. The replacement of hydrogen by deuterium generally results in a rise of the linear expansion temperature coefficient. If a polymorphic transformation is involved, this replacement causes a shift in the critical temperature of the transformation. The low-temperature transformation of the ammonium halides is discussed. After reviewing the equipment required to determine lattice parameters at liquid hydrogen or helium temperatures, the various transitions and lattice parameters are given for  $\text{He}^3$ ,  $\text{He}^4$ ,  $\text{Li}^6$ ,  $\text{Li}^7$ ,  $\text{Ne}^{20}$ ,  $\text{Ne}^{22}$ ,  $\text{Ni}^{53}$ ,  $\text{Ni}^{64}$ , and the hydrogen isotopes. Theoretical explanations of the isotopic effect in solids are based on the difference in zero energies for two isotopes that differ only in mass. The differences in lattice energies are given as a function of temperature and various binding energies for a number of isotopes. Phase diagrams are given for the hydrogen isotopes.

THE INFLUENCE OF THE ELECTRON CESIUM PLASMA ON CHARACTERISTICS OF A THERMOELECTRON TRANSFORMER, Morgulis, N. D., et al., 1962. A special transformer cell with independent arc discharge and incandescent tungsten cathode was introduced into an intra-electrode cesium plasma in order to eliminate the interference of the plasma with cell performance.

**$\gamma$ -RADIATION FROM HIGH-SPIN NUCLEI, Oganesyan, Yu. Ts., et al., 1963.**

-- The energy spectra of the  $\gamma$  rays produced in the interaction of accelerated  $O^{16}$  and  $Ne^{22}$  ions with Cu, Ta, W, and U nuclei are investigated in the  $74$  to 145 Mev energy range with help of a single-crystal scintillation spectrometer. In each decay of the compound nucleus, up to 13  $\gamma$  quanta with energies from 0.7 to 1.1 Mev were observed. The effect of the spin of the excited nucleus on the decay mechanism is discussed.

**DETERMINATION OF CRITICAL THERMAL FLUXES IN TUBES OF HIGH-BOILING COOLANT, Sterman, L. S., et al., 1963.** -- Critical heat flux values for monoisopropyl diphenyl boiling in pipes at 3, 5, and 7 atm of pressure, 4 to 8 m/sec flow rate, and 0 to 170°C ranged from  $1.5 \times 10^6$  to  $4.5 \times 10^8$  kcal/m<sup>2</sup>·hour. The data showed that the universal formulas are not sufficient for determining the heat flux of boiling organic fluid.

**THE COMPTON EFFECT ON RELATIVISTIC ELECTRONS AND THE POSSIBILITY OF OBTAINING HIGH ENERGY BEAMS, Arutyunian, F. R., et al., 1963.** -- When light photons are scattered on extremely relativistic electrons, the energies of the scattered photons are of the same order of magnitude as those of the electrons. The possibility of exploiting this feature for obtaining high energy  $\gamma$  beams in electron accelerators is considered. To obtain  $\gamma$  beams by this method high photon fluxes are required. Ruby lasers are discussed as a high intensity photon source.

Physics, Reactor Studies, etc.

- Aleksandrov, A. Yu. (1963) - 1 - spectra, organotin comp'ds, Mossbauer meth.
- Al'tshuler, A. A. (1962) - 1 - ionic cryst., spin-lattice relax.
- Andiankin, E. A. (1962) - 1 - explos., propag., hydrodyn.
- Antonov-Romanovskii, V. V. (1949) - 1 - phosphors, stoppage of light sum
- Arutyunian, F. R. (1963) - 1 - accelerators,  $\gamma$  beams, scattering from relativistic electrons
- Atsarkin, V. A. (1962) - 1 - theory, paramag. reson., Cr(III) ion
- Bak, M. A. (1959) - 1 - Ru-103, Ru-106, yields in U-235, Pu-239 fiss.
- Babenko, V. P. (1962) - 1 - cryog., nuc. quadrupole resonance spectra
- Bakhrakh, L. E. (1962) - 1 - electron beam focusing
- Bereznyak, N. G. (1962) - 1 - cryog. He isot.
- Garif'yanov, N. S. (1962) - 2 - glasses, EPR
- Kariss, Ya. E. (1963) - 1 - Laser action, Nd in  $\text{SrF}_2$  cryst.
- Kartashov, N. P. (1961) - 1 - ioniz. current from Ru
- Keylis-borok, V. I. (1962) - 1 - detect. of nuc. explos.
- Kogan, V. S. (1962) - 2 - cryog., sol-liq. H isot., struct. prop.
- Kondurov, I. A. (1962) - 1 - VVR-M, short-lived isotopes
- Kovrigin, O. D. (1963) - 1 - Eu-147, int. convers. spect.
- Krisiuk, I. T. (1960) - 2 - 14 Mev neutrs., F.P. yields
- Kuraev, E. A. (1963) - 1 - coalesc. of photons in nuc. coul. fields
- Kuz'minov, Yu. S. (1963) - 2 - Yt, magn. of ferrite, n-scattering
- Kuznetsov, K. F. (1962) - 1 - instr.
- Kuznetsova, M. Ya. (1961) - 1 - p-irrad., Te-127, I-127
- Likhachev, M. F. (1963) - 1 - instr., Cherenkov counter
- Liskovich, O. B. (1963) - 1 - instr., NaI, Tl crystals, temp.

Physics, Reactor Studies, etc., continued

- Lyakhov, G. M. (1962-63) - 2 - ground explosions, shock waves
- Mamyrin, B. A. (1962) - 1 - instr., mass spectrom.
- Mashkovich, V. P. (1962) - 1 - n-activat., threshold indicators
- Mednyak, V. N. (1962) - 1 - electrolyt. prep. of Cr foils
- Morgenstern, Z. L. (1963) - 1 - luminesc., alk. iodides
- Morgulis, N. D. (1962) - 1 - thermoelect. transformer, Cs plasma
- Muuga, I. (1962) - 1 - luminesc., phosphors,  $\text{Ca}_3(\text{PO}_4)_2$ -Mn, Ga, In
- Nerserov, I. L. (1962) - 1 - explosions, seismic waves
- Nikolaev, V. I. (1963) - 1 - Mossbauer eff.,  $\text{FeSn}_2$
- Oganesyan, Yu. Ts. (1963) - 1 -  $\gamma$ -rad., high spin nuclei
- Okhotsimskii, D. E. (1962) - 1 - explosions, air, shock waves
- Panasyuk, I. S. (1961) - 1 - theory, age of elements, radioact. decay
- Pankratov, V. M. (1963) - 1 - fiss. x-sects, 3-37 Mev n's, Th, U, Np isots.
- Predvoditelov, A. S. (1963) - 1 - explos., shock waves, etc., book
- Preobrazhenskii, N. G. (1963) - 1 - opt. spect., plasma inhomogeneities
- Roginskaya, Yu. E. (1963) - 1 - magn. meas., La, Bi, Fe, O syst
- Romanova, T. A. (1962) - 1 - fission, instr.,  $\text{UO}_2$ -acetate emulsion
- Smirnova, V. I. (1963) - 1 -  $\gamma$ -rad. eff., acetylene, EPR, 77°K
- Stakhov, E. A. (1962) - 1 - plasmas, super-high gas disch. attenuation
- Sterman, L. S. (1963) - 1 - react. mats., org. coolant, monoisopropyl diphenyl
- Tuchkevich, V. V. (1963) - 1 - 660 Mev p on Ta; Lu-169, 172; spectra
- Valiev, K. A. (1963) - 1 - theory, liq., magn. relax., molec. shape
- Vertebni, V. P. (1962) - 2 - neutron monochromator, chopper
- Volkenshtein, N. V. (1963) - 1 - Dy, Er, trans. of magn. props.
- Zaients, S. L. (1962) - 1 - spark discharge devices, controlled

Physics, Reactor Studies, etc., continued

- Zakharchenya, B. P. (1962-63) - 2 - emission spect.,  $\text{CaF}_2\text{-Eu}^{2+}$ ,  $\text{SrF}_2\text{-Sm}^{+2}$
- Zakharchenko, V. F. (1962) - 1 - geophys., well-logging, pulsed neutrs.
- Zhitkevich, V. F. (1963) - 1 - opt. spect., air-acetylene flame, anomalous excit.
- Zverev, G. M. (1962) - 1 - cryog., instr., radiospectroscope, paramagn. reson.
- See also Bessonov, Bovrovskiy, Galkin, Gerling, Gerlit, Gordeyev, Gorshkov, Kalyamin, Kondrat'ev, Laurukhina, Murin, Oganov, Pasztor, Petrzhak, Polikanov, Protopopov, Shvedov.

Heat Transfer

- Alad'ev, I. T. (1961) - 3 - water, tubes  
Konkov, A. S. (1962) - 1 - boil., tubes  
Kosterin, S. I. (1960) - 1 - gas, dynamics, convective  
Kutateladze, S. S. (1959) - 1 - hydrodynamic theory  
Luikov, A. V. (1963) - 1 - bibliography  
Morosov, V. G. (1962) - 1 - org. liquids, heating surfaces  
Rybin, R. A. (1962-63) - 2 - boiling liq., channels, hydrodyn.  
Smolin, V. N. (1962) - 1 - steam generat. tube  
Subbotin, V. I. (1962) - 1 - liq. Na, 190-310°C, in tubes  
Zenkevich, B. A. (1962) - 1 - channel geom., ht loads

Shielding Methods, Designs, etc.

- Desov, A. E. (1962) - 2 - concrete

Instruments

- Adam, A. (1962) - 1 - fast-n ioniz. chamber
- Andreyev, E. P. (1961) - 1 - therm.-n scintillator
- Androsenko, D. (1962) - 1 - simple isodose n-detector
- Artem'ev, V. V. (1962) - 1 - radiomet. apparat., effic., criteria
- Arutyunian, E. A. (1963) - 1 - magnetic  $\gamma$  spectrometer
- Doroshenko, G. G. (1963) - 3 - neutrs,  $\gamma$ 's
- Egorov, A. F. (1959) - 1 - actuator, manipulator, rad. handling
- Gorbachev, V. M. (1962) - 1 - nanosec. pulse gen.
- Kelman, V. N. (1962) - 2 - prism.  $\beta$ -spectrom.
- Kocarov, G. E. (1961) - 1 -  $\alpha$ -spectrom.
- Kocharov, G. E. (1963) - 1 - proportional counters
- Lukirskii, A. P. (1963) - 3 - soft x-ray counters
- Listengarten, M. A. (1963) - 1 -  $\beta$  spectrometer
- Mateev, V. V. (1962) - 1 - scint. count., photomult. tubes
- Mikhailchenko, G. A. (1962) - 1 - dosimetry,  $\beta$  source calibr.
- Milevskii, E. B. (1962) - 2 - radioact. meas., component diameters
- Morasova, N. G. (1957-62) - 2 - U spectra,  $\gamma$  dosimetry
- Nagornaya, L. I. (1962) - 1 - photoluminesc., polymers, scintillation
- Narbutt, K. I. (1962-63) - 2 - prop. counters, x-ray spectra
- Nekrashevich, I. G. (1960) - 1 - dosimetry, semicond. electronics
- Ofengenden, R. G. (1962) - 2 - pulse analyzers
- Ozhdyan, L. (1962) - 2 - scint., photomult.
- Panchenko, A. M. (1963) - 1 - small counter, dosimetry
- Pasztor, E. (1961) - 1 - ion sources
- Petrzhak, K. A. (1959-61) - 2 - counters, studies of fiss. fragments
- Prokopets, G. A. (1963) - 1 - n-detect.,  $\gamma$ -background, scint., stilbene
- Rakhovskii, V. I. (1960) - 1 - mass spectrom., ion current meas.

Instruments, continued

- Samokhalov, A. A. (1961) - 1 - rad. detectors, Se photocell, etc.
- Sanin, A. A. (1961) - 1 - elect. equip. used in nuc. phys., book
- Savosin, S. I. (1961) - 1 - radio-logging, oil, pulsed n-generator
- Semenov, A. G. (1962) - 1 - spectrometer, EPR
- Sen'ko, A. K. (1962) - 1 - well-logging,  $\gamma$ -n, Be
- Sergienko, V. A. (1962) - 1 -  $\gamma$  spectrometers
- Shaevich, A. B. (1962) - 1 - basic terms in lit.
- Shipitsin, F. N. (1960) - 1 -  $\beta$  counters,  $\gamma$  background, scint.
- Sinaev, A. N. (1962) - 1 - multichannel pulse analyzer
- Stavisskii, Yu. Ya. (1962) - 1 - scint. counter,  $\text{CaF}_2$  cryst.;  $\gamma$ 's, pres. of  
n's
- Stolyarova, E. L. (1962) - 1 - fast n-spect., n-dosimetry
- Sumbayev, O. I. (1963) - 1 - Cauchois spectrom., n-capt.,  $\gamma$ -rad. res
- Timofeyeva, L. P. (1961) - 1 - calorimeter, meas. act. of non-std. Ra sources
- Vishnevskii, V. N. (1963) - 2 - NaI-Tl cryst., x-ray luminesc.
- Vlasov, A. D. (1962) - 1 - Klystron, amplif. cascades
- Vyazemskii, V. O. (1961) - 1 - radiometry, scint. methods, book
- Vylkov, N. (1962) - 1 - scint. detectors, semi-conductors
- Zaytsev, E. I. (1961) - 1 -  $\beta$ -counter, scint.
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Joint Institute for Nuclear Research, Dubna

In March, 1956, by agreement between the U.S.S.R. and 11 satellite nations to collaborate in the field of nuclear physics, the "Joint" Institute was projected for research and development on nonmilitary applications of atomic energy. The final charter was signed in September, 1956.

The Institute functions under the guidance of a council of authorized representatives of its member nations, meeting annually to confirm both administrative and financial structure. At all other times, administration is performed by a directorial staff comprising of a Director, elected for a term of three years, two Vice Directors, elected for terms of two years, and a Scientific Council, which decides upon the research program and issues periodic progress reports. Each member nation contributes financially to the maintenance of the Institute (roughly, U.S.S.R. - 75 per cent; China - 20 per cent; other countries - 5 per cent), and each has equal voice in decision making. Other countries can petition for membership and be elected by vote of the charter group.

The Institute confers the Degrees of Doctor and Candidate. Scientific studies are published in technical journals and reported at meetings; copies of all finished studies are supplied to member nations.

Originally, about 100 scientific collaborators were working at the Institute; by 1959, 420 professional and 1,400 other personnel were employed.

The Institute's development was aided by the U.S.S.R., which donated the following facilities as the technical basis for its growth: (a) The Institute of Nuclear Problems, Academy of Sciences, U.S.S.R. (with a synchrocyclotron producing 680,000,000 electron volts), and (b) the Electro-physical Laboratory, Academy of Sciences, U.S.S.R. (with a proton synchrotron producing 10,000,000 electron volts). Five laboratories were organized and staffed.

(1) Laboratory for Nuclear Problems. Studies have been concerned primarily with the investigation of pion-nucleon interaction at several 100 Mev.

(2) High-Energy Laboratory. Among their more important studies was the discovery of the anti-sigma-minus-hyperon ( $\bar{\Sigma}^-$ -hyperon), announced in 1960.

(3) Laboratory for Neutron Physics. This group has taken over the further development and construction of a pulsed fast-neutron reactor designed by the Institute of Physics of the State Committee for Application of Atomic Energy. The reactor is unique in that it operates periodically in a supercritical regime.

(4) Laboratory for Nuclear Reactions. An accelerator for multi-charged ions has been installed. Investigations have considered the interaction of heavy ions with nuclei; the synthesis of element 102 and the development of its  $102^{253}$  isotope have been accomplished.

(5) Laboratory for Theoretical Physics. This laboratory houses computer center (with computers of the URAL-1 and KIYEV types) and the technical library. Its staff has engaged primarily in research in the areas of superconductivity and application to nuclear structure, neutrino theory, particle scattering, and dispersion relations.

Besides the activities outlined for specific laboratories, other published work of interest describes, (1) apparatus developed to analyze bubble-chamber photographs; (2) a fiber scintillator using ultrafine strands of plastic fiber to transmit light produced by ionizing particles; and (3) a "ring" or "annular" phasotron, constant in time but with reversible-sign magnetic field, for increased charged-particle-beam intensity and acceleration of particles to relativistic energies suggesting theoretical work on a unified-field theory.

In 1961, a branch of the Physics Faculty of Moscow University was opened at the Institute. In addition, there is close cooperation with all scientific institutions throughout the U.S.S.R. and member nations; 125 collaborators from satellite countries were working at the Institute by 1960. Members of the staff regularly attend international conferences and have worked, under exchange agreements, at scientific institutions of Western countries.

YIELD OF CALIFORNIUM ISOTOPES PRODUCED IN THE INTERACTION BETWEEN CARBON ISOTOPES AND URANIUM NUCLEI, Gerlit, Yu. B., et al., 1957. -- In a 67 cm cyclotron four-fold charged carbon ions are accelerated up to 90 Mev. With this energy they impinge upon a thick uranium target and cause the reaction  $U(C,n)Cf$ . The absolute yields per impinging carbon ion and the following reactions are:  $U-239 (C^{12}, 4n) Cf-246 - 1.5 \times 10^{-9}$ ;  $U-239 (C^{12}, 5n) Cf-245 - \sim 3.0 \times 10^{-9}$ ;  $U-239 (C^{12}, 6n) Cf-244 - \sim 9 \times 10^{-11}$ . The fissioning of uranium bombarded with carbon was found to be  $3.8 \times 10^3$  times more probable than the evaporation process of neutrons from the intermediary nucleus  $Cf-250$ .

THE YIELD OF RARE EARTHS IN THE SPLITTING UP OF BISMUTH BY 660 MeV-PROTONS, Kalyamin, A. V., et al., 1958. -- With the aid of chromatographic methods especially rare-earth products were gathered in the splitting up of  $Bi-209$  by 660 MeV-protons and the following cross sections were determined:  $Ce-134 - \sim 0.4$  mb;  $Nd-140 - \sim 0.25$  mb;  $Gd-147 - \sim 0.95$  mb;  $Tb-153 - \sim 0.9$  mb;  $Tb-154 - \sim 1.0$  mb;  $Er-160 - \sim 2.0$  mb;  $Tm-165 - \sim 4.0$  mb;  $Yb-166 - \sim 2.5$  mb;  $Yb-169 - \sim 7.0$  mb;  $Lu-170 - \sim 6.5$  mb;  $Lu-171 - \sim 5.5$  mb.

EXPERIMENTS IN THE PRODUCTION OF A NEW FERMIUM ISOTOPE, Perelygin, V. P., et al., 1959. -- An investigation was made of the  $\alpha$ -active products interaction between accelerated oxygen  $O^{16}$  ions and uranium  $U^{238}$  nuclei. The energy of accelerated oxygen ions was 84-98 Mev, and the beam was monochromatic. The  $U-238$  targets were prepared by sublimation under vacuum and by precipitation with tetraethyleneglycol on an Ni holder. Targets had a thickness from  $200 \mu g/cm^2$  to  $800 \mu g/cm^2$   $U-238$  atoms. The registration of  $\alpha$ -decay was carried out by means of a fast and highly sensitive method, which was originally developed by G. N. Flerov, et al. The measurements gave some proof of the existence of a new fermium isotope  $Fm-249$  which possesses a half-life of about 150 sec and an  $\alpha$ -particle energy of  $(7.9 + 0.3)$

mev. The procedure for the identification of transuranium isotopes was based on the registration in photographic emulsions of their successive  $\alpha$ -decays. Three excitation curves were presented for reactions involving the emission of four and five neutrons.

THE PRODUCTION-CROSS SECTIONS FOR CALIFORNIUM ISOTOPES BY THE IRRADIATION OF U-238 WITH ACCELERATED CARBON IONS, Volkov, V. V., et al. 1959.

-- In the course of the irradiation of heavy elements with multi-charged ions compound nuclei are formed, which decay again as the result of fission or neutron evaporation. Important conclusions may be drawn with respect to new transuranium synthesis from the ratio of the two decay processes in dependence on the excitation energy and the parameters of the compound nucleus. In the present paper results obtained concerning the energy dependence of the cross sections of the reactions  $U-238(C^{14}, 4n-5n)Cf^{246-245}$  and  $U-238(C^{13}, 5n-6n)Cf^{246-245}$  are discussed. The  $+4C^{12}$ -ions were accelerated on the 150 cm cyclotron of the AS USSR up to 78 and 84 Mev respectively (with an accuracy of 3%). Energy measurement was carried out by absorption in aluminum, measurement of the ion flux on the target was carried out by means of an integrator (0.2 - 0.3  $\mu a$ ). Figure 3 shows the cross section of the reactions  $(C^{12}, 4n-5n)$  and  $(C^{13}, 5n-6n)$  referred to the total production cross section for the compound nucleus in dependence on excitation energy. Each of the curves shows a characteristic maximum. The shifting of the maximum of the reaction  $(C^{12}, 5n)$  towards that of the reaction  $(C^{13}, 5n)$  is assumed to be due to an inaccuracy of ion energy measurement. For the connection between the decay probabilities and the cross sections it holds that  $\sigma_n = \sigma_t (\bar{W}_n / (\bar{W}_n + \bar{W}_f))^n$  and  $\sigma_n$  = total cross section of the neutron emission reaction in the case of a given energy.  $\sigma_f$  = cross section for the formation of a compound nucleus at the same energy.  $n$  = average number of emitted neutrons.  $W_n$  = probability of neutron emission.  $W_f$  = fission probability; ( $\bar{W}$  denotes the mean value).  $\bar{W}_n/\bar{W}_f$  for californium is  $\sim 1/4$  and varies only little in the interval of the excitation energy of 35-55 Mev.  $W_n/W_f$  for  $Cf^{246}(4n-5n) \sim 1/3$ .

RADIOCHEMICAL INVESTIGATION OF URANIUM FISSION PRODUCTS OBTAINED BY 660 MEV PROTON BOMBARDMENT, Lavrukhina, A. K., et al. 1960. -- Fission and spallation products of uranium obtained by bombardment with 660 Mev protons were investigated radiochemically. From experimental data and results obtained by interpolation a full chart of residual nuclide products is prepared and basic regularities in their formation are determined. High-energy fission was discovered in 1947 by G. T. Seaborg et al. The present authors started in 1955 detailed radiochemical investigations of fission products (in the interval  $Z = 78 - 93$ ) obtained by 660 Mev proton bombardment of uranium. Comparison with literature data on fission products of copper and bismuth can give information concerning the dependence of fission characteristics on the atomic number of the target-element (from  $Z = 29$  up to  $Z = 92$ ).

RADIOGRAPHY OF SPONTANEOUS NUCLEAR FISSION, Perelygin, V. P., et al. 1962. -- A technique for registering the spontaneous fission fragments is described by which the radiography of the mendelevium and fermium elements separated by a chromatographic column can be obtained.

**EXTRACTION OF FERMIUM AND MENDELEVIUM (TBP - HNO<sub>3</sub> AND TBP - HCl SYSTEMS), Brandshtet, I., et al. 1962.** -- The chromatographic extraction of  $Mi-256$ ,  $Fm-256$ ,  $Fm-252$ , and  $Cf-246$  by tri-n-butylphosphate (TBP) from aqueous HNO<sub>3</sub> and HCl solutions was investigated. Data on distribution ratios are included. The separation factors for TBP-HCl system are higher than for TBP-HNO<sub>3</sub> system.

**THE HALF-LIFE OF A SPONTANEOUSLY FISSIONABLE ISOMER, Pereygin, V. P., et al. 1963.** -- The half-life of a spontaneously fissionable isomer obtained in the reactions of accelerated ions of O-16, Ne-20, and Ne-22 with U-238 was measured. It was found to be  $(13.5 \pm 1.2)$  msec. The fission fragments were recorded by using nuclear emulsions. From a comparison of all the measured half-lives a conclusion was drawn that in all these reactions one and the same isomer was observed.

**SOME REGULARITIES IN MASS SPECTRA OF HEAVY NUCLEI FISSION PRODUCTS, Vasil'ev, I. A., Petrzhak, K. A., 1962.** -- Good agreement was obtained with the author's experiment on photofission of Th-232 and with literature data on photofission of U-235, U-238 and on spontaneous decay of U-238, Cm-242 and Cf-252.

**SPONTANEOUS FISSION WITH AN ANOMALOUSLY SHORT PERIOD, Polikanov, S. M., et al. 1962.** -- U-238 was irradiated by accelerated Ne-22 and O-16 ions from the internal beam of the 300 cm cyclotron of the OIYaI. By means of an ionization chamber, spontaneous fission fragments of an unknown isotope having a half-life of  $\sim 0.02$  sec were recorded. The nucleus obtained is assumed to be in an isomeric state with spontaneous fission probability increased (by more than  $10^9$  times). From experimental data the atomic number is estimated to be  $\leq 100$ .

**FORMATION OF NUCLEI WITH AN ANOMALOUS SPONTANEOUS FISSION PERIOD IN REACTIONS INVOLVING HEAVY IONS, Polikanov, S. M., et al. 1963.** -- The interactions of heavy ions (Ne, O, B) with uranium nuclei that lead to the formation of a spontaneously fissioning isotope with an anomalously small decay lifetime are investigated. The yield curves for the spontaneously fissioning isotope in various reactions are obtained and the half life is measured. It is suggested that transfer reactions occur with the Ne and O ions and that the atomic number of the unknown isotope is  $Z \leq 97$ .

**$\Lambda$ -HYPERON PRODUCTION BY 7-8 BEV NEGATIVE PIONS ON HYDROGEN, Belyakov, B. A., et al. 1963.** -- It is reported that  $\Lambda$ -hyperon production and decay was observed. The magnitude of the cross section for  $\Lambda$  generation by 7-8 BeV  $\pi^-$  mesons on hydrogen was estimated to be  $\approx 3\mu b$ .

**INELASTIC  $\pi^-p$  INTERACTIONS AT AN ENERGY OF 7 BEV, Kopylova, D. K., et al., May 1963.** -- 154 inelastic  $\pi^-p$  interaction events involving the emission of secondary protons with momenta between 180 and 500 Mev/c are selected from stereoscopic photographs of a propane bubble chamber irradiated by a beam of  $6.8 \pm 0.6$  Bev/c  $\pi^-$  mesons. An analysis of the events indicates that they possess some features characteristic of peripheral interactions. These features are more pronounced in two-prong interactions than in four-prong interactions. A criterion for specifying interactions involving free protons is considered. It is connected with calculation of the so-called missing mass. With this criterion it is shown in particular that in four-prong stars the fraction of background interactions with carbon is much higher than in two-prong stars.

TOTAL CROSS SECTIONS FOR NEUTRON-NEUTRON INTERACTIONS AT 8.3 BEV, Khachatryan, M. N., et al., Apr. 1963. The total cross section for neutron-neutron interactions was measured by various methods using 50.1 and 55.60 g/cm<sup>2</sup> thick H<sub>2</sub>O and D<sub>2</sub>O targets. The result for an effective energy of ~8.3 Bev was  $\sigma_{nn} = 31.5 \pm 1.7$  mb.

ELASTIC SCATTERING OF 8.35-Bev PROTONS ON PROTONS, Seb, Do In; et al., May 1963. -- An accurate value of the differential cross section for pp scattering at 8.35 Bev, obtained by measurements in photographic emulsions, is presented. The data are analyzed on the basis of the Regge pole technique and are compared with data from other experiments. The total pp elastic scattering cross section is found to be  $(10.8 \pm 0.8)$  mb; the mean square interaction radius is  $(1.07 \pm 0.08)$  f.

CROSS-SECTION FOR THE FORMATION OF Li<sup>8</sup> IN A NUCLEAR EMULSION BY 9-Bev PROTONS, Bogachev, N. P., et al., Feb. 11, 1963. -- The formation cross section of Li<sup>8</sup> by protons of 9-Bev energy was calculated to be  $2.4 \pm 0.6$  mb. This agrees with values of approximately 2 mb found in other work with 1-Bev particles. The calculation was made from statistical data obtained by microscopic examination of tracks in irradiated NIKFI-R emulsion. Of 19,411 nuclear disintegrations observed, 133 (after necessary corrections were made) were characteristic of Li<sup>8</sup>.

Institute of Physics, Yerevan

Founded in the early 1940's, the Institute specialized in cosmic-ray physics during its early years. Its Cosmic-Ray Laboratory on Mount Aragats is located 3,250 meters above sea level and is equipped with a 100-ton permanent magnet, a 150-ton electromagnet, and a 70-ton magnet.

The Institute recently built a 6-Bev annular particle accelerator which will further the primary work, i.e., the study of the high-energy interaction of elementary particles. In connection with this work, methods of detecting charged particles and measuring their velocities and masses have been developed. In addition to this work, theoretical investigations in electro-dynamics and ultrahigh densities of matter have been conducted.

PRODUCTION OF HYPERNUCLEI BY 8.8-Bev PROTONS, Arustamova, M. E., et al., Mar. 1963. The production of hypernuclei by ~9 Bev protons was investigated. 132 decay events of hypernuclei were detected.  $\Lambda^B^{10}$  and  $\Lambda^{Be^{11}}$  hypernuclei were observed for the first time.

INTERACTION OF A HIGH-ENERGY MULTI-CHARGED PARTICLE WITH A PHOTOGRAPHIC EMULSION NUCLEUS, Babayan, Kh. P., et al., Mar. 1963. -- A unique interaction event of the  $16 + 201 Z$  type between a multicharged particle with an energy of  $3 \times 10^{11}$  ev per nucleon and a nucleus in a photographic emulsion is investigated. Because of the high multiplicity of the interaction and also the convenient position of the event in the photographic emulsion, it was possible to obtain sufficiently good statistics for observing the correlation between the emission angle and the transverse momentum of the secondary particles in the small angle region ( $\theta_1 < 4^\circ$ ). A correlation coefficient of 0.81 was obtained. The transverse momentum distribution is consistent with that previously obtained for secondary particles produced in nucleon-nucleon and nucleon-nucleus interactions. The mean transverse momentum is found equal to 215 Mev/c. The angular distribution satisfactorily agrees with the hydrodynamic theory.

High-energy Physics, Accelerators, etc.

- Aleksandrov, Yu. A. (1962) - 1 - bubble chamber, liq., rad. sensitiv.
- Alikhanyan, A. I. (1963) - 1 - detector, 100 Bev neutrinos (cosmic rays),  
prop. meth.
- Almazov, V. Ya. (1963) - 1 - instr., bubble chambers, automat. meas.
- Arustamova, M. E. (1963) - 1 - 8.8 Bev protons, hyperons, B-10, B-11
- Babayan, Kh. P. (1963) - 1 - react. of 300 Bev/nucleon particle in photo-  
graphic emulsion.
- Balandin, M. P. (1963) - 1 - 2-meter propane bubble chamber
- Bazin, A. P. (1963) - 1 - sol. st.; 14-25 Mev, dielect.
- Beliaev, B. N. (1960) - 1 - 660 Mev; ch. sep; astatine
- Belovintsev, K. A. (1963) - 1 - 6.5 Mev, synchrotron
- Belyakov, B. A. (1963), 7-8 Bev, hyperons
- Bem, Ya. (1963) - 1 - 7 Bev, pion-nucleon
- Bogachev, N. P. (1963) - 1 - 9 Bev, Li-8
- Dudarev, V. Ya. (1962) - 1 - met. ion bomb. of other metals
- Fogel, Ya. M. (1963) - 1 - Pt-argon ions
- Gavrilov, K. A. (1961) - 1 - Pu-multiply chg'd ions
- Gerlit, E. K. (1955-57) - 2 - U-carbon ions, Cf, Tc.
- Guseva, M. I. (1962) - 1 - 5-30 Kev D and Kr ions on steel, Ta.
- Ivanovskaya, I. A. (1963) - 1 - 2.8 Bev  $\pi$  mesons on Xe
- Kaftanov, V. S. (1963) - 1 - instr., spark chambers
- Kalyamin, A. V. (1958) - 1 - 660 Mev  $H^+$  on Bi
- Khachaturyan, M. N. (1963) - 1 - 8.3 Bev, n-n interactions
- Kopylova, D. K. (1963) - 1 - 7 Bev, inelast.  $\pi^-$  p interact.
- Krasik, V. R. (1962) - 1 - strong mag. fields
- Kumpf, G. (1963) - 1 - Th irradi. by Ne-22 ions
- Morosov, V. M. (1962) - 1 - electrostat. gen., ion energ. meas.

High-energy Physics, Accelerators, etc., continued

- Nikitin, S. Ya. (1963) - 1 - 7 Bev, instr., bubble chamber
- Nyagu, D. (1962) - 1 - instr., bubble chambers,  $\text{CH}_3\text{l}$ ,  $\text{C}_3\text{H}_8$
- Perelygin, V. P. (1959-63) - 3 - TRU, 84-89 Mev 0-16 ions, Ne-22, on U, Fm-249, Mi, etc.
- Peter, G. (1962-63) - 1 - instr., spark tube, chamber, image intensifier
- Polikanov, S. M. (1962-63) - 2 - TRU, 0-16, Ne-22 ions on U, spont. fiss. isot.
- Seb, D. I. (1963) - 1 - 8.35 Bev, p-p, elast. scat. x-sect.
- Seb, T. Y. (1962) - 1 - instr., emulsion chambers
- Shevchenko, V. G. (1963) - 1 - 15-33.5 Mev,  $\alpha$ -p on W, excit. funct.
- Shumilov, S. N. (1963) - 1 - 85 Mev Be-9 ions on Ag, Br, Be-8
- Tyapkin, A. A. (1962) - 1 - discharge form., spark chamber

The Scientific Research Institute of Atomic Energy Reactors,  
New Melekess

The primary purpose of the Institute, which was begun in 1958, is to develop and test new types of reactors with emphasis on the selection and testing of materials. The Institute has 2000 employees, of whom 800 are scientists and engineers. It is located on a 56-km<sup>2</sup> "sanitary zone," a heavily wooded rise south and east of the town of Melekess. The site contains the newly built town of New Melekess, a steam plant, other auxiliary facilities, and the scientific installation of the Institute. The latter are located in a 1.3-km<sup>2</sup> area about 5 km from the town.

The SM-2 reactor is of special interest because it is presently (1963) producing the highest thermal flux of any reactor in the world. It is being used for the production of transuranium elements and engineering tests and physical researches with neutrons. The reactor was designed for a high flux by the following combination of features: high specific power, 2750 kw/kg U<sup>235</sup>, epithermal spectrum in fuel, and flux trap in center of reactor where an unperturbed thermal flux of  $2.2 \times 10^{15}$  is developed. Experimental facilities include the central high-flux region, 16 vertical channels in which materials or engineering test loops may be installed, and five 83-mm-diameter horizontal beam holes from which beams of  $4 \times 10^{10}$  neutrons/cm<sup>2</sup>/sec can be obtained for physical experiments. Each beam hole ends in a separate cell.

Fuel for the reactor is a compact of 35 vol % uranium dioxide enriched to 90% U<sup>235</sup>, and 65 vol % nickel. Fifty-four fuel plates, 0.5 mm thick and 3.5 cm wide by 25 cm long, clad with 0.15-mm nickel, are mounted in a nickel channel, 7 cm square, with 1.5-mm water spacing between adjacent plates. Each fuel element contains 650 g U<sup>235</sup>.

The core of the reactor consists of a 6 x 6 square grid. Fuel elements may be mounted in all positions except the four at the center and the four at the corners. The four at the center are used to hold a tube 10 cm in diameter and 28 cm high, in which the highest flux is produced. The four at the corners are used for top-driven control rods. The remaining 28 positions are used for fuel elements after burnup reaches a steady state; with fresh fuel, less than 28 full assemblies (about 20) suffice for operation at full power. The core of the reactor is surrounded by a beryllium-oxide reflector 45 cm high. Core and reflector are contained in a pressure vessel 1.5 m in diameter. Shielding above the reactor is provided by water in the pressure vessel.

Primary water at 50 atm and an inlet temperature of 30 to 50°C, depending on the season, flows through the reactor at a rate of 2000 m<sup>3</sup>/hr and leaves at a temperature 20°C higher. Flow is up through the reflector and down through the core. The water velocity through fuel elements is in the range of 7 to 10 m/sec. The maximum heat flux is 5 to 6 x 10<sup>6</sup> kcal/m<sup>2</sup>/hr (1.8 to 2.2 x 10<sup>6</sup> BTU/sq ft/hr), and the heat transfer coefficient is 35,000 to 40,000 kcal/hr/m<sup>2</sup>/°C/m (7200 to 8000 BTU/hr/sq ft/°F/ft). There are four separate primary loops. Water from the primary circuit is degasified, and

the separated hydrogen and oxygen are recombined catalytically. Each of the 16 vertical access holes and the central high-flux channel is provided with its own cooling system.

In addition to fuel elements occupying the 28 core positions, a storage rack within the pressure vessel provides space for 14 additional elements. A fueling machine within the vessel can be operated remotely without reducing pressure and is used to shuffle fuel within the core and replace spent fuel in the core with fresh fuel from the storage rack. During fuel movement the reactor is at zero power, but the water pressure is maintained. Since it is then unnecessary to remove the head of the reactor, only about 30 min is needed to replace an element. Two elements are replaced every 5 days. With 14 fresh elements and an equilibrium core, the reactor can be operated for about 40 days without being opened to recharge fuel.

Construction of SM-2 was started in 1959. Criticality was attained in October 1961. Operation at full power began early in November 1962. The power level is about 40 Mw. In the central flux trap facility 10 g of plutonium containing 60% Pu<sup>242</sup> and 20% Pu<sup>240</sup> is being irradiated (1963), as the first step in producing californium-252 (Cf<sup>252</sup>). Milligram amounts (about 100) of this isotope are expected by early 1965. ●

Fuel has behaved satisfactorily at burnups up to 25%. Higher burnups are to be investigated. Samples of the beryllium-oxide reflector, examined after a cumulative neutron dose of  $10^{21}/\text{cm}^2$ , appeared good.

Test loops for irradiating materials in different coolants are still under construction (1963). The highest temperature loop at present is 900°C. A velocity selector with 100-m flight path has been installed.

The cost of the reactor, exclusive of fuel, was estimated to be about 10.4 million rubles.

One of the main purposes of the radiochemical laboratory is to isolate and separate isotopes of the lanthanides and transuranium elements (Tramex process, with pulse columns?) and to determine their physical and chemical properties. The laboratory will also study certain fission products and translead isotopes. The cold section of this laboratory is equipped and in operation (1963). It is a three-story building, with 19 bays on each side of a corridor running the length of each story, about 300 ft.

The hot section of the laboratory provides 16 hot cells for radiochemical work, of which six extend up an additional story. These cells are presently under construction, but much of the large equipment for these cells, such as dissolvers and columns, have been installed and the rough cell enclosures are completed. Each of these cells is designed to handle up to  $10^5$  curies of gamma activity. A second story provides warm cells for handling up to 0.5 curies of gamma activity. A third story provides additional space for cold and warm work. A laboratory for handling alpha-active material, containing 30 glove boxes, is also provided.

The hot laboratory is expected to be in operation by December 1963, at which time the present staff of 100 may be increased to about 300. The cost of the entire radiochemical laboratory is estimated to be 8.4 million rubles.

The cold section of the metallurgy laboratory is well equipped for preparation and investigation of solid materials. A well designed facility for carrying out metallurgical operations on alpha-active material is presently under construction. This consists of about 25 inter-connected stainless-steel cells with glass windows, provided with special ventilation and equipped with gloves, remote manipulators, and intercell transfer equipment.

The hot section of the laboratory is partially completed. It is to consist of 36 hot cells designed for  $10^5$  curies of gamma activity. The cells are arranged in two rows, with a maintenance corridor common to both rows between them, with an overhead crane on rails above each row of cells, and with an operating corridor outside each row of cells. Each cell is equipped with a pair of remote manipulators and is lined with stainless steel, 3 mm thick. Each is provided with one air change every 3 min. Exhaust air is drawn into a duct below the cells. The entire layout appears to be very well conceived.

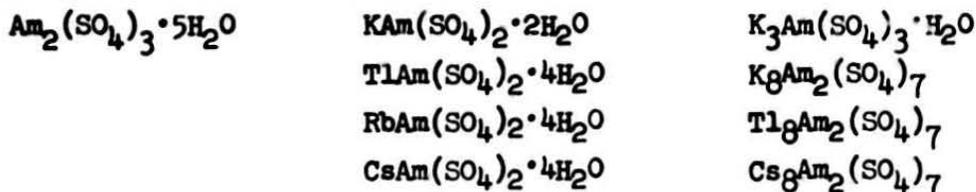
The design of the hot laboratory differs from U.S. practice in one respect: the operating areas of the hot laboratory are not held at a lower air pressure than adjacent areas of the cold laboratory.

The total cost of this metallurgical laboratory is estimated to be about 7.6 million rubles.

COPRECIPITATION OF AMERICIUM(V) WITH DOUBLE CARBONATES OF URANIUM(VI) OR PLUTONIUM(VI) WITH POTASSIUM, G. N. Yakovlev, et al., 1955. -- A method of isolating americium from dilute solutions containing the rare earth fraction of uranium fission products is based on the possibility of oxidizing americium to the pentavalent state in concentrated potassium carbonate solutions with the subsequent formation of a difficultly soluble compound. The rare earth elements and curium remain in solution, as their double carbonates are quite soluble. For the separation of small amounts of americium from weighable amounts of rare earth elements, potassium uranyl tricarbonate was chosen as the carrier for Am(V). The authors also studied the coprecipitation of Am(V) tricarbonate with plutonium tricarbonate. According to x-ray diffraction analysis, potassium Am(V) tricarbonate is not isomorphous with the carriers used. The coprecipitation of Am(V) with hexavalent uranium and plutonium tricarbonates is evidently caused by the formation of anomalous mixed crystals.

THE PREPARATION OF THIN FILMS OF PLUTONIUM, AMERICIUM, AND CURIUM BY AN ELECTROLYTIC METHOD, Yakovlev, G. N., et al., 1957. -- Methods for quantitative electrodeposition of Pu, Am, and Cm, on metallic surfaces were developed. The elements were deposited as hydroxides from neutral and weakly acidic alcoholic solutions of the chlorides.

INVESTIGATION OF THE DOUBLE SULFATES OF AMERICIUM ACCORDING TO THE ABSORPTION SPECTRA IN THE CRYSTALS, Yakovlev, G. N., et al., 1958. -- The normal sulfate and the double sulfate of americium with potassium, thallium, rubidium and cesium were investigated. The normal sulfate as well as the following double sulfates of americium were identified:



As it is known, the double sulfates of the rare earths and of the alkali metals are difficult to solve and, therefore, are of importance for the analytical chemistry of these elements. (According to the actinide theory, the transuranic elements are analogs of the rare earths, and in their case the analogy of the chemical properties of many compounds also plays a role, especially the similarity of the double sulfates with the alkali metals.) The absorption spectra of the polycrystalline samples of these compounds were taken within the range of 4000-8500 Å at 300, 200 and 80° K (Figs 3-11). Phase diagrams were taken for the synthesis  $\text{R}_2\text{SO}_4\text{-Am}_2(\text{SO}_4)_3\text{-H}_2\text{O}$  (R = K, Tl and Rb) (Figs 1,2). The split of the electron band  $\text{Am}^{+++}5030 \text{ Å}$  in the crystals of the compounds to be investigated was studied. The group of electronically oscillating "bands" within the range of 4500 Å were identified which are not observed in solutions and which are in a high degree sensitive to a change of the composition of the compound. The influence of the temperature and the amount of crystal water on the character of the split of the electron band  $\text{Am}^{+++}5030 \text{ Å}$  and the combination of the above mentioned "bands" within the range of 4500 Å were investigated.

DISPROPORTIONATION OF Am(IV), Zaytsev, A. A., Yakovlev, G. N., et al., 1959. -- As a preliminary result, it is said that the reactions  $2\text{Am}^{4+} + 2\text{H}_2\text{O} = \text{Am}^{3+} + \text{AmO}_2^+ + 4\text{H}^+$  and  $\text{Am}^{4+} + \text{AmO}_2^+ = \text{Am}^{3+} + \text{AmO}_2^{2+}$  have actually been experimentally proved. The production of the various chemical solutions and the times needed for working-up the material are given. The concentration of Am(III), Am(IV), and Am(VI) was measured by means of the quartz spectrometer SF-4. The material to be measured was filled into a hermetically closable cylindrical cuvette of 2 cm length, and was measured in the spectrometer in this condition. Total americium concentration was determined from the α-activity of the  $\text{Am}^{241}$ . Apart from the initially mentioned results, it was further stated that the reactions:  $3\text{Am}^{4+} + 2\text{H}_2\text{O} = 2\text{Am}^{3+} + \text{AmO}_2^{2+} + 4\text{H}^+$ , and  $2\text{AmO}_2^+ + 4\text{H}^+ = \text{AmO}_2^{2+} + \text{Am}^{4+} + 2\text{H}_2\text{O}$  can be proved. The yields of individual reactions depending upon the molar concentration of the various solutions are mentioned.

THE RADIOLYTIC REDUCTION OF Am(VI) AND Am(V), Zaytsev, A. A., Yakovlev, G. N., et al., 1959. -- The constants of the radiolytic reaction rate of  $\text{AmO}_2^{2+}$  in hydrochloric-, nitric- and sulphuric acid are experimentally determined, the radiation yields of the reduction products furnishing the values for calculating the reactor rate. If these quantities are combined with the production of hydrogen peroxide, it is possible therefrom to draw conclusions as to the contribution made by hydrogen radicals in the reduction

reaction. On the basis of experimental data it is believed to be possible to give a mechanism for the radiolytic reduction of  $\text{AmO}_2^{2+}$  and  $\text{AmO}_2^+$ . From the equations deduced for the reduction rate of  $\text{AmO}^+$  it is possible to calculate the production of hydrogen peroxide and of hydrogen radicals in the solutions investigated. Chemically pure  $\text{Am}^{241}$  was used, which contained less than 1% impurities. The chemical reagents were purified separately although they were "chemically pure." The americium concentration in the solutions were radiometrically measured. The production of  $\text{Am(V)}$ ,  $\text{Am(VI)}$ , the self-reduction of  $\text{Am(V)}$  and  $\text{Am(VI)}$ , and the accumulation of hydrogen peroxide in  $\text{Am}^{241}$ -solutions are described in detail. The results obtained are partly shown by diagrams, and the following curves deserve special mention: a) radiolytic reaction of americium in 2.0 M  $\text{HClO}_4$  and in 0.2 M  $\text{HClO}_4 + 1.0$  M  $\text{Li}_2\text{SO}_4$ ; radiolytic reaction of  $\text{Am(V)}$  and accumulation of  $\text{H}_2\text{O}_2$  in 1.0 M  $\text{H}_2\text{SO}_4$ . b) Variation of the average valence state (N) of americium concentrations. c) Variation of the average valence state (N) of americium in the radiolytic reaction in 0.5 M  $\text{HNO}_3$  up to 14.3 M  $\text{HNO}_3$ . The rates and the yield of the radiolytic reduction of  $\text{AmO}_2^{2+}$ , the observed and calculated reduction rate of  $\text{AmO}_2^+$  in 0.1 M  $\text{H}_2\text{SO}_4$ , as well as the yields of  $\text{H}_2\text{O}_2$  and of the hydrogen radicals in sulphuric- and hydrochloric acid are given.

KINETICS OF THE REDUCTION OF AMERICIUM(V) BY HYDROGEN PEROXIDE, Zaytsev, A. A., Yakovlev, G. N., et al., 1960. -- The kinetics of the reduction of  $\text{AmO}_2^+$  by hydrogen peroxide are complicated by the decomposition of hydrogen peroxide under the effect of  $^{241}\text{Am}$  radiation. In spite of this difficulty the authors obtained values for the velocity constants of the reduction reaction of  $\text{AmO}_2^+$  by hydrogen peroxide which made it possible to calculate satisfactorily the curves of the variation of the concentrations of americium(V) and (III) at a given initial hydrogen peroxide concentration. The reaction was carried out in 0.1 M  $\text{HClO}_4$  at  $30^\circ$ . The relation between the velocity constant of the reaction and temperature was determined. The activation energies of the reaction and the variation in the enthalpy of the activated complex were calculated.

DETERMINATION OF THE COMPOSITION AND INSTABILITY CONSTANTS OF OXALATE, NITRATE AND SULPHATE COMPLEXES OF  $\text{Am(II)}$  and  $\text{Cm(III)}$  BY THE ION-EXCHANGE METHOD, Lebedev, I. A., Yakovlev, G. N., et al., 1960. -- The existence of complex ions of the following composition:  $\text{AmC}_2\text{O}_4^+$ ,  $\text{Am}(\text{C}_2\text{O}_4)_2^-$ ,  $\text{CmC}_2\text{O}_4^+$ ,  $\text{Cm}(\text{C}_2\text{O}_4)_2^-$ ,  $\text{AmNO}_3^+$ ,  $\text{CmNO}_3^+$ ,  $\text{AmSO}_4^+$ ,  $\text{Am}(\text{SO}_4)_2^-$ ,  $\text{CmSO}_4^+$ ,  $\text{Cm}(\text{SO}_4)_2^-$  was established on the basis of an analysis of the relation between the sorption of  $\text{Am}^{3+}$  and  $\text{Cm}^{3+}$  by a cationite and the concentration of the corresponding anion.

The constants characterizing the stability of these complex ions were calculated for different values of the ionic strength of the solution.

DETERMINATION OF THE COMPOSITION AND INSTABILITY CONSTANTS OF LACTATE COMPLEXES OF  $\text{Am(III)}$  AND  $\text{Cm(III)}$  BY THE ION-EXCHANGE METHOD, Lebedev, I. A., Yakovlev, G. N., 1961. -- The existence of the complex ions  $\text{AmLact}^{2+}$ ,  $\text{Am}(\text{Lact})_2^+$ ,  $\text{CmLact}^{2+}$  and  $\text{Cm}(\text{Lact})_2^+$  was established by means of an investigation of the sorption of  $\text{Am(III)}$  and  $\text{Cm(III)}$  on cationite U-2 in relation to the lactate-ion concentration; the instability constants of these four complex ions were calculated, the values being  $1.90 \times 10^{-4}$ ,  $3.1 \times 10^{-3}$ ,  $1.83 \times 10^{-4}$  and  $4.0 \times 10^{-3}$ , respectively.

INVESTIGATION OF COMPLEXING OF AMERICIUM AND CURIUM WITH  $\alpha$ -HYDRO-ISOBUTYRIC ACID, Dedov, V. B., Yakovlev, G. N., et al., 1961. -- The authors investigated the adsorption of Am(III) and Cm(III) on KU-2 cationite from solutions of ammonium  $\alpha$ -hydroxyisobutyrate as a function of the concentration of the  $\alpha$ -hydroxyisobutyrate ions from  $6 \times 10^{-4}$  to  $3 \times 10^{-1}$  M and at constant ionic strength of 0.5. It was established that the following complex ions are present under these conditions  $\text{Am}(\text{hydrox-But})^{2+}$ ,  $\text{Am}(\text{hydrox-But})_2^+$ ,  $\text{Am}(\text{hydrox-But})_3$ ,  $\text{Cm}(\text{hydrox-But})^{2+}$ ,  $\text{Cm}(\text{hydroxy-But})_2^+$  and  $\text{Cm}(\text{hydrox-But})_3$ . The stability constants of these complex ions were calculated for an ionic strength ( $\mu$ ) of 0.5 and at zero ionic strength. It was established that the stability constants of curium complex ions are 1.3 times greater than those of americium complex ions, the values for Am and Cm (at  $\mu = 0.5$ ) being  $2.4 \times 10^2$  and  $2.7 \times 10^2$  respectively, while at  $\mu = 0$  they were  $2.1 \times 10^3$  and  $2.5 \times 10^3$  respectively.

THE DETERMINATION OF THE COMPOSITION AND STABILITY CONSTANTS OF THIOCYANIDE COMPLEXES OF Am(III), Cm(III) AND Ce(III) BY AN ION EXCHANGE METHOD, Lebedev, I. A., Yakovlev, G. N., 1962. -- Complex formation of trivalent actinides and lanthanides with thiocyanide ion is used for group separation of these elements, but the exact composition of these complexes and their stability constants are unknown. The authors studied complex formation of trivalent americium and curium with thiocyanide anions on changes in their concentration from 0.064 to 5.0 M. For comparison the formation of complexes of Ce(III) under the same conditions was also studied. The experimental method consisted of the determination of the sorption of  $\text{Am}^{3+}$ ,  $\text{Cm}^{3+}$  and  $\text{Ce}^{3+}$  on cationite (KU-2) in ammonium or sodium form on the concentration of thiocyanide ions at ionic force 0.5 and 5. Tracer quantities of  $\text{Am}^{241}$ ,  $\text{Cm}^{242}$  and  $\text{Ce}^{144}$  were used. Experiments at ionic force  $\mu = 0.5$  were made in ammonium thiocyanide solutions with additions of ammonium perchlorate and at  $\mu = 5.0$  in sodium thiocyanide with addition of sodium perchlorate. In all cases pH = 4 was maintained. It was found that at  $\mu = 0.5$  complex ions of the form  $\text{MSCN}^{2+}$  are present. At  $\mu = 5.0$  the type of complexes formed depended on the concentration of thiocyanide ions. At concentrations up to 1 M only  $\text{MSCN}^{2+}$  ions and at concentrations above 1 M mainly ions of the type  $\text{M}(\text{SCN})_3$  were present. Moreover, at concentrations between 4 and 5 M the appearance of considerable quantities of complex ions  $\text{Am}(\text{SCN})_4^-$  and  $\text{Cm}(\text{SCN})_4^-$  was observed, while cerium did not form this type of ions. On the basis of experimental results stability constants for the respective compounds were calculated. It is concluded that the possibility of group separation of trivalent lanthanides and actinides on an anionite using a concentrated thiocyanide solution is based on a substantial difference in the stability constants of complex ions formed under these conditions, as well as on the formation by actinides negatively charged complex ions.

ELECTROLYTIC PRECIPITATION OF AMERICIUM AND CURIUM FROM THEIR AQUEOUS SOLUTIONS ONTO A PLATINUM CATHODE, Samartseva, A. G., 1962. -- The problem of electrolytic separation of Am and Cm from their aqueous solutions was investigated; the study resulted in the development of a quantitative electrolytic separation method of the 2 elements. The nitric acid solutions contained  $1.4 \times 10^{-10}$  M  $\text{Am}^{241}$  and  $10^{-13}$  M  $\text{Cm}^{242}$ . A small Pt cup served as anode, while the Pt strip cathode with a surface of  $1 \text{ cm}^2$  was rotated to stir the solution. The radioactive element was deposited simultaneously on both surfaces of the cathode; its concentration was calculated from the

absolute counts with a  $4\pi$  counter. The electrolysis of the solution resulted in the quantitative deposition of Am at pH = 1.3 to 4.3 and of Cm at pH = 1.3 to 3.0; the differential behavior is due to the hydrolysis of Cm which starts at lower pH values than Am. A deposition yield of 100% at reasonably short operational periods was obtained for both elements at a current density of 500 milliamp/cm<sup>2</sup>. The method may be used for quantitative analytical determinations. Although anions do not exert a strong effect, solutions containing HNO<sub>3</sub> favor the complete separation of the two elements.

COMPLEXING OF AMERICIUM WITH NEUTRAL PHOSPHOROORGANIC COMPOUNDS. (PART I.), Zemlyanukhin, V. I., et al., 1962. -- Studies of americium extraction by phosphoroorganic compounds (tri-n-butyl-phosphate, di-n-butyl ester of n-butyl phosphonic acid, n-butyl ester of di-n-butylphosphinic acid, and tri-n-butyl phosphine oxide) showed that americium and neutral phosphoroorganic compounds form americium trisolvate: Am(NO<sub>3</sub>)<sub>3</sub>·3TBP, Am(NO<sub>3</sub>)<sub>3</sub>·3DBEBP, Am(NO<sub>3</sub>)<sub>3</sub>·3BEDBP, and (AmNO<sub>3</sub>)<sub>3</sub>·3TBPO. Complexing constants for the above compounds are:  $K_{TBP} = 0.4$ ,  $K_{DBEBP} = 7.4$ ,  $K_{BEDBP} = 112$ , and  $K_{TBPO} = 1780$ .

COMPLEX COMPOUNDS OF TRANSURANIUM ELEMENTS, Gelman, A. D., Moskvin, A. I., Zaitsev, A. A., and Mefod'eva, M. P., 1962. -- This book surveys the world literature on the transuranium elements 93-101 (Np, Pu, Am, Cm, Bk, Cf, Es, Fm, and Md) and describes additional studies in the USSR. Complexes with EDTA, TTA, acetate, oxalate, citrate, lactate, tartrate,  $\alpha$ -hydroxyisobutyrate, cupferron and thiocyanate are discussed. Ion exchange studies with cationites (Dowex-50 and KU-2) and anionites (Dowex-1), and extraction studies with TBP and TTA-benzene, ethers, ketones, amines, and so forth, are discussed. Isolation and decontamination of plutonium by precipitation (sodium uranyl triacetate, bismuth phosphate, etc.), extraction, and ion exchange methods are also discussed. In valence adjustments of the various elements, a wide variety of oxidants and reductants are considered.

Transuranium Element Chemistry, Physics, etc.

- Baranov, S. A. (1963) - 1 -  $\alpha$ -decay, Am-241
- Brandshtetr, I. (1962) - 1 - Fm, Md, TBP, HNO<sub>3</sub>, HCl
- Chmutova, M. K. (1963) - 1 - Np, Pu, Am, ext'n, BPHA
- Dedov, V. B. (1961) - 1 - Am, Cm, org. complexes
- Flerov, G. N. (1963) - 1 - spont. fiss.
- \*\*\*Gelman, A. D. (1957-62) - 25 - Pu, U, Np, complex comp'ds
- Grebenshchikova, V. I. (1957-63) - 20 - Pu, Am, RE's, co-precip., co-cryst.
- Ivanov, R. B. (1962) - 1 - Cm,  $\alpha$ -decay
- \*\*Lavrukhina, A. K. (1955-63) - 13 - RE's, HEP, IX, ext'n, electrol., Fe spallation by 150 Mev p's; U fiss. by 660 Mev p's.
- \*Lebedev, I. A. (1960-62) - 6 - Am, Cm, Pa, RE's, IX
- Mikheyev, V. L. (1959) - 1 - Am-241, spont. fiss.
- \*\*Moskvin, A. I. (1957-63) - 11 - complexes, IX, sol'n chem.
- Oganov, M. N. (1956) - 1 - instr., Am, atomic spect.
- Protopopov, A. N. (1959) - 1 - Am-241, x-sect, 14.6 Mev n's, T(d,n)  $\alpha$
- \*Samartseva, A. G. (1960-63) - 5 - electrolyt. sep'n of trace U, Pu, Np, Am, Cm; Pu(IV) ads. on glasses, Pt.
- Vasil'ev, I. A. (1962) - 1 - photofission of Th-232, U-238, Cm-242, Cf-252
- Volkov, V. V. (1959) - 1 - Cf isots., x-sects., 78-84 Mev C ions on U-238
- \*Yakovlev, G. N. (1955-58) - 5 - Am, Cm, Pu, Np, SO<sub>4</sub>, CO<sub>3</sub>, spectr., electrolyt prep. of films on metal surfaces.
- \*Zaytsev, A. A. (1957-60) - 6 - Am, valence chgs., disproport; red.
- Zemlyanukhin, V. I. (1961-62) - 3 - Am, ext'n, organophos.
- Znoiko, A. P. (1950) - 1 - predict. of Md isots., el. 97, half-lives, props.
- See also Gerlit, Khlebnikov, Makarov, Nikolayev, Pereygin, Preobrazhenskiy, Samsonov, Starik.

## VII. Chemical Processing, Solvent Extraction, Ion Exchange, Etc.

Soviet work in these areas is undoubtedly going on at many of the USSR institutes; however, three of these appear to deserve especial mention:

The Institute of General and Inorganic Chemistry imeni N. S. Kurnakov, directed for many years by I. I. Chernyayev, is comprised of a number of laboratories, such as the Laboratory of the Chemistry of Metal Alloys, the Mechanical Tests Laboratory, the X-ray Laboratory, and the Laboratory of High Pressures, and of several sections or divisions, such as the Division of Physical-Chemical Analysis and the Division of Platinum and Other Noble Metals. Metal alloys, electrodeposition, and rare-earth and diffuse elements are investigated here. Research on inorganic compounds, complex compounds, solvent extraction, ion exchange, and inorganic polymers has been done. Much work on methods of physical-chemical analysis is conducted. Recently, a ternary solid solution having valuable thermoelectrical properties was found, and a synthesis of boron arsenide was developed.

The Moscow Order of Lenin Chemical Engineering Institute imeni D. I. Mendeleev (MChTI), founded in 1920, is an outstanding Soviet chemical engineering institute. Its staff has made significant contributions in many fields, but particularly in the study of plastics, ceramics, and glasses. Research has been conducted on organosilicon compounds, nitro esters, nitroglycerine and diglycol dinitrate, polymer binders for explosives, lithium-organic synthesis, silanes, polycondensation theory, alkylchlorosilanes, organostannoxanes, furan monomers, phenol-carbamide resins, interfacial polyesterification, ionites, and ion-exchange resins.

Research also has been done of high-temperature electrolysis, hot cathodes and luminophors, electrodeposition of metals, alkali-earth element metal corrosion, electrolytic iron powders, ceramic cutting tips of alumina and magnesia, refractory ceramics of pure MgO, ZrO<sub>2</sub> and ThO<sub>2</sub>, heat-resistant aluminum-phosphate cements for bonding metals to ceramics, ion-exchange membranes for use in hydrometallurgy of uranium, solvent extraction, organosilicon coatings of glass for increasing properties, nuclear engineering, physics of glass, glass foil one micron thick, foamed glass, foamed quartz, glass crystals, and combustion explosives.

Courses are offered in fuel technology, inorganic chemistry, technology of rare elements, electrochemical processes, silicates (binders and cementitious materials, ceramics and refractories, and glass), dyes and intermediate products, plastics, and varnishes, paints, and nonmetallic coatings.

The Radium Institute imeni V. G. Khlopin, in Leningrad, was founded in 1922 by merging the former Radium Commission and the Laboratories for Mineralogy and Radium Research of the Academy of Sciences. During its history, V. G. Khlopin and B. A. Nikitin, both deceased, have served as Directors. The work of this institute is concerned primarily with radioactivity, its properties, and applications. Some recent studies have dealt with measurement

of the cosmogenic isotopes of the Yarymly meteorite, and RIAN scientists have also established the absolute age of Antarctic bed rock. RIAN possessed a cyclotron as early as 1940 and is still active in the development and application of nuclear physical equipment.

This institute was visited by the U.S. Atomic Energy Delegation in May 1963, and the following comments were included in the Trip Report.

The chemistry effort at the Institute was initiated by Khlopin, and subsequent leaders in the work were Politsitsky, A. Kh. Ratner, and B. A. Nikitin. The latter pioneered the work on the chemical distribution of plutonium, and the program is now directed by B. P. Nikolsky.

It was at this Institute, in 1946, that Academician Grinberg independently arrived at the actinide hypothesis two years after G. T. Seaborg's disclosure. Grinberg at the time was attempting to prepare carbonyl compounds of uranium and decided, on the basis of uranium's chemical reactions, that it was not chemically analogous to tungsten and molybdenum but belonged in an actinide series.

The primary emphasis of the research, carried on largely at tracer concentrations, is still the distribution of chemical elements, especially the actinides, between two phases: solid-solid, solid-molten, liquid-solid and liquid-liquid. The chemistry of the actinide elements is also studied in solution, in complex compounds, and in the solid phase. The research includes the study of the thermodynamics and kinetics of the reactions in both aqueous and non-aqueous media. Finally, the chemistry program also includes some research on isotope exchange, radioactive source preparation, and the migration of radioactive nuclei.

Active work is being conducted on the extraction of the actinide elements from aqueous solution with tributyl phosphate and organic solvents generally containing oxygen such as ethers, ketones, and alcohols. The chemical distribution is studied by the usual methods, including absorption and infrared spectroscopy. Salting out phenomena are actively studied with a variety of chemical salts. The distribution studies also include precipitation work.

Studies are pursued on the ion exchange behavior of chemical elements. Some of the resins being studied are Soviet-produced equivalents of the Dowex series. The chemistry group has developed a technique to study the state of an ion in solution through the simultaneous exchange on a mixed cation-anion resin bed. The ion exchange work is done in close cooperation with the needs of the physics program for chemically separated nuclides. The usual lanthanide and actinide separations have been performed, including the separation of tracer amounts of americium, curium, berkelium, and californium. In no cases have they handled macroscopic quantities of these heavier actinide elements. In general, the research workers feel they have gained a good understanding of the ion exchange mechanism.

Research is also performed by a group headed by Samartsova, a woman scientist, on the electrochemical separation of elements by electroplating.

Such elements as uranium, neptunium, plutonium, americium, and curium are actively being studied. The techniques developed permit the quantitative deposition of these actinide elements from dilute acidic solution. The kinetics of the processes are such that neptunium, plutonium, and americium can be separated from uranium.

The delegation was shown a considerable amount of research on the complex compounds, solution chemistry, and solid phase of uranium and other elements. The complex peroxides and carbonates of uranium and plutonium are being studied. The hydrolysis, ion exchange behavior, and other parameters of these complex compounds are investigated. There is an extensive study of the reactions of uranyl ion with hydrogen peroxide headed by Sinitsyna, a woman scientist. The delegation was shown eleven new peroxide compounds found in these studies. The complex hydrolysis reactions of the uranyl and hydroxyl ion are also investigated. Some similar studies are being conducted on plutonium, vanadium, and multinuclear complexes. Research is also conducted on nonaqueous systems - for example, the reactions of uranium dioxide with nitrogen dioxide.

The chemistry program also includes research under Grebenshchikova, a woman scientist, on the crystallization and coprecipitation of the lanthanide and actinide elements. This work was begun by Khlopin, and the present studies include the coprecipitation of americium, plutonium, europium and yttrium with lanthanum oxalate and potassium sulfate.

The delegation was briefed by Academician Grinberg on the work of his group on isotope exchange. With radioactive tracers they have been able to obtain a good insight into the exchange mechanisms. One interesting result presented was that, in certain families of complex compounds, the more stable structures had the faster rates of exchange.

There is a small laboratory where labeled compounds with radioactive carbon, iodine, and tritium are prepared. Considerable emphasis is placed on radioactive labeled nucleic acids and proteins. In discussing this area of work with the researchers, the impression was gained that use of radioactive isotopes in medicine in the Soviet Union was not abreast of that in the United States. For example,  $I^{131}$  was still considered a new treatment of diseases of the thyroid and was not in general therapeutic use.

The chemistry program at the Radium Institute also conducts studies on radioactive source preparation. The delegation was shown a demonstration of sources developed by the Institute for industrial applications which are useful for reducing the electrostatic charge on materials. Radioactive materials included in these sources are plutonium, promethium, strontium, or actinium. The group was shown a 1-mc plutonium source with a  $1/2\text{-}\mu$  protective coating which was quite successful in the demonstration.

The Institute has an extensive program in geochemistry headed by Deputy Director Starik. With such a large effort in this field, it is natural that there exists a diffuse boundary between it and chemistry in general. The geochemistry program at the Institute includes the study of radioactive elements in very dilute concentrations and on large scales. The migration

of radioactive materials in nature is investigated, and there is an active program on fallout measurement. Work on radioactive dating is also being performed.

The delegation visited several laboratories working with radioactive isotopes in great dilutions. Studies have been conducted on polonium adsorption on glass and its radio-colloid formation. The adsorption of zirconium, protactinium, americium, and  $\text{Pu}^{4+}$  on quartz has been investigated. Protactinium and other radioactive isotopes, such as zirconium, uranium, bismuth, thallium,  $\text{Bi}^{210}$ , and  $\text{Th}^{234}$ , have also been studied in dilute solutions, generally in the concentration range from  $10^{-6}$  to  $10^{-10}$  moles/liter. In general, the scientists feel that they are close to an understanding of very dilute solutions in both aqueous and nonaqueous media.

Techniques used in the study of these are conventional, including ion exchange behavior to determine the ionic state in dilute solutions. One interesting development has been in the group's work on polarography, headed by Ziv, which began in 1947 when the valence of polonium in solutions was determined. With careful control of the electrode materials and accurate measurement of the critical potential, the properties of certain ionic species are determined in very dilute solutions. The scientists claim to be able to detect lead and bismuth impurities in tellurium and germanium down to concentration of  $10^{-14}$  moles/liter. This is equivalent to roughly  $10^7$  atoms of impurity per gram.

The fallout studies group, headed by Gedeonov, measures fallout in fresh water, ocean water (Atlantic), and foodstuffs, in addition to atmospheric samplings. The delegation was shown a chart of  $\text{Cs}^{137}$  fallout in Leningrad and environs for the past several years. The results exhibited the usual sinusoidal pattern, with the spring fallout the heaviest. The maxima were descending in the years 1959, 1960, and 1961, with the expected increase in 1962. It was mentioned that ruthenium, zirconium, and cerium fallout had also been investigated. As in many other laboratories, the delegation saw a well constructed 100-channel analyzer built by Soviet industry and used for these studies.

Gedeonov felt that these fallout studies provided considerable insight into the nature of the atmosphere. He noted that the radioactive debris is distributed in the atmosphere in several different states, including aerosols and pseudocolloids. This group at the Radium Institute participated in an oceanographic investigation on the research ship Lomonosov in October 1962, in order to continue these atmospheric studies and measure  $\text{Sr}^{90}$  concentration in the ocean as well. It was noted that a surprisingly high concentration peak of  $\text{Sr}^{90}$  was found in the equatorial waters of the Atlantic off Africa, which had not been seen previously.

Finally, Gedeonov showed the delegation some specific fallout results from the French nuclear explosion of February 13, 1960, which took place in the Sahara Desert. The samples were taken in the Crimea and the open water, and he noted that Israel received considerable fallout from this event seven days after the test. The group was told that it was possible to trace back from the debris the date of testing and the type of device

tested. It was noted in this discussion that every atmospheric nuclear explosion is investigated in the same way and that it is possible to tell a great deal about the test from the debris.

The final research work of the Institute in geochemistry which the delegation visited was the radioactivity dating studies. Effort has been given to the dating of cores from ocean bottoms similar to the work in this country. The ionium-uranium, ionium, and ionium-protactinium techniques are utilized. Sedimentation rates are studied with the  $C^{14}$  method. The age of meteorites and minerals is measured by the conventional lead, uranium, thorium, and radium determinations. The group has been working actively on the dating of tektites from Czechoslovakia. They agree with the general hypothesis that these are of extra-terrestrial origin.

The following abstracts from the book "Ekstraktsiya" help to illustrate the nature of the Soviet effort in solvent extraction, and the subsequent annotated lists of authors briefly suggest the extent of their overall effort in reactor fuel processing (and related subjects).

## Selected Abstracts (NSA, R.V.J.) from Volume 1 of the Book

EKSTRAKTSIYA

(Moscow, Gosatomizdat, 1962)

SEPARATION OF Zr AND Hf BY SOLVENT EXTRACTION, G. E. Kaplan, E. D. Moiseev, L. P. Dmitrieva, and S. A. Kostochkina, p 117-24. -- Separation of Zr and Hf by TBP and wet chlorination in nitric acid was studied. An analysis of Zr extraction using trioctylamine in xylene showed that with 20% reagent in 2N xylene the  $D_{Zr} = 1.4$  and in 0.7N xylene  $D_{Zr} = 5.5$ . Extraction with 10% reagent and equal phase volumes resulted in  $D_{Zr} = 0.67$  for 0.7N  $H_2SO_4$ , 0.42 for 2N  $H_2SO_4$ , and 0.31 for 4N  $H_2SO_4$ . The coefficient of Zr distribution increases with reagent concentration. With Zr extraction from 2N solutions the  $D_{Zr} = 0.4$  for 10% reagent, 1.4 for 20%, and 14.7 for 30%. Fluorine ions reduce Zr distribution. It was found that phosphoric acid esters and amines effectively contribute to Zr and Hf separation from sulfuric acid solutions.

GROUP SEPARATION OF RARE EARTHS BY COUNTER-CURRENT FLOW, G. V. Korpusov, I. V. Eskevich, and E. P. Zhironov, p 125-42. -- Group counter-current separation of rare earths was studied using an initial monazite concentrate, rare earth concentrate separated from cerium and basic lanthanum, and intermediate enriched yttrium subgroups. Distributions were determined for  $Ce^{144} \rightarrow Pr^{144}$ ,  $Nd^{147}$ ,  $Pm^{147}$ ,  $Eu^{152-154}$ ,  $Y^{91}$ , and  $Tm^{170}$ . Contents were determined by x-ray, spectral, and spectrophotometric analyses at  $\sim 20^\circ C$ .

URANIUM EXTRACTION WITH TRIOCTYLPHOSPHINE OXIDE, B. N. Laskorin, D. I. Skorovarov, and V. V. Shatalov, p 163-70. -- Solvent extraction of U(VI) by trioctylphosphine oxide (TOPO) synthesized by alkyl magnesium bromide reaction with phosphorus oxychloride ( $3C_8H_{17}MgBr + POCl_3 \rightarrow (C_8H_{17})_3PO + 3MgBrCl$ ) was investigated. Isotherms of U extraction from nitric, hydrochloric, sulfuric, and phosphoric acids by 0.1M TOPO in kerosene were analyzed. The results showed that TOPO is capable of satisfactory uranium extraction from any aqueous acid solution in the presence of small amounts of nitric acid.

EXTRACTIVE PROPERTIES OF ALKYL PHOSPHATES, B. N. Laskorin, V. S. Il'yanov, and R. A. Sviridova, p 171-87. -- Extraction of U from various solutions using mono(2-ethylhexyl) phosphoric acid (M2EHPA), di(2-ethylhexyl)phosphoric acid (D2EHPA), di(2-ethylhexyl) pyrophosphoric acid (D2EHPPA), and their mixtures with TBP, di-isocamyl ether, methylphosphonic acid (DAMPA), and tributylphosphine oxide (TBPO). Uranium distribution isotherms and efficiency graphs are given.

ANALYSIS OF THEORETICAL STEPS IN EXTRACTION COLUMN, V. V. Fomin, E. P. Mairova, and R. E. Kartushova, p 188-201. -- Extraction of uranyl nitrate and nitric acid by TBP was analyzed by determining the number of theoretical steps in an extraction column. Preliminary studies indicated 4 to 5 upper steps for complete U extraction at  $n = 4.2$ . The concentration of acid in solution is 2.12 due to reduced aqueous volume. Concentration of U from the sixth step is  $5 \times 10^{-6} M$ , and U is absent at lower stages. Graphs are given for uranium and acid step-by-step distributions.

## Selected Abstracts (NSA, TTT) from Volume 2 of the Book

EKSTRAKTSIYA

(Moscow, Gosatomizdat, 1962)

EXTRACTION OF URANYL NITRATE FROM NITRIC ACID SOLUTIONS BY NORMAL ETHERS, V. V. Fomin and R. N. Maslova, p 19-33. -- The solvation of  $UO_2(NO_3)_2$  (using  $U^{233}$ ) was studied in its extraction from aqueous nitric acid solution by di-n-butyl (DBE), ethyl-n-propyl (EPE), and di-n-propyl (DPE) ethers. With DBE the extraction of  $UO_2(NO_3)_2$  from 5M  $HNO_3$  did not change as the uranium concentration was increased from  $2.13 \times 10^{-4}$  to 0.12M. The solvate in the organic phase contains 1 molecule of uranyl nitrate under these conditions. With an aqueous nitrate concentration kept approximately constant, 6.3 to 6.6M, by addition of  $Ca(NO_3)_2$ , the distribution coefficient of uranyl nitrate and the acid concentration in the organic phase were approximately proportional to the aqueous  $H^+$  concentration. Although uranyl trinitrate is more extractable than uranyl nitrate, the trinitrate is not likely to form under the conditions used, and the increased extraction may be due to the change in the aqueous uranyl nitrate activity coefficient and in the organic extractant and solvate activity coefficients in going from 3.15M  $Ca(NO_3)_2$  to 6.3M  $HNO_3$ . With varying DBE concentrations, two solvates were shown:  $UO_2(NO_3)_2 \cdot 3H_2O \cdot 3DBE$ . With EPE and DPE,  $UO_2(NO_3)_2 \cdot 3EPE$  and  $UO_2(NO_3)_2 \cdot 3DPE$  were formed; they contained water but the amount was not determined. The logarithm of the constant of formation of uranyl trinitrate in extraction from 4.2M  $HNO_3$  depended linearly on the ratio of the number of C and O atoms in the extractant, which agreed with earlier data for some other extractants.

EXTRACTION OF URANIUM BY A MIXTURE OF TRIBUTYL PHOSPHATE AND THE DI-ISOAMYL ESTER OF METHYL PHOSPHONIC ACID, V. V. Fomin, R. E. Kartushova and E. P. Mayorova, p 37-46. -- The distribution of both micro and macro amounts of uranyl nitrate ( $U^{233}$ ) between aqueous solutions and two neutral extractants, tributyl phosphate (TBP) and di-isoamyl ester of methyl phosphonic acid (DAPA), and mixtures of them was studied. Equal volumes of the two phases were mixed in separatory funnels; kerosene was the diluent. With micro amounts of uranium and a constant uniform aqueous phase containing 1M nitrate ion (ammonium nitrate plus 0.05M  $HNO_3$  to prevent hydrolysis), the distribution coefficients of the uranium were much higher with mixtures of the extractants than were the additive values. The free solvent concentration did not change, essentially, with extraction of micro amounts of uranium. The solvates  $UO_2(NO_3)_2 \cdot 2DAPA$  and  $UO_2(NO_3)_2 \cdot 2TBP$ , together with  $UO_2(NO_3)_2 \cdot DAPA \cdot TBP$ , were formed. With macro amounts of uranium, each extractant formed solvates and its equilibrium concentration was less than that of the original. From 1M  $HNO_3$  the distribution coefficients for macro amounts of uranium were only slightly higher than the additive values of those of the individual extractants. A detailed mathematical treatment is included.

**THE USE OF A COMPLEX IN THE EXTRACTION PROCESS FOR RECOVERING A RARE EARTH Er-Lu CONCENTRATE**, V. F. Eskevich and P. M. Seredenko, p 112-16. -- A process is outlined (with both batch and continuous countercurrent schematic flowsheets) for recovering the Er-Lu rare earths by liquid-liquid ion exchange, i.e., by extraction with ethylenediamine tetraacetate (EDTA). This reagent can be used in a pH range from 2 to 9. In experiments on extraction by 100% TBP (tributyl phosphate) at pH 2.3 from an aqueous phase containing 800 g of  $\text{NH}_4\text{NO}_3$  per liter as salting-out agent, the rare earth distribution coefficient was high. However, rare earth solubility in this aqueous feed is low and stable emulsions are formed in the extraction. With Trilon B (dihydrate of the EDTA disodium salt, solubility 10 to 25 g/liter at pH 1.5 to 4.0) added to the solvent, three equal-volume extractions were sufficient to recover 85 to 90% of the Er-Lu group. Back-extraction was with TBP.

**MECHANISM OF EXTRACTION DISTRIBUTION OF THE RARE EARTH ELEMENTS IN NEUTRAL SOLUTION**, G. V. Korpusev, I. V. Eskevich, E. N. Patrusheva, V. V. Erchenkov, and L. R. Alekseeva, p 117-40. -- The mechanism of extraction of the rare earths by some phospho-organic solvents from aqueous containing just enough acid to prevent hydrolysis was studied. The organics were tributyl phosphate (TBP), the di-isocamyl ester of methyl phosphinic acid,  $(\text{C}_5\text{H}_{11}\text{O})_2\text{POCH}_3$  (DAPA), and toluene and benzene as diluents. As the total rare earth concentration increased from 100 to 150 g/liter, extraction of both the total rare earths and of the individual elements of the cerium sub-group increased. The maximum rare earth capacity of 100% TBP is 190 to 200 g/liter and of 70%, 140 g/liter. The mole ratio of organic to rare earth was the same with individual rare earths as with a concentrate. With increasing amounts of salting-out agent, the distribution coefficient of micro amounts of rare earths increased. The capacity of DAPA was greater than that of TBP. Saturation of the organic phase was approached with a salting-out agent (Al, Zn, Li). The mole ratio of TBP to rare earth, which is 3:1 for 100% TBP with the cerium subgroup elements, sometimes went as low as 1:1 with dilution of the TBP to 20% with benzene. It was verified that for the cerium elements in neutral solution, inversion does not occur with increasing nitrate ion concentration or, actually with increasing concentration of salting-out agent or rare earth nitrates. The overall rare earth distribution coefficient decreased slightly with increasing temperature in the presence of a salting-out agent, a little more without salting-out agent at high equilibrium concentrations of rare earths in the aqueous phase. However, changing the temperature greatly affected the distribution of the more extractable elements. A plot of the distribution coefficient at first decreased (cerium subgroup), went through a maximum, and then fell (yttrium subgroup). Under some conditions, e.g., 100% TBP and 6N  $\text{Al}(\text{NO}_3)_3$  as salting-out agent, a definite break occurred in the curve at gadolinium. A mathematical treatment of the data is included.

**EXTRACTION OF ZIRCONIUM AND HAFNIUM BY TRI-N-OCTYLAMINE FROM METAL FLUORIDE SOLUTIONS**, G. A. Yagodin and A. M. Chekmarev, p 141-53. -- Tri-n-octylamine (TOA), 10% in benzene, did not extract zirconium or hafnium from their aqueous potassium fluoride solutions in the absence of acid. In the presence of acid both metals were extracted, the distribution coefficient varying with the acid used, decreasing in the order  $\text{H}_2\text{SO}_4 \rightarrow \text{HCl} \rightarrow \text{HNO}_3$ . With  $\text{H}_2\text{SO}_4$  solutions, extraction by 10 vol % TOA in benzene was

maximum for both metals with an initial aqueous acidity of 0.2 to 0.3N. From sulfuric acid solution, hafnium was principally extracted, and from nitric acid, zirconium. From HCl the distribution coefficients were not large, and, depending on the acid concentration, might be greater or less than 1. The effect of impurities was shown by extraction from a solution containing 8.7 g of  $K_2ZrF_6$  per liter by 5% TOA in benzene, the amine being previously saturated with  $H_2SO_4$ . With increasing KCl,  $NH_4NO_3$ ,  $K_2SO_4$ , or KF in the solution the distribution coefficient decreased. In the presence of 0.2M oxalic acid and with 10 g of  $K_2ZrF_6$  per liter (the amine not previously treated with sulfuric acid), the zirconium distribution coefficient was nearly 5 times that of hafnium. The extraction mechanism involved transfer of the zirconium and fluoride, but not the potassium, from the aqueous  $K_2ZrF_6$  solution to the organic phase, 1 mole of zirconium combining with 2 moles of amine:  $2(NR_3H)HSO_4 \text{ org} + K_2ZrF_6 \text{ aq} \rightleftharpoons (R_3NH)_2ZrF_6 \text{ org} + 2KHSO_4 \text{ org}$ . The logarithm of the zirconium coefficient plotted against that of the TOA concentration was a straight line with slope of approximately 1. The diluted (with benzene) TOA bisulfate is believed to be polymerized.

DISTRIBUTION OF THORIUM AND RARE EARTHS IN TRIBUTYL PHOSPHATE EXTRACTION, G. E. Kaplan, S. D. Moiseev, V. M. Gavrillin, G. I. Semenov, and V. P. Vorotilin, p 154-9. -- In experiments on extraction with 40% tributyl phosphate (TBP) from aqueous solutions containing 30 to 130 g of thorium per liter, the thorium distribution coefficient increased with increasing  $HNO_3$  concentration in the aqueous phase from 1 to 5M and then dropped, especially sharply for the 30-g/liter concentration. An increased rare earth concentration in the initial solution somewhat increased the thorium distribution coefficient, apparently by a salting-out effect, with increase also in the extracted rare earths. The chief disadvantage of using a solution with a high rare earth content is the inability to increase the thorium content as much as desirable because of the high viscosity of the solution caused by the high concentration of the total components. The extract was washed many times with 3.7 to 4.0 N  $HNO_3$ , and the rare earth content in the final extracted product, which contained from 97.5 to more than 99% of the original thorium, was  $10^{-3}$  to  $10^{-4}\%$ , based on thorium. The experiments were made in a 12-stage countercurrent mixer-settler.

EXTRACTION OF THORIUM BY DI-ISOAMYL ESTER OF METHYL PHOSPHONIC ACID FROM HYDROCHLORIC AND PERCHLORIC ACID SOLUTIONS, V. D. Nikol'skii and M. E. Pozharskaya, p 160-4. -- The distribution of thorium between aqueous HCl and  $HClO_4$  solutions and solutions of di-isoamyl ester of methyl phosphonic acid (DAPA) in  $CCl_4$  was studied. Equal-phase volumes, 4 ml each, were used in graduated test tubes. DAPA extracted  $HClO_4$  solutions much better than HCl. The solubility of perchloric acid in DAPA was practically negligible. From 5 M HCl, with increase in aqueous thorium from 1 to 230 g/liter, the distribution coefficient decreased with 20 and 50 vol % DAPA but changed slightly and irregularly with 10%. With 10, 30 and 50 vol % DAPA in  $CCl_4$ , the distribution coefficient of thorium increased linearly with increasing HCl concentration from 0.2 to 4M, but above 5M HCl the distribution coefficient increased abruptly. This may be due to the formation of a new, readily extractable, compound, e.g.  $HThCl_5$ ,  $H_2ThCl_6$ ,  $H_4ThCl_8$ , or to the increased salting-out effect of the HCl. In low-acid solutions the thorium was shown to be in the form of the ions  $ThOH^{3+}$ ,  $Th(OH)_2^{2+}$ , and  $Th(OH)_3^+$  and was extracted

chiefly as  $\text{Th}(\text{OH})\text{Cl}_3 \cdot n\text{DAPA}$ . At  $5M$   $\text{HCl}$  the neutral salt  $\text{ThCl}_4$  is formed, which is extracted better than the basic salt. From perchloric acid varying from  $1.0$  to  $6.0M$ , the distribution coefficients of thorium from a solution containing  $20 \text{ g}$  of thorium per liter were similar to those from  $\text{HCl}$  but a little higher.

EXTRACTION OF URANYL NITRATE BY TRIBUTYL PHOSPHATE AND OTHER NEUTRAL PHOSPHO-ORGANIC COMPOUNDS FROM NITRIC ACID ELUATES, B. N. Laskorin, D. I. Skorovarov, and V. V. Shatalov, p 174-8. -- Extraction of uranyl nitrate from low-acid eluates, obtained from ore pulps, by alkyl phosphate (TBP), alkyl phosphonates (DAPA), trioctyl phosphine oxides (TOPO), and other compounds in this series was studied. The sulfate in solutions prepared by sorption of uranium from ore pulps and elution with dilute nitric acid may be kept low by sufficient washing of the resin before elution. Uranium may be completely extracted by  $30\%$  TBP in kerosene in 5 stages from an eluate containing  $10 \text{ g}$  of  $\text{SO}_4$ ,  $40 \text{ g}$  of  $\text{HNO}_3$ , and  $20 \text{ g}$  of  $\text{NO}_3$  per liter. The  $\text{NO}_3/\text{SO}_4$  mole ratio should not be less than 8. Study of the properties of a series of phospho-organic compounds showed that with increase in the number of C-P bonds, the extraction capacity for uranium increases. The distribution coefficient of uranium was higher with  $10\%$  DAPA than with  $40\%$  TBP or  $1\%$  TOPO plus  $40\%$  TBP from an acid solution containing  $45 \text{ g}$  of acid per liter. With a mixture (e.g.,  $1\%$  TOPO plus  $40\%$  TBP or  $5\%$  DAPA plus  $35\%$  TBP) pure uranium solution may be obtained. The total impurity in the uranium oxide obtained by this method was not more than  $0.1$  to  $0.2\%$ . The loss of extractant was almost directly proportional to the volume of aqueous solution processed, but a large part of the lost extractant could be recovered by washing the mother liquor with kerosene.

SYNERGISM IN THE EXTRACTION OF URANYL NITRATE, V. B. Shevchenko, V. S. Smelov, and A. V. Strakhova, p 179-89. -- Extraction of uranyl nitrate from nitric acid solutions by acid (dibutyl, DBP, and di-isoamyl) and neutral (tributyl, TBP) phosphates was studied in glass separatory funnels at  $22^\circ\text{C}$ . Equal phase volumes were used. The diluent was thiophene-free benzene. The synergistic effect increased as the TBP in the organic phase increased and approached a maximum of about 6 for a TBP-DBP mixture and about 8 for a TBP-di-isoamyl phosphate mixture. The TBP was varied from  $50$  to  $8000\%$  of the stoichiometric amount needed to form the uranyl nitrate disolvate. A change in the dialkyl phosphate concentration to 1- to 2-fold excess over stoichiometric did not affect the synergistic effect, but the effect was decreased somewhat with much lower dialkyl phosphate concentrations. With low  $\text{HNO}_3$  concentrations, with a mixture of TBP and either DBP or di-isoamyl phosphate, the synergistic effect sharply increased to a maximum and then fell. Changing the uranium concentration from  $1$  to  $50 \text{ g/liter}$  did not affect the synergism under the conditions. The extraction mechanism with a mixture of extractants appears to be extraction of a complex containing 1 mole of TBP:  $\text{UO}_2^{2+} + 2\text{HA} \rightleftharpoons \text{UO}_2\text{A}_2 + 2\text{H}^+$  and  $\text{UO}_2\text{A}_2 + \text{TBP} \rightleftharpoons \text{UO}_2\text{A}_2 \cdot \text{TBP}$ .

EXTRACTION OF URANYL SULFATE BY TRI-N-OCTYLAMINE, B. N. Laskorin, Z. Sh. Golyenko, and D. I. Skorovarov, p 190-8. -- The mechanism of extraction of uranyl sulfate by tri-n-octylamine (TOA) was studied. The TOA was dissolved in sulfonated kerosene to  $0.16$  to  $0.46M$  and contained  $5 \text{ vol } \%$  decyl alcohol.

The aqueous uranyl sulfate solutions had uranium concentrations of 1.06 to 60.67 g/liter and a pH of 1. Equilibrium in extraction was reached in 20 to 40 sec. At equilibrium the TOA/U ratio was 4.8. For an organic phase far from saturated, the distribution coefficient was directly proportional to the free amine concentration. Near saturation conditions, a uranyl aminosulfate complex formed with practically constant ratio of uranyl sulfate and aminosulfate. A characteristic of TOA is its ability to quickly approach saturation of the organic phase with low equilibrium concentrations of uranium in the aqueous phase. The optimum conditions for extracting uranium from sulfuric acid media is a TOA/U weight ratio of 8 to 9. Further increase in the ratio does not increase the extraction. With a TOA/U weight ratio less than 5, the uranium distribution coefficient decreases, and it is difficult to obtain a low equilibrium uranium concentration in the aqueous phase. Extraction and ion exchange properties are very similar, and quantitatively the extraction isotherm may be determined from the equations for ion exchange processes.

DENSITY, VISCOSITY, SURFACE TENSION OF SOLUTIONS AND DIFFUSION COEFFICIENTS OF SUBSTANCES IN THE WATER-URANYL NITRATE-NITRIC ACID-TRIBUTYL PHOSPHATE SYSTEM, E. V. Voronetskaya and A. M. Rozen, p 199-208. -- Various constants were measured for use in analyzing mass transfer and hydrodynamic data in extraction columns. The extractant was TBP in kerosene. At 20°C, with increase in the TBP concentration from 0 to 100%, the surface tension at the aqueous-air interface varied from 50 to 35 dynes/cm. TBP had a higher surface activity than kerosene. HNO<sub>3</sub>, which lowered the surface tension of the H<sub>2</sub>O, in the presence of organic phase somewhat increased the surface tension of the aqueous phase and of the interphase at concentrations of the order of 10M. The surface tension of uranyl nitrate at the boundary with air was higher than with water. In the system aqueous uranyl nitrate solution plus nitric acid - 20% TBP in kerosene, the surface tension increased with increasing uranium concentration, especially in the presence of 2 M HNO<sub>3</sub>. From 20 to 60°C, the surface tension of the aqueous and organic phases at the air boundary decreased linearly with increasing temperature. The interphase tension increased linearly. Clean surfaces were poorly wet by 20% TBP in kerosene. Tables and graphs show the viscosity and specific gravity values for various solutions under various conditions, and diffusion coefficients for uranyl nitrate in the aqueous and organic phases are recorded.

EFFECT OF MONO- AND DIBUTYL PHOSPHATES ON EXTRACTION OF URANIUM(VI) BY TRIBUTYL PHOSPHATE, V. B. Shevchenko and V. S. Smelov, p 219-26. Since dibutyl (DBP) and monobutyl (MBP) phosphates, decomposition products of tributyl (TBP) phosphate, have a tendency to transfer to the aqueous solution, their distribution coefficients between benzene and aqueous solutions containing varying amounts of nitric acid, lithium nitrate, and perchloric acid (ionic strength of 4) were investigated. DBP transferred in insignificant amounts to aqueous solutions containing LiNO<sub>3</sub>, HNO<sub>3</sub>, and HClO<sub>4</sub>, especially at high concentrations of the last. MBP transferred readily, the amount increasing with increasing acidity. Extraction of uranium by 20% TBP in kerosene was strongly affected by DBP but was essentially not affected by MBP. The distribution coefficient of uranium between the benzene and aqueous solutions varied as the square of the MBP and DBP concentrations and inversely as the hydrogen ion concentration. Varying the nitrate ion concentration in the range 1 to 3M had practically no effect. The proposed mechanism is:  $UO_2^{++} \text{ aq} + 2HA \text{ org} \rightleftharpoons UO_2A_2 \text{ org} + 2H^+ \text{ aq}$ .

EXTRACTION DISTRIBUTION OF VANADIUM AND URANIUM, V. I. Kuznetsov and I. V. Seryakova, p 227-34. -- For use in analyzing solutions for uranium, optimum conditions were determined experimentally for separating a large amount of vanadium(V) from uranium. The vanadium was extracted from a  $H_2SO_4$ -HCl medium, which permitted making a "superconcentrated" HCl medium while increasing the vanadium extraction by tying up some of the other elements, especially the uranium, in a sulfate complex. In the proposed method, concentrated  $H_2SO_4$  and HCl are added to 5 to 10 ml of solution to be analyzed. This solution should contain no more than 0.5 to 1.0N chloride and nitrate and its vanadium content should be 100 to 150 mg. The vanadium is extracted with amyl acetate plus toluene, and the residual acid solution is oxidized with solid  $KClO_3$  and again extracted. After four extractions, 94 to 96% of the original uranium remains in the acid layer and less than 0.05% of the vanadium.

ON THE THERMODYNAMIC EXTRACTION EQUILIBRIUM OF PLUTONIUM, A. M. Rozen and E. I. Moiseenko, p 235-56. -- The activity coefficient for micro amounts of Pu(VI) in extraction by 20% tributyl phosphate (TBP) from aqueous solutions ranging in acidity from 0.1 to 10 M and in uranium concentration from 0 to 400 g/liter was close to that of U(VI), as were values for micro amounts of Pu(IV) in the presence of  $HNO_3$ , Th(IV) in macro concentration, and Pu(IV) in macro concentration. A sharp drop with increasing nitrate ion concentration is explained by the action of electrostatic forces. An increased activity coefficient at high temperatures is probably connected with decreased association. The higher activity coefficient of macro amounts of plutonium at high ion strength may be explained by the greater hydration of plutonium than of hydrogen ions. When the aqueous solution contains uranium, it transfers to the organic, tying up TBP and decreasing the plutonium distribution coefficient. In the absence of uranium, at acidities up to about 6M the Pu(IV) distribution coefficient decreased with increasing temperature but at high acidities, increased. At acidities from 0.1 to 10M, with an aqueous uranium concentration higher than 5 g/liter, Pu(IV) extraction increased with increasing temperature. Because of the decreasing uranium distribution constant under these conditions, the free TBP concentration increased, overlapping the effect of the lower Pu(IV) distribution constant. With only 5 g of uranium per liter of aqueous phase, Pu(IV) extraction showed a maximum with temperature. Of eight diluents tested,  $CCl_4$  caused the least deviation from theoretical,  $CHCl_3$  the most. Measurements in the  $HNO_3$ - $HClO_4$ -1M TBP (in benzene) and the  $CuCl_2$ - $Cu(NO_3)_2$ -20% TBP systems indicated that less than 4 nitrate ions are in the Pu(IV) complex. With increasing temperature from 20 to 70°C, the complex formation constant decreased, in agreement with an electrostatic explanation. With macro plutonium concentrations, extraction from 0.1M  $HNO_3$  increased with increasing plutonium concentration up to 250 g/liter, the increase being considerably greater with 100% than with 20% TBP. With 0.72M TBP, benzene diluent gave the best results in extraction, out of four tried. Increased acidity increased the plutonium in the organic, especially at low concentrations. The di-isoamyl ester of methyl phosphonic acid and TBP were much better extractants than diethyl or dibutyl ether. Measurements of the heat effect showed  $5700 \pm 200$  cal/mole for extraction of  $Pu(NO_3)_4$  by TBP.

MASS TRANSFER IN EXTRACTION AND STRIPPING OF URANYL NITRATE IN PACKED COLUMNS, A. M. Rozen, S. M. Karpacheva, S. F. Medvedev, E. P. Radionov, and L. F. Kiseleva, p 284-93. -- The effectiveness of packing in the column was studied for the extraction of uranyl nitrate by tributyl phosphate. HETS and HTU values are presented in graphs for various extraction and stripping conditions. The extraction experiments were carried out with a 25-mm diameter, 1-m high laboratory column, while for the reextraction 2 and 5.8-m high columns were used; details of the experiments were similar to those described by A. Rozen et al., (Khim. Prom. 627 (1957) No. 7). The U concentration of the uranyl nitrate solutions was varied from 1 to 310 g/liter during the extraction step and from 10 to 70 g/liter during the reextraction while the  $\text{HNO}_3$  concentration was kept at about 0.5 and 2M during the extraction; for the re-extraction distilled water acidified with 0.05M  $\text{HNO}_3$  was used.

Solvent Extraction Studies Employing Various Organic Extractants

- Arbusov, A. E. (1962) - 1 - organophos. comp'ds, chem., applic., book
- Davankov, A. B. (1962) - 1 - U, sea water
- Eremin, G. K. (1961) - 1 - alk. phos., Nd, Pr
- Gelperin, N. I. (1956-58) - 4 - contactors, columns
- \*Gindin, L. M. (1958-61) - 7 - exch. ext'n, metal soaps, etc.
- Golovatenko, R. T. (1962) - 2 - U, ether
- Goroshchenko, Ya. G. (1959) - 1 - Ta, Nb, cyclohex.
- Kafarov, V. V. (1951-56) - 3 - contactors, columns, hydrodyn.
- \*Karpacheva, S. M. (1957-62) - 7 - U, Cs, Fe, contactors, TBP, carbox. acids
- Khokhryakov, P. (1954) - 1 - countercurrent formula
- Komar, N. P. (1957) - 1 - complex comp'd dist.
- \*Komarov, Ye. V. (1959-62) - 6 - U, U-complexes, organophos. reag.
- Kozlov, V. N. (1950-58) - 2 - theory, contin. countercurrent
- Kriss, E. E. (1960-62) - 3 - RE's, Lanthanides, TBP, DBP
- Krupatkin, I. L. (1956) - 1 - liq-liq. equilib.
- Kurnakova, A. G. (1958) - 1 - U, Th, salting agents, solub.
- Kuznetsova, A. A. (1961) - 1 - sol'n chem., salting agents
- Maslova, R. N. (1961-62) - 2 - ethers, U, HNO<sub>3</sub>
- Mel'chakova, N. V. (1962) - 1 - Zr complexes, selenenoyl, acetone, benzene
- Mikulski, J. (1962) - 1 - chloroform, thioxinates, Mn, Fe, Co, Cu, Zn
- Moseev, L. I. (1961) - 1 - ethers, chloride syst.
- Moucka, V. (1962) - 1 - U(VI), dibenzoyl methane
- Nikol'skii, V. D. (1957-62) - 4 - TBP, DAPA, Ru, Pu, Th
- Patzek, T. (1959-62) - 2 - raw mat's, TBP, mepasin, Zr, Hf
- Petrov, K. A. (1960) - 1 - organophosphorus extractants, processing
- Petrukhin, O. M. (1961) - 1 - analyt., radiochem., book

Solvent Extraction, etc., continued

- Planovskaya, M. A. (1950) - 1 - packed columns, opt. op. conditions
- Planovskii, A. N. (1960) - 1 - perfor. plate columns, sep'n chamber, calc.
- Privalova, M. M. (1960) - 1 - Sb, eth., alc., hydrolysis
- Rosyanov, S. P. (1962) - 1 - Th sep'n from Ce, salicylates
- Salamatov, I. I. (1959) - 1 - rotary contin. c.c. contactor, TBP syst.
- Samoilov, O. Ya. (1960-62) - 3 - salting agents, TBP, U, Th, theory, etc.
- Shevyakhova, I. P. (1956) - 1 - motion of drops of varying mass in liq. media.
- Shuvalov, O. N. (1961) - 1 - c.c., TBP, columns, calc. of stage eff.
- Siekierski, S. (1959-61) - 3 - TBP, amines, U, Pu, Zr, Nb, sil. gel
- \*\*Solovkin, A. S. (1957-60) - 11 - diisopentyl methylphosphate, TBP, U, Pu, Zr, HNO<sub>3</sub>, etc.
- Sraier, V. (1963) - 1 - U, HNO<sub>3</sub>, n-ethylcyclohexanones, mixer-settlers
- Stary, I. (1959) - 2 - benzoylacetone, Y, Sr, etc.
- Timoshev, V. G. (1959-60) - 2 - lab extractor, with gas lifter, 48 theor. plates
- Troitskii, K. V. (1957-58) - 2 - Nb, Fe, thiocyanate, alc., ethers, esters
- Urbanski, T. S. (1961-62) - 2 - U, Fe, organophos. comp'ds, acids, SO<sub>4</sub> media, raw mats. (?)
- \*\*\*Vdovenko, V. M. (1957-63) - 42 - U, Pu, FP's, ethers, TBP, amines, etc.
- Voden, V. G. (1959) - 1 - U, organophos. comp'ds, TBP, DBBP, TBPO
- Yung-yu, W. (1961) - 1 - At, HNO<sub>3</sub>, diisopropyl ether
- \*Zaborenko, K. B. (1959-62) - 7 - U, Th, TBP, design continuous mixer-settler; automatic recording; nuc. emulsions; IX; etc.
- Zakharov-Nartsissov, O. I. (1961) - 1 - HNO<sub>3</sub>, triheptylamine
- Zefirov, A. P. (1962) - 1 - theory, applic., apparat., book
- Zharovskii, F. G. (1961) - 1 - HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>, H<sub>3</sub>PO<sub>4</sub>, O-cont. solvents
- See also Babko, Byk, Chukhlantsev, Faddeyeva, Galkin, Gindin, Grinberg, Kiss, Kriss, Kuznetsov, Lavrukhina, Mikhaylov, Mints, Nefedov, Nikitin, Peshchevitskiy, Rimoshev, Ryabchikov, Ryskin, Shevchenko, Shvedov, Slepyan, Solov'ev, Starik, Suglobova, Taube, Tserkovnitskaya, Tyrkin, Yeregin, Zolotov, Zvyagintsev.

Solvent Extraction Studies Employing TBP, Tri-n-butylphosphate

- Adamskii, N. M. (1960-61) - 3 - ext'n: temp., Zr, carboxylic acids
- Chaykhorskiy, A. A. (1961) - 2 - benzene-H<sub>2</sub>O, butylacetate-benzene, temp.
- Egorov, G. F. (1960) - 1 - Zr, Hf
- Erzhabek, V. (1958) - 1 - ext'n, RE's
- Eskevich, V. F. (1962) - 1 - ext'n, RE's, IX, EDTA
- \*\*\*Fomin, V. V. (1956-62) - 21 - ext'n, U, Th, Pu; Fe, DBE;
- Gerabek, V. (1958) - 1 - RE ext'n
- Granovskii, Yu. V. (1963) - 2 - Hf, Zr
- Gunzler, G. (1963) - 2 - V ext'n, HCl
- Ilazhev, A. P. (1960) - 1 - ext'n, MBP, DBP
- Mayorova, Ye. P. (1958-59) - 3 - Th, SO<sub>4</sub>, NO<sub>3</sub>
- \*\*Nikolaev, A. V. (1958-62) - 15 -phosphonates, U, RE's, Pa, Th, salicylic acid, Ru dist., etc.
- Povitskii, N. S. (1958) - 1 - ext'n of HClO<sub>4</sub>
- Prokhorova, N. P. (1962) - 1 - Hf ext'n, NO<sub>3</sub>
- Pushlenkov, M. F. (1960-62) - 3 - U, eff. of diluents, organophos. comp'ds
- Reznik, A. M. (1963) - 1 - Zr, Hf, HNO<sub>3</sub>, HCl
- \*Rozen, A. M. (1956-1963) - 13 - U, Pu, Th, ext'n columns; isot. exch., Li, D.
- Sheka, Z. A. (1959-63) - 5 - DBP, RE's, organophos. comp'ds, alc., ketones
- Siuda, A. (1962) - 1 - DBP, MBP, rad. eff., P-32(n, $\gamma$ ) P-32
- Tsvetkova, Z. N. (1960-61) - 2 - ext'n, Zr, citric acid
- Voronetskaya, E. V. (1962) - 1 - U, Pu, FP's; meas. of sol'n props, ext'n columns, mass transf., hydrodynamics
- See also Korovin, Martynenko, Minc, Nikolayev, Shevchenko.

Thorium Chemistry, Properties, etc.

- Bokoba, G. B. (1960) - 1 - met., comp'ds  
 Dzionko, V. M. (1963) - 1 - org. complexes
- Essen, L. N. (1958-62) - 2 - complex comp'ds
- Filinov, F. M. (1960) - 1 - solid-sol'n chem.
- Huang-pang, C. (1961) - 1 -  $\text{SO}_4$ , Na,  $\text{H}_2\text{O}$
- Karavaev, G. F. (1963) - 1 -  $\text{Th}_3\text{P}_4$ -type cryst., energ. spec.
- Karyakin, A. V. (1962) - 1 - IR spect., carb. complexes
- Kovalenko, K. N. (1960-62) - 2 - phenylacetic acid, salicylate
- Kovaleva, I. S. (1962) - 1 - sol'n chem., ( $\text{C}_2\text{O}_4$ ),  $\text{CO}_3$
- \*Lapitskiy, A. V. (1959-62) - 6 - Pa, Nb, Ta, Ti, co-cryst., complexes, IX
- Luzhnaya, N. P. (1961) - 2 - oxalates, carbonates, alk. met.
- Mikhailov, A. A. (1961-62) - 2 - Th sep'n from Ce
- Mokrushin, S. G. (1954) - 1 - OH, colloids, Ti, electrolytes
- Molodkin, A. K. (1962) - 1 - Cs, CNS, complex compounds
- Mzareulishvili, N. V. (1962) - 1 - hydroxide
- Shakhova, Z. F. (1958-62) - 2 - Mo, Ce, IX, heteropoly acid
- Shalabutov, Yu. K. (1955) - 1 - oxide, elect. optics
- \*\*Smirnov, M. V. (1956-62) - 14 - fused salts, Cl, F, electrolyt., also alloys, Th-Zn, Th-Pb; also Ti, Be, Hf
- Tserkovnitskaya, I. A. (1960-62) - 4 - ext'n, phenylacetate, dieth. ether, U, Zr
- \*Yatsimirskii, K. B. (1960-63) - 6 - Zr, Hf, complex comp'ds; iodides; oxalates; orgs.
- Yen, K. (1963) - 1 - oxychloride, thermodyn. props.
- Zaykovskiy, F. V. (1958) - 1 - analyt., arsenazo, photom.
- Zozulya, A. P. (1959) - 1 - complex comp'ds

See also Chernyayev, Gagarinskiy, Grinberg, Huang-Pang, Ivanov, Ivanova, Khlopin, Kuznetsov, Luk'yanov, Mamedov, Ostroumov, Rosyanov, Ryabchikov, Samsonov, Shaykind, Shchukarev, Sviridova, Tananayev, Zolotukhin.

Protactinium Chemistry, Separation, etc.

Dyachkova, R. A. (1962-63) - 2 - ads., chromat., sep'n from Zr, Ti, Nb

Geletseanu, I. (1962) - 2 - IX, carbonic acids

Palshin, E. S. (1959-63) - 2 - Np, ext'n

Sheidina, L. D. (1961) - 1 - ext'n, TBP-benzene

See also Lapitskiy, Lebedev, Mikhaylov, Nikolayev, Shevchenko, Spitsyn,  
Starik.

Uranium Chemistry, Properties, etc.

- Aglintsev, K. K. (1961) - 1 - duration of reactor irradi., based on effective age of FP's e.g. Sr, Ce
- Aminov, T. G. (1959) - 1 - U(IV), oxalate complexes, magn. suscept.
- Andreeva, I. V. (1962-63) - 2 - U, complex comp'ds, polyacrolein
- Arutyunyan, E. G. (1963) - 3 - Th, comp'ds, cryst.
- Bekturov, A. B. (1958) - 1 - succinate, Ca salt
- Blinova, N. I. (1962) - 2 - oxides
- Elovskikh, N. N. (1961-62) - 2 - carbonates, oxalates
- Ermolaev, N. P. (1962) - 1 - U(IV), sol'n chem.
- Fedorova, L. A. (1962) - 2 - sol'n chem., chlorate oxid.
- Fioletova, A. F. (1962) - 1 - analyt., Al
- Fischer, C. (1962) - 1 - O, F.
- Gagarinskii, Yu. V. (1959) - 3 - Th, tetrafluorides
- Gordeyev, I. V. (1962) - 1 - U-235 and U-233 x-sect. reson. energ.
- Gordon, B. E. (1951) - 1 - luminesc. spect.
- Gorshkov, V. K. (1957) - 1 - U-235 fission yields
- \*\*Gurevich, A. M. (1957-61) - 10 - perox. salts, complexes
- Ippolitova, Ye. A. (1959-62) - 3 - uranates, alk. met., alk. earths
- Ivanov, R. N. (1957) - 1 - U-233 fiss. yields
- Kaplyanskii, A. A. (1962-63) - 4 - cryst. spect., RE's, LiF:U, NaF:U
- Kapustinskii, A. F. (1948-55) - 3 - phys. chem., sol'ns, cryst.
- Karabash, A. G. (1958-60) - 2 - Th, properties, ext'n
- Karpov, V. I. (1961-62) - 4 -  $PO_4$ , ppt'n process
- Kaufman, L. E. (1940) - 1 - sep'n, tannin
- Khiaginina, V. G. (1959) - 1 -  $PO_4$  comp'ds solub.

Uranium Chemistry, Properties, etc.

- \*Khlopin, V. G. (1936-50) - 5 - U, Th, Ra, chem., F,  $\text{SO}_4$ ,  $\text{LaF}_3$  cryst.
- Knyaginina, V. G. (1959) - 1 - U, phosphorus acid comp'ds
- Kobyshev, G. I. (1958-63) - 3 - luminescence of  $\text{UO}_2$
- Kovacevic, O. Z. (1955) - 1 - glass, fluoresc.
- Krot, N. N. (1962) - 1 - U(IV), EDTA
- Kurbatov, V. V. (1958) - 2 - peroxyuranates, x-ray invest. of ppts
- Lipilina, I. I. (1954-61) - 4 - sol'n chem., Cl,  $\text{NO}_3$
- Luk'yanychev, Yu. A. (1962) - 1 - sol'n chem., OH, F
- Lyalin, G. N. (1963) - 1 - phthol-ocyanine compl., luminesc.
- Malkin, L. Z. (1960) - 1 - U-233 decay,  $\alpha$ -decay of Ra-225
- \*\*Markov, V. P. (1959-63) - 14 - complexes, thiocyan., urea, org. acids
- Martynov, N. P. (1961) - 1 - U-237, dibenzoyl methane, Szilard-Chalmers
- \*Minc, S. (1958-60) - 8 - uranyl, TBP, isoprop. alc., spectra, properties
- Murav'yeva, I. A. (1962) - 1 - uranyl, phosphates
- Muromskiy, Yu. P. (1961) - 1 - uranyl,  $\text{PO}_4$ , CaO, hi-temp.
- Nikolaeva, N. M. (1962) - 1 - uranyl,  $\text{NO}_3$ , hydrolysis
- Pankratova, L. N. (1963) - 1 - complex comp ds, Schiff bases
- Pavlovskaya, M. P. (1960) - 1 - uranyl, complex comp'd
- Perova, A. P. (1956) - 2 - K,  $\text{NO}_3$ ,  $\text{H}_2\text{O}$ , ternary salts, low temp.
- Peshchevitskiy, B. I. (1959) - 1 - complex comp'd, trithiocarbamate
- Polonnikova, G. A. (1961) - 2 - uranyl, sulfite, sesquicarb., cryst.
- Pozharskii, B. G. (1962) - 1 - uranyl,  $\text{HNO}_3$ , abs. spect., temp. eff.
- Prusakov, V. (1958) - 1 -  $\text{UF}_6$ , spent fuel recov. and decontam. proc.
- Ptitsyn, B. V. (1959) - 1 - uranyl, oxalates, instab. const.
- Rafal'skiy, R. P. (1959-62) - 2 - Feed mat.(?),  $\text{UO}_2$ , U(VI) red. in  $\text{SO}_4$  sol'n

Uranium Chemistry, Properties, etc.

- Rozental', R. I. (1958) - 1 - U(IV) oxid., electroch., Pt electrode
- Ryskin, Ya. I. (1958-59) - 3 - uranyl nitrate, IR spectrosc., ethers, ketones, H<sub>2</sub>O
- Samoylov, B. N. (1948) - 1 - uranyl, luminesc. spect. at low temp.
- Savich, I. A. (1956-57) - 4 - complex comp'ds, Schiff bases, naphthols, etc.
- Sevchenko, A. N. (1951) - 1 - uranyl, fluoresc. spect., H<sub>2</sub>O of cryst.
- \*\*\*Shchukarev, S. A. (1956-62) - 21 - Th, halides, rare metals, inorg. chem.
- Sheremet'er, G. D. (1957) - 1 - UF<sub>6</sub>, photoluminesc., temp. depend.
- \*\*\*Shevchenko, V. B. (1958-62) - 29 - Pu, FP's, Pa, ext'n processes, organo-phos., amines, eff. of diluents, synergism, etc.
- Sinitsyna, G. S. (1959) - 1 - Pu, electrolytic sep'n
- Slepian, T. A. (1960) - 1 - uranyl, HNO<sub>3</sub>, properties sp. g., visc., conductivity., R.I.
- Solntsev, V. M. (1961) - 1 - U-oxide powders, dissolution, H<sub>2</sub>SO<sub>4</sub>, kinetics
- Stabrovskii, A. I. (1960) - 1 - carbonate, bicarb., polarog.
- \*\*\*Starik, I. Ye. (1955-62) - 46 - raw mats. U, Th; Pa, Po, Am, Ac, Ru, Cs, Sr, RE's, Zr, Nb; adsorp.; IX, PE-9; SX; RE's, Zr, Nb; adsorp.; micro-comp. chem., C-dating; ext'n, etc.
- Stepanov, B. I. (1951) - 1 - uranyl, adsorp., fluoresc.
- Stepanov, M. A. (1960) - 1 - U(IV), hydroxide, solub. prod.
- Stobrovski, A. E. (1960) - 1 - carbonate, bicarb., polarog.
- Tekster, E. N. (1959) - 1 - uranyl, oxalates, Mg, instabil. constants
- Tolstopyatova, A. A. (1963) - 1 -  $\alpha$ -U<sub>3</sub>O<sub>8</sub>, catalysis, dehydrog., dehyd., alc., tetralin
- Tolstoy, N. A. (1962) - 1 - alk. and alk. earth met. fluorides, relax. spectra
- Vidavskiy, L. M. (1962) - 2 - oxides, react. with Na, K sulfates, nitrates
- Yakimov, M. A. (1958-63) - 5 - NO<sub>3</sub>, solub. isothes, alk. mets., alk. earths, Tl nitrates
- Yakovieva, M. N. (1959) - 1 - transport. forms in dialysis of H<sub>2</sub>O

Uranium Chemistry, Properties, etc.

Yefremova, K. M. (1959-62) - 2 - uranates, alk. met.

Yevteyev, L. I. (1959) - 1 - synt. of U(IV) sulfate by rongalite red. of uranyl nitrate

Zagorets, P. A. (1958) - 1 - complex comp'd, miricitrine, abs. spect.

Zaitseva, L. L. (1962) - 1 - uranyl fluoride complexes, CsF,  $UO_2F_2$

Zakharova, F. A. (1960) - 1 - oxalate complexes

Zelentsov, V. V. (1960-62) - 4 - complex compounds, IR spect.

Zil'berman, Ya. I. (1960) - 1 - complex comp'ds, diethyldithiocarbamate

See also Bol'shakov, Chernyayev, Chukhlantsev, Djoshi, Dobroliubskaya, Dyatkina, Galkin, Gelman, Goryushina, Grigorev, Grinberg, Kanevskiy, Kleyb, Klygin, Komarov, Kovba, Krylov, Kurnakova, Kuteynikov, Kuznetsov, Makarov, Morachevskiy, Morozova, Moskvina, Narbutt, Nesmeyanova, Nikolayev, Nikolov, Ostroumov, Paramonova, Ponomarev, Ratner, Ripan, Selitskiy, Shaykind, Simon, Spitsyn, Starik, Sverdlov, Tananayev, Upor, Vdovenko, Yeskevich, Zagorets, Avyagintsev, Zybalkina.

Neptunium Chemistry, Separation, etc.

Kondratov, P. I. (1960) - 2 - Np IV and VI, phenyl arsonates

Mefod'eva, M. P. (1959-61) - 3 - complexes, acet., trilon B

\*\*Zolotov, Yu. A. (1959-63) - 10 - actinides, TRU, complex comp'ds, sep'n, SX, IX, chromatog., etc.

See also Alimarin, Chudinov, Gel'man, Kurchatov, Moskvina, Pal'shin, Shvetsov, Starik.

Plutonium Chemistry, Physics, etc.

- Alenchikova, I. F. (1958) - 4 - fluorides, chlorides, oxyfluorides.
- Aron, P. M. (1962) - 1 - prep. of thin films, layers between perchlorovinyl resins
- Artyukhin, P. I. (1958-59) - 3 - oxid-red.
- Denotkina, R. G. (1960-61) - 3 -  $PO_4$  complexes
- Deychman, E. N. (1962) - 1 - F
- Drabkina, L. E. (1958-60) - 4 - sol'n chem.
- Dzhelepov, B. S. (1962-63) - 2 -  $\alpha$ -decay, spallation
- Ermakov, A. N. (1959) - 1 - IX, Zr, Hf
- Kabanova, O. L. (1960-61) - 2 - redox, Pu V, EDTA
- Kartushova, R. Ye. (1958) - 1 - oxalates, therm. diss.
- Kazachkovskiy, O. D. (1962) - 1 - nuc. power engr.
- Khalkin, V. A. (1963) - 1 - ext'n,  $HNO_3$ , ketones, ethers, etc.
- Kondratev, L. N. (1957) - 1 - Pu-238  $\alpha$ -decay
- Konobeevskii, S. R. (1962) - 1 - equil. diagrams
- Korovina, I. A. (1958) - 1 - comp'ds, UV abs. spect.
- Krevinskaya, M. Ye. (1959) - 3 - sol'n chem.,  $PuO_2^{++}$ ,  $HNO_3$
- Leontovich, A. M. (1957) - 1 - salts, absorp. spect.
- Lipis, L. V. (1960) - 3 - complexes,  $SO_4$ , halides
- Lipovskii, A. A. (1959) - 1 - Pu(IV),  $HNO_3$ , sulfato complexes, spectroph.
- Moiseev, I. V. (1961) - 1 - cupferate, prop.
- Pasternak, A. (1958-61) - 4 - sol'n prop., ext'n, TBP, TTA, ppt'n, alizarin, Th
- Popov, N. I. (1958-62) - 3 - x-rad. eff. on valence,  $NO_3$ ,  $ClO_4$ ; Sr-90, fall-out, ocean
- P. . ., V. (initials only) (1957) - 2 - FP's, from irradi. U, IX, molt. U,  $UF_3$ - $BaCl_2$ ( $F_3$ )

Plutonium Chemistry, Physics, etc.

Shvetsov, I. K. (1955) - 1 - Pu, Np, sep'n methods

Striganov, A. R. (1955-63) - 3 - TRU, Dy, spectra, isot. shifts

Taube, M. (1962-63) - 3 - TRU, SX, synergism; propos., fused Cl salt syst., fast-breeder react.

Tolmacheva, Yu. M. (1943-61) - 3 - PuO<sub>2</sub> dissol., U adsorp. on C, schists; compl. comp'ds, Th

Zastenker, E. E. (1963) - 1 - PuO<sub>2</sub> oxidation by air

Zaydel, A. N. (1957) - 1 - analyt., evap., spectra.

See also Artyukhin, Formin, Galkin, Gelman, Grebenschikova, Klygin, Kurchatov, Moskvina, Nikol'skiy, Paley, Shevchenko, Sokhina, Yakovlev, Yermakov.

Complex Compounds, Involving Various Inorganic Salts and Organic Compounds

- Babushkin, A. A. (1959) - 1 - Pt, olefins
- \*\*\*Chernyayev, I. I. (1957-63) - 22 - U, Th, Pt, amines
- \*Dyatkina, M. Ye. (1958-62) - 5 - U, Pt
- \*\*Golevnaya, V. A. (1958-63) - 12 - U, Pt, RE's
- \*\*\*Grinberg, A. A. (1955-62) - 37 - Pt, U, Th, Pd, Ti, Zr, ext'n, IX
- Ivanova, O. M. (1958) - 1 - Pt, amines
- Kalinkina, O. M. (1962) - 1 - HF
- Kleiner, K. E. (1950) - 1 - Al, F
- Migal, P. K. (1960) - 1 - Cd, ethanolamines
- Muraveishkya, G. S. (1959) - 1 - Pd, nitrochlor-diamine
- Nazarenko, V. A. (1962) - 1 - trioxyfluorones, Zr, Ge, Sb, Sc
- Parpiev, N. A. (1959) - 1 - Ru, Cl, org..
- Peshkova, V. M. (1958-61) - 4 - spectroph., ext'n, RE's, Zr, Hf, org.
- Pyatnitskii, I. V. (1963) - 1 - metals-citrate; tartrate
- Razbitnaya, L. M. (1961) - 1 - U, RE chelates, amines
- Savchenko, G. S. (1960) - 1 - Al ions, EDTA
- Shchebetkovskiy, V. N. (1959) - 1 - radiochem. symposium
- Shustorovich, E. M. (1958-63) - 4 - theory, transit. mets., aromatic-metal
- Syrkin, Ya. K. (1958) - 1 - Ru, nitrosyl
- Trailina, E. P. (1961) - 1 - U, Cu, Ni, 8-hydroxyquinoline
- Tronev, V. G. (1958) - 4 - Ge, Re, org.
- Vasil'ev, V. P. (1958) - 3 - alk. earths, etc., orgs., polymers, etc.
- Volkov, V. L. (1958) - 1 - Mo, W, carbonyls
- \*\*\*Zvyagintsev, O. E. (1955-63) - 24 - Ru, U, Th, Nd, Pr, Au, Pt, orgs., etc.

Solution Chemistry, Crystallization, Theory, etc.

- Bobrova, V. N. (1960) - 3 -  $\text{SO}_4$ , Pu, Zr, K, Ba, Ce, La
- \*Chukhlantsev, V. G. (1956-61) - 5 - U, Th, Nb, Zr, Be, Ge
- Deichman, E. N. (1962) - 2 - Pu, In
- Gliner, Iu. G. (1959) - 1 - co-cryst., complexes
- Gonikberg, M. G. (1955-57) - 3 - Ce, isot. exch.
- Gorshtein, G. I. (1958-61) - 4 - complexes
- Ioffe, E. M. (1958-60) - 3 - mixed cryst.
- \*Makarov, Ye. S. (1958-63) - 6 - cryst., rare elem., U, Th, Np, Pu, Mo, Zr, etc.
- Mironov, V. E. (1963) - 1 - Ag halides,  $\text{Tl}^{+1}$
- Rotshtein, V. (1950) - 1 - solvation of Nd ions, water, alc.
- See also Blidin, Dapustinskiy, Gordon, Kleiner, Klokman, Klygin, Kurnakova, Nikolayev, Nikolskiy, Ryskin, Shchukarev. Also Alimarin, Bykovskiy, Grebenshchikova, Grinberg, Kuznetsov, Melikhov, Merkulova, Murin Ratner.

Ion Exchangers, Ion Exchange Separations, etc.

(from "Atomic Energy in the Communist Bloc," G. A. Modelski, 1959)

The following abstracts illustrate the nature of ion exchange studies by scientists of the USSR and the Communist Bloc nations.

THE TEMPERATURE INFLUENCE ON THE STATE OF THE ION EXCHANGE, Matorina, N. N., et. al., 1958. This is an investigation of the sulfo-polystyrene cationite SM-12 with a varying content of divinyl benzene (4, 8, 16 and 20%) and the cationite KU-2. The selectivity coefficient in the exchange of the ion-pairs  $H^+ - Ca^{++}$ ,  $H^+ - Sr^{++}$ ,  $Sr^{++} - Ca^{++}$ ,  $H^+ - Ce^{+++}$  and  $H^+ - Cs^+$  was determined. The ion concentrations were determined radiometrically by means of tracer atoms ( $Cs^{137}$ ,  $Ca^{45}$ ,  $Sr^{89}$ ,  $Ce^{144}$ ). The state of the ion-exchange was established for two temperatures. The heats of reaction in the ion-exchange are proportional to the heats of hydration of ions in solution. Their sizes and signs depend on the relation of the heat of hydration of the ion in solution to that in the cationite. In the exchange of hydrogen ions apparent divergencies are noticed, but can be explained by the fact that the  $H^+$ -ion is always represented in water as a hydroxonium ion ( $H_3O$ ). On the basis of the calculations a quantitative prediction of the temperature-conditioned changes in the ion-exchange in sulfo-synthetic resins is possible.

THE ION EXCHANGE AND SORPTION OF RADIO-ELEMENTS, Nikol'skiy, B. P., 1958. -- The importance of ion exchange and sorption in radiochemistry is very great at present. As is known, radioactive elements are sorbed at the vessel walls and at other surfaces with which they come into contact. Therefore their sorption will be one of the most important phenomena determining the reaction of these elements in solutions, if, as a rule, they are in solutions in very small concentrations. Since radioelements appear in solutions mostly in the form of ions, the assumption would be natural that their adsorption in most cases represents an ion exchange plus sorption. This is proved by the part played by the pH-value and the concentration of radioelements during sorption at many surfaces. Such a part played by hydrogen ions has been proved by many researchers very clearly. The author gives a survey of the works on ion exchange, together with the regularities explored thereby. These regularities proved to be completely analogous to those of cation exchange. They made possible the working out of an ionite classification which is based on their reaction to hydrogen ions (or hydroxyl). A figure shows the absorption curves of ions (e.g. of Na or Cl) by ionites of 4 possible classes in dependence on the pH-value of the p(OH) value. Organic ionites (resins) compared with mineral ionites have a number of characteristics, e.g. the capability of swelling, on which occasion the concentration of their active group changes, as well as the activity coefficients of the ion absorbed. The problem of specific ion absorption by absorbents is known, but it's nature is not clear. Their absorption by an-ionites from oxalate-solutions is without doubt an ion exchange process. A figure gives the absorption curve of sodium ions by the resin SG-2. The absorption of Na begins at  $pH > 3$  and gradually reaches 75% at  $pH = 8$ . The SG-2 resin is capable of a great specific absorption of  $Fe^{3+}$ , that is to say, from a 0.1 n-solution of  $Fe(NO_3)_3$  at pH 1.5. These data can be explained as an ion exchange, at least formally. The increase of the pH-value increases the absorption. With still higher pH-values a

deposit of hydroxide is precipitated and Fe is no longer absorbed by the resin. Apparently the resin absorbs, however, the hydrolysis complexes of iron. The additions of substances which form complex compounds with iron (trilon B, oxalic acid, citric acid) to the solution decrease the iron absorption by carboxyl-resin. Only acetic acid increases the absorption. The use of the ion exchange in radiochemistry. From the above we can form an idea of the possibilities of the use of ionites in radiochemistry. A simplification of the basic equation of the ion-exchange equilibrium results in

$$\frac{\Gamma_1}{C_1} = K^{z_1} \left( \frac{\Gamma_2}{C_2} \right)^{z_1/z_2} f(\gamma) = \alpha_1 = \text{const.}$$

where C = the concentration of the ion,  $f(\gamma)$  = a multiplier containing the activity coefficients in resin and in the solution;  $\alpha_1$  = the distribution coefficient of ion No. 1 (microcomponent) between the ionite and the solution. It is constant on the conditions given. It will transform at the change of the nature of the second ion of its concentration, as well as with the introduction of new ions, and finally with changes of pressure and temperature. One of the most interesting possibilities of use of the ion exchange is the determination of the state of radioelements in the solution. Also the valence of the ions can be determined under certain conditions. The exchange can become useful in the investigation of radio-colloids. This way the activity coefficients of an electrolyte can be determined from several others. Radioelements can be isolated and purified. Finally the importance of this method in analytical chemistry is increasing (mixtures of actinides and lanthanides, as well as new unknown transuranium elements, especially mendelevium).

THE STABILITY OF ION-EXCHANGING RESINS IN AQUEOUS SOLUTIONS SUBJECTED TO THE ACTION OF  $\gamma$ -RADIATION OF  $\text{Co}^{60}$ , Man'-wei, Chzhan; et al., 1958. -- The resins SDV-3 (styrene sulfonic acid + divinyl benzene sulfonic acid) and MMG-1 were irradiated by means of a  $\text{Co}^{60}$ -source. The average  $\gamma$ -dose rate extended from 68 to 1250 r/s. All resin solutions were exposed in glass ampoules. For the liquid phases, water, a saturated NaCl solution, a 1.8% sulfuric acid solution, and a 1 M acetic acid solution were used.

In water SDV-3 was irradiated as a hydrogen- and MMG-1 as an hydroxyl-compound. In the salt solutions SDV-3 was irradiated in its sodium form. The physico-chemical parameters of the resins were determined in accordance with GOST-4, No. 5695, Group L-99. For SDV-3 the static capacity (SOE) with respect to uranyl ions was also measured.

The radioresistance of the resins was also determined on the basis of the oxidizability of a permanganate solution which was in contact with the resin during irradiation. The formation of hydrogen peroxide was determined polarographically by means of 0.1 N ammonium chloride as carrier electrolyte. Results are given in form of tables and curves.

The destruction of the resins is accompanied by an increase of the (SOE). This is indicative of an increase of the number of ion-exchanging functional

groups in the resin. The inclination of the resins towards capturing hydroxyl radicals confirms the results obtained by a test carried out with SDV-3 with an irradiation dose of 60 r/s. Contact between the resins and acidified water reduces the formation of hydrogen peroxide considerably. The increase of the capability of swelling and of the moistness of SDV-3 is accompanied by a noticeable decrease of acidity.

RADIATIVE-CHEMICAL STABILITY OF SOME ION-EXCHANGE RESINS AGAINST THE ACTION OF X-RAY AND GAMMA RADIATION, Nikashina, V. A., et al., 1959. -- The authors investigated the chemical stability of some domestic cationites against x-ray and  $\gamma$ -radiation. The following types of cation-exchangers were investigated: DU-1 (Sulfo-cationite on the basis of phenol formaldehyde); KU-2 (Sulfo-cationite, product of copolymerization of styrene and divinyl benzene); KB-4 (saponification product of copolymer from methylmethacrylate and divinyl benzene, contains the carboxyl group as functional group). In the introduction to the paper some data contained in publications regarding the use of ion-exchange resins when working with radioactive substances, are discussed. In order to be able to record the changes in the exchanger-resin caused by radiation, the most important characteristics of the exchanging qualities of the resins were determined. These characteristics are: static exchanging capacity indicating the total number of functional groups capable of exchange; the exchanging capacity with the given pH-value of the medium; swelling capacity of the resin depending on the degree of interlacing of the resin with given humidity, and determining in its turn the penetrability of various ions into the pores of the resin; the oxidizability of the filtrate depending on the solubility of the exchanger in the respective medium. Radiation of air-dried exchanger samples with x-rays was carried out by means of especially strong tubes in the laboratory of the Institute of Physical Chemistry of the AS USSR. The use of especially strong tubes made it possible to provide considerable integral doses of radiation in a comparatively short time. Results of investigations are given in a table and figure. As x-rays cannot penetrate deeply into the exchanger,  $\gamma$ -rays were used for testing following these investigations. These experiments were carried out in an apparatus for radiation-chemical investigations of type "K-20000" of the Institute of Physical Chemistry imeni L. Ya. Karpov. Some results of these investigations are given in a table and in four figures. It appeared that in all investigated exchanger-resins, under the radiation influence, decomposition processes and cross-linkage processes are competing. The radiative-chemical changes are more radical in aliphatic resins than in aromatic resins. The quality of the functional groups of the investigated exchangers remains the same, whereas their number decreases somewhat with increasing radiation dose. Among the resins investigated the cationite of the type KU-2 proved to be the most stable.

ION EXCHANGE SEPARATION OF ELEMENTS. VI. ALKALI-EARTH ELEMENTS, O. M. Lillova, et al., 1960. -- The coefficients of separation of the alkali-earth metals were determined by ion-exchange on a sulphonated polystyrene cationite (KU-2 or Dowex-50) at temperatures of 20 and 90°. The results are given in Table I (which for purposes of comparison gives data for other eluting agents.)

Table 1. Separation Coefficients of Neighbouring Alkaline-Earth Elements on Sulphonated Polystyrene Cationites of the KU-2 or Dowex-50 Type With 12% Vivinyl Benzene.

Eluting solution and temp. (°C)	Mg/Be	Ca/Mg	Sr/Ca	Ba/Sr	Ra/Ba
Ammonium acetate, 20°	-	2.2	2.5	4.5	2.2
Ammonium acetate, 90°	-	2.0	2.8	2.4	1.55
1-2 M ammonium lactate, 20°	-	-	1.5	2.5	-
Ammonium lactate, 80°	3.7	2.8	3.1	3.2	2.1
5% ammonium citrate (pH = 5.4) 80%	-	1.7	1.8	3.4	-
Hydrochloric acid, 80°	2.3(1.5M)	4(1.5M)	1.8(2M)	-	-
Hydrochloric acid, 80°	-	3.3(2.5M)	2.3(4M)	3(4M)	1.1(6M)

These results show that the separation coefficients are independent of the rigidity of the structure of the resin (i.e. its content of divinyl benzene); the comparison of various eluting agents shown that ammonium acetate is most efficient at room temperature, while ammonium lactate is somewhat more efficient at 80°.

In the case of elution from the column by 1.5 M ammonium lactate at 80° the position of the maxima of the peaks of the elements, expressed in free volumes of the column, are as follows:

Mg 2.5, Ca 6, Sr 18, Ba 65, Ra 130.

It was shown that the use of weak complexing agents in high concentrations makes it possible to increase markedly the load on the column, while retaining the normal conditions of separation.

ION EXCHANGE SEPARATION OF ELEMENTS. V. ELEMENTS OF THE ALKALI GROUP, Lilova, O. M., et al., 1960. -- It is shown that alkali metals can be successfully separated by the use of phenol-formaldehyde sulfocationite (mark KU-1). It was established that during this process, complexing of the alkali metals with the phenol groups of the resin takes place, increasing markedly as one passes to the heavier metals; this allows them to be separated particularly efficiently ( $\alpha$  Cs/Rb = 4.2). This effect must be particularly marked for francium.

ELUTION OF U(VI) IONS FROM SULFOCATION COLUMNS, Zhukov, A. I., et al., 1962. -- Studies of the influence of pH on the sorption, eluate acidity, temperature, amount of resin, and other factors in uranium (VI) elution

from columns of KU-2, SDV-3, MSF-3, KU-1, and SBS-1 resins by stoichiometrically neutral ammonium nitrate solutions showed that U(VI) can be completely eluted only from KU-2 and SDV-3. The experimental data were in agreement with an assumption that incomplete separation is due to ion complexing with the resins.

STUDIES OF INDIUM BEHAVIOR IN SULFATE-ION SOLUTIONS BY MEANS OF ION EXCHANGE, Tsintsevich, E. P., et al., 1962. -- Distribution of indium between the KU-2, KU-1, and SBS cationites and  $\text{LiSO}_4$ ,  $\text{Na}_2\text{SO}_4$ ,  $(\text{NH}_4)_2\text{SO}_4$ ,  $\text{MgSO}_4$ , and  $\text{H}_2\text{SO}_4$  was studied. It is shown that a rise in sulfate ion concentration inhibits indium sorption.

PHOTOREDUCTION OF THE URANYL ION ON THE STRONGLY BASIC ANION EXCHANGER, Majchrzak, K., et al., 1962. -- Reduction of the uranyl ion on the strongly basic anion exchanger Dowex 1 was investigated. The reduction was found to be promoted by sunlight and ultraviolet light. The process does not depress the exchange capacity of the resin, which means that its active groups do not become oxidized in it.

CHARACTERISTICS OF THE REGENERATION OF ANION-EXCHANGING RESINS OF VARIOUS TYPES, Meleshko, V. P., et al., 1963. -- This study was motivated by the incompleteness and lack of systematization of literature dealing with more important Soviet industrial anionites (AN-1, AN-2F, EDE-10P, AV-16 and AV-17). The resins were prepared by treatment with saturated  $\text{NaCl}$ , washing with water, packing into a column, threefold successive washing with 0.5 N  $\text{NaOH}$  and 0.02 N  $\text{HCl}$ , and finally by washing with 5 volumes of distilled  $\text{H}_2\text{O}$  per volume of resin. In the regeneration tests, samples of the resin thus prepared were then packed into 0.8 cm dia x 40 mm long columns and were treated with 0.25, 0.5, 1.0 and 2.0 N  $\text{NaOH}$ , the flow rate being 5 m/hr. The filtrate was titrated for  $\text{Cl}^-$  with  $\text{AgNO}_3$ . "Regeneration curves" of filtrate volume plotted against the  $\text{Cl}^-$  content were then constructed. The most economic regenerating solution was found to be 0.25 N  $\text{NaOH}$  for all resins, with the exception of AV-17 for which 0.5-1.0 N  $\text{NaOH}$  should be used. The volumes of regenerator necessary to remove the adsorbed ions varied from 1.25-1.5 equivalent volumes for AN-2F, EDE-10 P, and AV-16, to 10 equivalent volumes for AV-17. It is considered that the regeneration curves are one of the more important properties is estimating the economic and operating indices of ionites. Application of these results to the deionization of water shows that the preferred ionite would be EDE-10P. in spite of its cost.

Ion Exchange Separations

- Al'tshuler, O. V. (1958) - 1 - Nb, Ti
- Bryukher, E. A. (1963) - 2 - Ac, Ra
- Egorov, E. V. (1962) - 1 - org-min., rad. synth.
- Elovich, S. Yu. (1957-61) - 4 - compl. comp'ds, Ni
- Fodor, M. (1962) - 1 - U
- Gapon, E. N. (1948) - 4 - chromat., analyt.
- Golovatyi, R. N. (1962) - 1 - Cr, V, Ce from Mn
- Gordiyevskiy, A. V. (1960) - 2 - U, V, anionites
- Gorshkov, V. I. (1957) - 1 - mechanism
- Grigorov, O. N. (1950) - 1 - eff. of ppts
- Ivanenko, D. D. (1948) - 1 - dynamics
- Kastromina, N. A. (1958-62) - 3 - La, gluconic acid
- Kazantsev, Ye. I. (1962) - 1 - Np(IV), anionite AM
- Kazimierz, M. (1962) - 1 - properties of anion resins
- Kiseleva, E. D. (1962) - 2 - rad. stabil. of resins
- Koch, H. (1963) - 1 - Po from Bi
- Krawczyk, I. (1960) - 1 - U from RE's, EDTA
- Lilova, O. M. (1960) - 2 - alk. met., KU-1, alk. earths, KU-2, Fr, Ra
- Majchrzak, K. (1962) - 1 -  $UO_2^{+2}$ , photored., Dowex-1
- Man-wei, C. T. (1958) - 1 -  $\gamma$  rad. stabil., MMG-1, SDV-3
- \*Marov, I. N. (1957-62) - 5 - Zr, Hf, Pu, KU-2, cation. exch.
- Maslova, G. B. (1960) - 1 - radioact. RE s
- Materova, E. A. (1961) - 1 - B, F, potentiomet.
- Matorina, N. N. (1958-60) - 4 - alk. earths, EDTA, Ce, Cs, Ku-2, SM-12
- Meleshko, V. P. (1961-63) - 2 -  $D_2O$ , resin regen., AN-1, AN-2F, EDE-10P, AV-16, AV-17

Ion Exchange Separations, continued

- Moskvin, L. I. (1962) - 1 - anion exch., Sb, Szilard-Chalmers
- Nikashina, V. A. (1959) - 1 - resin stabil., x- $\gamma$  rad. eff., KU-1, KU-2, KB-4
- Nikitina, M. K. (1963) - 1 - monosulfide resins, HF, HEP, 660 Mev, p<sup>+</sup>, U  
Ta, Hf, W, FP's
- \*\*Nikol'skii, B. P. (1957-61) - 10 - SG-2, etc., EDTA, U, Th, Ba, Rd; adsorp.,  
Nb, Zr
- Oleynik, A. V. (1962) - 1 - eff. of resin shape, swelling, KU-2, AN-2F, SDV
- Pakholkov, V. S. (1963) - 1 - U(VI), F, Cl, SO<sub>4</sub>, KU-2 resin
- \*\*Paramanova, V. I. (1956-63) - 13 - adsorp., Nb, Zr, RE's, Th, U
- \*Preobrazhenskii, B. K. (1957-62) - 9 - TRU, RE's, groups III, Cu, V, etc.,  
KU-2, AV-17, Dowex 1, 50
- Rachinskii, V. (1956) - 1 - chromat., theory
- Senyavin, M. M. (1958) - 2 - Sr, RE's, KU-2, complexes
- Serdobol'skii, I. P. (1955) - 1 - anion exch. reactions
- Shemyakin, F. M. (1954) - 1 - chem., biol., and medic applications
- Sobinyakova, N. M. (1961) - 1 - Nb, Ti, anionites, sulf., oxalic
- Starobinets, G. L. (1963) - 1 - alk. mets., sulfurized styrene, divinyl-  
benz. polymers
- Titov, V. S. (1962) - 1 - polymeric exchangers, rev. of USSR and western res.
- Tsintsevich, E. P. (1962) - 1 - In, SO<sub>4</sub>, KU-2, KU-1, SBS cationites
- Tunitskii, N. N. (1958-62) - 2 - RE's, KU-2, theory; rad. eff., org
- Zhukov, A. I. (1962-63) - 2 - U, Th, NO<sub>3</sub>, KU-2, SDV-3, MSF-3, KU-1, SBS-1
- See also Alimarin, Davankov, Lavrukhina, Ryabchikov, Samsonov, Yermakov.

Chromatographic Techniques, Applications, etc.

Bresler, S. E. (1952-59) - 3 - ionites, isot. sep.

Fu-tsung, W. (1962) - 1 - At concentration

Galkina, N. K. (1960) - 1 - IX, alk. met.

Glyukauf, E. (1962) - 1 - radioact. gases

Kabanova, O. N. (1963) - 1 - gases, zeolites

Saldadze, K. M. (1954) - 1 - IX, devel. of theory

See also Alimarin, Gapon, Lavrukhina, Matorina, Nikolskiy, Preobrazhenskiy,  
Rachinskiy, Ryabchikov, Samsonov, Senyavin.

Adsorption

- Abyayev, Sh. A. (1959) - 1 - gases, sil. gel,  $\gamma$ -rad. eff.
- Belousov, Ye. A. (1961) - 1 -  $MnO_2$ ,  $UX_1$
- Belyakova, L. D. (1962) - 1 -  $BaSO_4$
- Dzhigit, O. M. (1963) - 1 - zeolites, vapors
- Gromov, V. V. (1962-63) - 2 - radioact. ppts., dyes
- Kiselev, A. V. (1963) - 1 - graphite, thermodyn.
- Kuzin, I. A. (1962-63) - 3 - inorg. sorbents, C, coal, U, Th, others
- Maidanovskaya, L. G. (1959) - 1 -  $ZrO_2$ , H, Na, K, Ba
- Nikolaev, V. M. (1963) - 1 - Sr, Cs, vermiculite
- \*Ratner, A. P. (1956-62) - 8 - U, peruranates, co-cryst., Ba, Pb,  $SO_4$ , Cl, etc.
- Regak, N. Ya. (1955) - 1 - gases, activ. C
- Rozovskaya, N. G. (1960) - 1 - glasses, P
- Selitskiy, Yu. A. (1959) - 1 - depos. of U and Th layers on metals, org. films
- Starodubtsev, S. V. (1959) - 1 - gases, sil. gel,  $\gamma$ -rad. eff.
- Tsitsishvili, G. V. (1950-58) - 2 - Askan clay and gel; HF, association
- Vasil'eva, E. K. (1959) - 1 - sil. gel, Co comp'ds, eff. of  $\gamma$ -rad.
- Zhukovitskii, A. A. (1955-63) - 2 - chromatog., diffusion, alloys, columns, radioisot. res.
- Zlobin, V. S. (1962) - 1 - Zr-phosphates, remov. of Zr, Y, from acid sol'ns
- See also Balashova, Ivanenko, Mal'tsev, Murin, Nikol'skiy, Pasternak, Roginskiy, Siekierski, Spitsyn, Starik, Stepanov.

Rare Gas Separation, Production, etc.

\*Fastovskiy, V. G. (1947-58) - 5 - Kr, Xe

Fridberg, P. Sh. (1962) - 1 - He, phys., diamagn. suscept.

Fursov, V. S. (1955) - 1 - spectra

Grigorev, V. N. (1962) - 2 - Kr, Xe, H<sub>2</sub>-D<sub>2</sub>

Nikitin, B. A. (1948-52) - 2 - Rn, react. with p-chlorophenol

Petukhov, S. S. (1957) - 1 - Kr, adsorption

Slivnik, J. (1962) - 1 - Xe, XeF<sub>6</sub> synthesis, properties

Tkachenko, A. I. (1962) - 1 - cryogenics, He-3, He-4, gasifier, press. up to 100 atmos.

Vagin, E. V. (1957-61) - 4 - Kr, Xe, tech. proc., adsorp-therm sep'n, C, sil gel

Vasaru, Gh. (1962) - 1 - He, He-H<sub>2</sub> sep'n, thermodiffusion

See also Bryzgunov, Burbo, Gerling, Regak.

Analytical Chemistry or Methods

- Adamovich, L. P. (1959-62) - 3 - sp-ph, complex compounds, Be, alberon
- Akishin, P. A. (1956) - 1 - spectroscop., Ca, Sr, Ba isotopes, IX, Al-silicate ion emitter.
- Alekperov, A. I. (1960) - 1 - uranyl ions, dropping Hg electrode
- Aleksandrov, E. B. (1962) - 1 - K-40, opt. spectroscopy
- \*\*\*Alimarin, I. P. (1955-63) - 24 - IX, SX; Np, U, Th, Zr, Nb, Hf, Mo, Fe, Be, Al, Ti, Cr, Y, Ta.
- Anokhin, V. L. (1960) - 1 - counting, use of Al absorbers, etc.
- Antoshevskii, R. (1960) - 1 - chromatog., det'n spec. act. of phos. comp'ds
- Astakhov, K. V. (1961-62) - 3 - sp-ph, RE's, Ru
- Avtokratova, T. D. (1962) - 1 - Ru, in elements, minerals, ores, book
- \*\*\*Babko, A. K. (1959-63) - 26 - U, Ce, Ti, Mo, Zr, Nb, In, RE's
- Bar, Y. (1959) - 1 - FP's, sep'n methods, review
- Baran, V. (1963) - 1 - U, perchlorate sol'n
- Belayavskaya, T. A. (1956-62) - 3 - IX, Be, Zr
- \*Busev, A. I. (1960-62) - 6 - ext'n
- Chaikin, P. I. (1962) - 2 - emanat. meth., Rn
- Chudinov, E. G. (1962) - 4 - Np, Pa, sp. ph.
- Davydov, A. V. (1961) - 1 - U, fluoresc.
- Djoshi, M. K. - 1 - U, vol'm.
- Dobrolyubskaya, T. S. (1962-63) - 3 - U, luminesc., fluoromet.
- Elinson, S. V. (1961-63) - 2 - Zr, Nb, Hf, Ta
- Fadeeva, V. I. (1962) - 1 - Th, Zr, Ti, Sc
- Gallai, Z. A. (1957) - 1 - amperomet., V, Cl
- Garif'yanov, N. S. (1963) - 1 -  $Gd^{+3}$  in RE salt sol'ns
- Gelfman, A. Ya. (1962) - 1 - Cs, ferrocyanide

Analytical Chemistry or Methods, continued

- Gladyshev, V. P. (1957) - 1 - F
- Golutvina, M. M. (1960-63) - 3 - Ge-71, Sr-90
- Gornyi, G. Ya. (1962) - 1 - Tb, RE's
- Goryushina, V. G. (1959) - 1 - U, volum.
- Gribov, L. A. (1962) - 1 - molec. spect.
- Grigorev, V. F. (1960) - 1 - U, luminesc.
- Gusev, S. S. (1962) - 1 - adsorp, U, cellulose
- Gusyatskaya, E. V. (1955) - 1 - Zr, Hf, op. sp.
- Hojman, J. M. (1955) - 1 - Ce, cit., sp. ph.
- Jakowlew, Ju. W. (1962) - 1 - neut. activ.  $\gamma$ -ray spect.
- Jezowska-Trzebiatowska, B. (1963) - 1 - molec. sp., U-org.
- Kalinin, A. I. (1962) - 1 - neut. activ.,  $\text{SiO}_2$
- Kanaev, N. A. (1963) - 1 - CeIV, antipyrine
- \*Kanevskiy, E. A. (1960-62) - 9 - U,  $\text{UO}_2$ , polarog., coulomet.
- Kaplan, B. Ya. (1962-63) - 2 - RE's, Sc, polarog., chromat.
- Kish, P. P. (1962) - 1 - In, photom.
- Kiss, A. (1958) - 1 - ext'n, U, Th, DBP, morin
- Kleybs, G. A. (1956-58) - 2 - U, ferrocyanide ppt'n
- Klimov, V. V. (1963) - 1 - Nb, fluorescence
- \*\*Klygin, A. E. (1958-61) - 12 - res., U, Th, Pu, EDTA, complex comp'ds
- Konovalov, E. E. (1963) - 1 - spect. met., zone-melting, pure Bi
- Kovalenko, P. N. (1961-62) - 2 - Zr, Hf, Sm, photocol.
- Kozlov, A. G. (1960-61) - 2 -  $\text{UO}_2^{++}$ , EDTA, hydroxylamine
- Kozlov, A. S. (1958) - 1 - Cs, Cd cyanide, nephelometric
- Kryuger, G. (1954-55) - 2 - Zr, Hf, La, RE's, spect. chem.

Analytical Chemistry or Methods, continued

- Kurbatov, D. I. (1962) - 1 - polarog., Nb, W, Ti, Fe
- Kurchatov, B. V. (1955) - 1 - Pu-Np sep'n,  $\text{SO}_4$
- Kustas, V. L. (1963) - 1 - RE's, spectr., IX
- \*\*Kuznetsov, V. I. (1944-63) - 19 - U, Th, Pu, Am, RE's, Zr, V, Be
- Lbov, A. A. (1962) - 1 - n-activ., Au minerals
- Lebedev, V. G. (1960) - 1 - Ge, 8-hydroxyquinoline
- Lebedeva, A. I. (1961) - 1 - F, organo-fluorine comp'ds
- Levin, I. S. (1962) - 2 - In, Sn, ext'n, alkyl. phos. acids
- Luk'yanov, V. F. (1961-63) - 2 - Th, Be, photomet.
- Luzina, G. S. (1949) - 1 - F, amperomet.
- Mambetov, A. A. (1960) - 1 - Nb, permanganatomet.
- Mamedov, I. A. (1961) - 1 - Th, iodometric
- Maryanov, B. M. (1963) - 1 - Nd, radiomet. tit.
- Mendlina, N. G. (1963) - 1 - Ce, in  $\text{Al}_2\text{O}_3$ -methanol
- \*Mikhailov, V. A. (1958-61) - 8 - Pa, Th, U, Zr, RE s, Au,  $\text{HNO}_3$ , ext'n, IX
- Mishchenko, V. T. (1962) - 1 - RE's, EDTA, spectroph.
- \*\*Morachevskiy, Yu. V. (1956-60) - 14 - U, electrochem., ppt'n, IX, PE-9, EDE-10, polarog., amperomet.
- Myasoedov, B. F. (1963) - 1 - Pa, sep'n, radiomet.
- Nemodruk, A. A. (1963) - 3 - U, Pu, arsenazo III, photomet.
- Nikolov, K. (1962) - 1 - U, diethyl ether ext'n
- Onosova, S. P. (1962) - 1 - RE's, Th, complexomet. titr.
- Ostroumov, E. A. (1937-63) - 4 - U, Th, Zr, Ti, In, Ga
- Ostrovskaya, G. V. (1963) - 1 - spectrosc., Ga ions, abs. bands
- Palei, P. I. (1957) - 1 - actinides, sep'n and det'n

Analytical Chemistry or Methods, continued

- \*Paley, P. N. (1960-61) - 6 - U, Pu, EDTA, arsenazo
- Pompowski, T. (1961) - 1 - K, Rb, Cs, paper electrophoresis
- Ponomarev, V. D. (1960-63) - 3 - U, ferrocyanides
- Pozdnyakov, A. A. (1956) - 1 - RE's, Y, chromatog.
- Rakovskii, E. E. (1963) - 1 - Sn, Sb, In
- Ripan, R. (1960) - 1 - U(VI), spectroph., salicylaldehyde
- Rovinskii, F. Ya. (1963) - 1 - ext'n, TBP, Sr-90, Ce-144, soils, etc.
- Rozhdestvenskaya, Z. B. (1963) - 1 - U, amperomet., graph. elect.
- Rusanov, A. K. (1962) - 1 - RE's, ores, spectrographic
- \*\*\*Ryabchikov, D. I. (1950-63) - 23 - IX, SX, Titr., electrolyt., n-activ.,  
RE's, Th, B, F, Yb, Zr, Hf, Ga, Sc, Bi, Ca
- Semenenko, K. A. (1963) - 1 - Zr, Nb, phosphomolyb., spectrog.
- Serdyuk, L. S. (1959-63) - 2 - RE's, photomet.
- Shamaev, V. I. (1960) - 1 - n-activation, Se, Te
- Shaykind, S. P. (1961) - 2 - U, Th, polarog.
- Shcheglova, E. P. (1962) - 1 -  $\text{NH}_4$  ions, Be
- Sheskolskaya, A. Ya. (1962) - 1 - Zr, in Mo, W.
- Shkaravskii, Yu. F. (1963) - 1 - Nb, Ti, phosphomolybd
- Simon, V. (1957) - 1 - U, coulometric, ferricyanide
- Sinyakova, S. I. (1959-63) - 2 - uranyl, Cu, Pb, Cd, Zn, polarog.
- Skylyarenko, Yu. S. (1961-63) - 3 - Pu(IV), RE's, La, thermograv.
- Tikhonov, V. N. (1963) - 1 - RE's, Ce, peroxide complexes
- Ushakova, A. M. (1963) - 1 - U, Ce, Nb, Luminesc., raw mats. (?)
- Vainshtein, E. E. (1949-62) - 4 - X-ray spect., RE's, Zr, Hf, borides
- Vasil'eva, N. L. (1963) - 1 - Zr, use of formazans
- Vasil'eva, N. M. (1963) - 1 - O, in In, Ga alloys

Analytical Chemistry or Methods, continued

- Vernyy, Ye. A. (1960) - 1 - Al, in U, spectrogr.
- Vetrov, A. G. (1962) - 1 - Raw mats., U, radiometric.
- Vilesov, F. I. (1962) - 1 - mass spectroscopy, complex orgs, photoion. source
- Vinogradov, A. V. (1961-63) - 2 - Zr, alk. met., chem. spectrogr.
- Yashchenko, M. L. (1960) - 1 - alk. mets. in minerals, ores
- Yeskevich, V. F. (1960) - 1 - U, amperometric
- Zeidel, A. N. (1957) - 1 - Th, Be, impurities, evap., spectra
- Zeitlin, S. G. (1961) - 1 - Ra, EDTA
- Zharov, P. N. (1960) - 1 - Ra, co-ppt'n, electrometer
- Zhiglinski, A. G. (1962-63) - 2 - Sr-87, Pb-204, spectromet.
- Zolotavin, V. L. (1960-61) - 2 - waste disp. Sr, open basins; U, V.
- Zolotukhin, V. K. (1955) - 1 - free acid, in Th salts
- Zyabkina, E. P. (1961) - 1 - U, amperomet.
- See also Bochkova, Fioletova, Fomin, Kuteynikov, Moskal'kova, Nikol'skii, Petrukhin, Ryskin, Savich, Savvin, Stepanov, Trailina, Vasil'yev, Vdovenko, Zaydel', Zolotov.

Radioelement Separation or Production, Fission Product Recovery, etc.

- Alekseyev, R. I. (1961) - 1 - ext'n, Mo-99 from FP's
- Dakar, G. M. (1962) - 1 - Sb-125, ext'n
- Faddeeva, M. S. (1958) - 1 - ext'n, Tc
- Gromov, K. Ya. (1962-63) - 2 - Tm-163, Tm-165, decay scheme
- Iofa, B. Z. (1959-62) - 3 - La, Bi, Cu, Sb, Ac, int. electrol.
- Khripin, L. A. (1960) - 2 - Cs, K-alum cryst.
- Kirgintsev, A. N. (1958-60) - 2 - Sr, K, Cr, cryst.
- Korshunov, I. A. (1958-61) - 4 - P, (Zr,C)
- Krasnov, K. S. (1958-60) - 3 - Fr, halides, volatility
- Krestov, G. A. (1962-63) - 3 - thermodyn., Fr, Po, At, actinides
- Kuzina, A. F. (1960) - 1 - Tc, chromatog.
- Kyrsh, M. (1958-63) - 4 - Cs, Prussian blue, nitrobenz.
- \*Levin, V. I. (1960-63) - 7 - Ag-111, Co-58, Mn-54, TBP, AS-74, Ca-45, F-18
- Lukovnikov, A. F. (1962) - 1 - Mo, co-ppt'n, PbS
- \*Melikhov, I. V. (1959-62) - 6 - co-cryst., Pb, Cd, La, etc.
- Merkulova, M. S. (1958) - 1 - co-ppt and co-cryst.
- Mikheev, N. B. (1958-63) - 2 - Cs, K-alum, phosphotung. acid
- Moskal'kova, E. A. (1961) - 1 - Zr isotopes
- \*\*Murin, A. N. (1950-62) - 11 - FP's, Po, Hg, IEP, co-ppt., co-cryst., exch.
- Nazin, A. G. (1962) - 1 - Y-90, ext'n, TBP
- \*Nefedov, V. D. (1958-62) - 7 - Tc, Mo, W, Cr, Re, P, Zn, Bi, Tl, Sb
- Potapova, S. A. (1961-63) - 2 - ext'n, Zr-95, Y-90
- Ratov, A. N. (1959) - 1 - Ba-140, La-140, dioxane
- Rodin, S. S. (1962) - 1 - Cs, Fr, inorg. IX, Zr molybdate
- Roginskii, S. Z. (1956-62) - 4 - Cs, adsorp., glauconite, ferrocyan.
- \*Rudenko, N. P. (1956-61) - 8 - ext'n, IX, electroch., Pb, Bi, In, Mn, Cr, Fe, Ca, Y, Tc, Nb, Be, carrier-free

Radioelement Separation or Production, etc., continued

Sedletskii, R. V. (1962) - 1 - FP's from n-irrad. of U and Th, F, IX

Sekerski, S. (1959) - 1 - Zr, Nb, ext'n, chromatog., sil-gel

\*\*\*Shvedov, V. P. (1959-62) - 23 - electrochem., RE's, Pu, Cs, Sr, Sb, Nb, etc.

Svoboda, K. (1958) - 1 - Szilard-Chalmers, primary retent.

Tronova, I. N. (1962) - 1 - Pm-149, Nd-147, chromatog.

Vol'kvin, V. V. (1961) - 1 - FP's, OH ppt'n, colloidal, freezing techn.

Volkova, E. A. (1961) - 1 - Ac-228, methyl alc-ether meth.

Zaitsev, V. A. (1961) - 1 - Cs-137, applic., props., source handling

Zaitseva, N. G. (1960-62) - 2 - I, Hf, IX,  $\beta$ -spectroscopy

Ziv, D. M. (1959-61) - 4 - electrochem., Bi, Po, ppt'n, Rd Th

Zosimovich, D. P. (1961) - 1 - electrochem., Cd, Zn

See also Bar, Burtseva, Dzantiev, Gerlit, Kiselev, Tananayev, Spitsyn.

Health Physics, Radiation Safety, etc.

- \*Baranov, V. I. (1958-62) - 8 - rad. saf., fallout
- Baratov, G. F. (1962) - 1 - public safety, civil defense, book
- Dubrovina, Z. V. (1962) - 1 - fallout
- Fedorov, A. F. (1962-63) - 2 - sea contamin.
- \*\*Gandin, L. S. (1952-62) - 13 - meterol., reservoirs, stacks
- Golenetskii, S. P. (1962) - 1 - radioact. aerosols, analyt.
- Gorbatyuk, N. V. (1960) - 1 - reservoirs, F.P. migrat.
- Grayevskii, E. Ya. (1963) - 1 - chem. prot. against rad.
- Gusarov, I. I. (1962) - 2 - meterol., air pollution, Ru
- Ilin, D. I. (1958) - 1 - reservoirs, radioact. migr.
- Ivanov, V. I. (1962) - 2 - dosimetry,  $\gamma$ , n, rad. prot.
- Juda, J. (1961) - 1 - atmos. pollution
- Kalistratova, V. S. (1963) - 1 - Sr-90, lungs
- Karolya, I. L. (1962) - 1 - meteorology
- Kharadzha, F. N. (1962) - 1 - instr., x and  $\gamma$  dosage rates
- Kodochigov, P. N. (1962) - 1 - dosimetry
- Kokotov, Yu. A. (1961) - 1 - FP sorb. on soils, clays
- Kosourov, G. I. (1962) - 1 - instr., counting
- Kozlov, V. F. (1962-63) - 2 - dosimetry, Si and Ge ion beams
- Krongaus, A. N. (1962-63) - 2 - dosimetry, instr.
- Kurshakov, N. A. (1963) - 1 - rad. expos., effect of ACTH, cortisone, etc.
- Kuznetsova, L. V. (1963) - 1 -  $\beta$ , rad. exp., cyclotron
- Kuznetsova, S. S. (1962) - 1 - dosimetry,  $\text{FeSO}_4$
- Lavrenchik, V. N. (1963) - 1 - atmos. contamin.
- Lebedeva, G. D. (1962) - 1 - Sr, uptake by micro-organisms

Health Physics, Radiation Safety, etc., continued

- Leipunskii, O. I. (1962) - 1 - n-dosimetry
- Leshchinskii, N. I. (1962) - 1 - ship. radioact. mat., safety, monitoring
- Lyush, D. V. (1962) - 1 - dosimetry, N-powered ships
- Maiseytsev, P. I. (1962) - 1 - rad. safety in geolog. explor.
- Marsalek, J. (1962) - 1 - radioact. eff. on human populat.
- Novikov, Yu. V. (1962) - 2 - fallout, populat. health
- Revel'skii, A. L. (1962) - 1 - rad. monitoring, military reconn.
- Romantsev, E. Ye. (1962) - 1 - rad. prot., USSR regulations
- Sapozhnikova, S. A. (1946) - 1 - meteorol., wind veloc. changes
- Savenko, I. A. (1962) - 1 - abs. dose, space satellites
- Semenov, L. F. (1963) - 1 - rad. sickness, monkeys
- Sereda, G. A. (1963) - 1 - Sr-90, lakes, migrat., bottom depos.
- Shikhov, V. N. (1962) - 1 - rad. safety, prot. meas., clothing, dosimetry
- Soloveychik, R. E. (1943-47) - 4 - meteorology, theory
- Styro, B. I. (1962) - 1 - fallout, atmosph. ppt'n
- Yanina, L. V. (1962) - 1 - rad. injuries, handling, transporting radioact. mats., etc.
- Yudin, M. R. (1961) - 1 - fast neutron dosimeter, tissue equiv.
- Zamorskii, A. D. (1946) - 1 - meteorolog.
- Zloblinskii, B. M. (1961) - 1 - rad. safety, shielding, dosimet., design, book
- Zolin, L. S. (1962) - 1 - fast-n dosimetry, nuc. emuls.
- See also Vinogradov.

Radioactive Waste Treatment and Disposal

- Agafonov, B. M. (1960) - 1 - FP dist. in tanks, reservoirs
- Bagretsov, V. F. (1960) - 1 - Cs, Sr sorp. on biotite
- Bagrentsov, V. G. (1960) - 1 - FP sorp. on dolomite, magnomass
- Egorov, Yu. V. (1961-62) - 3 - Sr, co-precip., radio-Sr radiomet.
- Mal'tsev, E. D. (1962) - 1 - U.G. disp., heat aspects
- Oreshnikov, V. F. (1962) - 1 - treat, sewers, radioact. sorp. on peats
- Pekhtashev, I. S. (1959) - 1 - Cs, Sr,  $\text{SO}_4$ , solub., org. solvents
- Ponomareva, L. K. (1959) - 2 - Sr, Cs, reservoirs, suspensions
- Pushkarev, V. V. (1961-62) - 2 - FP adsorp., Fe-hydrox,  $\text{MnO}_2$ , gelatin, froth
- Sachse, G. (1963) - 1 - treat., rev. of U.S. and Canadian methods, etc.
- Skrylev, L. D. (1961-62) - 3 - treatment, U, Cs, foam sep'n
- Vlasova, T. A. (1962) - 1 - reservoirs, Ce-144 sorp., biomasses
- Voznesenskii, S. A. (1958-61) - 3 - Sr, Cs adsorp.,  $\text{Al}(\text{OH})_3$ , Dolomite
- Yegorov, Yu. V. (1961) - 3 - Sr removal, adsorp., Fe-hydrox. co-ppt'n,  $\text{MnO}_2$
- See also Bokova, Gorbatyuk, Il'in, Kovalenko, Shvedov, Starik.

Radiation Effects

- Abramova, L. V. (1963) - 1 - synt. of Sn, dibromodibutyl
- Akhundov, A. A. (1963) - 1 - IRT-2000 reactor loop, hydrocarb. tests, etc.
- Andronikashvilli, E. L. (1962) - 1 - IRT-2000 reactor loop, In-Ga loop
- Anokhina, I. N. (1962-63) - 2 - alk. halide cryst.
- Avdonina, E. N. (1962) - 1 - T recoil, n-irrad benzene, cyclohexane, damage
- Avetisyan, M. A. (1963) - 1 - uranium, photochem. behavior, luminesc.
- Bagdasar'yan, Kh. S. (1962) - 1 - frozen methyl methacrylate, cation radicals
- Bakh, N. A. (1955) - 1 - aqueous sol'ns, inorg. salts
- Barkalov, I. M. (1962) - 4 - polymerization, acetylenes
- Blokh, G. A. (1955-62) - 4 - rubber
- Breger, A. Kh. (1960-61) - 3 - sources,  $\gamma$
- Dmitriev, M. T. (1963) - 1 - N oxide and  $C^{14}$  formation in air
- Gromov, V. F. (1961) - 1 - polymerization, ethylenes, etc.
- Kalyazin, E. P. (1963) - 1 -  $CO_2$  react. with alkanes, etc.
- Karapetyan, G. O. (1963) - 1 - glasses, EPR
- Karpov, V. L. (1955-63) - 2 - Rad. Eff.,  $\gamma$ , polymers, rubber
- Kazanskii, V. B. (1962) - 1 -  $\gamma$ , sil. gel, EPR
- Keytlin, L. G. (1961) - 1 -  $\gamma$ , polymers
- Khenokh, M. A. (1956) - 1 - Co-60, proteins, amino acids
- Khramchenkov, V. A. (1963) - 1 - polymers, fluoro-olefins
- Kolbanovskii, Yu. A. (1961) - 1 -  $\gamma$ , oxide catalysts
- Kolontsova, E. V. (1962) - 2 - x,  $\gamma$ , cryst., quartz
- Kongrauz, V. A. (1963) - 1 - energ. transm. by luminesc. and rad. chem.
- Konobeevskii, S. T. (1962) - 1 - on materials
- Kuz'minskii, A. S. (1962) - 2 -  $\gamma$ , rubbers, free-radicals

Radiation Effects, continued

- Mikhail, R. (1962) - 1 - chem. react., hydrocyanic acid synth.
- Mikhailenko, I. E. (1963) - 1 - phase transformation, W, S comp'ds
- Mokul'skiy, M. A. (1959) - 1 - polymers
- Molin, Yu. N. (1962) - 1 - org. comp'ds, solids, radical form.
- Nath, A. (1962-63) - 2 - n-2n,  $\gamma$ -n, Co, recoil eff.
- Nazarenko, G. T. (1963) - 1 - electron irradi., steel, surf. strength
- Nepomnyashchii, A. I. (1963) - 1 -  $\gamma$ , radicals, polymers
- Nikol'skii, V. G. (1962) - 1 - radiolysis, polymers, low temp
- Olshanskaya, N. I. (1962) - 1 - polymers, dielect. losses
- Oreshko, V. F. (1955-62) - 2 -  $\gamma$ , colloids, starch radiolysis
- Pavlovskaya, T. E. (1963) - 1 - dyes, protein coupling, O<sub>2</sub> effect.
- Polak, L. S. (1962) - 2 - radiochem., geophys., books
- Potakhova, G. I. (1963) - 1 -  $\gamma$ -rad, epoxides, dielect. prop.
- Pravdyuk, N. F. (1962) - 2 - reactor rad. damage to mats., x-rays, elect. microscope
- Proskurnin, D. A. (1955-57) - 4 - oxid-red., rad. chem., aq., org.
- Pshezhetsky, S. Ya. (1955-62) - 3 - rad. chem., ozone form., oxid. of N<sub>2</sub>, etc., book
- Rozovskii, M. I. (1962) - 1 - metal rod deformation, Fe, theory
- Saraeva, V. V. (1962-63) - 4 - ext'n, radiolysis of diethyl ether
- Sharpatyi, V. A. (1960-63) - 4 - radiolysis, sol'n chem., H<sub>2</sub>O, org.
- Shteding, M. N. (1962) - 1 -  $\gamma$ , polyvinyl chloride, thermomech. eff.
- Shubin, V. N. (1963) - 1 - rad. chem., competitive scavengers
- Shvidkovskii, E. G. (1963) - 1 - n-irrad. of In foils
- Sokhina, L. P. (1960) - 1 -  $\alpha$ -rad., Pu-oxalate complexes
- Sokolov, Yu. L. (1962) - 1 - biol., plants, solar, cosmic rays
- Stolyanova, I. G. (1963) - 1 - elect. microsc., rad. dam., polyethylene

Radiation Effects, continued

- Tarasova, Z. N. (1962) - 1 - vulcan. of rubber, polymerization, EPR
- Topchiev, A. V. (1962) - 1 - radiolysis of hydrocarb., book
- Troitskii, O. A. (1962-63) - 2 -  $\beta$ ,  $\gamma$ -rad, Zn cryst., mech. props
- Tsetlin, B. L. (1963) - 1 - polymeriz., gas phase-solid base
- Tsetskhladze, T. V. (1962) - 1 - silkworm cocoon killing
- Tupikov, V. I. (1963) - 1 - ammonia, hydrazine, low temp., radicals
- Vaisburd, D. (1962) - 1 - on prop. of mats., conference
- Vannikov, A. V. (1963) - 1 - polyethylene, I, elect. props.
- Vargin, V. V. (1962) - 1 -  $\gamma$ , on glasses,  $\text{Na}_2\text{O}-\text{Al}_2\text{O}_3-\text{SiO}_2$
- Vasil'ev, R. F. (1962) - 1 - hydrocarbons, liq. phase oxidat., rates
- Vedula, Yu. S. (1963) - 1 - W surf. adsorp. of U, Ba, electron bombard.
- Vereshchinskii, I. V. (1951-61) - 2 - radiolysis of proto-porphyrin; rad. chem.
- Vladimirova, M. V. (1960) - 1 -  $\text{H}_2\text{SO}_4$  radiolys.,  $\alpha$ , Po-210
- Vladimirova, V. I. (1963) - 1 - oxide catalysis, dehydrogenation, cyclohexane
- Volkova, E. V. (1962) - 1 -  $\gamma$ , polymeriz. of vinylidene fluoride
- Vorozhtsov, B. I. (1962-63) - 4 -  $\gamma$ , insulat. mats., elect. prop. meas.
- Yershova, Z. V. (1958) - 1 -  $\alpha$ , Po, Aq. acid sol'ns,  $\text{H}_2\text{O}_2$  formation
- Yurin, V. A. (1962) - 1 -  $\gamma$ , triglycine sulfate cryst., dielect. props.
- Zamotrinskaya, E. A. (1963) - 1 -  $\gamma$ ,  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  crystals.
- Zaytsev, L. N. (1962) - 1 - precast concrete shielding, process, mfg.
- See also Byalobzheskiy, Chernova, Dain, Emanuel, Kabakchi, Kuzin, Popov,  
Pshezhetsky, Shub.

Radioisotope Research and Application

- Aivazov, B. V. (1949) - 1 - C isots., tracers, org. and biochem.
- Alekseeva, F. A. (1959) - 1 - oil geology
- Andreeva, O. I. (1960) - 1 - C-14 labelling of elemental C
- Andrianova, T. I. (1952-53) - 3 - C<sup>14</sup> labeled comp'ds
- Antipov-Karatayev, I. N. (1955) - 1 - soil electrolytes, soil improvement
- Badenko, I. I. (1962) - 1 - prep. of monomolec. P-32 source
- Belikov, M. P. (1961) - 1 - applic. in hydrotechnology
- \*Brodskii, A. I. (1952-57) - 5 - books
- Dontsova, E. I. (1948-56) - 3 - O-isotopes
- Gar, K. A. (1955) - 1 - plants, insecticides
- Glazman, Yu. M. (1958) - 1 - sols, lyophobic
- Glazov, N. V. (1962) - 1 - eng'ring studies
- Gorodisskaya, G. Ya. (1957) - 1 - biochem.
- Grozin, B. D. (1955-63) - 3 - steel, machines
- Ivanova, I. K. (1963) - 1 - C-dating
- Jordan, G. G. (1955) - 1 - process control
- Kalenikhin, Yu. N. (1961) - 1 - Co-60, Cs-137, welding
- Keier, N. P. (1950) - 1 - catalysis, adsorp.
- Kidin, I. N. (1955) - 1 - uses in metallurgy
- Klechkovskii, V. M. (1955) - 1 - fertilizers
- Kokochashvili, V. I. (1962) - 1 - C-dating, counting
- Kondratjev, V. N. (1955) - 1 - tracers in chem. react.
- Kovba, L. D. (1959) - 1 - tracers, Ag
- Kurdyumov, G. V. (1955-57) - 2 - diffusion in alloys, etc.
- Levi, G. I. (1961) - 1 - C-14 labelling of org. comp'ds
- Mandelbaum, Ya. A. (1955) - 1 - P, S, fertilizers

Radioisotope Research and Application, continued

- Mikhailin, A. D. (1960) - 1 - labelled carbon, HAC
- Mikhnev, G. F. (1962) - 2 - raw mat., feed mat., indust., etc.
- Mikheeva, L. M. (1961) - 1 - analyt. chem. dev.
- Musakin, A. P. (1959) - 1 - labelled comp'ds, synth.
- Nazarov, S. T. (1955) - 1 -  $\gamma$ -ray radiogr.
- \*Neiman, M. B. (1952-62) - 5 - labelling, isot. exch., tracers
- \*\*Nesmeyanov, A. N. (1956-62) - 18 - n-irrad., recoil effects, met-org. comp'ds, etc.
- Nisnevich, A. I. (1962) - 1 - engine wear
- Petrova, N. A. (1961) - 1 - nuc. irrad., in USSR, book
- Popov, S. (1963) - 1 -  $\gamma$ -rad., flaw detection
- Postnikov, V. I. (1961) - 1 -  $\gamma$ -rad., flaw detection
- Pozdeev, V. V. (1962-63) - 4 - tritium-labelled org., recoil, Li-6(n, $\alpha$ )T
- Raiskii, S. M. (1956) - 1 - tracers, book
- Samarin, A. M. (1955) - 1 - proc. for iron, steel production
- Sanadze, V. V. (1962) - 1 - self diffus. in Fe, eff. of Zr, Nb, Mo
- Shushumov, V. A. (1958) - 1 - react. of tritium, H, with metal oxides
- Sinotova, Ye. N. (1959) - 1 - C, isot. exch., phenyl radicals
- Sokolov, A. V. (1955) - 1 - P, soils, agriculture
- Soyuzkhimeksport, V. O. (1962) - 1 - stable isot., avail. isot., USSR, book
- Strazhesko, D. N. (1958) - 1 - salt sorp. on charcoal, tracers
- Styrikovich, M. A. (1955) - 1 - tracers, steam-H<sub>2</sub>O hydrodyn.
- Yanushkovskii, V. A. (1955) - 1 - met., surface 'branding' of steel by indust.
- Zakharievskii, M. S. (1962) - 1 - tracers, meas. diffus. coeffs.
- Zaslavsky, Yu. S. (1955) - 1 - oils, fuels, anti-wear props.

Radioisotope Research and Application, continued

Zel'venskii, Ya. D. (1959) - 1 - S, Cl, isot. exch.

Zhavrova, G. M. (1959) - 1 - adsorp., zinc oxide

Zhitkov, P. N. (1959) - 1 - tracers, pressed wood, bulk dens.

See also Alimarin, Bloch, Englegardt, Gertsricken, Gimel'shteyn, Grinberg, Guryanova, Ioffe, Kedrov-Zikhman, Kishkin, Kursanov, Kuzin, Pastukhova, Petriaev, Raginskiy, Samarin, Spitsyn, Tatevskiy, Zaborenko.

Biology and Medicine

- Abdullaev, V. D. (1963) - 2 - rad. sickness, effects, U. V.
- Afanaslev, G. G. (1963) - 1 - rad. eff., tumor cells, inhibitors
- Akoev, I. G. (1963) - 1 - rad. injuries, immunobiol. resistance
- Aleksandrov, S. N. (1963) - 1 - irradi. eff., leukoses
- Alikhanyan, S. I. (1962) - 1 - microorganisms, rad-induced mutations
- Amirogova, M. I. (1962) - 1 - radioprotection, propylgallate
- Andreev, S. V. (1962) - 1 - dose depend., survival rate, granary weevils
- Antipenko, E. N. (1963) - 1 - rad. sickness, man
- Antipov, V. V. (1963) - 1 - rad. sickness, mice
- Bagdasarov, A. A. (1961) - 1 - anemia, leukemia, bone-marrow transp.
- Balabukha, V. S. (1963) - 1 - elimination of Sr from organisms
- Dubinina, N. P. (1962) - 3 -  $\gamma$ , mutations
- Glemobitskii, Ya. L. (1962) - 2 - mutations, insects
- Gruzdiev, G. P. (1963) - 1 - rad., bone marrow
- Ivanitskaya, A. F. (1961) - 1 - x-rays, cells
- Ivanov, I. D. (1962) - 2 - U.V., DNA, trypsin
- Kakushkina, M. L. (1963) - 1 - radio-protectors, amines
- Kalinicheva, V. I. (1961) - 1 - bone marrow transplants
- Kedrov-Zikhman, O. K. (1955) - 1 - plant nutrit., Co-60
- Knizhnikov, V. A. (1962) - 1 - Sr-90, hematopoiesis, rats
- Kursanov, A. L. (1955) - 2 - radioisot. res., plants
- Kuzin, A. M. (1952-55) - 2 - radioisot. util., biosynthesis, etc.
- Lifshits, N. N. (1962) - 1 - rad. eff., nervous syst.
- Livanov, M. N. (1962) - 1 - rad. eff., nervous syst.
- Loshadkin, N. A. (1962) - 1 - rad. sickness, organophos. comp'ds
- Meissel, M. N. (1961) - 1 -  $\gamma$  rad. eff. on cells

Biology and Medicine, continued

- Melnik, L. A. (1963) - 1 - rad. sickness, treatment
- Metlitskii, L. V. (1962) - 1 -  $\gamma$  rad. eff., food preservation
- Mukhin, E. N. (1963) - 1 - rad. eff., potatoes, phenolic components
- Muksinova, K. N. (1963) - 1 - irradi. rats, use of bone marrow
- Nadareyshvilli, K. Sh. (1963) - 1 - ioniz. rad., irrit. eff.
- Nuzhdin, N. I. (1962) - 2 - genetics, mice, rad. sensitivity
- Palamarchuk, A. S. (1960) - 1 -  $\gamma$ , x-rad. eff., stim. plant root growth
- Petrov, V. A. (1962) - 1 - med., elect. sources, dosimetry
- Raushenbach, M. O. (1961) - 1 - rad. eff., animals, bone marrow transpl.
- Shapiro, N. I. (1962) - 1 - rad. eff., oestrus disorders, mice
- Sharifkhodzhaev, A. T. (1961) - 1 - rad. injury, phagocytic activ.
- Shrago, M. I. (1961) - 1 - anemias, bone marrow transf.
- Silant'ev, E. I. (1962) - 1 - ioniz. rad., animals, anthrax immun.
- Slekseeva, M. S. (1963) - 1 - rad. eff.,  $\gamma$ , rats, higher nervous activity
- Smirnova, O. V. (1963) - 1 - rad. eff., animals, eff. of antiplague vaccine
- Sondak, V. A. (1963) - 1 - rad. eff., UV, animals, spleen
- Spizharskaya, L. M. (1961) - 1 - anemias, use of bone marrow from cadavers
- Tarusov, B. N. (1963) - 1 - rad. injury, primary processes
- Vainberg, M. Sh. (1963) - 1 - medic., Cs-137 source, control
- Vakhtel, V. S. (1963) - 1 - medic., rad. sick., cystamine hydrochloride
- Viktorina, V. P. (1962) - 1 - medic., rad. safety, x-rays
- Yarmonenko, S. P. (1962) - 1 - rad. protect. of rats by drugs.
- Zakharova, N. I. (1963) - 1 - photosynth., leaves, C-14
- Zaretskaya, Yu. M. (1961) - 1 - rad. pathol., lymphoid organs
- Zaretskii, I. I. (1961-63) - 2 - leukemia, bone marrow transp., etc.

VIII. Some Reagents Employed in the Research and Development

(Abbreviated notations and some author references are given.)

ACETAMIDE: Li, NO<sub>3</sub>, uranyl: Klochko, Markov

ACETATE: Np complexes; bromo and chloro, n-irrad., radioel. sep'n; U-monoacetate; Li-acetate, Li-6 (T,2n) Be-7, sep'n; Ce; RE's, thiourea; Be-oxyacetate; uranyl, aniline: Mefod'eva, Nesmeyanov, Nikol'skii, Rudenko, Ryabchikov, Sakharova, Semenenko, Paramanova, Vagina, Vdovenko

ACETOFLUORIDE: U complexes: Golovnya

ACETONE: Zr complexes, selenenoyl, benzene, ext'n; uranyl, chloride complexes: Mel'chakova, Vdovenko

ACETYL ACETONE: Th ext'n, sep'n from Ce; Hf; Np(V): Peshkova, Rosyanov, Zolotov

 $\alpha$ -ALANINE: NdCl<sub>3</sub>, complex comp'ds: Zvyagintsev

ALBERON: Be, analyt.: Adamovich

ALIPHATIC ACIDS, SOAPS: ext'n, U, Flotation: Gindin, Grekulova, Ter-Oganesov

ALIPHATIC AMINES: Be oxyacetate comp'ds: Grigor'ev

ALIZARIN: Pu, co-ppt'n: Pasternak

ALKYLAMINES: di and tri, U ext'n from PO<sub>4</sub> soln's; In, Sn; BF<sub>3</sub>-comp'ds: Laskorin, Levin, Ryss

ALKYLPHOSPHONATES: extractants, U processing: Petrov

ALKYL PHOSPHORIC ACIDS: D-2EHPA, U ext'n from ore leach liquors; Pa: Laskorin, Shevchenko

AMIDES: trimethylthiocarbamide-Pt; infl. on spectra and conductiv. of UO<sub>2</sub>(NO<sub>3</sub>)<sub>2</sub> in TBF. Golovnya, Minc

AMINENITRIDE: Pt complexes: Golovnya

AMINES (see also individ. amines): U, Pt, diarylnitrogenoxide radicals by peroxides; BF<sub>3</sub> comp'ds: Chernyaev, Chupakhina, Fomin, Ivanova, Koritskii, Laskorin, Ryss, Savich, Vdovenko, Zvyagintsev

B-AMINOETHYLISOTHIURONIUM BROMIDE: radiation protection, protons, O-effect: Yarmonenko

AMYL ACETATE: Pa-233 isol'n proced., ext'n of cupferron complex; Nb ext'n, thiocyanate complex: Spitsyn, Troitskiy

- ANILINE:  $\text{BF}_3$  comp'ds; Re complex; uranyl triacetate: Ryss, Tronev, Vdovenko
- ANISOLE ( $\text{C}_6\text{H}_5\text{OCH}_3$ ): isot. sep'n, B,  $\text{BF}_3$  isot. exch.: Panchenkov
- ANTHRANILIC ACID: Zr, zirconyl complex: Zaitsev
- ANTIPYRINE: analyt., Ce IV: Kanaev
- ARMIN: organophos. comp., rad. sickness: Loshadkin
- AROMATIC HYDROCARBONS: Be-oxybenzoate comp'ds: Kurdymov
- ARSENAZO II: analyt., U, photomet.: Kuznetsov, Savvin
- ARSENAZO III: analyt; Np, Pu(IV); Th; U(IV); Am(III): Chudinov, Klygin, Kuznetsov, Luk'yanov, Savvin, Paley, Upor, Zaykovskiy
- ASPARTIC ACID: La, Ce, Pr, Nd complexes: Batyaev
- BENZENE: ext'n, Zr complexes, acetone, selenenoyl; deuterated, tritium exch., n-irrad: Mel'chakova, Nesmeyanov, Peshkova, Pozdeev
- BENZOATE: Be oxide benzoate: Semenenko
- BENZOHYDROXAMIC ACID: Ti react.: Alimarin
- BENZOYL ACETONE: ext'n of In and Cd (in chloroform, benzene,  $\text{CCl}_4$ ); Zr, (L-phenylbutane-1,3 dione)-Zr-benzene- $\text{H}_2\text{O}$ ; Sr, Y: Peshkova, Rudenko, Stary
- BENZYLALDEHYDE: ext'n, Pu(IV): Khalkin
- N-BENZOYLPHENYLHYDROXYLAMINE: ext'n, Pu, TRU; Sn and Sb from In; Pa: Chmutova, Rakovskii, Palshin
- BIOTITE: adsorp., Sr, Cs: Bagretsov
- BIPHENYL-ME:  $\text{me}_2(\text{Zn})$ , isot. exch., sep'n: Nefedov
- BIS(ACETYLACETONE)-ETHYLENEDIIMINE/ $\overline{\text{NN'}}$ -ETHYLENEBIS-1-(ACETONYLETHYLIDENEIMINE)]: Nd complex, analyt., sp. ph.: Astakhov
- BIS-(N,N'-DI-(3 NITROSALICYLYL) ETHYLENEDIAMINE)- $\mu$ , AQUADICOBALT: isot. sep'n, O, isot. exch., eff. of temp.: Panchenkov
- P-BROMOMANDELIC ACID: Zr, Nb complexes; ext'n: Alimarin
- BUTYLACETATE:  $\text{H}_2\text{O}$  ext'n; Pu(IV): Chaykhorskiy, Khalkin
- BUTYL ALCOHOL: Nb ext'n, thiocyanate complex; Np(V), Co(II), TTA: Troitskiy, Zolotov
- BUTYLAMINE: Be oxyacetate comp'ds: Grigor'ev

- BUTYL FORMATE: ext'n, Pu(IV): Khalkin
- BUTYL RHODAMINE NITRATE: analyt., Pu(IV) ppt'n: Kuznetsov
- CAMPHORATES:  $\alpha$ -Br-(D-camphor)- $\pi$ -sulfonates, RE's: Dodonov
- CARMINE: analyt., B, SO<sub>4</sub>, colorimet.: Ryabchikov
- CARBONIC ACID ESTERS: C<sup>14</sup>-labeled: Andrianova
- CARBONIC ACIDS (also see individ. acids): Pa complexes, lactic acid, IX: Geletseanu
- CARBOXYLIC ACIDS: ext'n, H<sub>2</sub>O-kerosene; Cs, Fe ext'n: Adamski, Karpacheva
- CETANE:  $\gamma$ -radiolysis, oxidation: Proskurnin
- CHLOROFORM: ext'n, thiooxinates of Fe<sup>+3</sup>, Mn<sup>+2</sup>, Co<sup>+2</sup>, Cu<sup>+2</sup>, Zn<sup>+2</sup>: Mikulski
- P-CHLOROPHENOL: react. with Rn, analogous to H<sub>2</sub>S-3ClC<sub>6</sub>H<sub>4</sub>OH: Nikitin
- CHLOROPHOSPHONAZO III: analyt., photom., Th, Zr, Ti, Sc, Np: Chudinov, Fadeeva
- CHLOROPHOSPHONAZO R: analyt., Be, photomet.: Luk'yanov
- CINNAMIC ACID: analyt., sep'n of In and Ga from Mn, Ni, Co, Zn: Ostroumov
- CITRIC ACID: Nb complexes, RE complexes, In, Zr; ext'n by TBP; Np(V), IX: Alimarin, Malyarov, Moskvina, Ryabchikov, Senyavin, Sheronov, Pyatnitskii, Stepanov, Tsvetkova
- CUMENE: CO<sub>2</sub> react., rad. induc.: Kalyazin
- CUPFERRON: Th complex, UO<sub>2</sub><sup>+2</sup>, sp. phot., RE's; Pa; Zr, alk. mets; Np(V): Dzionko, Maryanov, Morachevskiy, Spitsyn, Vinogradov, Zolotov
- CYANIDES: U, Fe<sup>+2</sup>, Cs-Cd; ferrocyanides, Cs; dicyanauric(I) acid: Borisikhina, Kozlov, Ponomarev, Roginskii, Tananayev, Zvyagintsev
- CYANOARGENTATES: RE's: Chupakhina
- CYCLOHEXANONE: interact. with hydroperoxides; ext'n, UO<sub>2</sub>(NO<sub>3</sub>)<sub>2</sub>; HNO<sub>3</sub> ext'n; Ta, Nb, from H<sub>2</sub>SO<sub>4</sub> sol'n: Denisov, Fomin, Mints, Goroshchenko
- CYSTAMINE HYDROCHLORIDE: treat. of rad. sickness: Vakhtel
- CYSTEINE AMINE: radio-protection (biol.): Kakushkina
- DAPA (DIISOAMYL ESTER OF METHYL PHOSPHONIC ACID): Th ext'n from HCl and HClO<sub>4</sub> soln's: Nikol'skii

- 1,8-DIAMINONAPHTHALENE: **analyt., Am(III), co-ppt'n: Kuznetsov**
- DIAMINOTETRACETIC ACID, ETHYL ESTER: **complexes, Y(III), Ce(III), U(VI): Razbitnaya**
- DIAMYL PHOSPHORIC ACID: **ext'n, RE's: Patrusheva**
- DIANTIPYRIDINYLPROPYLMETHANE: **analyt., Os, photom.: Busev**
- DIARYLNITROGENOXIDES: **react. of amines with perox. radical: Koritskii**
- DIARYLPHOSPHORIC ACIDS: **Y-90 from Sr<sup>90</sup>-Y<sup>90</sup>, ext'n, CHCl<sub>3</sub>, CCl<sub>4</sub>, C<sub>6</sub>H<sub>6</sub>: Potapova**
- DIBENZOYL METHANE: **uranyl comp'd, n-irrad., Szilard-Chalmers: Martynov, Moucka**
- DIBENZYLPHOSPHATE: **Y-90 ext'n: Potapova**
- DIBROMODIBUTYL: **Sn(ous), rad. synth.: Abramova**
- DIBUTYL ETHER: **FeCl<sub>3</sub> ext'n, HNO<sub>3</sub>, U, Pu(VI), Np(VI): Fomin, Golavatenko, Khalkin, Maslova, Vdovenko**
- DIBUTYL PHOSPHATE (DBP): **RE ext'n: Kriss**
- B,B'-DICHLORODIETHYL ETHER: **uranyl nitrate-H<sub>2</sub>O solub.: Vdovenko**
- P-DICRESYL PHOSPHATE: **Zr-95 ext'n, in chloroform, Y-90: Potapova**
- DIETHYLDITHIOCARBAMINATE: **Cu, coprecip. of Ag, In, Ti; Zr ext'n: Efremov, Tserkovnitskaya, Vdovenko, Zil'berman**
- DIETHYLENE GLYCOL DIBUTYLATE: **HNO<sub>3</sub> ext'n: Vdovenko**
- DIETHYLENETRIAMINO PENTACETIC ACID: **complexes, Y(III), Ce(III), U(VI): Razbitnaya**
- DIETHYL KETONE: **ext'n, Pu(IV): Khalkin**
- N,N'-DI(2-HYDROXY-5 SULFOPHENYL)-C-CYANFORMAZAN: **analyt., Zr, photomet.: Vasileva**
- DI(2-ETHYLHEXYL PHOSPHORIC ACID (D2EHPA): **ext'n, U(VI), Fe(III), SO<sub>4</sub> syst.: Urbanski**
- DI-ISOAMYL ESTER OF METHYL PHOSPHONIC ACID (DAMPA): **with TBP, U ext'n; Am: Fomin, Shevchenko, Zemylanukhin**
- DI-ISOAMYLPHOSPHORIC ACID: **Pa, ext'n: Mikhailov**
- DIISOBUTYL SULFIDE: **Fe, Cl, ext'n: Vdovenko**

- DIISOCTYLPYROPHOSPHATE: extractant (TBP subs.) used in rotary contactor  
exps.: Salamatov
- DIISOPENTYL ETHER: ext'n, Sb: Privalova
- DIISOPENTYL METHYLPHOSPHONATE: ext'n,  $H_2O$ ,  $HNO_3$ ,  $H_2SO_4$ , U, eff. of salting  
agents: Solovkin
- DIISOPROPYL ETHER: In bromide ext'n from 5 M HBr sol'n, Astatine, ext'n:  
Sinyakova, Yung-Yu
- DIMETHYLGLYOXIME: Zr, zirconyl complex: Zaitsev
- $\beta$ -DINAPHTHYL PHOSPHATE: Y-90 ext'n: Potapova
- DIOXANE: La, Bi,  $H_2O$ , Ba-La(140): Iofa, Ratov
- DIPHENYL QUANIDINE SALT OF ANTHRACENE- $\alpha$ -SULFONIC ACID: analyt., Th, ppt'n:  
Kuznetsov
- DIPHENYL PHOSPHATE: Y-90 ext'n: Potapova
- DIPHOSPHONATES: extractants, U processing: Petrov, Voden
- DIPICRYLAMINE: Cs, nitrobenzene sol'n, ext'n: Kyrsh
- DIPROPYL ETHER: ext'n, U,  $HNO_3$ : Maslova
- 2,2'-DIPYRIDYL:  $UO_2^{+2}$  salts, comp'ds: Markov
- N,N' DISALICYLAL ETHYLENEDIAMINE)- $\mu$ -AQUODICOBALT: isot. sep'n, O, absorb  
at 40°C, desorb at 60°C: Panchenkov
- DITHIOZONE: analyt., ext'n, Bi complex: Busev
- DODECYL PHOSPHORIC ACID: U(VI), Fe(III) ext'n,  $SO_4$  sol'ns: Urbanski
- EDTA:  $Tl^{+3}$  (with di-sodium salt); RE's, IX; U(IV) and Pu(IV) complexes;  
 $UO_2^{++}$  complex; Np; Ra, Ba; Th: Busev, Eskevich, Gelman, Kabanova, Klygin,  
Kozlov, Krawczyk, Krot, Martynenko, Mefod'eva, Mishchenko, Mitrofanova,  
Morachevskiy, Nikol'skii, Ryabchikov, Shvedov, Paley, Tananayev, Zeitlin,  
Zolotov
- ERIOCHROME BLACK: analyt., Am(III), ppt'n; RE's: Kuznetsov, Onosova
- ETHANOL: comp'ds with La, Ce chlorides; analyt., ext'n Rb and Cs chlorides:  
Sheka, Yashchenko
- ETHANOLAMINE (MONO, DI, or TRI): Pt comp'ds: Gil'dengershel, Migal
- ETHER, DIETHYL: Th ext'n, salicylate; U ext'n; radiolyt. eff; Np; Be,  
Complex comp'ds; Pu(IV): Nikolaev, Nikolov, Khalkin, Palshin, Rosyanov,  
Saraeva, Turova, Vdovenko, Zolotov

- ETHYLACETATE: ext'n, Pu(IV): Khalkin
- ETHYLAMINE: Be oxyacetate comp'ds: Grigor'ev
- ETHYLENE: Pt comp'ds: Dyatkina
- NN -ETHYLENEBIS(salicylideneiminato): complexes, Ti, Nb, Ta: Lapitskii
- ETHYLENEDIAMINE: Ni complex, IX; Re complex: Elovich, Tronev
- ETHYLPROPYL ETHER: ext'n, U, HNO<sub>3</sub>: Maslova
- FERRON: analyt., U reaction: Mikhailov
- FORMAZANS: analyt., Zr, photomet.: Vasil'eva
- GLUCONIC ACID: La complex, IX, RE complexes: Kastromina (or Kostromina)
- GLUTAMINE: biosynthesis, C-14 labelling: Kuzin
- GLYCINE: La, Pr, Nd complexes: Batyaev, Zvyagintsev
- HEPTANE: CO<sub>2</sub> react., rad. induced: Kalyazin
- HEXACARBONYLS: radioel. sep'n, cryst., Cr, Mo, W, Tc, Re: Nefedov, Nesmeyanov
- HEXAMETHYLENE DIAMINETETRAACETIC ACID: RE complexes, Th: Kuz'menko, Ryabchikov
- HEXAMINE: Ni complex, IX; Pt(IV): Elovich, Grinberg
- HYDRAZINE: Li, Cl: Klochko
- HYDROARSENATE: analyt., Th ppt'n: Mamedov
- HYDROCYANIC ACID: synthesis; by rad. eff, Pt catalyst: Mikhail
- α-HYDROISOBUTYRIC ACID: complexes, TRU, Am, Cm: Dedov
- 2-HYDROXY-1,4-NAPHTHOQUINONE: Th complex: Zozulya
- HYDROXYNITROSOTETRAMINE: ruthenium chloride complex: Parpiev
- HYDROXYLAMINE: UO<sub>2</sub><sup>++</sup> complexes; Ce sep'n from Th: Kozlov, Tserkovnitskaya, Zvyagintsev
- 8-HYDROXYQUINOLINATE: HF complex; Nd; In, Sn-salt in chloroform; U, complex comp'd; Cu, Ni; Zr; alk. mets; Np(V): Kalinkina, Panova, Pavlovskaya, Maryanov, Rudenko, Trailina, Vinogradov, Zelentsov, Zolotov
- 5-HYDROXYTRYPTAMINE HYDROCHLORIDE: treatment of radiat. sickness: Semenov
- ISOAMYLACETATE: IX, In, Tl, on a fluoropolymer column: Preobrazhenskii

- ISOAMYL ALCOHOL: HCl, CaCl<sub>2</sub> ext'n: Gindin
- ISOPENTYL ALCOHOL: ext'n, Sb: Privalova
- ISOPROPYL ALCOHOL: Chlorouranyl complexes; catalyt. dehyd. and dehydrogenation by  $\alpha$ -U<sub>3</sub>O<sub>8</sub>: Minc, Tolstopyatova
- ISOPROPYLBENZENE: cracking, using irradi. catalyst, and aluminosilicate, eff. of rad.: Panchenkov
- KETONES (also see individ. ketones): comp'ds with La, Ce chlorides: Sheka
- LACTIC ACID: rare earth ext'n, IX, Y: Kamenev, Paramanova, Ryabchikov
- LUMOGALLION: Nb, analyt.; Mo: Alimarin, Busev, Klimov
- MALEIC ACID: Eu complex: Paramanova
- MALIC ACID: RE complexes, Th, IX; uranyl complexes: Davidenko, Lapitskii, Markov, Zvygintsev
- MALONIC ACID: Eu complex: Paramanova
- MANDELIC ACID: analyt., Zr; Pa ppt'n: Ostroumov, Starik, Tserkovnitskaya
- MEPASIN: TBP diluent: Patzek
- 8-MERCAPTOQUINOLINE: ext'n, chloroform, Fe<sup>+3</sup>, Mn<sup>+2</sup>, Co<sup>+2</sup>, Cu<sup>+2</sup>, Zn<sup>+2</sup> (thiooximates): Mikulski
- METHYL ALCOHOL: ether mixture, Ac-228 sep'n from Ra-MsTh bromide: Volkova, Ziv
- METHYLAMINE: Be oxyacetate comp'ds: Grigor'ev
- METHYLBENZYL ETHER: ext'n, U, HNO<sub>3</sub>: Maslova
- METHYL n-BUTYL KETONE: ext'n, Pu(IV): Khalkin
- METHYLCYCLOHEXANONES: ext'n, U, HNO<sub>3</sub>, 10 stage mixer settler, lab scale: Sraier
- METHYLDIOCTYLAMINES: analyt., Nb, Ta ext'n: Vdovenko
- METHYLETHYLKETONE: H<sub>2</sub>O-phenol: Byk
- METHYL IODIDE-METHYL PROPANE MIXTURE: bubble chamber: Nyagu
- METHYL ISOBUTYL KETONE: HNO<sub>3</sub> ext'n; U, Cs, Ca, Sr, La; Pu: Fomin, Khalkin, Starik, Vdovenko
- METHYL VIOLET THIOCYANATE: analyt., U, ppt'n: Kuznetsov

- MIRICITRINE: U, complex comp'd: Zagorets
- MONO-ISOAMYLPHOSPHORIC ACID: Pa, ext'n: Mikhailov
- MONOISOPROPYL DIPHENYL: react. coolant, boiling org. fluid, heat flux, 0-170°C: Sterman
- MORIN: analyt., U: Kiss
- MUREXIDE: indicator, RE analyt.: Onosova
- 1,2 NAPHTHOQUINONE: complex comp'ds, U, 3-bromo-1,2 naphthoquinonemonoxime-1 and 3-4 dichloro-1,2 naphthoquinonemonoxime-1: Savich
- NITRILACETIC ACID: RE complexes, analyt., sp. ph.; Ra, Ba; Th: Astakhov, Nikol'skii, Ryabchikov
- NITROBENZENE: Cs, ext'n of polyiodides: Kyrsh
- 4'-NITRO-2,2'-DIOXY-4-METHYL-5-ISOPROPYL AZOBENZENE: Th complex: Dziomko
- M-NITROPHENYL ARSONIC ACID: analyt., U, amperomet.: Zyabkina
- $\alpha$ -NITROSO- $\beta$ -NAPHTHOLATE: ext'n, U from Fe; Np(V): Alimarin, Savich, Zolotov
- NONANE: CO<sub>2</sub> react., rad. induced: Kalyazin
- OCTYLAMINE: Th ext'n, SO<sub>4</sub> syst.: Vdovenko
- OLEFINS: Pt complexes: Babushkin
- ORGANOPHOSPHORUS COMPOUNDS: U extractants, various; rad. sickness; Fe(III); Am: Laskorin, Loshadkin, Petrov, Shevchenko, Siekierski, Solovkin, Taube, Urbanski, Vdovenko, Voden, Yerebin, Zemylukhin
- OXALATES: U(IV) complexes, etc.; RE's, Th, Pu, In, Np(IV); Ru-nitroso; Sc; TRU; uranyl thiocyan. comp'ds, Y, IX, Nb: Aminov, Bol'shakov, Bryzgalova, Bykhovskii, Chernyaev, Drabkina, Dubovenko, Elovskikh, Essen, Fomin, Gelman, Grinberg, Kartushova, Kondratov, Korenman, Lebedev, Markov, Maryanov, Moskvina, Ryabchikov, Savits'kaya, Shatskii, Panova, Ptitsyn, Sobinyakova, Tananayev, Tekster, Vagina, Vlasov, Yatsimirskii, Zaitsev, Zakharova, Zolotov, Zvyagintsev
- OXINE: yttrium ext'n in chloroform from 3 M perchlorate: Panova
- OXYBENZOATE: Be comp'ds, aromatic hydrocarbons: Kurdyumov
- OXYDICARBOXYLIC ACID: Th complexes, IX: Lapitskii
- $\beta$ -OXYQUINOLINATE: ext'n, Nb, Ta, U: Alimarin, Klygin, Kuznetsov, Mambetov
- PENTAMINE: Pt comp'd, mixed: Grinberg

- PHENANTHROLINE: RE complexes;  $UO_2^{+2}$  salts, comp'ds: Konenko, Markov
- PHENOL:  $H_2O$ -methylene ketone, phase equilibria: Byk
- PHENYLACETIC ACID:  $Th(NO_3)_4$ ; Th phenylacetate ext'n in dieth. ether; U, uranyl ammonium phenylacetate: Kovalenko, Tserkovnitskaya
- PHENYL ARSENATES: Np(IV) and (VI), Zr, Th, U, Pu: Kondratov, Mikhailov, Starik
- PHOSPHINE OXIDES: extractants, U processing: Petrov
- PHTHALIC ACID:  $\beta$ , alums, phosphorescence: Kislyak
- PHTHALOCYANINE:  $UO_2^{+2}$ , luminescence: Kobyshev, Lyalin
- PHYTIC ACID: analyt., Th: Ryabchikov
- POLY( $\alpha$ -METHYL) ACROLEIN: U(VI) complex: Andreeva
- POLY PHENYLS: react. coolant, org. bound S problem: Sevast'yanov
- PROPYLGALLATE: radioprot. in glycine, hemin: Amirogova
- PROTEINS: C-14 labelled, biosynthesis: Kuzin
- PRUSSIAN BLUE: Cs, co-ppt'n: Kyrsh
- PURPUGALLIN: Zr, analyt.: Alimarin
- PYRIDINE: react. with tetraborane; sep'n of U, Zr and Ti from Mn, Co, Ni; sep'n of Th from RE's, Re; Pt tetramines: Mikheeva, Ostroumov, Tronev, Zvyagintsev
- 1-(2-PYRIDYLAZO)-RESORCINOL: sp. ph., Nb, Ta, analyt: Alimarin, Elinson
- 4-( $\alpha$ -PYRIDYLAZO)-RESORCINOL: analyt, In, photom: Kish
- PYROCATECHIN VIOLET: analyt., Zr, colori.; B: Cheng, Serdyuk
- PYROCATECHOL VIOLET: indicator, analyt., Th, RE: Onosova
- PYROGALLOL: Nb complexes, analyt.: Babko
- QUERCETIN: analyt., Np, photom.: Chudinov
- RHODAMINE C: In, analyt., fluoresc: Babko
- RHODANIDE: Fe ext'n, analyt: Vdovenko
- RHODIZONE: analyt., Na rhodizonate, Zr-89, 90: Zolotavin

- RONGALITE: U(IV): Grinberg, Yevteyev
- SALICYLALDOXIME: analyt., U(VI), orange-colored complex: Ripan
- SALICYLAL ETHYLENE DIIMINATE: Nb, Ta complexes, Pa: Lapitskii
- SALICYLATE: Th, ether ext'n; U, Pu: Kovalenko, Nikolaev, Rosyanov, Zvyagintsev
- SCHIFF'S BASES: Nb, Ta, Ti complexes, Pa co-cryst.; U: Lapitskii, Pankratova Savich, Zelentsov
- SELENEOYL: Zr complexes, acetone, benzene, ext'n: Mel'chakova
- SELENOCYANATE: Ag complexes in methanol and mixed solvents: Golub
- SODIUM DIETHYLDITHIOCARBAMATE: analyt., U ppt'n: Kuznetsov
- SODIUM PIPERIDINEDITHIOCARBAMINATES: Ru ext'n, analyt: Astakhov
- "STILBAZO": analyt, Mo, photom.; Pu(IV) ppt'n: Busev, Kusnetsov
- SUCCINATE: Ca, U salt: Bekturov
- SULFOSALICYLIC ACID: analyt., Be: Kalinchenko
- TANNIN: U sep'n from impurities: Kaufman
- TARTARIC ACID: Th complexes, IX; RE, Nb, uranyl complexes; Np(V), IX: Lapitskii, Pyatnitskii, Malyarov, Mambetov, Markov, Moskvina, Zolotov, Zvyagintsev
- TBP, ORGANOPHOSPHORUS COMP'DS: ext'n, HNO<sub>3</sub>, U, Th, Zr, RE's, HClO<sub>4</sub>, V, Fe, Ca, Sc, F, cit. acid, Am: Adamskii, Arbuzov, Brandshtet, Eremin, Erzhabek, Eskevich, Fomin, Gerabek, Granovskii, Gunzler, Ilazhev, Kaplan, Korpusov, Kriss, Laskorin, Levin, Martynenko, Mayorova, Mikhailov, Minc, Pasternak, Plaksin, Pushlenkov, Reznik, Rozen, Samoilov, Sekerski, Sheidina, Sheka, Shevchenko, Siekierski, Solovkin, Taube, Tsvetkova, Vdovenko, Voden, Voronetskaya, Yerzhabek, Zemylanukhin
- TETRAHYDROXYADIPIC ACID: Th, complex comp'd: Zvyagintsev
- TETRALIN: catalytic dehyd. and dehydrogenation by  $\alpha$ -U<sub>3</sub>O<sub>8</sub>: Tolstopyatova
- TETRAPHENYLARSONIUM FLUOROTANTALATE: ext'n, Ta from Nb: Alimarin
- THIOCYANATE: U complexes; Nb complex, ext'n in butyl alcohol, etc.: Markov, Troitskiy
- THIOETHER-AMINE: Pt<sup>+2</sup> comp'ds: Derendyaev
- THIOUREA: uranyl comp'ds; RE complexes, acetates: Markov, Sakharova

- THORONE II: analyt., Th, photomet: Kuznetsov
- TRI AND TETRAPHENYLBENZYLPHOSPHONIUM NITRATES: RE's, double salts: Medoks
- TRIACEYL ACETONATE: Co(III) comp'ds, n-irrad.: Nath
- TRIBUTYLPHOSPHINE OXIDE (TBPO): binary mixture with DAMPA, U ext'n, synergism: Pushlenkov, Shevchenko, Voden
- TRI-N-DECYLAMINE:  $\text{HNO}_3$ , U, ext'n;  $\text{UO}_2\text{F}_2$  ext'n: Vdovenko
- TRIETHYLEDIAMINE: cobalt, thiocyanate uranyl comp'ds: Markov
- TRIGLYCINATE: Co(III) comp'ds, n-irrad: Nath
- TRIEPTYLAMINE:  $\text{HNO}_3$  ext'n: Zakharov-Nartsissov
- TRIHEXYLAMINE NITRATE: in benzene, hydration, polymerization: Vdovenko
- TRIHIDROXYGLUTARIC ACID: RE complexes; uranyl; Th: Davidenko, Markov, Paley, Zvyagintsev
- TRILON B (EDTA):  $\text{Np}^{+4}$ ,  $\text{NpO}_2^+$  complexes; RE analyt.; U, amperometric: Gelman, Mefod'eva, Moskvin, Onosova, Rozhdestvenskaya
- TRIMETHYAMINE: chloride, double salts, RE chlorides; react. with tetraborane: Sakharova, Mikheeva
- TRI-N-NONYLAMINE:  $\text{HNO}_3$ , U, ext'n; HF, uranyl fluoride: Vdovenko
- TRIOCTYLAMINE:  $\text{H}_2\text{SO}_4$  ext'n; Pu, HCl syst.; U(VI); Zr, Hf; ext'n, hyd. dicyanurate: Fomin, Shevchenko, Siekierski, Vdovenko, Yagodin, Zvyagintsev
- TRIOCTYL PHOSPHINE OXIDE: TOPO, SX, U(VI), from acid ore liquors: Laskorin
- TRIOXYFLUORONES: phenylfluorone, propylfluorone, react. with multivalent metals: Nazarenko
- TRIOXYGLUTARIC ACID: Th complex, IX: Lapitskii
- TRIPHENYL-ME: me(Bi, Sb), isot. exch., labelling: Nefedov
- TRIPHENYL PHOSPHINE OXIDE: radioel. sep'n., P: Nefedov
- TRITHIOCARBAMATE: U, uranyl complex: Peshchevitskiy
- TRYPTAMINE (CHLOROHYDRATE OF 3-(2-AMINOETHYL)INDOLE): rad. sickness, mice: Antipov
- TRYPTOPHAN: rad. induc. changes: Duzhenkova

TTA, THENOYLTRIFLUOROACETONE: Pu(IV) ext'n; Zr, Nb, TTA-benzene on teflon column, IX; Np(V), Co(II), in butyl alc.: Pashernak, Preobrazhenskii, Taube, Zolotov

URAMYLDIACETIC ACID: analyt., Th, complex comp'd: Ryabchikov

UREA:  $UO_2^{+2}$  salts, comp'ds: Markov

XYLENOL ORANGE: Nb, analyt., photomet.; Zr, Th, in Mg, Al, Cu alloys, complexometric: Babko, Volodarskaya

**IX. Brief Biographical Sketches of Selected Authors**

(alphabetical listing)

The following brief biographical or professional sketches of some of the major authors (see articles listed at the end of the report) may afford some degree of personal acquaintanceship with those who are guiding the Nuclear Fuel Cycle effort in the USSR. For more complete and thorough acquaintanceship, one should consult publications such as (1) Who's Who in Atoms; (2) Soviet Men of Science (by Dr. John Turkevich), D. Van Nostrand Company, Princeton, N. J.; (3) Who's Who in the USSR, International Book and Publishing Company, Ltd., Montreal, Canada; (4) Biographical Directory of the USSR, Scarecrow Press, Inc., New York; (5) Who's Who in Soviet Science and Technology (by Ina Telberg, 1960), Telberg Book Company, New York; (6) Who's Who in Soviet Nuclear Science (by Lawrence Ruby and Joan Hurst), University of California, LRL, Berkeley; (7) Biographic Data Publications by the Office of Technical Services (OTS), Joint Publications Research Service (JPRS), U.S. Department of Commerce, Washington, D. C.; and others.

AGEYEV, Nikolay Vladimirovich (b. 1903), Dr. Chemical Sci., Corr. Mbr., Acad. Sci. USSR; Dep. Dir., Inst. Metallurgy im A. A. Baykov, Acad. Sci. USSR 1953-1958, Mbr., Ed. Bd., Problemy Sovremennoy Metallurgii 1956. CHEMISTRY, METALLURGY. Mbr., Leningrad Polytechnical Inst. im M. I. Kalinin 1928-1936, Mbr., Cent. Sci. Res. Inst. Metals 1928-1936, Mbr., Leningrad Inst. Physical Chemical Analysis 1933-1935, Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1935-1952 (Hd., Lab. Roentgenography c1944-1952), Assoc., Moscow Inst. Non-ferrous Metals and Gold im M. I. Kalinin 1947. Order Lenin, Order Labor Red Banner. Electron density of alloys, metallic bonding in unalloyed metals and in alloys, prevention of oxidation of steel.

AKSEL'RUD, N. V., Mbr., Inst. Gen. and Inorganic Chemistry, Acad. Sci. UkSSR 1955-57. CHEMISTRY. Electroconductivity of iodine solutions, solubility products of metal hydroxides, effect of anions on pH of amphoteric systems, polarographic study of indium on a sulphuric acid base, indate solutions.

ALIMARIN, Ivan Pavlovich, Dr. Chemical Sci., Corr. Mbr., Acad. Sci. USSR; Hd., Chair Analytical Chemistry, Moscow State Univ. im M. V. Lomonosov 1955-58, Mbr., Inst. Geochemistry and Analytical Chemistry im V. I. Vernadskiy, Acad. Sci. USSR 1954-55, Mbr., Moscow Inst. Fine Chemical Technology im M. V. Lomonosov 1948-55, Mbr., Ed. Bd., Zavodskaya Laboratoriya 1948-56, Mbr., Ed. Bd., Zhurnal Analiticheskoy Khimii 1946. CHEMISTRY, MINERALOGY. Mbr., All-Union Sci. Res. Inst. Mineral Raw Materials 1932-46. Analytical chemistry, mineral ores and rocks, use of radioactive isotopes, blue Ge-heteropolyacid reduction products, ultramicroanalysis, nickel, cobalt, iron vanadium, vibrating platinum microelectrode, radiometric titration, bismuth, thorium, uranium, vanadium, lead, haloid compounds, mobile field chemical laboratory for iron and manganese ore testing, colombium, tantalum, sulphur, germanium compounds, tin.

**BABKO**, Anatoliy Kirillovich (b. 15 October 1905), Dr. Chemical Sci., Active Mbr., Acad. Sci. UkSSR; Hd., Lab. Analytical Chemistry, Inst. Gen. and Inorganic Chemistry, Acad. Sci. UkSSR; Hd., Lab. Analytical Chemistry, Inst. Gen. and Inorganic Chemistry, Acad. Sci. UkSSR 1941-47, Mbr., Kiev State Univ. im T. G. Shevchenko 1934-57 (Hd., Chair Analytical Chemistry 1944-57), Mbr., Com. Analytical Chemistry, Acad. Sci. USSR 1947-54. CHEMISTRY. ed. Kiev Polytechnical Inst. 1927; Mbr., Kiev Technological Inst. Food Ind. 1931-34, Mbr., Ukrainian Sci. Res. Inst. Construction Materials 1933. Order Lenin, Badge of Honor. Colorimetry in ultraviolet and infrared parts of spectrum, potentiometric titration, solid reducing agents, formation of complexes of metals with weak acids, reaction of iron ion with phenol, analytical use of dithizone, hydrogen ion concentration on colored complexes, cobalt thiocyanate complexes in solution, phosphomolydate complexes in solution, cerium, glyoxime, chemistry of sequestering agents, spectro-photometrical methods of determining constant dissociation of complex compounds, isochroms of ternary systems, solubility of precipitates in presence of common and foreign ions, chemistry of complex fusion.

**BARANOV**, Vladimir Il'ich, Dr. Physico-Mathematical Sci.; Mbr., Biogeochemical Lab., Inst. Geochemistry and Analytical Chemistry im V. I. Vernadskiy, Acad. Sci. USSR 1943-54 (Hd. Sector 1945), Assoc., Kazan' Affil., Acad. Sci. USSR 1954. CHEMISTRY, PHYSICS, GEOLOGY. Mbr., Radium Inst. im V. G. Khlopin, Acad. Sci. USSR 1928-44, Assoc. Leningrad Pedagogical Inst. Health Resorts 1943, Assoc., All-Union Sci. Res. Inst. Mineral Raw Materials 1946, Mbr., Geophysics Inst., Acad. Sci. USSR 1952. Order Lenin, Order Labor Red Banner, Presidium Prize, Acad. Sci. USSR. Radioactive ore deposits, radioactive muds and soils, uranium prospecting from the air, practical utilization of the neutron core-drilling method in searches for boron-bearing bodies after the example of magnetic-type deposits, aeroradiometric prospecting for thorium, interpretation of gamma anomalies, ionium-radium method for the determination of the age of marine sediments, process of fission of bismuth, thorium, and uranium nuclei under the action of protons of various energies, determination of the period of semi-disintegration of radioactive isotopes, character of their radiation, energy of radiation, isotopic analysis of natural chemical combinations to determine the absolute age of rocks and minerals, diffusion and absorption of radon in natural muds, dynamics of gas exchange during inhalation of thoron containing air, determination of emanating radioactive elements by X-rays, radium content of petroleum waters, adsorption power of clays, application of sodium tannate in the repair of cave-ins, photographic plates with thick emulsion for investigation in the distribution of radioactive elements in natural substances, absolute quantitative determination of actinium by the emanation method, determination of mesothorium in radium preparations, horizontal distribution of radioelements in the atmosphere, determination of the active principle in solids, assimilation of radioactive elements by plants, fixation of carboxylic acids with acetylenic glycols, content and determination of actinium and its products in mineral waters, microradiography, preparation of the products of reduction of carbon dioxide.

**BRODSKIY, Aleksandr Il'ich** (b. Dnepropetrovsk 19 June 1895), Dr. Chemical Sci., Active Mbr., Acad. Sci. UkSSR, Corr. Mbr., Acad. Sci. USSR; Dir., Inst. Physical Chemistry im L. B. Pissarzhevskiy, Acad. Sci. UkSSR 1938-57, Hd., Comm. Tracer Atoms, Acad. Sci. UkSSR 1956. CHEMISTRY, PHYSICS. ed. Moscow State Univ. im M. V. Lomonosov; Hd., Chair Physical Chemistry, Dnepropetrovsk Chemical Technology Inst. im F. E. Dzerzhinskiy c1927-c38, Mbr., Moscow Inst. Steel im I. V. Stalin c1946-48. Stalin Prize, Order Lenin, Order Labor Red Banner, Presidium Prize Acad. Sci. UkSSR, Prize im D. I. Mendeleev, Prize im Kucherov, Mbr., London Faraday Soc., Mbr., American Chemical Soc. Heavy water production, quinhydrone electrodes, electrochemistry of ion of mercurous oxide, thermodynamics and electrochemistry of solutions, Raman spectra in solutions, arsenic trichloride in methyl and ethyl alcohols, exchange reactions of hydrogen and deuterium, refraction of solutions of electrolytes, oxygen isotopes in water distillation, stable isotopes of light elements, interferometric analysis, isotope exchange of hydrogen in hydrogen-silicon bond, study of polythionate reactions with tagged sulphur, formation of secondary amines studied with heavy nitrogen, oxygen exchanges in halogens, separation of uranium isotopes by thermal diffusion, separation of uranium 235 from uranium 238, tautomeric transformation of toluene and mesitylene.

**BUKHALOVA, G. A.**, Mbr., Rostov State Univ. im V. M. Molotov 1953-55, Assoc., Rostov Construction Engineering Inst. 1955-57. CHEMISTRY. Mbr., Lab. Molten Salts and Multi-Component Systems, Inst. of Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR c1947-55. Stratification in fusions of mutual systems with participation of salts of Groups I and II, topology of reciprocal complex formation in ternary and quaternary systems, thermochemical interrelation in ternary reciprocal systems forming complexes, heat of formation of double salts, adiaagonal reciprocal systems, fluxes for remelting secondary light metals, ternary reciprocal system of sodium and strontium fluorides and chlorides, characteristics of fused sodium and potassium molybdates and tungstates.

**BUSEV, Aleksey Ivanovich**, Dr. Chemical Sci.; Lect., Chair Analytical Chemistry, Moscow State Univ. im M. V. Lomonosov 1955. CHEMISTRY. Mbr., Far Eastern Polytechnical Inst. im V. V. Kuybyshev 1947-53 (Mbr.; Lab. Analytical Chemistry 1947-49). Research on reaction of organic reactions containing phosphorus, sulphur, selenium, and arsenic, potentiometric determination of manganese in manganese ore, ferromanganese, nichrome, and high chrome steels, direct bromometric titration of bismuth, iron, copper, and other hydroxyquinolates, present state of colorimetric and nephelometric methods for determination of bismuth, specific atomic group for detection of molybdenum, precipitation of pentavalent arsenic with hydrogen sulphide in systematic qualitative analysis, determination of osmium in the presence of ruthenium with the aid of thiocarbamide and diethyldithiophosphoric acid, separation of bismuth and lead.

- CHERNYAYEV, Il'ya Il'ich (b. Spassk, Vologda Oblast 21 January 1893), Dr. Chemical Sci., Active Mbr., Acad. Sci. USSR; Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1934-56 (Hd., Dept. Complex Compounds 1934-41, Dir. Inst. 1941-56), Prof., Moscow State Univ. im M. V. Lomonosov since 1945. CHEMISTRY. ed. St. Petersburg State Univ. 1915; Mbr., St. Petersburg State Univ. 1915-18 (Asst., Chair Inorganic Chemistry 1918), Mbr., Inst. Platinum and Other Rare Metals, Acad. Sci. USSR 1918-33 (Sci. Assoc. 1918-30, Sr. Chemist 1930-33), Mbr., Leningrad State Univ. im A. A. Zhdanov 1925-35 (Hd., Chair Inorganic Chemistry 1933-35), Hd., Lab. Gen. Chemistry, Leningrad Chemical Technology Inst. im V. M. Molotov 1930-32, Prof. and Hd., Chair Inorganic Chemistry, Moscow Petroleum Inst. im I. M. Gubkin 1935-41, Assoc., Sci. Res. Inst. 9 c1947, Mbr., Ed. Bd., Zhurnal Neorganicheskoy Khimii 1954-56. Order Lenin (2), Order Labor Red Banner, Stalin Prize (2), Prize im N. N. Zinin, Prize im A. A. Voskresenskiy, Prize im L. V. Pisarzhevskiy. Production of uranium tetrafluoride, plutonium purification, nitrites of platinum methylamine compounds, pentamines, determination of iridium in chloroplatinates, pyridine compounds of bivalent platinum, heat capacity of stereo-isomers of platinum diammine chloride, chemistry of potassium hypoborate, hydroxylamine and nitro-compounds of bivalent platinum, development of Chernyayev (transeffect) law of ability of substitutes to react in internal sphere of complex compounds, study of change of sign of rotation of light polarization plane by optically active amines of quadrivalent platinum and their conversion into amides (or imides).
- CHUKHLANTSEV, V. G., Mbr., Ural Affil. Acad. Sci. USSR 1956. CHEMISTRY. Solubility products of uranyl arsenates.

DYATKINA, M. Ye., Dr. Chemical Sci.; Mbr., Lab. of Structure of Matter, Sci. Res. Physico-Chemical Inst. im L. Ya. Karpov 1940-1955, Assoc., Brest Pedagogical Inst. im A. S. Pushkin 1956. CHEMISTRY. ed. Sci. Res Physico-Chemical Inst. im L. Ya. Karpov 1947; Mbr., Moscow Inst. Fine Chemical Technology im M. V. Lomonosov 1945-46. Ionic character and dipole moments of bonds, resonance theory in organic chemistry, raman spectra of halogen substituted fatty acids, heterocyclic rings, electronic levels of free radicals, biradical state of hydrocarbons, energy of quinoid forms, resonance energy of six-member nitrogen heterocycles, molecular orbitals, thermodynamic functions of normal alcohols.

FASTOVSKIY, V. G., Dr. Technical Sci.; Prof., All-Union Electrical Engineering Inst. im V. I. Lenin 1939-55. CHEMISTRY. Analysis of gas mixtures by determination of heat conductivity, solubility of gases in liquids at low temperatures and high pressures, solubility of helium in liquid oxygen, neon-helium mixtures, adsorptional method of separating krypton and xenon, preparation of pure neon, solubility of solid methane in liquid nitrogen and oxygen, distillation method of determining small amounts of admixtures in gases, continuous analysis of ozone in gas mixtures using an ultraviolet photocolormeter, liquid-vapor equilibrium in an argon-nitrogen system, investigation of columns with a plurality of gauze plates, binary system oxygen-krypton, solubility of hydrogen and helium in liquid methane, catalytic oxidation of low concentration of acetylene, gas balance.

- GANDIN, Lev. Semenovich, Cand. Physico-Mathematical Sci.; Mbr., Main Geophysics Observatory im A. I. Voyeykov 1949-55. GEOPHYSICS, METEOROLOGY. Mbr., Cent. Geophysics Observatory of the Red Army 1943-46, Mbr., Sci. Res. Inst. Main Admin. Hydrometeorological Service USSR 1946. Accuracy of wind measurements by three declination angles of an airplane, application of theory of observations from three points to problem of acoustical artillery reconnaissance, theory of lateral distribution of sunspots, atmospheric turbulence, methodology of determining co-efficient of turbulent mixing, determining path of coefficient of turbulence depending on altitude through observing periodic fall of heavy particles, convergence of iterative process, evaporation from bounded reservoirs, forecasting speed of displacement of pressure units, characteristics of evaporation near shore line, approximate computation, problem of laminar boundary layer by a porous wall.
- GEL'MAN, Anna Dmitriyevna (b. c1902), Dr. Chemical Sci.; Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1937-54 (Hd., Lab. Synthesis of Coordination Compounds 1950). CHEMISTRY. Prize im D. I. Mendelejev. Ethylene compounds of platinum, stability of coordinated ethylene hydrocarbons, compounds of platinum and carbon monoxide, theory of complex compounds.
- GERLING, Erikh Karlovich, Dr. Chemical Sci.; Mbr., Lab. Pre-Cambrian Geology, Acad. Sci. USSR 1952-56. CHEMISTRY. Mbr., Radium Inst. im V. G. Khlopin, Acad. Sci. USSR 1937-1948 (Lab. Hd. 1947, Mbr., Sci. Council 1948). Badge of Honor. Radiochemistry, conditions for use of argon or helium method to determine age of minerals, age of stony meteorites, spontaneous fission, rare gases and their isotopes, migration of radioelements, origin of tectites, uranium-xenon ratio in minerals.
- GOLOVNYA, V. A., Assoc., Ukrainian Physico-Technical Inst., Acad. Sci. UkSSR 1956. CHEMISTRY, PHYSICS. Assoc., Sector of Platinum and other Rare Metals, Inst. Gen. and Inorganic Chemistry im V. I. Vernadskiy, Acad. Sci. USSR 1939-c52. Order of Lenin, Order Labor Red Banner. Polarization of low-energy protons on occasion of scattering by carbon, uranyl aquo-carbonate compounds: synthesis of  $UO_2CO_3$  and  $UO_2CO_3 \cdot H_2O$ , compounds of platinum with nitriles, ammonia compounds of bivalent platinum.
- GREBENSHCHIKOVA, Vera Il'inichna, Cand. Chemical Sci.; Assoc., Soil Inst. im V. V. Dokuchayev, Acad. Sci. USSR 1947, Assoc., Radium Inst. im V. G. Khlopin, Acad. Sci. USSR 1947. CHEMISTRY. Badge of Honor. Sulphate method of separating plutonium and neptunium, nature of ion absorption by clays and soils.

GRINBERG, Aleksandr Abramovich (b. St. Petersburg 2 May 1898), Dr. Chemical Sci., Active Mbr., Acad. Sci. USSR; Prof., Leningrad Technological Inst. im Lensovet 1936-58 (Mbr., Chair Gen. Chemistry 1947-53), Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1936-55 (Hd., Section Physical Chemistry of Complex Compounds 1938, Mbr., Div. Platinum and Rare Metals 1947-55), Mbr., Radium Inst. im V. G. Khlopin, Acad. Sci. USSR 1945-55 (Chief, Chemical Div. 1945-47, Mbr., Sci. Council 1947). CHEMISTRY. ed. Leningrad State Univ. im Budnov 1924; Mbr., Inst. Study of Platinum and Other Rare Metals, Acad. Sci. USSR 1926-34, Mbr., 1st Leningrad Medical Inst. im I. P. Pavlov 1938-42 (Mbr., Chemistry Lab. 1938-41, Mbr., Chair Gen. Chemistry 1942), Mbr., Kazan' Chemical Technology Inst. im S. M. Kirov 1942-44, Mbr., Ed. Bd., Zhurnal Obshchey Khimii 1947-48, Mbr., Chair Inorganic Chemistry, Leningrad Chemico-Pharmaceutical Inst. 1948, Mbr., Leningrad Chemical Technology Inst. im V. M. Molotov 1953. Order Labor Red Banner, Stalin Prize, Order Lenin, Red Star. Radioactive isotopes for research into structure of complex compounds, chemistry of platinum and other rare metals, equilibrium of aqueous solutions of complex compounds, strength of geometrically isomeric bases, reaction of an added component on solubility of material in a mixed solution, refraction of sulphur-containing inorganic compounds, periodic law and stability of complex compounds, displacement reaction in internal sphere of complex compounds.

GRUM-GRZHIMAYLO, N. V., Mbr., Inst. Metallurgy im A. A. Baykov, Acad. Sci. USSR 1956. METALLURGY, CHEMISTRY. ed. Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1952. Structural steel of high chromium content as a substitute for chrome-nickel steel, granular structure of steels, heat resistance of some alloy steels, law of changes of crystalline lattice parameter of solid solutions, thermodynamics of crystallochemical compounds of austenite, electric resistance and Hall effect in gold-silver alloys, chemical changes preceding ordering of 50 percent alloy of iron with cobalt, electrical resistance of iron, copper, and nickel alloys in a longitudinal magnetic field, Goldhammer effect in alloys of ternary system iron-nickel-cobalt, changes in galvanomagnetic properties in relation to composition of alloys, diffusion in titanium-niobium alloys, residual electric resistance of binary systems of metallic alloys.

GUREVICH, Anna Moiseyevna, Cand. Chemical Sci.; Mbr., Dept. Chemical Sci. Acad. Sci. USSR 1953. PHYSICS, CHEMISTRY. Mbr., Radium Inst. im V. G. Khlopin 1937-47 (Sr. Sci. Assoc., Chemistry Div. 1947). Medal Labor Valor, medal Labor Achievement. Oxidation-reduction potentials in the system  $UO_2SO_4-U(SO_4)_2$  as functions of the acidity of the solution, adsorption of radium by glass.

- KANEVSKIY, Ye. A., Mbr., State Sci. Res. Inst. Rare Metals 1947-49. METALLURGY, CHEMISTRY. Differential method of polarographic analysis, theory of electrode potential, electrochemical potential of an electron in a metal, polarographic determination of molybdenum in ores, hydration energy of ions.
- KARPACHEVA, S. M., Possibly Assoc., Inst. Physical Problems im S. I. Vavilov, Acad. Sci. USSR 1950-53. CHEMISTRY. Mbr., Carbon Black Lab., Sci. Res. Inst. Rubber Ind. 1938-41, Possibly Assoc., Sci. Res. Physico-Chemical Inst. im L. Ya. Karpov 1949. Carbon black production, diffusion in oxide lattices in reactions with oxygen-reduction mechanism and oxygen exchange, use of  $O^{18}$  as indicator in heterogeneous catalysis, oxygen exchange between oxide catalysts and water vapor, mobility of oxygen of manganese dioxide and catalytic oxidation of carbon monoxide.
- KLOCHKO, Mikhail Antonovich (b. c1905), Dr. Chemical Sci.; Mbr., Ed. Bd., Zhurnal Obshchey Khimii 1956, Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1947-55 (Hd., a Lab. 1950). CHEMISTRY. Mbr., Inst. Physical Chemical Analysis 1933, Mbr., Ed. Bd., Zhurnal Prikladnoy Khimii 1948. Stalin Prize, Order Lenin. Binary one-phase systems, electrolysis of salts of the alkali metals, theory of physico-chemical analysis, conductance of electrolytic systems, electric conductivity isotherms of two-component systems, palladium for electroplating, electroconductivity and viscosity of lithium nitrate system, electrochemical dissolving of solutions, silver perchlorate system, anode behavior of silver-palladium alloys.
- KLOKMAN, V. R., Mbr., Radium Inst. im V. G. Khlopin, Acad. Sci. USSR 1947-54 (Mbr., Chemistry Div. 1947). CHEMISTRY. Heat capacity of aqueous solutions of potassium permanganate and calcium permanganate, distribution of radium between fused mass and crystals of non-isomorphic salt, mechanism of attainment of equilibrium in distribution of microcomponent between solid crystalline isomorphic phase and melt, determination coefficient of distribution radium and its isotope  $ThX$  between melt and crystals calcium nitrate, determination crystallization coefficients for radium in case of distribution among melts and crystals of barium and lead chlorides.
- KOMISSAROVA, L. N., Cand. Chemical Sci.; Mbr., Moscow Inst. Fine Chemical Technology im M. V. Lomonosov 1952-56. CHEMISTRY. Separation of zirconium and hafnium, interaction of sodium, potassium, calcium, cesium, rubidium, and lithium chlorides in melts.
- KRIP'YAKEVICH, P. I., Mbr., L'vov State Univ. im I. Franko 1950-57. CHEMISTRY, METALLURGY. Solubility of zinc in metal compounds  $Cu_2Mg$  and  $Cu_2Cd$ , systematics of intermetallic phases, relationship between lattices of the types  $NiAs$  and  $Ni_2In$  and certain orthorhombic lattices, new compound in the manganese-beryllium system, crystal structure of nickel manganese alloys.

KRYLOV, E. I., Mbr., Ural Polytechnical Inst. im S. M. Kirov 1938-56.

METALLURGY. Assoc., Ural State U. im A. M. Gor'kiy 1955. Formation and properties of thin sulphur films on surface of copper chloride solutions, polarographic investigation of titanium and niobium sulphate solutions, strontium metaniobate and its hydrates, composition and properties of hydrochloric acid solutions of niobium pentoxide, synthesis and properties of niobium bronzes, analogs of tungsten bronzes, determination of number of electrons participating in electrolytic reduction of niobium and titanium, metaniobates of calcium and barium and their hydrates, ridding niobium of accompanying titanium by means of cationites, the valency of copper in some complex compounds, hydrides of transition elements, uranyl and thorium selenites.

KUZNETSOV, Vitaliy Ivanovich, Dr. Chemical Sci.; Mbr., Inst. Geochemistry and Analytical Chemistry im V. I. Vernadskiy, Acad. Sci. USSR 1950-57 (Lab. Hd. 1950-54), Assoc., Inst. Chemical Physics, Acad. Sci. USSR 1957. CHEMISTRY. ed. Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1950. Assoc., Saratov State Univ. im N. G. Chernyshevskiy 1938, Mbr., Organic Chemistry Lab., Saratov Automobile and Road Inst. im V. M. Molotov 1939-46, Mbr., All-Union Inst. Mineral Raw Materials 1940-50 (Mbr., Lab. Analytical Chemistry 1941-46), Assoc., Industrial Lab., Sanitation and Epidemiology Station, Kirov Rayon, Moscow 1950, Mbr., All-Union Sci. Res. Inst. Chemical Reagents 1950-56. Badge of Honor. Use of radioactive isotopes in analytical chemistry, higher sensitivity of colorimetric reactions, organic coprecipitants, use of the phenomenon of complex-formation in the precipitation of microquantities of elements, organic reagents in inorganic analysis, determination of manganese by the persulphate method using cobalt as catalyst, preparation of azo dyes from pyrocatechol, chromorphic action of the elements, polychloronaphthalenes, chemical activity of inner-complex and cyclic salts, rapid determination of antimony in bronze and brass, extraction of iron chloride from hydrochloric acid solutions, gray and black vat dyes, test paper for carbon disulphide, diphenylguanidine, resorcinol, reaction of aminophenylarsenic acid with furfural, color reaction of phenols, iron, aluminum, magnesium hydroxide, zirconium, beryllium, zinc, phosphates, chloride, and other minerals, organic structure analysis, possible losses of thallium during the analysis of silicates, precise determination of gamma quantities of mercury, extraction of mercuric chloride with mixed solvents, theoretical chemical bases of isolation of elements by extraction, use of organic coprecipitants in studying the flow of reactions in highly diluted solutions, molecular heat capacity of organic compounds with different degrees of hydrogenation, exhaustive action of individual organomagnesium compounds with furfuryl alcohol, ketoles of the aliphatic series, furan compounds and their condensation, polyene compounds, eutectics of keteno-phenolic systems and the fixing among them of oxonium complexes, synthesis of polyonic ketones, reduction of oxidation products of violanthrone and methylation of the product, production of lead peroxide, synthesis of arylalkyl-substituted dithiocarbamates, diphenylthiocarbamide, thiuram synthesis, heavy metal salts of aralkyldithiocarbamic acids, lead peroxide.

LAPITSKIY, A. V., Mbr., Moscow State Univ. in M. V. Lomonosov 1946-47 (Mbr., Chair Inorganic Chemistry 1953-57). CHEMISTRY. Sodium metacolumbate, anhydrous potassium metacolumbate, reaction of niobium pentoxide with sodium hydroxide, production of radioisotopes, lithium salts of orthoniobic and orthotantallic acids, properties of tantalum pentoxide, anhydrous metaniobates and metatantalates of alkali metals, niobates and tantalates of alkali earth metals, dehydration of potassium niobate, determination of solubility of anhydrous metaniobates of alkali metals by means of tagged atoms, isotopic exchange between types of salts of columbic acid, solubility of hexaniobates of some bivalent metals, sodium orthoniobate, thermographic and radiographic study of dehydration of sodium and potassium niobates, thermography of interaction of niobium pentoxide with sodium hydroxide.

LAVRUKHINA, Avgusta Konstantinovna, Dr. Chemical Sci.; Sr. Sci Assoc., Inst. Geochemistry and Analytical Chemistry in V. I. Vernadskiy, Acad. Sci. USSR 1954-55. CHEMISTRY, PHYSICS, METALLURGY. ed. Inst. Geochemistry and Analytical Chemistry in V. I. Vernadskiy, Acad. Sci. USSR 1955. Mbr., Inst. Gen. and Inorganic Chemistry in N. S. Kurnakov, Acad. Sci. USSR 1949. Medal Labor Valor. Radiochemical investigation of the fission of bismuth, thorium, and uranium with 480 Mev protons, methods for determining a metal and its oxides of various valences in the case of their simultaneous presence, transuranic elements, radiochemical investigation of nuclear transformations occurring under the influence of high-energy particles, spallation of copper and bismuth nuclei, behavior of ultra-small quantities of elements, manganese oxides, cuprous oxide.

- MAKAROV, Yevgeniy Sergeyevich** (b. c1910), Dr. Chemical Sci.; Mbr., Inst. Geochemistry and Analytical Chemistry im V. I. Vernadskiy, Acad. Sci. USSR 1957. CRYSTALLOGRAPHY. ed. Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1954; Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1939-54 (Mbr., Roentgenography Lab. 1949). Study of phases having a nickel arsenide structure in iron, cobalt, and nickel-antimony systems, sodium-lead system, solid phases with variable numbers of atoms in elementary cell, X-ray examination of thorium-zinc, magnesium, silicon, and aluminum alloys.
- MARKOV, V. P.** Mbr., State Inst. Nitrogen Ind. 1939-40. CHEMISTRY. Compressibility of gaseous mixtures, data for binary and ternary mixtures of hydrogen, nitrogen, and carbon dioxide, structure of complex uranyl compounds, research through 1958.
- MIKHEYEVA, Vera Ivanovna**, Dr. Chemical Sci.; Mbr., Sector Physico-Chemical Analysis, Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1938-53 (Sr. Sci. Assoc. 1944, Mbr., Lab. Peroxide Compounds 1953). CHEMISTRY, METALLURGY. Mbr., Inst. Physical Chemical Analysis 1935, Mbr., Moscow Inst. Steel im I. V. Stalin 1941. Badge of Honor, Medal Labor Valor. Copper-magnesium, copper-cadmium, aluminum-magnesium, aluminum-magnesium-zinc and iron-chromium-aluminum systems, solubility of beryllium in aluminum, ternary alloys of magnesium, aluminum and cerium, alloys of magnesium with aluminum and zinc, alloys of magnesium, aluminum and cadmium, chemical nature of bertholides and of potassium hypoborate, polythermic volume of crystallization of a hard mixture of aluminum-magnesium-zinc, law of mass action, theoretical and general crystal types of sphalerite, construction of melting diagram for ternary metal systems, reaction of magnesium-boride with water.
- MORACHEVSKIY, Yuriy Vital'yevich** (b. 1894), Dr. Chemical Sci.; Mbr., Leningrad State Univ. im A. A. Zhdanov 1935-41 and c1944-56 (Lect., Chair Analytical Chemistry 1935-41, Hd., Chair Analytical Chemistry c1944-55, Prof. 1955), Mbr., Inst. Chemistry of Silicates, Acad. Sci. USSR 1950-56 (Hd., Analysis Lab. 1950-55). CHEMISTRY. ed. Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov and Inst. Chemistry of Silicates, Acad. Sci. USSR; Mbr., All-Union Sci. Res. Inst. Geology 1918-35 (Mbr., Analytical Lab. 1918-c31, Hd., Geochemical Sector 1931-35), Mbr., Ukrainian Sci. Res. Inst. Silicate Ind. 1929, Mbr., Inst. Physicochemical Analysis 1930, Mbr., Mining Inst. (Probably of the Acad. Sci. USSR) 1935-c38 (Lect., and Prof., Chair Gen. and Physical Chemistry), Mbr., All-Union Inst. Halurgy 1938-50 (Dep. Sci. Dir. 1944). Chemistry of salts of the Upper Kama deposit, composition of uranium vanadates, phase analysis of iron ores, selective dissolution of magnetite in presence of chalcopyrite, spectrophotometric study of aqueous solutions of pentavalent vanadium, separation of phosphate ion from some cations by anionite resins, use of tagged atoms in studying conditions for separation of zinc and cobalt from aluminum and iron, determination of fluorine content in silicates, solubility of silicic acid, plasticity of Ukrainian kaolins, gas occlusion in potassium salt deposits of the Verkhnekamsk district, composition of natural salt and lake brine, chemistry of colored glass, determination of sulphate sulphur, separation of lead from barium with anionite resins, colorimetric determination of small quantities of vanadium in materials of high chromium content.

MOROZOV, Ivan Semenovich, Cand. Chemical Sci.; Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1944-55 (Sr. Sci. Assoc. 1944, Mbr., Lab. Roentgenography 1949). CHEMISTRY. Mbr., State Inst. Applied Chemistry 1932-34. Medal Labor Valor, Order Lenin. Gamma-modification of manganese dioxide, volatility of hydrogen chloride in hydrochloric acid solutions of various salts, chlorination of loparite concentrate, powdered mixture of columbium and tantalum, experimental investigation of chloridization of copper-nickel-and iron-bearing mat, treating of calcium hypochlorite waste liquors, using chlorine gas in nonferrous metallurgy, production of potassium chlorate by way of magnesia, preparation of water-soluble colloidal antimony, chlorination of niobium pentoxide and zirconium dioxide.

MURIN, Andrey Nikolayevich, Cand. Physico-Mathematical Sci.; Mbr., Radium Inst. im V. G. Khlopin, Acad. Sci. USSR 1941-57. CHEMISTRY, PHYSICS. Medal Labor Valor. Linear acceleration of mass-spectroscopical processes, mean range of recoil nuclei in heavy lead halides, diffusion of silver and lead ions in silver bromide, thermal diffusion of sodium ions in sodium chloride crystals, distribution of fission fragments according to masses and charges, radioactive isotopes, ion beam and energy of ions in a cyclotron, separation of isotopes with a linear accelerator, separation of isotopes by thermodiffusion, equilibrium in distribution of a microcomponent between solid crystalline isomorphous phase and melted salt; enrichment of radioactive elements by nuclear recoil, silver bromide lattices, spallation reactions of medium and heavy nuclei, radiochemistry of fission products of nuclear reaction in the radiation of bismuth with 660 Mev energy protons.

**NESMEYANOV, Aleksandr Nikolayevich** (b. Moscow 9 September 1899), Dr. Chemical Sci., Active Mbr., Acad. Sci. USSR; Pres., Acad. Sci. USSR 1951-58, Mbr., Moscow State Univ. im M. V. Lomonosov 1922-58 (Asst., Chair Organic Chemistry 1935-38, Hd., Chair Organic Chemistry 1944-57, Rector Univ. 1948-51), Dir., Inst. Organo-Elemental Compounds, Acad. Sci. USSR 1954-58. CHEMISTRY. ed. Moscow State Univ. im M. V. Lomonosov 1922; Hd., Lab. Organic Chemistry, Sci. Res. Inst. Fertilizers and Insectofungicides im Ya. V. Samoylov 1930-34, Mbr., Inst. Organic Chemistry im N. D. Zelinskiy, Acad. Sci. USSR 1935-54 (Hd., Lab. Metallo-Organic Compounds 1935-54, Dir. Inst. 1939-54), Prof. and Hd., Chair Organic Chemistry, Moscow Inst. Fine Chemical Technology im M. V. Lomonosov 1938-41, Mbr., Presidium, Acad. Sci. USSR 1946-57, Academician Sec., Dept. Chemical Sci., Acad. Sci. USSR 1946-48, Dep. Chairman, Supreme Soviet RSFSR 1947-51, Dep., Supreme Soviet USSR 1951-54. Stalin Prize, Order Lenin (4), Order Labor Red Banner, Hon. Mbr., Acad. Sci. TuSSR, Hon. Mbr., Bulgarian Acad. Sci., Hon. Mbr., Polish Acad. Sci., Hon. Mbr., German Acad. Sci., Mbr., World Peace Council 1954. Synthesis of aromatic mercurio-organic salts, properties of halo-mercuric benzoic acids, electron negativity of organic radicals, preparation of diazo compounds by organometallic compounds, determination of calcium and strontium vapor pressure with tagged atoms, onium compounds, Raman spectra of chlorovinyl derivatives of mercury and antimony, isotope exchange of phosphorus, new synthesis of pyrazoles, preparation of alpha-mercurated ketones by decarboxylation of mercury salts of alpha-ketone acids, synthesis of polyhalogen derivatives of propane and propene containing the trichloromethyl group, obtaining primary aryl phosphinic acids, preparation of alkoxytitanium trichlorides from titanium tetrachloride and alcohols, stereoisomeric sodium enolates, radiochemistry, production of radioisotopes, synthesis of stereoisomeric organomercury compounds from organolithium compounds, isotope exchange method for measuring velocity of evaporation and coefficient of diffusion in solid metals, halide compounds of ferrocene.

**NIKOLAYEV, Anatoliy Vasil'yevich**, Corr. Mbr., Acad. Sci. USSR, Dr. Chemical Sci.; Mbr., Siberian Dept., Acad. Sci. USSR 1957-58 (Mbr., Sci. Council 1957, Mbr., Presidium 1958), Dir., Inst. Inorganic Chemistry, Siberian Dept., Acad. Sci. USSR 1957. CHEMISTRY. Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1939-57 (Mbr., Sector Physico-Chemical Analysis 1940-49, Sr. Sci. Assoc. 1945, Mbr., Analytical Lab. 1946-47, Mbr., Sector Platinum and Other Rare Metals 1948), Mbr., Inst. Geology, Acad. Sci. USSR 1941, Mbr., Moscow Inst. Nonferrous Metals and Gold im M. I. Kalinin 1951-52. Prize im V. I. Vernadskiy, Order Distinguished Badge. Debyeograms of uranium oxides, differential thermal microanalysis, colorimetric determination of lithium, composite study of precipitates, potassium in natural waters and the mechanism of diffusive dispersion of elements, investigations of sparingly soluble crystalline precipitates, physicochemical investigations of Inderskiy borates, storing liquids in chemically treated soils, electrostriction of solutions, protective films on salts and their utilization, study of certain peculiarities of the process of melting mixtures of mirabilite and salt, film formation on gypsum surface, water-proofing soils by the formation of a surface film by means of slaked lime or its mixture with sand, influence of boric acid on the evaporation of natural brines, primary deposition

of borates from sea water, heating curves of bivalent metal sulphates, heating curve method of thermal stability and transformations of certain complex compounds of platinum, use of the Kurnakov recording pyrometer in the study of changes in starch, rapid determination of small amounts of arsenic in organic material, artificial dehydration of hydrated salts by means of solar energy.

NIKOL'SKIY, Boris Petrovich, Corr. Mbr., Acad. Sci. USSR; Mbr., Leningrad State Univ. im A. A. Zhdanov 1951-57 (Mbr., Chair Physical Chemistry 1955). CHEMISTRY. Mbr., Leningrad Inst., Experimental Agronomy 1929, Mbr., Leningrad Lab., Acad. Agricultural Sci. im V. I. Lenin 1930, Mbr., Leningrad Agro-Soil Inst. 1930, Mbr., Leningrad Affil. All-Union Sci. Res. Inst. Fertilizers, Agrotechnics, and Agro-Soil Sci. im K. K. Gedroyts, Acad. Agricultural Sci. im V. I. Lenin 1935, Mbr., Sci. Council, Radium Inst. im V. G. Khlopin, Acad. Sci. USSR 1946. Soil acidity and alkalinity, antimony electrode for determining hydrogenation concentration in soils, Haber glass electrode, potentiometric determination of potassium, properties of (electrical) double layer and exchange adsorption of ions on nonmetallic surfaces, surfaces, exchange of cations in soils, potential difference between solid silver halides and aqueous solutions, theory of Wiegner and Pallman suspension effect, theory of solution, oxidation potential of hypochloride solutions, behavior of glass electrode on nonaqueous and mixed solutions, electrode properties of ionite membranes.

NISEL'SON, L. A., Cand. Technical Sci.; Mbr., Moscow Inst. Nonferrous Metals and Gold im M. I. Kalinin 1956-58. METALLURGY. ed. Moscow Inst. Nonferrous Metals and Gold im M. I. Kalinin 1956. Application of the rectification processes for the separation of alkali metals, zirconium, hafnium, tantalum, niobium, phosphorus oxychloride.

**PALEY, Petr Nikolayevich**, Cand. Chemical Sci.; Assoc., Dept. Chemical Sci., Acad. Sci. USSR 1953. CHEMISTRY, HYDROLOGY. Mbr., Lab. Hydrogeological Problems im F. P. Savarenskiy, Acad. Sci. USSR 1948, Mbr., Hydrochemical Inst., Acad. Sci. USSR 1948, Assoc., Inst. Geochemistry and Analytical Chemistry im V. I. Vernadskiy, Acad. Sci. USSR 1949. Order Labor Red Banner, Order Lenin. Origin of underground brine, calcium content in drinking water.

**PANCHENKOV, Georgiy Mitrofanovich** (b. Moxcow 1909), Dr. Chemical Sci.; Mbr., Moscow State Univ. im M. V. Lomonosov 1946-57, Mbr., Inst. Mineral Fuels, Acad. Sci. USSR 1955, Mbr., Moscow Petroleum Inst. im I. M. Gubkin 1938-56. CHEMISTRY. Stalin Prize. Molecular polarizations, increasing oil viscosity by violet ray action and by high-frequency electromagnetic field, polymerization of oils in an electrodeless high-frequency discharge, dielectric losses in nitrobenzene mixtures, friction between metals in presence of lubricants, viscosity of mineral oils, liquid mixtures and molten metals, absolute values for and pressure dependence of viscosity of liquids, kinetics of catalytic disproportionation of hydrogen in gasolines, chain reactions and catalytic cracking of gas oil and geometric isomers of decalin, kinetic cracking of cumene and cetane over aluminosilicate catalysts, use of diffraction micrometer in determining diffusion coefficient in liquids, preparing pure boron fluoride by decomposition of fluorides of aryldiazones, nuclear energy in petroleum refining, ion-exchange mechanism, analysis of boron fluoride isotopes by mass spectroscopy, isotopic analysis of alkali elements with aid of synthetic aluminosilicate ion source, concentration of carbon 13 and oxygen 18 isotopes in carbon monoxide by thermal diffusion method, separation of boron isotopes by thermal diffusion, ion exchange on aluminum silicate catalysts in an alkali flow with short contact times.

**PLAKSIN, Igor' Nikolayevich** (b. Ufa 8 October 1900), Corr. Mbr., Acad. Sci. USSR, Dr. Technical Sci.; Prof., Moscow Inst. of Nonferrous Metals and Gold im M. I. Kalinin 1930-57 (Mbr., Lab. Rare Metallurgy 1940, Hd., a Chair 1953-57), Mbr., Inst. Mining, Acad. Sci. USSR 1944-57 (Hd., Lab. Dressing of Mineral Ores 1944-47, Dep. Dir. 1947-55, Dir. 1956-57, Hd., Div. Enrichment of Useful Minerals 1957). METALLURGY, CHEMISTRY. ed. Far Eastern State Univ. 1926; Mbr., Lab. Gen. Chemistry, Acad. Sci. USSR 1927-34, Mbr., Inst. Platinum, Acad. Sci. USSR 1933; Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1934-38, Sci. Dir., All-Union Sci. Res. Inst. Mechanical Processing of Minerals 1941-44, Mbr., Technical Council, Min. Nonferrous Metallurgy USSR 1943. Order Lenin, Stalin Price (2), Order Labor Red Banner. Moisture in coal, analysis of gold and gold alloys by hydrazine-hydrochloride method, recovery of gold and silver from graphitic and nongraphitic waste, technique of amalgam assaying of platinum, hygroscopicity of cyanide slimes, hydration of complex salts and nickel sulphate, recovery of gold and platinum from slimes, action of oxidants in flotation of minerals as related to hydrogen-ion concentration and structure of crystalline lattice, depression of pyrite and arsenopyrite in flotation in alkaline medium, diaphragm-type jigs with multiple frequency screens, effect of sludge and action of reagents and pulp aeration in coal flotation, mechanism of action of nonpolar reagents on flotation of coal, adherence

of sulphide minerals to air bubble in absence of reagents, oxygen absorption in sulphide suspensions, tagged atoms, influence of oxygen, nitrogen, and hydrogen on ethylxanthate adsorption on gold, silver, copper, and their alloys, xanthogenate adhesion to surface of silver during preparation for flotation.

PREOBRAZHENSKIY, B. K., Mbr., Radium Inst. im V. G. Khlopin, Acad. Sci. USSR 1955-57. PHYSICS. Spallation reactions of medium and heavy nuclei, rapid separation of radioactive rare earth elements by means of the cationite resin KU-2 without use of pH meter, radiochemical investigations of products of spallation and fission nuclear reactions from exposure of bismuth to protons of 660 Mev energy.

- ROZEN, A. M., Mbr., Inst. Physical Problems im S. I. Vavilov, Acad. Sci. USSR 1950-52. CHEMISTRY. Mbr., State Inst. Nitrogen Ind. 1943-47. Adsorption from solutions at high pressure, approximate equation of state for gases under high pressure, anomalous phase transitions, oxygen<sup>18</sup> as indicator in heterogeneous catalysis, adiabatic process of compression of real gases, oxygen exchange between oxide catalysts and water vapor and between alcohol vapor and dehydration catalysts, thermodynamics prerequisites of three-component distillation, application of law of corresponding states to convective heat exchange under pressure, certain relations in diffusion of gases in a solid, some rules of sorption of gases by polydisperse catalysts during combination of adsorption and solution, mobility by oxygen of manganese dioxide and catalytic oxidation of CO, calculation of thermodynamic quantities from experimental P-V-T data role of diffusion in lattice oxides during reactions with an oxidizing-reducing mechanism and an oxygen exchange, oxygen mobility of certain solids and the geologic thermometer, behavior of gases in the supercritical region.
- RUDENKO, N. P., Mbr., 2nd Sci. Res. Physics Inst., Moscow State Univ. im M. V. Lomonosov 1956-57. PHYSICS. Methods of isolation of carrier-free radioactive isotopes, production of radiochemically pure ThB and ThC, methods for the separation of radioactive isotopes with the aid of complexing, separation of radioactive indium-115, chromatographic separation of radioactive hafnium and radioactive tantalum.
- RYABCHIKOV, Dmitriy Ivanovich (b. 1904), Dr. Chemical Sci.; Prof., Inst. Geochemistry and Analytical Chemistry im V. I. Vernadskiy, Acad. Sci. USSR 1948-57 (Dep. Dir. 1954-56), Mbr., Ed. Bd., Zhurnal Analiticheskoy Khimii 1956-58. CHEMISTRY. ed. Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1942; Student, Moscow Inst. Nat'l. Economy im V. G. Plekhanov 1931, Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1931-c48 (Mbr., Platinum Sector 1938, Mbr., Physical Chemical Analysis Sector 1940), Hd., Chair Chemistry, Moscow Oblast' Pedagogical Inst. prior 1954, Assoc., Sinop and Agudzeri Nuclear Res. Insts. c1946-55. Stalin Prize, Badge of Honor, Red Banner, Order Lenin Investigation of complex compounds of thorium with aminopolycarbonic acids by high-frequency titration, thiosulphate compounds of platinum and other rare metals, separation of chromium, manganese, iron, nickel, copper, uranium, molybdenum, and thenuim by ion-exchange chromatography, determination of beryllium in bronzes with a cationite, use of radioactive indicators in chromatographic separation of rare earths, methods for determination of humidity, electrolytic reduction of ytterbium, production of iodine-131 without carrier in radio-chemically pure state and bromine-82 radioactive preparations, atomic energy.

- SAMARTSEVA, Anna Georgiyevna, Cand. Chemical Sci.; Mbr., Dept. Chemical Sci., Acad. Sci. USSR 1953. CHEMISTRY. Mbr., State Radium Inst. im V. G. Khlopin, Acad. Sci. USSR 1937-41. Badge of Honor. Uranium minerals, compounds of bivalent polonium, solubility of secondary uranium minerals, contents of radioelements in waters of oil fields of Central Asia.
- SAMSONOV, Georgiy Vasil'yevich (b. Gor'kiy 5 September 1920), Dr. Technical Sci.; Assoc., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1956, Mbr., Moscow Inst. Non-Ferrous Metals and Gold im M. I. Kalinin 1955-56 (Mbr., Chair Metallurgy of Rare Metals 1956), Assoc., Physics Faculty, Moscow State Univ. im M. V. Lomonosov. METALLURGY. ed. Moscow Inst. Non-Ferrous Metals and Gold im M. I. Kalinin 1956; Mbr., Leningrad Physico-Technical Inst., Acad. Sci. USSR c1945-50. Physicochemical analysis of titanium boride, nitride, boron-carbon, thorium, and zirconium alloys, binary systems of titanium, formation of isomorphous boride alloys.
- SAVITSKIY, Yevgeniy Mikhaylovich, Cand. Technical Sci., Dr. Chemical Sci.; Mbr., Inst. Metallurgy im A. A. Baykov, Acad. Sci. USSR 1955-56 (Hd., Rare Metals Lab. 1956), Mbr., Ed. Bd., Problemy Sovremennoy Metallurgii 1956. PHYSICS, METALLURGY. Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1940-55 (Lab. Hd. 1944, Hd., Lab. Mechanical Testing 1950). Badge of Honor, Medal Labor Valor. Plasticity of certain magnesium alloys, mechanical testing of alloys, metallographic polishing with strong etching agents, electrochemical alloying, alloy casting, plasticity of intermetallic phases, structure of some aluminum magnesium alloys, obtaining double salts under pressure, plasticity of some brittle metallic substances, recrystallization of titanium and its alloys, effects of temperature of mechanical properties of lanthanum and cerium, universal instrument for micromechanical tests.
- SEMENENKO, K. N., Mbr., Chair Inorganic Chemistry, Moscow State Univ. im M. V. Lomonosov 1953-56. CHEMISTRY. Characteristics of tantalum pentoxide, lanthanum acetate, beryllium oxyacetates with pyridine and dioxane and with beryllium oxymonochloroacetate, beryllium hydroxyacetate with ammonium difluoride, laboratory instrument for hygroscopic and hydrolyzing substances.
- SHCHUKAREV, S. A., Mbr., Leningrad State Univ. im A. A. Zhdanov 1947-56, Mbr., Ed. Bd., Zhurnal Obshchey Khimii 1948-56, Mbr., ed. bd., Vestnik Leningradskogo Universiteta, Seriya Matematiki, Fizikii, Khimii 1955-56. CHEMISTRY. Mbr., Leningrad Inst. Analytical and Physical Chemistry 1930, Hd., Solutions Lab., Leningrad Inst. Chemical Physics prior 1943. Colloidal-chemical theory of salt lakes, oxidation of sodium sulphide and sodium hydrosulphide, mobility of chlorine and hydrogen ions in presence of gelatin, element weight as a periodic function, theories of twin elements, anomalies of atomic weights, missing perissade and artiads having no stable odd sub-elements, enthalpy of the formation of zinc compounds with antimony, thermal stability of copper halides, iodine in several organic solvents, nature of aqueous solutions, thermodynamic processes in reduction of iron chloride and iron bromide, colorimetric analysis in the ultraviolet region, properties of chromium dioxide, gravimetric measuring of pressure of a saturated vapor, periodicity of properties of electron shells of free atoms, determination of aliphatic alcohols colorimetrically in ultraviolet range, higher barium phosphides.

SHEKA, I. A., Dr. Chemical Sci.; Mbr., Inst. Gen. and Inorganic Chemistry, Acad. Sci. UkSSR 1948-57 (Mbr., Lab. Complex Compounds 1949-51). CHEMISTRY. Mbr., Chemistry Inst., Acad. Sci. UkSSR 1939-47. Electrodeposition of Silver from organic solvents, dielectric properties of systems formed by allyl mustard oil and amines, application of dielectric polarization for the determination of the composition of complex compounds in solutions, dipole moment of iodine bromide, complex compounds of aluminum bromide and chloride with quinoline ethyl bromide, aluminum halides with dioxane, refractometric investigation of complex compounds of aluminum bromide with halides of alkali metals in benzene, electrochemical and cryoscopic investigation of triple systems: aluminum-bromides of lithium, copper, and silver and solvents benzene, toluene, and xylene, dipole moments of indium and thallium trihalides, compounds of zirconium tetrachloride with phosphorus oxychloride.

SHEKA, Z. A., Mbr., Inst. Gen. and Inorganic Chemistry, Acad. Sci. UkSSR 1949-56 (Mbr., Lab. Complex Problems 1954-56). CHEMISTRY. Electrochemical extraction of bromine from bromine-containing waters, refractometric study of complex compounds of aluminum bromide with halides of alkali metals in benzene, compound between aluminum bromide and ethyl bromide, transfer of ions in solutions of bromides of aluminum and sodium in ethyl bromide, ionic composition of thallic chloride in methyl alcohol and acetone, stability of zinc cathodic deposits in electrolytes, complexing in aqueous solutions of sulphuric acid and of sulphates of certain metals, formation of cobaltic xanthogenate, separation of cobalt during electrolysis of zinc solutions, use of radioactive isotopes in studying behavior of impurities in a zinc sulphate electrolyte, separation of antimony during electrodeposition of zinc.

SHEVCHENKO, V. I., Cand. Chemical Sci.; Mbr., Dnepropetrovsk Metallurgical Inst. im I. V. Stalin 1953-56, Mbr., Dnepropetrovsk Chemical Technology Inst. im F. E. Dzerzhinskiy 1956. CHEMISTRY. Research on organophosphorus compounds, dialkyl ethers of arylsulphonamidophosphoric acids, amides of sulphuric acid, reaction of trichlorophosphazosulphonyls with phenols and aromatic esters of arylsulphonamidophosphoric acids, mixed esters of arylsulphonimidophosphoric acids and isomerism of non-rotating tetrahedron, chlorides of acidic aromatic esters of arylsulphonimidophosphoric acids, reaction of trichlorophosphazosulphonyls with alcohols, alkoxydianilinophosphazosulphonyls.

SMIRNOV, M. V., Mbr., Ural Affil. Acad. Sci. USSR 1953-57 (Mbr., Inst. Chemistry and Metallurgy 1953, Mbr., Lab. Electrochemistry 1955-57, Mbr., Lab. Wood Chemistry 1956-57). CHEMISTRY. Student, Lab. Organic Chemistry, Ural State Univ. im A. M. Gor'kiy, 1940. Action of magnesium isomyl bromide on mesityl oxide, decomposition potentials of molten lead and thorium chloride, uranium dioxide anodes in melted chloride electrolytes, cathodic deposition of nickel from fused chloride baths, determination of vapor tension of metals with radioactive isotopes, adsorption of steam on mercury, solubility of thorium in liquid zinc, thermodynamics of fused alkali metals and thorium mixtures, interaction of thorium oxide with its chloride in salt melts.

**SPITSYN, Viktor Ivanovich** (b. 1902), Dr. Chemical Sci., Active Mbr., Acad. Sci. USSR; Mbr., Inst. Physical Chemistry, Acad. Sci. USSR 1949-58 (Dep. Dir. 1949-53, Dir. 1953-58), Prof., Moscow State Univ. im M. V. Lomonosov 1942-56 (Prorector 1942-48, Mbr., Lab. Inorganic Chemistry 1951-52, Hd., Lab. Chemistry of Rare Elements and Hd., Chair Inorganic Chemistry 1956). CHEMISTRY. ed. Moscow State Univ. im M. V. Lomonosov 1922; Mbr., Radium Inst. im V. G. Khlopin, Acad. Sci. USSR 1928, Mbr., Lab. Inorganic Chemistry, Moscow State Pedagogical Inst. im K. Libknecht 1939, Mbr., Bureau, Dept. Chemical Sci., Acad. Sci. USSR 1949-55. Order Lenin, Order Labor Red Banner. Nuclear structure, oxygen isotopes, tungstates, molybdenum, radio-isotopes, inorganic chemistry, thermal stability and volatility of normal sulphates of alkali elements, periodicity of dominant isotopes, ratio of number of neutrons and protons in atomic nuclei, phosphates of titanium, investigation of structure of isopoly and heteropoly compounds by isotope exchange, uranium chemistry, rare elements in USSR, production of anhydrous beryllium chloride, reaction of columbium pentoxide with hydrogen chloride, titanium compounds, molybdenum and wolfram compounds, alkali metals, radioactive indicators, conversion processes, periodic law.

**STARIK, Iosif Yevseyevich** (b. 1902), Dr. Chemical Sci., Corr. Mbr., Acad. Sci. USSR; Mbr., Radium Inst. im V. G. Khlopin, Acad. Sci. USSR 1933-58 (Dept. Hd. 1945, Mbr., Sci. Council 1947, Dep. Dir. 1946-1958), Prof., Leningrad State Univ. im A. A. Zhdanov 1946-55. CHEMISTRY, GEOLOGY. ed. Moscow State Univ. im M. V. Lomonosov 1924; Mbr., Cent. Sci. Res. Geological Prospecting Inst. 1937, Mbr., Wismuth AG, Brand-Erbisdorf, Germany 1947-48 (Consultant 1947, Chief, Project 26 1948), Mbr., Comm. on Absolute Age of Geological Formations, Acad. Sci. USSR 1947-54 (Chairman 1947). Order Lenin (3), Order Labor Red Banner. Geochemistry of radium and uranium, radiochemical analysis of khlopinite, migration of ionium, uranium mining administration, adsorption of radium by glass, determination of radium in rocks and minerals by emanation method, alpha-particle measurements, secondary uranium minerals, content and isotope composition of uranium in meteorites, fabrication of pure plutonium form irradiated rods, separation of plutonium, radioactive isotopes, colloidal properties of polonium, ferrithorite in North Kirgiz, determining age of geological formations.

**SVECHNIKOV<sup>1</sup>, Vasilii Nikolayevich** (b. 1891), Dr. Technical Sci., Active Mbr., Acad. Sci. UkSSR; Mbr., Sci. Council, Inst. Metal Ceramics and Special Alloys, Acad. Sci. UkSSR 1956, Mbr., Inst. of Physics of Metals, Acad. Sci. UkSSR 1957. METALLURGY. ed. Petrograd Polytechnical Inst. 1917; Mbr., Inst. Ferrous Metallurgy, Acad. Sci. UkSSR 1940-53 (Mbr., Sci. Council 1953), Mbr., Kiev Polytechnical Inst. 1945-49, Mbr., Metallurgical Physics Lab., Acad. Sci. UkSSR 1953-55. Order Labor Red Banner, Hon. Worker Sci. UkSSR. Gases in steel, effects of alloying elements on the polymorphism of iron, structure of grains and intergranular areas of steel alloys subjected to overheating, cold shortness of high-phosphorous steel, effect of heating on hardened carbon steels, wear of piston parts, annealing brittleness of structural steels, effect of small additions on properties of high-chromium heat-resistant steel, allotropic transformations in iron-arsenic and iron antimony alloys, reagents for etching steel and cast iron, Hadfield steel.

TANANAYEV, Ivan Vladimirovich (b. 4 June 1905), Dr. Chemical Sci., Active Mbr., Acad. Sci. USSR; Mbr., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1935-58 (Hd., Lab. Analytical Chemistry 1939, Hd., Lab. Chemistry and Analysis of Rare Elements 1948-54, Dep Dir. 1948-54), Hd., Chair Chemistry, Moscow Engineering Physics Inst. 1954. CHEMISTRY. ed. Kiev Polytechnical Inst. 1925; Hd., Chair Analytical Chemistry, Kiev Chemico-Pharmaceutical Inst. 1925, Mbr., Chair Analytical Chemistry, Kiev Polytechnical Inst. 1925-34, Prof., Inst. Chemistry im P. G. Melikishvili, Acad. Sci. GSSR 1934-35, Hd., Chair Analytical Chemistry, Tbilisi Chemical Technology Inst. 1934-35, Mbr., Plant 12, Noginsk Elektrostal' Metallurgical Plant 1946-47, Prof., Belorussian Polytechnical Inst. im I. V. Stalin 1949, Assoc., Inst. Physical Chemistry Acad. Sci. BSSR 1949, sometime Mbr., Moscow Inst. Nonferrous Metals and Gold im M. I. Kalinin. Stalin Prize (2), Red Star, Order Lenin, Order Labor Red Banner, Prize im N. S. Kurnakov. Complex compounds of tantalum and niobium, solubility of silver bromate in solutions of electrolytes, cryolite determination of aluminum in complex alloy steels, activity of solution components in liquid hydrogen fluoride, lathanum ferrocyanides and their use in analytical chemistry, study of indium fluoride and oxalate, isotherm of solubility of system lithium fluoride-hydrofluoric acid-water at 25 degrees, reaction of zirconium and fluorine ions in solution, stability of standard arsenous acid solutions, study of zinc in zinc oxide and zinc chloride, sodium cobalt-nitrite determination of potassium, ethyl-blue as a redox indicator, absorption of water ions by precipitates, photolorimetric determination of chromium in steel.

TOROPOV, Nikita Aleksandrovich, Dr. Technical Sci.; Mbr., Inst. Chemistry of Silicates, Acad. Sci. USSR 1949-57 (Lab. Hd. 1949-51, Sci. Assoc. 1951, Mbr., Physico-Chemical Lab. 1952, Dir. Inst. 1953-57). CHEMISTRY. Mbr., State Planning Inst. Cement Ind. Enterprises 1948-49, Mbr., All-Union Aluminum Magnesium Inst. 1950, Mbr., Leningrad Technological Inst. im Lensovet 1950. Stalin Prize. Chemical Engineering, analysis of nickel and ferric oxides, new orthosilicates of potassium and sodium, fluoberyllates and other crystallochemical analogs of silicates and like substances, ionization X-ray analysis for examination of cements, chemistry and petrography of cements, calcium hydrosilicates, problem of mullite, system tricalcium silicate-tricalcium phosphate.

VDOVENKO, Viktor Mikhaylovich (b. Kiev 1906), Dr. Chemical Sci.; Corr. Mbr., Acad. Sci. USSR; Mbr., Inst. Radium im V. G. Khlopin, Acad. Sci. USSR 1937-56 (Dir. 1953-56). PHYSICS, CHEMISTRY. Mbr., Leningrad State Univ. im A. A. Zhdanov 1936-45 (Mbr., Lab. Inorganic Chemistry, Sci. Res. Inst. Chemistry c1939-41, Lect. 1944). Order Distinguished Badge. Mobility of chlorine and hydrogen ions in presence of gelatin, action of atomic hydrogen on tin dichloride, artificial dehydration of hydrated salts by solar energy, absorption of radium by glass, potential differences between solid silver halides and aqueous solution, effect of water of crystallization on fluorescence spectrum of uranyl nitrate, influence of gelation on transport numbers and conductivity of hydrochloric acid and potassium chloride, absorption of ions and potential rise at interface solid electrolyte-solution, research through 1958.

VINOGRADOV, Aleksandr Pavlovich (b. St. Petersburg 21 September 1896), Dr. Chemical Sci., Active Mbr., Acad. Sci. USSR; Dir.-Organizer, Inst. Geochemistry, Siberian Dept., Acad. Sci. USSR 1958, Dir., Inst. Geochemistry and Analytical Chemistry im V. I. Vernadskiy, Acad. Sci. USSR 1948-57 (Hd., Biogeochemistry Lab. 1956), Hd., Chair Geochemistry, Moscow State Univ. im M. V. Lomonosov 1953-56, Actg. Chairman, Meteorites Comm., Acad. Sci. USSR 1956, Mbr., Ed. Bd., Atomnaya Energiya 1956-57, Chief Ed., Zhurnal Analiticheskoy Khimii 1956-57, Chief Ed., Geokhimiya 1956-57. GEOCHEMISTRY, PHYSICS. ed. Military Medical Acad. and Leningrad State Univ. 1924; Mbr., Biogeochemical Lab., Acad. Sci. USSR c1924-43 (Dep. Dir. 1938-43), Mbr., Lab. Geochemical Problems im V. I. Vernadskiy, Acad. Sci. USSR 1943-48 (Actg. Dir. 1943-48), Mbr., Radium Inst. im V. G. Khlopin, Acad. Sci. USSR c1943, Mbr., Comm. Absolute Age of Geologic Formations, Acad. Sci. USSR 1947-54, Assoc., Atomic Div., 1st Chief Directorate, Council Min. USSR c1947-48, Assoc., Sungul Nuclear Res. Inst. 1948-51, Mbr., Bureau, Dept. Chemical Sci., Acad. Sci. USSR 1946-56 (Dep. Academician Sec. 1953). Order Lenin (3), Hero Socialist Labor, Stalin Prize (2), Order Labor Red Banner (2), Mbr., Moscow Soc. Naturalists. Chemical warfare defense, peaceful uses of atomic energy, nuclear chemistry, liberation of metals from fission of high-energy neutrons, acceleration problems, polarimetric method for determination of traces of elements, nuclear transformations in metals caused by high-energy particle bombardment, geochemical significance of isotopes of metals, chromatography, physiochemical methods of uranium production control, quantitative X-ray spectrum analysis, radiochemical study of the products of high-energy spallation of copper and bismuth, heavy water research, biochemical prospecting, determination of absolute age of earth, geochemistry of rare and dispersed elements in the soil, distribution of elements in primary rocks and sedimentary covering of the earth, isotopes in meteorites, marine animal and plant life as geological phenomena, research on photosynthesis in plants with tracer atoms, origin of salt in oceans, effect of boron in soil, fertilizers, extraction processes for separation of higher transuranium elements, atomic content of meteorites, biological role of potassium-40 radioactivity in animals, causes for high titanium content in bauxite, origin of the biosphere, isotopic content of lead, isotopic ratio of sulphur  $^{32}$ /sulphur in sulphides.

VLASOV, V. G., Assoc., Ural Polytechnical Inst. im S. M. Kirov 1951. METALLURGY. Reduction of metallic oxides by solid carbon, interaction of oxide and their compounds with solid carbon.

YAKOVLEV, G. N., Mbr., Inst. Atomic Energy, Acad. Sci. USSR 1958. PHYSICS. Assoc., Lab. Measuring Instruments, Acad. Sci. USSR 1954. Spectrophotometric studies of the behavior of americium ions in solution, sulphate method of separating plutonium and neptunium, production of thin layers of plutonium, americium, and curium by the electric deposition method, hyperfine structure of paramagnetic resonance, nuclear spin and magnetic moment of the isotope europium 152 with half life of 5.3 years.

YATSIMIRSKIY, Konstantin Broisovich, Mbr., Ivanovo Chemical Technology Inst. 1947-55 (Mbr., Chair Inorganiz Chemistry 1947, Mbr., Chair Analytical Chemistry 1950-52). CHEMISTRY. Mbr., Thermodynamics Lab., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci USSR 1947-50. Acid-base reactions in acetic anhydride, proton affinity of some anions, thermochemical radii of ions and heats of formation of salts, heat of hydration of ions and the lattice energy, standard entropies of ions in the crystalline state, hexachlorostannate series, calculation of the ionization potentials of lanthanides with the aid of the Kapustinskiy equation, lattice energies of salts of metals of the sub-groups of the periodic system, thermochemistry of cobalt acidopentamine salts, extreme points on property curves of binary systems in volume analysis, entropies of ions in crystals and solubility of salts, cobaltic salts with neutral additives.

- ZABORENKO, K. B., Mbr., Moscow State Univ. im M. V. Lomonosov 1949-56 (Mbr., Chair Inorganic Chemistry 1949). CHEMISTRY, PHYSICS. Isotope exchange of iodine between KI and  $KIO_3$  in water solutions, radioactivity, use of sodium ethylenediaminetetraacetate (Trilon B) in emissive determination of radium.
- ZAITSEV, A. A., Mbr., Moscow State Univ. im M. V. Lomonosov 1948-53 (Mbr., Sci. Res. Inst. Physics 1948-51, Mbr., Chair Electron Optics and Oscillography 1950-53). PHYSICS. Mobile layers in a stationary glow discharge, effects of contraction of a smoldering discharge in absence of external fields, stratified high-frequency discharge in inert gases, self-excited oscillatory regimes and traveling layers in a discharge.
- ZOLOTOV, Yu. M., Mbr., Dnepropetrovsk Metallurgical Inst. im I. V. Stalin 1949-55 (Mbr., Chair Organic Chemistry 1952-53). CHEMISTRY. Research on organophosphorus compounds, new method of synthesizing amides of carboxylic acids directly from the acids, transformation of carboxamides into nitriles, free imidosulphamide and its properties, preparation of sulphamide, methylation of imidosulphamide, dimethylamidation of carboxylic acids, hydrolysis of 2-methylimidodisulphamide and monomethylsulphamide, 3-ethylimidodisulphamide and ethylsulphamide, tribromophosphazodisulphamides, bromides of arylsulphonamidophosphoric acids.
- ZVYAGINTSEV, Orest Yevgen'yevich (b. 1894), Dr. Chemical Sci.; Prof., Inst. Gen. and Inorganic Chemistry im N. S. Kurnakov, Acad. Sci. USSR 1934-57 (Mbr., Sector Platinum and Rare Metals 1953-55, Sector Hd. 1950-56, Dep. Dir. Inst. 1934-37, Sci. Assoc. cl943-44, Dep. Sci. Dir. 1946-53), Hd., a Chair, Moscow Inst. Chemical Technology im D. I. Mendeleev 1955-57, Mbr., Ed. Bd., Zhurnal Prikladnoy Khimii 1956-58. GEOLOGY, CHEMISTRY, METALLURGY. ed. Moscow Inst. Nat'l. Economy im V. G. Plekhanov 1920; Mbr., Moscow Platinum Works 1920-22, Mbr., Ural Platinum Trust 1922-26, Mbr., Inst. Platinum, Acad. Sci. USSR 1926-32, Dir., Inst. Chemistry, Ural Affil. Acad. Sci. USSR 1932-34, Mbr., Inst. Chemistry im P. G. Melikishvili, Acad. Sci. GSSR 1939-45 (Dep. Dir. cl941-45), Mbr., Sci. Council Georgian Polytechnical Inst. im S. M. Kirov 1942, Sci. Dir., Sci. Res. Inst. 9 1945-54, Mbr., Ed. and Publishing Council, Acad. Sci. USSR 1955, Assoc., Moscow Inst. Nonferrous Metals and Gold im M. I. Kalinin 1955-56, Assoc., Moscow State Univ. im M. V. Lomonosov 1955. Order Labor Red Banner (2), Stalin Prize, Order Lenin. Ternary compounds of rhodium, action of hydrogen on solutions of ruthenium salts at high pressures and temperatures, analytical separation of copper from rhodium and osmiridium, metallurgy and technology of platinum and platinum group aurosmiridium, iridosmine, complex manganese compounds, electroplating of platinum and palladium on copper, new reactions for detection of niobium and tantalum, wet method of determining gold in ores, high oxygenous compounds of iron, solubility of tantalum chloride and bromide in organic solvents, action of ultra-short waves on complex compounds, pressing of platinum powders and similar metals, compounds of manganese salts with spridine and ethylenediamine, crystallo-alcoholates of manganous chloride, sodium-tungsten bronzes, energy coefficients of crystalline lattices and structure of binary metallic alloys, rational phase analysis of slimes from nickel electrolysis, increased content of helium in certain minerals, new hydrochemical method of determining petroleum and gas deposits, separation of plutonium from uranium, production of  $D_2O$ , radioactivity and thermal regime of earth, silicon monoxide, thermochemistry of complex compounds, transactivity of ligands in complex compounds of bivalent platinum.

X. List of Some of the Contributing Organizations  
and Selected Staff Members

(Alphabetical, according to city. Organizations within the Communist Bloc Nations are included near the end, i.e. following "Yerevan.")

Reference to the book, Directory of Selected Scientific Institutions in the USSR (prepared by Battelle Memorial Institute for the National Science Foundation, January 1963), has been helpful in preparing these lists - along with references to authors' "associated institutions" included in a number of the abstracts and articles listed at the end of this report. No guarantees are made concerning the accuracy or currency of the selected staff memberships. The map in Figure 1 will be helpful in perceiving locations of the USSR cities and the various institutions outlined in this section. Institute associations are cross-referenced (by abbreviated notations) with the selected articles in Section XII.

Locations of Some of the Institutes in the USSR

(See map on page 205. Numbers in parenthesis refer to the number of institutes, as presented in the following lists of contributing organizations and selected membership.)

<u>Map Code</u>	<u>City</u>	<u>Map Code</u>	<u>City</u>
51	Moscow (51) Mo	v	Dubna (1) Du
21	Leningrad (21) Le	u	New Melekes (1) NM
12	Kiyev (12) Ki	t	Obninsk (1) Ob
R	Kharkov (6) Kh	s	Krasnodar (1) Kras
Q	Novosibirsk (7) No	r	Voronezh (1) Vo
P	Sverdlovsk (7) Sv	q	Tartu (1) Tr
O	Minsk (5) Mi	p	Frunze (1) Fr
N	Tbilisi (5) Tb	o	Novocherkassk (1) Nv
M	Alma-Ata (4) AA	n	Ivanova (1) Iv
L	Tomsk (3) To	m	Perm' (1) Pe
K	Dnepropetrovsk (3) Dn	l	Sukhumi (1) Su
J	Kazan (3) Ka	k	Vladivostok (1) Vl
I	L'vov (3) Lv	j	Kuybyshev (1) Ku
H	Gor'kiy (2) Go	i	Uzhgorod (1) Uz
G	Rostov-on-Don (2) Ro	h	Simferol (1) Si
F	Yerevan (2) Ye	g	Irkutsk (1) Ir
E	Krasnoyarsk (2) Kr	f	Poltava (1) Po
D	Riga (2) Ri	e	Baku (1) Ba
C	Saratov (2) Sa	d	Cherkassy (1) Ch
B	Tashkent (2) Ts	c	Kherson (1) Kher
A	Vil'nyus (2) Vi	b	Kishinev (1) Kish
		a	Odessa (1) Od



Fig. 1. Locations of Some of the Institutes in the USSR (see list on page 204).

Alma-Ata, Institute of Chemical Sciences (AA-1)

\*Bekturov, A. B. - Director

\*Mun, A. I.

Goryayev, M. I.  
 Il'yasov, A. K.  
 Rafikov, S. R.  
 Sokolov, D. V.  
 Sokol'skiy, D. V.  
 Solomin, A. V.  
 Stender, V. V.  
 Suvorov, B. V.  
 Zhaimina, R. E.

Alma-Ata, Institute of Metallurgy and Ore Beneficiation (AA-2)

Sokolov, M. A. - Director

\*Isokova, R. A.

\*Ponomarev, V. D.

Avetisyan, Ka. K.  
 Benkovskiy, V. G.  
 Grigorovich, A. N.  
 Kuznetsov, Yu. N.  
 Lebedev, K. B.  
 Loshakova, A. K.  
 Ponomareva, Ye. I.

Alma-Ata, Kazakh Mining-Metallurgical Institute (AA-3)

Baykamurov, A. O. - Director

\*Ponomarev, V. D.

Ankinovich, S. G.  
 Bok, I. I.  
 Buketov, Ye. A.  
 Kolomitskiy, F. M.  
 Popov, A. S.  
 Sergiyev, N. G.

Alma-Ata, Kazakh State University imeni S. M. Kirov (AA-4)

Karkanbayev, T. B. - Director

\*Bekturov, A. B.

\*Cherdyntsev, V. V.

\*Gladyshev, V. P.

\*Isabaev, Ye. A.

\*Rozhdestvenskaya, Z. B.

\*Knizhnikov, V. A.

Asylbaev, U. Kh.  
 Balika, Yu. D.  
 Barikov, V. G.  
 Kozlovskiy, M. T.  
 Petrova, N. M.  
 Sokol'skiy, D. V.  
 Songina, O. A.  
 Tolst'kov, G. A.  
 Usatov, E. P.

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 \*First author(s).

**Baku, Azerbaijan Research Institute of Hematology and Blood Transfusion (Ba-1)**

\*Efendiyev, F. A.  
\*Fedotenkov, A. G.

Akhundova, A. M.  
Diskant, I. P.  
Mefedova, N. A.  
Ragimov, Sh. R.  
Ter-Mkrtycheva, O. Kh.

**Baku, Azerbaijan Industrial Institute imeni M. Azizbekov (Ba-2)**

\*Mamedov, I. A.

Shakhtakhtinskiy, G. B.

Cherkassy, Cherkassy Pedagogical Institute (Ch-1)

Tkanko, A. T. - Director

\*Krupatkin, I. L.

Kuznetsov, S. M.



**Dubna, Joint Institute of Nuclear Research (Du-1)**

**Blokhintsev, D. I. - Director**

*Almazov, V. Ya.	Belushkina, A. A.	Pacuraru, V. A.
*Balandin, M. P.	Borisov, N. G.	Pantuev, V. S.
*Belonogov, A. V.	Buk, M.	Pasyuk, A. S.
*Belyakov, B. A.	Chou, M.	Petrukhin, V. I.
*Bichkov, Yu. A.	Chuvilo, I. V.	Petukhov, V. A.
*Blokhintsev, T. D.	Donets, Ye. D.	Pisarev, A. F.
*Bogachev, N. P.	Druin, V. A.	Pleve, A. A.
*Brandshtetr, I.	Dzheleпов, V. P.	Podgoretskiy, M. I.
*Budagov, Yu. A.	Fal'Brukh, K. M.	Prokoshkin, Yu. D.
*Butslov, M. M.	Fefilov, B. V.	Rizaev, Kh.
*Dunaitzev, A. F.	Filippova, K. V.	Rybakov, V. N.
*Dvoret'skii, A. S.	Flyagin, V. B.	Rykalin, V. I.
*Flerov, G. N.	Fomichev, Iv. A.	Selivanov, G. I.
*Gavrilov, K. A.	Frolov, A. M.	Shafranova, M. G.
*Gerlit, Yu. B.	Frolov, N. S.	Sheshunov, V. M.
*Golovin, B. M.	Golutvin, I. A.	Shlyapnikov, P. V.
*Khachaturyan, M. N.	Grebinnik, V. G.	Sikodenko, V. F.
*Kopylova, D. K.	Grigor'ev, E. L.	Silvestrov, L. V.
*Kuznetsova, M. Ya.	Grigoreva, G. M.	Sinaev, A. N.
*Lachinov, V. M.	Guseva, L. I.	Skobelev, N. K.
*Likhachev, M. F.	Gvuzd, E.	Skryl, I. I.
*Mikheyev, V. L.	Inkin, V. D.	Snyatkov, V. I.
*Myasoyedov, B. F.	Ivanov, V. G.	Solov'ev, M. I.
*Oganesyan, Yu. T.	Karnaukhov, V. A.	Stavinskiy, V. S.
*Ozhdyan, L.	Karzhavin, Yu. A.	Stepanov, V. D.
*Perelygin, V. P.	Katz, E.	Subbotin, V. G.
*Peter, G.	Kazakov, V. A.	Tarantin, N. I.
*Polikanov, S. M.	Kekk, Kh.	Ter-Akopyan, G. M.
*Seb, D. I.	Khalkin, V. A.	Tret'yakova, S. P.
*Seb, T. Y.	Khvastunov, M. S.	Trka, Z.
*Taube, M.	Kirillova, L. F.	Tsislyak, O. M.
*Tyapkin, A. A.	Kolesov, I. V.	Tzou, C.
*Yung-yu, W.	Korbel, Z. F.	Vasilenko, A. T.
*Zaitsev, N. G.	Kukhareva, R. P.	Veksler, V. I.
	Landsman, A. P.	Vinaver, R.
	Levenberg, I. Yu.	Viryasov, N. M.
	Libman, G.	Volkov, V. V.
	Lomakin, Yu. F.	Volkov, V. Ya.
	Lyubimov, V. B.	Von, Vi Chun
	Maly, Ya.	Wang, Tung-Seng
	Medvedev, M. N.	Wang, Yung-Chang
	Merekov, Yu. P.	Yuan, Jung-Fang
	Moiseenko, V. A.	Zhukov, V. A.
	Nemenov, L. L.	
	Neustroev, V. D.	
	Oravets, Yu.	
	Osipenko, B. P.	
	Pacuraru, T.	

**Frunze, Institute of Chemistry (Fr-1)****Bleshinskiy, S. V. - Director****\*Fridman, Ya. D.****Dolgoshova, N. V.****Druzhinin, I. G.****Mustayev, A. K.****Sorochan, R. I.****Tronov, B. V.****Yanko, A. P.**

Gor'kiy, Scientific Research Institute of Chemistry (Go-1)

Razuvayev, G. A. - Director

*Korenman, I. M.	Rabinovich, I. B.
*Shushumov, V. A.	

Gor'kiy, Gor'kiy State University (Go-2)

\*Korshunov, I. A. - Director

*Glasov, V. M.	Amenitskaya, R. V.
*Gorodiskaya, G. Ya.	Chernyayev, N. P.
*Korenman, I. M.	Dubovskaya, V. N.
*Mironov, N. N.	Ginzburg, V. L.
*Oleynik, A. V.	Leonov, M. R.
	Malyugina, N. I.
	Markov, A. N.
	Novotorov, N. F.
	Odnosevtsev, A. I.
	Okrokov, I. S.
	Pestunovich, N. A.
	Polikarpov, Yu. S. S.
	Prokhorov, S. I.
	Rabinovich, I. B.
	Shafiev, A. I.

Gor'kiy, Gor'kiy Pedagogical Institute imeni A. M. Gorkiy (Go-3)

*Fadeyeva, M. S.	Bakunina, V. V.
	Pavlov, O. N.

Irkutsk, Institute of Geochemistry (Ir-1)

\*Vinogradov, A. P. - Director

Devirts, A. L.  
Dobkina, E. A.  
Tauson, L. V.

Irkutsk, Irkutsh Institute of Rare Metals (Ir-2)

\*Chipanin, I. V.

**Ivanovo, Ivanovo Chemical Engineering Institute (Iv-1)****Belonogov, K. N. - Director****\*Krestov, G. A.****\*Vasilev, V. P.****\*Yatsimirskiy, K. B.****Arkhipov, M. I.****Berezin, B. D.****Godnev, I. N.****Kirillov, I. P.****Kisel'nikov, V. N.****Kochin, I. N.****Korableva, V. D.****Kuz'min, L. L.****Raizman, L. P.****Spryskov, A. A.****Zhukov, Yu. A.****Ivanovo, Ivanova Power Engineering Institute imeni V. I. Lenin (Iv-2)****\*Petrova, N. Ya.**

Kazan, Kazan' State University imeni V. I. Ul'yanov-Lenin (Ka-1)

Nuzhin, M. T. - Director

*Al'tshuler, S. A.	Abrahmanov, M. I.
*Arbuzov, A. Ye.	Afanas'eva, A. F.
*Pominov, I. S.	Arbuzov, B. A.
	Bazhanov, A. T.
	Goryunov, V. F.
	Kiselev, O. M.
	Petrov, A. Z.
	Romanov, I. M.
	Subbotina, E. A.
	Usmanov, Kh. U.

Kazan, Physical-Technical Institute (Ka-2)

Mishtari, Kh. M. - Director

*Fedotov, V. N.	Al'tshuler, A. S.
*Garif'yanov, N. S.	Kozyrev, B. M.
	Mazitov, R. K.
	Timerov, R. Kh.
	Usacheva, N. F.
	Yafaev, N. R.

Kazan, Kazan Chemical Engineering Institute imeni S. M. Kirov (Ka-3)

\*Usmanov, A. G. - Director

*Arbuzov, A. Ye.	Gil'marshin, G. G.
*Mochalov, K. H.	Grigor'yev, A. M.
	Kozlov, L. M.
	Kuznetsov, Ye. V.

**Kharkov, Khar'kov Polytechnic Institute imeni V. I. Lenin (Kh-1)**

Semko, M. F. - Director

*Boiko, B. T.	Akhonin, F. I.	Lukashenko, L. I.
*Korsunskiy, M. I.	Atroshenko, V. I.	Nesterenko, L. L.
	Belov, K. A.	Palatnik, L. S.
	Bugay, P. P.	Rod'kina, N. I.
	Chernyy, I. I.	Verkhoglyadova, T.S.
	Genkin, Ya. E.	

**Kharkov, Physical-Technical Institute (Kh-2)**

\*Sineln'nikov, K. D. - Director

*Amonenko, V. M.	Aliev, F. Yu.	Papirova, I. I.
*Grigoryev, V. N.	Bulatova, R. F.	Petelguzov, I. A.
*Grishaev, I. A.	Finkel, V. A.	Polyarzenko, R. F.
*Ivanov, V. Ye.	Grizhko, V. M.	Pugachev, N. S.
*Klyucharev, O. P.	Korzhev, A. A.	Rudenko, N. S.
*Kogan, V. S.	Khorenko, V. K.	Shkoda-
*Kovtun, S. F.	Klyucharev, A. P.	Ul'yanov, V. A.
*Lazarev, B. G.	Kornieko, L. A.	Shramenko, B. I.
*Matyushenko, N. N.	Kruglycharev, A. P.	Sikora, D. I.
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*Onosova, S. P.	Krylov, V. E.
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*Pushkarev, V. V.	Lyubimov, A. S.
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*Smirnova, V. I.	Safronnikov, A. N.
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Zemljic, Z.**

## XI. Some of the Available Translations of USSR Publications

(Translations by Consultants Bureau Enterprises, Inc., New York; also Columbia Technical Translations, New York; National Science Foundation (Israel Program for Scientific Translations), Washington, D. C.; American Institute of Physics, New York; Pergamon Press (translators A. G. Mattock and S. E. Hall), Oxford and London, England; etc.)

SOVIET JOURNAL OF ATOMIC ENERGY (Atomnaya Energiya)\* - Soviet physicists and nuclear engineers at the Dubna Joint Institute for Nuclear Research, the Kurchatov Institute of Atomic Energy, the Lebedev Institute of Physics, and at atomic power stations throughout the USSR report their experimental design and operational findings in this journal, a joint publication of the Academy of Sciences and the State Committee for Research in Atomic Energy. It publishes original and review articles on nuclear physics, atomic power, atomic raw materials, applications of radioactive isotopes, and radiation protection.

News of atomic developments in Soviet bloc countries is included in the Consultants Bureau translation, as is one of the more valuable regular features of the journal—its monthly bibliography of pertinent papers from the world periodical literature, classified by subject.

The editorial board, headed by M. D. Millionshchikov, Vice-President of the Academy of Sciences, includes internationally known Academicians such as A. I. Alikhanov and M. G. Meshcheryakov (nuclear physics); A. A. Bochvar (metallurgy); N. A. Dollezhal (mechanical engineering); I. I. Novikov (nuclear engineering); V. I. Veksler (physics); A. P. Vinogradov (geochemistry); and A. V. Lebedinskii (physiology).

Typical contents include:

- Calculation of the Interaction Between Fast Protons and Heavy Nuclei Including Fission
- Excitation Functions of the Individual Levels of the Nuclei  $U^{235}$ ,  $U^{233}$ , and  $Pu^{239}$ , Including Competition Between Inelastic Neutron Scattering and Fission of the Nuclei
- A 30 MeV Linear Electron Accelerator Designed for Neutron Spectroscopy
- Design and Construction of Accelerator Signal Electrodes
- Model of Indium-Gallium Radiation Loop of the IRT-2000 Reactor in Tiflis
- New Automatic Control and Scram System for the VVR-S Reactor
- Heat Transfer Crisis in Steam-Generating Pipes
- Method of Measuring the Degree of Polarization of Neutron Beams  $U^{233}$ ,  $U^{235}$ , and  $Pu^{239}$  Fission Cross Sections for 0.3-2.5 MeV Neutrons
- Absorption Cross Section of  $U^{235}$  for Monochromatic Neutrons in the 0.02-2 eV Energy Range
- Calculation of  $U^{238}$  Neutron Cross Sections on the Basis of the Optical Model of the Nucleus
- Investigation of Neutron Diffusion in Water and Ice at Temperatures of About  $0^{\circ}C$  and  $-80^{\circ}C$

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\* ATER.

The Use of  $\gamma$  Spectroscopy for the Determination of Beryllium, Boron, and Fluorine in Beneficiated Ores from the  $\gamma$  Radiation Accompanying the Interaction of the Nuclei of These Elements with  $\alpha$  Radiation  
 Critical Thermal Loads during the Boiling of a Saturated Liquid in Tubes  
 A Study of Heat Transfer to Molten Sodium in Tubes  
 An X-Ray Diffraction Study of Deposits Obtained During the Bombardment of Metals by Ions of Other Metals  
 $\gamma$ -Control in the Inhalation of Radon  
 The Fall-out of Radioactive Substances with Precipitation (Snow)  
 Particle Generation at Very High Energies  
 680 MeV Synchrotron of the Institute of Physics, Academy of Sciences, USSR  
 Realizing the Maximum Injection Currents in a Strong Focusing Proton Synchrotron  
 Calculating the Transient Temperature Field in a Reactor Tube and the Thermoelastic Stresses in the Fuel Element Cladding  
 The Effect of Temperature and Microstructure of Sintered Beryllium Oxide on the Scattering Cross Section of Thermal Neutrons  
 Measuring the Moderation Length of Fission Neutrons in Sintered Beryllium Oxide at Energies of 1.44 and 0.3 eV  
 The absorption of Neutrons from a Fast Neutron Source Placed in an Aqueous Medium

SOVIET RADIOCHEMISTRY (Radiokhimiya)\* - This Soviet journal (first issued in 1959) publishes research works arising principally from the Khlopin Radium Institute, Academy of Sciences USSR, and is under the editorial supervision of Academician V. M. Vdovenko, director of the Institute. Other members of its editorial board include top researchers such as I. P. Alimarin, A. I. Brodskii, E. K. Gerling, A. A. Grinberg, V. R. Klokman, L. V. Komlev, B. V. Kurchatov, A. N. Nesmeyanov, A. V. Nikolaev, B. P. Nikol'skii, V. I. Spitsyn, I. E. Starik, and A. P. Vinogradov. Contributors to the journal also include S. Z. Roginskii, I. V. Tananaev, P. I. Kondratov, A. D. Gel'man, Yu V. Egorov, V. P. Zaitseva, V. P. Shvedov, A. N. Ponomarev, V. S. Zlobin, etc. The journal is issued bi-monthly.

Typical contents include:

Study of Coprecipitation of Microimpurities in Isothermal Relief of Supersaturation of a  $K_2SO_4$  Solution (Coprecipitation of Lanthanum with  $K_2SO_4$ )  
 Crystallization Coefficients of Some Alkali-Metal Halides with Microconcentrations of One of the Components  
 Coprecipitation of Microgram Amounts of Molybdenum with Some Inorganic Precipitates  
 Temperature Dependence of Distribution Coefficients in the Extraction of Uranyl Nitrate from Aqueous Solutions with Diethyl Ether  
 Physicochemical Characteristics of the Dynamics of Sorption of Radioactive Substances  
 State of Protactinium in Aqueous Solutions (Adsorption Properties of Protactinium)

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\* RDKH.

Sorption of Some Radioactive Isotopes from Aqueous Solutions by Active Manganese Dioxide  
 Adsorption of Yttrium and Zirconium by Zirconium Phosphates  
 Structure of Uranyl Nitrate Dihydrate  
 Plutonium Fluorides  
 Hydrolytic Behavior of Plutonyl in Aqueous Solutions (Pu Polymerization)  
 Elution of Neptunium from the Anionite AM  
 Use of Ion Exchange to Study the State of a Substance in Solution (Study of Uranyl Carbonate Solutions by Ion Exchange)  
 Chromatographic Separation of Protactinium from Zirconium, Titanium, and Niobium  
 Chromatographic Concentration of Astatine  
 Isolation of a Group of Carrier-Free Rare Earth Fission Products from Uranium and Thorium  
 Determination of  $M_{\text{ThI}}$  by  $M_{\text{ThII}}$   $\beta$ -Particles in the Presence of Radium-226  
 Determination of Radioactive Cesium by the Ferrocyanide Method  
 Determination of Low Levels of Radioactive Contaminants in Water  
 Reaction of Recoil Tritium Atoms with Benzene  
 Recoil Effect in Inner-Complex Compounds of Cobalt in the Reaction  $\text{Co}^{59}(n,2n)\text{Co}^{58}$   
 Yields of Spallation and Fission Reactions Induced by High-Energy Particles  
 Mechanism of Zirconium Extraction by Organophosphorus Compounds  
 Effect of Structural Factors on the Thermodynamic Characteristics of the Extraction of Salts of Basic Dyes  
 Effect of the Amount of Absorbed Ions in a Chromatography Column on the Position of a Peak on the Elution Curve  
 Tracer Study of the Possibility of Extraction Separation of Thorium from Some Elements  
 Diffusion of Strontium-90 in Soil and Sand  
 Reactivity Measurements and Information  
 Chromatographic Separation of Neptunium from Uranium, Plutonium, and Fission Products

**CHEMICAL ENGINEERING (Khimicheskoe Mashinostroenie)** - This scientific and technical journal deals with the equipment needed for the basic technological processes in chemical production and oil-refining. It presents the technical data of new designs; equipment and machines for sedimentation, filtration and centrifuging, refining of gases, mixing, evaporation and crystallization; equipment for contact-catalytical and thermal processes; industrial furnaces; machines and apparatus for deep and moderate refrigeration; apparatus for absorption, extraction, and adsorption; drying apparatus and installations; machines and apparatus for making plastic articles; equipment for manufacturing rubber articles, tires, synthetic fibers; pumps, compressors, turbo-compressors and gas-blowers; grinding and crushing equipment. The journal pays particular attention to methods of planning, designing, testing and modeling of chemical apparatus and machines. It publishes materials on the exchange of experience in the exploitation of chemical equipment, and articles on problems of corrosion and the anti-corrosive surfacing of metals, alloys and nonmetallic materials used in the manufacture of apparatus.

**SOVIET JOURNAL OF ANALYTICAL CHEMISTRY (Zhurnal Analiticheskoi Khimii)\* -** Soviet analytical chemists in laboratories, institutes, and chairs of analytical chemistry, charged with the establishment of close relationships with the needs of industry and engineering, report their work in this journal which is monitored by editorial board made up of internationally distinguished scientists such as D. I. Ryabchikov, A. K. Babko, A. I. Busev, A. P. Vinogradov, Yu. A. Zolotov, P. N. Palei, I. V. Tananaev, A. P. Terent'ev, and Z. F. Slakhova, with I. P. Alimarin as Editor-in-Chief. Its articles deal with analytical applications associated with the latest achievements in molecular physics; electron optics; radioelectronics; radiochemistry; the determination of impurities at levels of  $10^{-7}$  and  $10^{-8}\%$  in semiconductors, catalysts, and super pure materials; the development of new express methods, of automated methods of analysis and analytical methods of automation; etc.

Many of the papers originate at the All-Union Scientific Research Institute of Chemical Reagents and Substances of Special Purity; the Sverdlovsk Plant of Chemical Reagents; the V. I. Vernadski Institute of Geochemistry and Analytical Chemistry; the All-Union Scientific Research Institute of Monocrystals, Scintillating Materials and Highly Pure Chemical Substances; and the Kurnakov Institute of Organic Chemistry. It is now a monthly publication.

Typical contents include:

- The Analytical Properties of Phenol Acids of the Triphenylmethane Series
- Determination of Aluminum and Iron in Certain Metals
- 4-( $\alpha$ -Pyridylazo)-Resorcinol, A sensitive Reagent for the Photometric Determination of Indium
- A New Extraction-Photometric Method for the Determination of Titanium (The Peroxide Complex of Titanium in Isoamylphosphoric Extracts)
- Photometric Determination of Niobium by Means of Xylenol Orange
- Separation of Small Amounts of Tantalum from Niobium by Extraction of Tetraphenylarsonium Fluorotantalate
- A Titrimetric Method for Determining Molybdenum in its Carbides, Nitrides, Borides and Silicides
- 2-Mercaptobenzimidazole as a Reagent for Selenium
- A Spectrochemical Method for Determining Impurities in Selenium
- Determination of Small Amounts of Hydrogen and Oxygen in Metallic Uranium
- Simultaneous Determination of Germanium and Halogens in Organic Compounds
- A Simplified Method for Determining Mono-, Di-, and Triethylamines in Six-component Mixtures Obtained During Catalytic Deamination of Aliphatic Amines Over Oxidized Dehydrating Contacts
- Preparation of Hafnium 8-Hydroxyquinolate with a Definitive Composition
- Complexometric Determination of  $Pu^{IV}$  with an Arsenazo Indicator
- Determination of Microconcentrations of Selenium in Ores and Rocks
- Determination of Fluorine in Zirconium Metal Using the Discharge in Hollow Cathode
- On the Mass-Spectrometric Analysis of the Isotopic Composition of Elementary Boron

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\* ZAKH.

**SOVIET JOURNAL OF APPLIED CHEMISTRY (Zhurnal Prikladnoi Khimii)\*** - Comparable to **Industrial and Engineering Chemistry** in the U.S., this journal covers the entire field of industrial chemistry from fundamental inorganic chemistry (in relation to industrial processes) to industrial organic syntheses. Theoretical and fundamental aspects of industrial chemical processes are considered with thoroughness. On the purely practical side, rather detailed descriptions of operations and equipment are given. Contributors include top scientists such as Romankov (fluidization); Tishchenko (wood technology, lignin chemistry); Dobychn (special glasses); Rotinyan (electrochemistry); Samsonov (cermets, carbides, powder metallurgy); Pozin (inorganic technology -nitric acid, phosphates, etc.); Dubinin (adsorption, active carbons); Budnikov (silicate technology, ceramics); Kafarov (heat and mass transfer); Yakubchik (synthetic rubbers), etc.

Interesting new work such as the development of high-intensity adsorption equipment ("foam apparatus") is being reported from the Leningrad Technological Institute, Leningrad, while the S. M. Kirov Ural Polytechnic Institute reports on research in electrochemistry and metallurgy; and the Institute of High Molecular Compounds reports on plastics and resins. The Institute of Physical Chemistry and the S. M. Kirov Academy of Wood Technology are also represented, along with a number of leading institutes from other Soviet bloc countries.

Typical contents include:

Preparation of Lanthanum Hexaboride  
 Acoustic Coagulation of Mist Containing Fluorine Compounds  
 Investigation of Static Pressure of Foam on Sieve Plates  
 Absorption of Slightly Soluble Gases in a Foam Layer  
 Influence of the Chemical Composition and Structure of Organic Compounds on Their Ability to Inhibit Corrosion  
 Study of the Dehydrogenation of Alcohols over a Copper-Calcium Catalyst  
 Extraction of Uranium from Phosphoric Acid Solutions  
 Fractionation of Trace Components in Production of Highly Pure Antimony Oxide  
 Self-regulating Tetrachromate Electrolyte  
 Dynamics of Chlorine and Magnesium in Electrolysis of Fused Chlorides  
 Study of Pitting Corrosion of a Metal Under Stress by a Model Method  
 An Inhibitor of Pitting Corrosion  
 Use of Code By-Product Effluents for Protection of Metals Against Corrosion  
 Electrochemical Behavior of Steel in Concrete  
 Chemical Resistance of KU-2 Resin in Various Ionic Forms to the Actions of Radiations  
 Method for Production of the New Resin Ekra  
 Measure of Diffusing Power for Metal  
 Removal of Iron from Chloride Solutions by Extraction

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\* ZPKH.

**JOURNAL OF STRUCTURAL CHEMISTRY (Zhurnal Strukturnoi Khimii) \*** - The main task of this journal is systematic publication and discussion of research results in the structural chemistry of organic and inorganic compounds. The journal reports work on the structure of gases, liquids, and crystals and other solids, performed by modern physical and physicochemical methods. In addition to rigorous methods for solving problems of chemical bonding, research of a semiquantitative character—methods whereby particular problems in the theory of interatomic action can be solved rapidly as well as reliably—is published. Appearing in the journal are detailed presentations of methods for studying the structure of matter, with detailed discussions of new theoretical aspects of structural chemistry which arise in connection with such methods; work on the development of x-ray, electron, and neutron diffraction methods for studying the atomic structure of matter, as well as other methods—optical, magnetochemistry, colorimetry; applicability limits of various methods; comparison of the results obtained and their practical applications; etc.

The journal is edited by an impressive roster of Soviet researchers which includes S. S. Batsanov, G. B. Bokii, A. V. Nikolaev, B. V. Ptitsyn, O. Ya. Samoilov, Yu. T. Struchkov, Ya. K. Syrkin, V. V. Voevodskii, and M. V. Vol'kenshtein.

Typical contents include:

Lattice Model of the Ionic Atmosphere  
 The Thermodynamic Characteristics of Structural Changes in Water  
 Connected with the Hydration of Polyatomic and Complex Ions  
 The State of Water in Solutions of Strong Electrolytes  
 The Crystal Structure of Low-Silicon Ternary Compounds in the Cr-Ni-Si-  
 and Cr-Co-Si Systems  
 Symmetry of the Normal Equations in the Method of Least Squares in a  
 More Precise Determination of Crystal Structures  
 Effective Parameters of the Electron Shells of Atoms and Ions  
 X-Ray Spectral Analysis of Aromatic Complexes of the Transition Elements  
 Stabilization of the Structure of Water by Nonelectrolyte Solutions and  
 Solubility  
 Interaction of Ions in Aqueous Solutions with Nearest Water Molecules  
 Temperature Dependence of Distribution Coefficients in Boric Acid  
 Extraction from Aqueous Solutions  
 Crystal Chemistry of Complex Platinum Compounds  
 Effects of Ions on the Structure of Water  
 Phases Formed in the System Chromium - Boron in the Boron-Rich Region  
 Complex Compounds with Multiple Bonds in the Inner Sphere  
 Electron-Diffraction Investigation of the Structure of Nitric Acid  
 and Anhydride Molecules in Vapors  
 Proton Relaxation in Aqueous Solutions of Diamagnetic Salts (Solutions  
 of Nitrates of Group II Elements)  
 Oscillation Frequencies of Water Molecules in the First Coordination  
 Layer of Ions in Aqueous Solutions  
 Crystal Structure of the Ternary Phase in the Systems Mo(W)-Fe(CO,Ni)-Si

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\* ZSKH.

**JOURNAL OF GENERAL CHEMISTRY (Zhurnal Obshchei Khimii)\*** - This journal contains concise documentations of the continuing, systematic, studies-in-depth of organic substances being conducted in hundreds of Academy institutes, university departments and industrial research centers in the USSR. It has included many papers by Kucherov, et al., on stereochemistry of cyclic compounds, by Kost and his group on the pyrazoles, by Mikhailov and colleagues on organoboron compounds, by Melnikov on organic insecto-fungicides, etc. Significant theoretical reports, such as Nazarov's concept of the limited electron-donor and electron-acceptor ability of atoms and groups in organic compounds and such important single contributions as Berezovskii's synthesis of adenine with an overall yield of 68-69% have also been published. S. N. Danilov is Editor-in-Chief.

Typical contents include:

A New Method for Obtaining Hydrosilicates in Nonaqueous Media  
 The Reaction of Isonitriles with Salts of Amines  
 Solubility in the System Water-Sulfuric Acid-p-Chlorobenzenesulfonic Acid  
 Addition of Fluorohydrosilanes to Unsaturated Organic Compounds  
 New Polychlorothiophenyl Esters of N,N-Dialkylthiocarbamic Acids  
 Nucleotides, Coferments and Phosphoric Esters (Synthesis of the Monophosphoric Ester of Thiamine Phosphate)  
 Potential Antimetabolites (Synthesis of Aminonitropyrimidines by Nucleophilic Substitution Reactions)  
 Chemistry of Selenophene (Synthesis of Tetrasubstituted Ethylenediamines of the Selenophene Series)

**DOKLADY (PROCEEDINGS OF THE ACADEMY OF SCIENCES USSR)(Doklady Akademii Nauk SSSR)\*\*** - This widely known publication of the Academy of Sciences of the USSR, issued every ten days, serves Soviet Scientists as the medium for rapid communication of significant experimental or theoretical findings. Each report in Doklady is either authored or sponsored by a member of the Academy. Publication is extraordinarily prompt—rarely more than six months and frequently as little as two months after receipt.

The urgency of the communications are reflected in their terseness—two to five pages, with data usually presented in compact tabular and/or diagrammatic form—originating in the scientific research institutes of the Academy, laboratories of state universities, polytechnic, industrial, medical, or agricultural institutes.

The importance of Doklady is attested to by the fact that all 20 sections of the journal are now available in cover-to-cover translation into English.

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Sections include "Chemistry," "Physical Chemistry," "Chemical Technology," and "Biochemistry," etc. B. A. Kazansky, Head of the Catalytic Synthesis Laboratory and Director, Zelinskii Institute of Organic Chemistry, and A. N. Frumkin, Director, Institute of Electrochemistry, and Professor of Electrochemistry, Moscow State University, are both editors of Doklady.

A) DOKLADY CHEMISTRY (Doklady Akademii Nauk SSSR) - Reviewers of the contributions include such illustrious chemists as A. P. Vinogradov, B. A. Arbuzov; A. E. Arbuzov, I. I. Chernyaev; V. N. Kondrat'ev, A. A. Balandin, B. A. Kazanskii, A. N. Frumkin, A. A. Grinberg, etc.

B) DOKLADY PHYSICAL CHEMISTRY (Doklady Akademii Nauk SSSR) - Contributions include well-known scientists such as Rebinder, Simonov, Bochvar, Frumkin, Deryagin, and Kapitsa. Sources of research include: Moscow State University; Bakh Institute of Antibiotics; Physico-Technical Institute; the Institutes of Metallurgy, Electrochemistry, and Chemical Physics; etc.

C) DOKLADY CHEMICAL TECHNOLOGY (Doklady Akademii Nauk SSSR) - Though the smallest of the chemistry section, this contains reports of immediate practical interest in a broad range of industries. Experimental findings are published promptly (without inhibitions from patent considerations) on such topics as flotation; extraction; vulcanization; prevention and inhibition of corrosion; lubrication; foam suppression; adsorption and desorption processes; improvement of the resistance of material to heat, cold, shock, and wear; compaction; adhesion; gas purification; etc.

D) DOKLADY BIOCHEMISTRY (Doklady Akademii Nauk SSSR) - This section contains over 300 pages a year contributed by such Academy members as I. A. Egorov, V. V. Ponomarev, T. A. Alekseeva, L. V. Kozlov, I. D. Ivanov, A. A. Gurevich, N. S. Gel'man, L. Z. Pevzner, G. P. Sokolov, and M. F. Shemyakin.

BULLETIN OF THE ACADEMY OF SCIENCES, USSR, DIVISION OF CHEMICAL SCIENCE (Izvestiya Akademii Nauk SSSR Otdelenie Khimicheskikh Nauk) - This is considered to be the foremost general chemical journal of the USSR. With rare exceptions, it is reserved for publications stemming from the chemical institutes of the Academy of Sciences and its branches, and for work directed by Academicians at universities. The greater part of the journal is devoted to organic chemistry and notable contributors are from the schools of the following well-known chemists: Nesmeyanov (organometallic compounds, ferrocene derivatives, telomerization reactions); Nazarov (steroids, stereochemistry of cyclic compounds); Dubinin (adsorption); Balandin, Shuikin and Eidus (various aspects of catalysis); A. E. and B. A. Arbuzov (organophosphorus compounds); Mikhailov (organoboron compounds); Andrianov (organosilicon compounds); Shostakovskii (vinyl compounds and their polymerization); Korshak (polymerization and polycondensation); Knunyants (organic fluorine compounds); Kucherov (heterocyclic and polyacetylene compounds).

Among the Academy institutes that publish in this journal are those for General and Inorganic Chemistry, Silicate Chemistry, Chemical Physics, Physical Chemistry, Organic Chemistry, Heteroorganic Compounds, and Chemistry

of Natural Products; frequent contributions are made also by the universities of Moscow and Kazan. In scope, the journal compares with the Journal of the American Chemical Society and the British Journal of the Chemical Society.

Typical contents include:

- Synthesis of Bifunctional Organophosphorus Compounds (Addition of Phenylphosphine to Unsaturated Compounds)
- Activation of Metallic Catalysts (Ways in Which Free Valences Arise in Metals)
- Spectrophotometric Determination of the Dissociation Constants of Aliphatic Nitro Compounds
- Catalytic Alkylation of Tetralin (Alkylation of Tetralin with Alkyl Halides in Presence of Metallic Aluminum)
- Adsorptive Properties and Secondary Porous Structure of Adsorbents Showing a Molecular Sieve Effect (Maximum Adsorptive Volumes of Dehydrated Crystals of Synthetic Type X Zeolites)

KINETICS AND CATALYSIS (Kinetika i Kataliz)\* - The editorial board of this journal includes A. A. Balandin, G. K. Borezkov, V. T. Bykov, I. V. Kalechits, A. A. Koval'skii, V. N. Kondrat'ev, K. I. Matveyev, S. Z. Roginskii, M. G. Slin'ko, V. V. Voevodskii, N. N. Vorozhtsov. These and other researchers from the Soviet Union have added much to present knowledge - both theoretical and experimental - in the complex field of kinetics and catalysis. Essentially all important modern research techniques have been developed and/or applied by the Soviet scientists. Occasionally, owing to the absence of patent restrictions and publication delays, the work has appeared in the Soviet press somewhat earlier than that of their Western counterparts.

The journal also contains detailed reports from the various major conferences on catalysis held in the USSR which have included Isotopes in Catalysis, Catalytic Oxidation of Organic Compounds, Methods of Determining Catalyst Activity, etc.

Papers are included on such topics as solid state physics as applied to adsorption phenomena on catalytic surfaces (which provide an important step in the better understanding of the theoretical electronic aspects of catalysis). Theoretical reports such as those by Sutula, who developed a general electronic theory of chemisorption and a consideration of surface states, and by Sandominskii, who has attempted to improve Vol'kenshtein's quantitative model, are also included.

Typical contents include:

- Some Present Day Problems in Chemical Kinetics
- Some Problems in Heterogeneous Catalysis
- Formation of Radicals in the Radiolysis of Solid Organic Substances (Comparison of Radical Yields in Various Organic Compounds)
- The Catalytic Activity of Organic Polymers (Regularities in Catalysis on Chelating Polymers with Differing Chemical Composition and Structure; also Catalytic Activity of Chelate Polymers in the Decomposition of Hydrogen Peroxide)

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Gas Adsorption in the Presence of Surface States  
 The Theory of Chemisorption  
 The Chemisorption Capacity and Catalytic Activity of Semiconducting  
 Films on Metals  
 The Influence of the Temperature of Ignition of the Oxides of Rare  
 Earth Elements on Their Catalytic Activity  
 Isotherms and Differential Heats for the Adsorption of Certain Alkanes  
 and Napthenes on Silica Gel  
 Isotherms and Heats of Adsorption for Adsorption of Vapors of Certain  
 Aromatic Hydrocarbons on Silica Gel  
 The Dynamic Method of Determining Specific Surface of Absorbents  
 According to Adsorption from a Stream of Solvent  
 Application of Infrared Spectroscopy to the Investigation of Natural  
 Sorbents  
 Method of Studying Catalysts Showing a Rapid Change in Activity in the  
 Course of the Reaction  
 The Use of Electronic Paramagnetic Resonance in Chemistry  
 The Mechanism of Hydrogen-Isotope Exchange on Platinum Films

BIOCHEMISTRY (Biokhimiya) - This Soviet journal, in general comparable to the Journal of Biological Chemistry (USA) and the Biochemical Journal (England) publishes work such as that by Georgiev, Zbarskii and Belozerskii on nucleic acids, enzymology, amino acids, glycolysis and respiration, origin of life; Palladin on neurochemistry; Seitz and Lukanova on enzymology of blood cells; Braunshtein, Kaplanskii, Goryachenkova, Mardashev and Orekhovich on enzymology of amino acids, protein chemistry, clinical biochemistry. (Braunshtein and Engelhardt, both editors of the journal as well as frequent contributors, are Honorary Members of the American Society of Biological Chemists in recognition of their outstanding work.)

Biochemistry contains reports from the most important Soviet institutions in the field - the A. N. Bakh Institute of Biochemistry, Moscow; Institute of Biological and Medical Chemistry, Moscow; A. N. Severtsov Institute of Animal Morphology, Moscow; Institute of Blood Transfusion, Leningrad; Institute of Biochemistry, Kiev; Technological Institute of Food Production, Moscow; Institute of Nutrition, Moscow; etc.

Typical contents include:

Production and Characterization of Highly Polymerized Deoxyribonucleic Acids from Bacteriophages  
 The Sequence of Nucleotides in Ribonucleic Acid Triplets Which Determine the Uptake of Amino Acids in Proteins  
 New Data on the Structure of Nucleotide-Peptides, Components of Pancreatic Ribonucleic Acid  
 The Isolation of Pyrimidine Deoxyribonucleosides and the Production of Their Aminoacyl Derivatives  
 RNA Polymerase in Escherichia Coli B Infected with T2 Phage  
 The Macromolecular Configuration of Single Chained Globular Proteins in Spiraling Solvents  
 Oscillographic Polarography of Deoxyribonucleic and Apurinic Acid

**Bound and Soluble Desoxypolynucleotides in the Tissues of Irradiated Rabbits**  
**Determination of Chlorides in the Plasma and in the Blood by the Radio-metric Method**

**COLLOID JOURNAL (Kolloidnyi Zhurnal)\*** - This journal deals with the theoretical and applied physics and chemistry of colloids. Contributions include papers by Dogadkin on interpolymers of natural and butadiene-styrene rubbers, Segalova on cement hardening, Meerson on polymer thermodynamics, Kiselev on adsorption, Keryagin and Levi on kinetic non-wetting, Ermolenko on adsorptive purification of antibiotics, Rebiner on surface properties in disperse systems and on physicochemical mechanics, Dumanski on denaturation of protein, Klassen on flotation theory, etc.

Each issue contains approximately 25 reports of theoretical and applied work from the Laboratory of Surface Phenomena of the Institute of Physical Chemistry in Moscow, the Moscow Textile Institute, the Elastomer Labs at the Lomonosov Institute of Fine Chemical Technology, the Adsorption Labs and the Joint Institute for Polymers at Moscow State University, the Crimea Medical Institute, the Urals Polytechnical Institute, the Cinephoto Institute in Kiev, the Colloid Chemistry Labs and the Colloidal Metal Lab in Kiev, etc.

Typical contents include:

Dispersy of Mist Formed in Vapor Condensation on a Surface  
 Nonsteady-State Growth of a Solution Droplet (Thermal Relaxation)  
 Radioactive Investigation of the Sorption Capacity of Peat  
 The Nature of Adsorption of Zeolites (Differential Heats of Adsorption of Diethyl Ether and N-Pentane Vapors by Porous Crystals)  
 Investigation of Structure and the Adsorption and Ion-Exchange Properties of Synthetic Zeolites  
 Ion Diffusion in an Adsorbing Dispersion Medium  
 The Sorption of Streptomycin by Carboxylic Cation Exchange Resins from Aqueous-Methanol Solutions  
 The Sorption of Phenols on Ion Exchange Resins  
 A Study of the Disperse Structure of Cement Block  
 The Preparation and Stabilization of Organosols of Certain Metals  
 The Spreading of Liquid Metals on the Surface of Solid Metals in Relation to the Strength-Reducing Adsorption Effect  
 Study of Electrokinetic Processes and Sedimentation in Disperse Systems by the Radioactive Tracer Method  
 Crystallization Mechanism of Colloidal Titanium Dioxide

**GLASS AND CERAMICS (Steklo i Keramika)** - Under the editorial direction of S. S. Kopeikin, this publication of the USSR Ministry of the Construction Materials Industry is the sole medium for outstanding Soviet workers in the field. A partial roster includes: Botvinkin, known for his contributions in the field of glass structure; Appen, perhaps the leading Soviet

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\* KOZH.

scientist in the fields of chemistry of silicate melts, coordination of ions in melts, and surface tension; and Azarov, who enjoys a similar reputation in enamels.

The type of paper normally published in the journal generally includes more tables of data and illustrative material than US publications. The papers are well referenced to Soviet and foreign work. Its scope is extremely broad - covering basic research, applied research, and plant production techniques.

Research results are reported by Soviet scientists in glass structure, glass fabrication, annealing, glass to metal seals, tile, enamels, sanitary ware, color, glazes, electronic ceramics, whitewares, glass fibres, optical glass, lightweight ceramic products, mechanization, refractories, phase equilibria, silicate chemistry, raw materials, and other related areas.

Typical contents include:

Rapid Glass Melting

The Significance of the Polarization Properties of Ions for Developing Fusible Glasses

A New Method for Measuring the Viscosity of Glass in the Range  $10^5$ - $10^{14}$  Poises

Electrical Separation of Pegmatites

Equipment for Enriching Generator Gas with Liquid Fuel

Industrial Melting of Glasses Colored with Rare-Earth Elements in the Form of Concentrates and Ores

New Ideas on the Structure of Glass

Hydrogen in Glass

Investigating the Possibility of Obtaining Materials of the Devitro-ceram Type in the System

$\text{CaO} \cdot \text{TiO}_2 \cdot 2\text{SiO}_2 - \text{Li}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2 - \text{Li}_2\text{O} \cdot 2\text{SiO}_2$

Saratov Technical Glass Factory - A Model Experimental Concern

Accelerated Startup Schedules for Glass Furnaces

Stable Inorganic Fibers at High Temperatures, and Their Properties

Optics - A New Field of Application of Glass Fibers

Increase of the Thermal Endurance of Glass by Thermochemical Treatment  
Production and Uses of Photosensitive Glass

CHEMISTRY AND TECHNOLOGY OF FUEL AND OIL (Khimiya i Tekhnologiya Topliv i Masel) - The journal publishes articles about new methods of analyzing hydrocarbon gases, oil and solid fuels, and about the results of research done by factories, scientific and designing institutions with a view to elaborating new and perfecting existing methods of refining oil, gas and solid fuels. It pays particular attention to questions of oil-chemical synthesis. It prints detailed articles about the process of obtaining raw materials and semi-finished products for heavy organic synthesis. It publishes the most rational schemes of installations for refining oil, gas, solid fuels and oil-chemical products. One of its main tasks is to popularize advanced methods of improving the organization of production, enhancing labor productivity, bettering quality and reducing costs. It also

includes articles on the latest methods of analyzing processed products (spectroscopy, electronic microscopy, supersonics, radiochemistry, etc.), surveys on the state and prospects of the technology of refining oil, gas and solid fuels abroad, and has a bibliographical section.

SOVIET JOURNAL OF ENGINEERING PHYSICS (Inzhenerno-Fizicheskii Zhurnal) - The journal is concerned essentially with scientific problems arising from modern technology. In particular, the journal publishes the results of theoretical and experimental investigations in the area of thermophysics (heat exchange, theory of heat conductivity, thermodynamics, combustion physics, theory of drying), the physics of structures (soil mechanics, structural-mechanical and rheological characteristics of dispersive media, heat transfer in structural materials and insulation materials), the thermodynamics of irreversible processes and its application to technological processes and to heat transfer during phase, chemical, and nuclear transformations. The journal is also concerned with engineering methods of solving a wide variety of technological problems.

THE SOVIET ACADEMY OF SCIENCES - HIGH TEMPERATURE (Teplofizika Vysokikh Temperatur) - This is a unique journal reporting experimental methods and results of Soviet research in all areas of high-temperature physics, having value to physicists, engineers, space scientists, nuclear researchers, metallurgists, and chemists.

XII. List of Selected Articles from the Scientific and  
Technical Literature of the USSR and the Communist Bloc Nations

(alphabetical, according to "first authors")

Authors, sources (abbreviated), year of publication, and title are given. A considerable fraction of the individual articles appeared in the various USSR publications described in the foregoing section, and/or in the Proceedings of the 1955 and 1958 Geneva Conferences, and many have been abstracted for Nuclear Science Abstracts; however, in other cases, the following list of abbreviated "Origins" (and their assigned four-letter codes) may be useful in determining the source of the work.

Institute associations of the various authors are cross-referenced in as many cases as possible with the various cities and institutes as presented in Section X; however, no guarantees are made concerning the accuracy or currency of these "associations."

ORIGINS

ACHH	Acta Chim. Acad. Sc., Hung.
ACSC	Academy of Science, Publ. House, Moscow
AECT	AEC Translation
AERT	AERE Translation
AKNA	Akad. Nauk. SSR
AKNB	Akad. Nauk., Book
ASME	Am. Soc. Mech. Eng.
ATER	Atomic Energy (USSR)
ATMO	Atomizdat, Gosatomizat, Moscow
AZKZ	Azerb. Khim. Zh.
BEZH	Beton i. Zhelezobeton
BINA	Biol. Nauki. (Nauchn. Dokl. Vyss. Shkol.)
BINS	Bull. Inst. Nuc. Sc.
BMEB	Bulsh. Meditsin. Entsiklop.
CBEI	Consultants Bureau Ent. (Trans)
CCCC	Coll. Czech. Chem. Commun.
CCHA	Croat. Chem. Acta.
CCSC	Cand. Chem. Sci.
CHAW	Chem. Anal., Warsaw
CJPH	Czech. J. Phys.
CRYO	Cryogenics
DLPI	Dokl. L'vovsk. Politekhn. Inst.
EKST	"Ekstraktsiya"
ENOB	Entomol. Obozrenie
FISB	Fiz. Sbor.
FITT	Fiz. Tverdogo Tela
FMEM	Fiz. Met. i Metalloved.
FMEN	Fiz. Met. Estestv. Nauk (Mosk. Univ.)

<b>FPIS</b>	<b>Fed. Proc., Trans. Suppl.</b>
<b>GEAE</b>	<b>Geomag. i. Aeronomiya</b>
<b>GEFZ</b>	<b>Geofizika</b>
<b>GEKH</b>	<b>Geokhimiya</b>
<b>GISA</b>	<b>Gigiena i. Sanit.</b>
<b>GTEK</b>	<b>Gostoptekhnizdat</b>
<b>GTPZ</b>	<b>Gigiyena Truda i. Prof. Zabol.</b>
<b>HIGB</b>	<b>Higijena (Belgrade)</b>
<b>IAEA</b>	<b>Int. At. Energ. Ag. (Reprints, etc.)</b>
<b>IBEZ</b>	<b>Inst. Betona i. Zhelezobetona</b>
<b>IBIM</b>	<b>Inst. of Biochem., Moscow</b>
<b>ICMT</b>	<b>Inst. Chernoi Met.</b>
<b>ICPU</b>	<b>Int. Conf. Peace. Uses of A.E.</b>
<b>IJAR</b>	<b>Intern. J. Appl. Rad. Isot.</b>
<b>ILEI</b>	<b>Izv. Leningrad. Electrotekn. Inst.</b>
<b>INRW</b>	<b>Inst. Nuc. Res., Warsaw</b>
<b>IOKU</b>	<b>Issled. v. Oblasti Khimi Urana</b>
<b>IPSM</b>	<b>Izm. Prib. Sov. Min.</b>
<b>ISZE</b>	<b>Iskus. Sputniki Zemli</b>
<b>IVUZ</b>	<b>Izv. Vyss. Uchebn. Zaved. Fiz.</b>
<b>IZMT</b>	<b>Izmeritek. Tekhn. (IZTE)</b>
<b>JAEN</b>	<b>Jaderná Energie</b>
<b>JAPC</b>	<b>J. Appl. Chem.</b>
<b>JCPH</b>	<b>J. Chim. Phys.</b>
<b>JFPC</b>	<b>Jour. fur Prakt. Chemie</b>
<b>JGCH</b>	<b>J. Gen. Chem (USSR)</b>
<b>JHMT</b>	<b>Int. J. Heat Mass Transfer</b>
<b>JINR</b>	<b>Joint Inst. for Nuc. Res., Dubna</b>
<b>KERN</b>	<b>Kernenergie</b>
<b>KHIG</b>	<b>Khim i. Geokhim.</b>

KHMA Khim. Mashinostr.  
 KHPR Khimich. Promysh.  
 KIKA Kinetika i. Kataliz  
 KIKT Khim. i. Khim. Tekh.  
 KIRE Kauchuk i. Rezina  
 KOZH Koll. Zh.  
 KPFS Khimiya i. Primneniye Fosfor. Soyedin.  
 KPIL Kalinin Polytec. Inst., Leningrad  
 KRIS Kristallografiya  
 KSLD Kislород  
 KSMP Kiev, State Med. Publ. Ho.  
 KSPR Kuznecho-Shtampovochnoe  
  
 LCAM Lit. on Const., Archit. and Const. Mat. (MPH)  
 LGID Leningrad Gidrometizdat  
 LIGG (Lituanian SSR) Inst. of Geol. and Geog, AS  
 LIMH Lenin Inst, Minist. of Health, Medgiz  
 LNST Lit. on Nuc. Sc. and Tech., Mosc. Publ. Ho.  
  
 MASG Mashgiz., Moscow  
 MEGI Meteorolog. i. Gidrolog.  
 MERA Medical Radiology  
 METO Met. i. Toplivo  
 MIEP Moscow Inst. of Engr. Phys.  
 MISY Mineral'n Syr'e, Mosc. Sb.  
 MKFO Magyar Kemiai Foly. (Budapest)  
 MMCM Met. i. Metalloved  
 MMDB Milit. Pub. Ho. of Minist. of Def., Book  
 MOCH Monatsh Chem. Chist. Met. Sb. Nauchn. Rabot  
 MOGO Moscow, Gosatom, Gosgeo  
 MOME Moscow, Medgiz  
 MTOM Metalloved i. Term. Obrab. Metal  
  
 NEIR Nuc. Energ. Inst (USSR)  
 NEOP Neoplasma  
 NFKH Neftekhimiya

NIMR Nuc. Inst. Methods (USSR)  
NPKU Nauk. Provid., Kievsk. Univ.  
NSAT Nuc. Sc. Abs. (Trans.)  
NUKL Nukleonika  
NUPH Nuc. Phys.

OANI Oblasti Atomnoi Nauk i Tekhn. (Gos. Izd. Lit.)  
OKNL Okeanologiya  
OPSP Opt. Spectry. (USSR)

PBSH Pathol. Biol. Semaine Hop.  
PEGO Probl. Endokrinol. i. Gormonoter  
PHBT Probl. Hemat. i. Bl.Trans.  
PHML St. Pub. Ho. of Med. Lit.  
PHSB Pub. Ho. of Ship Build. Ind.  
PMTK Prikl. Mat. i. MEKH.  
PRIR Priroda  
PRKB Probl. Kosmich. Biol.  
PRLE Przegląd Lekar.  
PTEK Pribory i. Tekhn. Eksperim.

RARE Rad. Res.  
RDBI Radiobiologiya  
RDEL Radiotekhn. i. Elektron.  
RDKH Radiokhimiya  
RITR Rad. Inst. Tr.  
RJIC Russian Journal of Inorg. Chem.  
ROCH Roczniki Chem.  
RPRO Rev. Phys., Ac. Rep. Pop. Roumaine  
RZFZ Ref. Zh., Fizika  
RZKH Ref. Zh., Khimiya  
RZME Ref. Zh. Metallurgiya

SFKH Ser. Fiz. i. Khim.  
SPCR Sov. Phys., Cryst.

SPPR Spirt. Prom.  
 SPSR Space Sc. Rev.  
 SPSS Sov. Phys., Solid State  
 SRIH Cent. Sc. Res. Inst. of Phys., AS., Hungary  
 SSRP USSR Patent  
 STLW Scient. Tech. Lit (Warsaw Pub. Ho.)

TALA Talanta  
 TEHN Tehnika  
 TGGI Tr. Gos. Gidrolog. Inst.  
 TGGO Tr. Glav. Geofiz. Obser.  
 TIKS Tr. Inst. Kom. Standardov, Izm. Prib. Sov. Min.  
 TINM Trudy Inst. Met.  
 TLKI Tr. Leningrad Tekhn. Inst. im. Lensoveta  
 TLPI Tr. Leningrad Politekh. Inst.  
 TNPI Tr. Novocherk. Politekhn. Inst.  
 TORE Tekhn. Obshch. Radiotek. i. Electro., Minsk  
 TPER Teploenerg.  
 TRIA Tr. Radiev. Inst., AN, USSR  
 TRTA Tr. Tashkent  
 TSIA Tracer Stud. in Agri.  
 TSME Tsvetn. Met.  
 TVSR Tr. Vses. Soveshch. Riga

UKBZ Ukr. Biokhim. Zh.  
 (USBZ) Ukr. Botan. Zh.  
 UKFZ Ukr. Fiz. Zh.  
 UKHZ Ukr. Khim. Zh.  
 UKPH Ukr. SSR Pub. Ho., AS.  
 UNIM Ukr. Nauchn. Issl. Inst. Met.  
 USKH Uspekhi Khim.  
 USPF Uspekhi Fiz. Nauk. (USFN)  
 UZLG Uch. Zap. LGU

VELP	Vestn. Electroprom.
VMMF	Zh. Vychislitel. Mat. i. Mat. Fiz.
VOPI	Vopr, Pitaniya
VRIR	Vestn. Rentgenol. i. Radiol.
VSKI	Vses. Soveshch. Kiev.
VSLU	Vestn. Leningradskogo Univ.
VUZF	Izv. Vyss. Ucheb. Zaved. Fiz.
VYSH	Vysshaya Shkola
VYSO	Vysokomolekul. Soyedin.
ZAKH	Zh. Analit. Khim.
ZAVL	Zavodskaya Laboratoriya
ZETF	Zh. Eksperim. Teor. Fiz.
ZFKH	Zh. Fiz. Khim
ZHOB	Zh. Obshch. Biol.
ZHOK	Zh. Obshchei Khim.
ZHTF	Zh. Tekhn. Fiz.
ZIAV	Zinatnu Akad. Vestis
ZMEI	Zh. Mikrobio. Epid, i. Immunobio.
ZMTF	Zh. Prikl. Mekh. i. Tek. Fiz.
ZPKH	Zh. Prikl. Khim.
ZSKH	Zh. Strukt. Khim
ZTGU	Uch. Zap. Tomsk Gos. Univ.
ZVKO	Zh. Vses Khimi. Obsch. Imeni D.I. Mendeleeva

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