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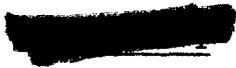
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ORNL-16
Monthly Progress Report
March 10, 1948

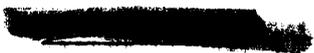
PROGRESS REPORT FOR THE MONTH OF JANUARY 1948

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BIOLOGY DIVISION

Radiobiochemistry Section

Experimental work is continuing on potassium exchange and the effects of ionizing radiation upon it. Results show that only about 20% of the cellular potassium of the dog erythrocyte exchanges freely with the plasma. Since the exchange has been shown to proceed fairly rapidly in the initial stages, techniques must now be developed for separating cells from plasma more quickly and cleanly, if the new accuracy requirements in measuring diffusion times are to be met. Although only three radiation experiments have been completed, it is tentatively concluded that the curves of radioactive potassium exchange are not highly sensitive to gamma ray exposures up to 13,000 r and possibly to 20,000 r.

Cytogenetics Section

Studies of radiation-induced reversions at specific loci concerned with biosyntheses in Neurospora are continuing. Clear-cut evidence for the segregation of radiation-reversible and -irreversible inositolless loci has been obtained. The analysis of slow neutron effects on Tradescantia is continuing.

The study of very low intensity effect of gamma radiation on mitosis in the grasshopper neuroblast was started this month. The dosage of 32 r at the rate of 1/4 roentgen per minute is being used. The data gathered has not been too satisfactory as results have not been too consistent. This is probably due to the fact that many abnormal embryos appear in one pod and the pods are from the last of the grasshoppers caught in the fall.

During January tests were made to determine whether the better method of treatment with P32 solution was in test tube or beaker, and the former method was discontinued in favor of the beaker. A glass stand was obtained, across which the cellophane is stretched to suspend the embryo in the solution in the beaker. Embryos are now being treated at a definite concentration of P32, at a definite time. Treatment at the desired concentration was delayed for two weeks due to the breakdown of P32 production. During this time, some embryos were mounted in a very weak solution of P32 media and observed for some time. It was considered best to obtain data on those mounted in normal media after treatment before this study was undertaken further.

Biochemistry Section

Sectioning of the majority of the tissues on hand has been completed and an additional group of the beta-exposed rats, as well as some of those infected with diarrhea, have been autopsied. Preparations for the beryllium project are complete regardless of the fact that the project has not yet been started. Techniques in imbedding and sectioning are not yet completely satisfactory. Much time has been spent this month in an attempt to eliminate these technical inadequacies. A suitable staining technique has been worked out.

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Mouse Genetics Experiment

The establishing and organizing of the mouse colony is proceeding rapidly. Several new shipments of animals have been received, materially increasing the number of genes and inbred strains represented. Breeding records for the month indicate that the conditions set up in the animal room (food, temperature, ventilation, etc) are adequate.

Physiology and Pharmacology

In order to control an outbreak of infectious diarrhea in the animal farm, it was decided to sacrifice all of the animals late in December. Before this was done, however, those which appeared in good health, were used in an exploratory experiment. Groups of 9 adult rats were irradiated in the new X-ray machine at 250 KV, 15 milliamps, unfiltered, at 100 r per minute. Their weight and general condition was followed for ten days subsequent to irradiation. The food supply was controlled to determine the effect upon survival and weight change. With exposures of 500, 800 and 1100 r. The following observations were made:

- a. The L.D. - 50% is approximately 800 r (followed only ten days).
- b. Withdrawal of food for the first week following irradiation does not effect the mortality.
- c. All animals receiving no food by mouth (or water) but given 15 cc of 10% glucose in 0.2% NaCl i.p. daily plus 2000 units of penicillin G died at 800 r.
- d. All animals receiving no food or water by mouth but given 15 cc of amigen i.p. daily plus 2000 units of penicillin died at 800 r.

Conclusion: Although the injected animals did not lose weight as rapidly as the starved or those allowed food ad libitum, their mortality was higher. A small scale experiment for testing the effect of rutin upon the course of radiation sickness in the rat was started in late January.

CHEMISTRY DIVISION

The study of the distribution of hydrazine in the process for recovering U235 has been completed, and in 1 M $\text{Al}(\text{NO}_3)_3$ solution the results can be expressed by the equation

$$\frac{\text{Total hydrazine in hexone}}{\text{Total hydrazine in aqueous}} = \frac{0.1055}{x} + 2.12 + 2.75 x$$

where $x = a_{\text{H}^+_{\text{aq}}} = 10^{-\text{pH}}$.

In addition, the influence of pH on the uranium distribution ratio has been measured and again in 1 M $\text{Al}(\text{NO}_3)_3$ solution is given by the equation

$$\log \frac{U \text{ in hexone}}{U \text{ in aqueous}} = 0.35 - 0.25 \text{ pH}$$

~~SECRET~~

The problem of measuring the neutron cross section of Xe^{135} is progressing satisfactorily. A method has been found for producing PdI_2 in a form suitable for centrifuging into a capillary for the neutron absorption. Originally the precipitated PdI_2 was so gelatinous as to be unmanageable for this purpose. Installation of equipment for the actual high-level separation is going somewhat slowly, but without uncovering any serious difficulties.

In the study of decay schemes of various radioisotopes, work has been completed on $^{104}dY^{88}$, and a gamma ray of $0.654 \pm 2\%$ mev has been found in $^8dI^{131}$ confirming a report that a gamma was present of energy higher than the known 0.391. mev. A report on erbium activities has been completed for presentation at the Physical Society meeting in January.

The synthesis of compounds containing C^{14} continues to progress satisfactorily. During the present period a process has been developed for the hydrogenation of potassium bicarbonate to potassium formate in good yield.

In the work on the decomposition of water and aqueous solutions by reactor radiation, considerable emphasis is being placed on the search for material more suitable than silica for irradiations. Gold shows some possibility of improvement in the reproducibility of results. An interesting observation in connection with recent interest in zirconium metal is that metallic zirconium in a silica ampoule had no particular effect on water decomposition in the pile. Another interesting observation is that pure H_2SO_4 is quite resistant to radiation and gas evolution from it is to be ascribed principally to water impurity.

Another radiation measuring device especially adapted to chemical processes is the continuous flow beta proportional counter which has been placed in operation during this month. It has excellent operating characteristics and is especially adapted to monitoring process solutions from such continuous chemical processes as ion exchange.

PHYSICS DIVISION

High Flux Reactor

Work on the high flux reactor has progressed very slowly as a result of the decision to move the reactor development program to the Argonne National Laboratory. Calculations on the Wigner disease in the graphite outside the pile show that with the original Be sleeve arrangement the loss in conductivity and expansion will be kept within tolerable limits, even if the pile is operated for more than 15 years.

The status of the control work is as follows: A large scale servo unit is being assembled and, judging from the performance of its components, it should work satisfactorily. The graphite ionization chamber is finished and is undergoing pile tests. A final report on the control interlock system is being written and the counting rate meter is completed.

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Critical experiments continue, with major emphasis on mocking up an exact replica of the pile. The effect of the holes in the reflector is somewhat greater than had been expected. A 6" hole at the center of the pile gives a loss in critical mass of 218 grams, and an 8" hole at the same place gives a loss of 470 grams. Fortunately, the effect of filling the 6" hole with paraffin was well within the control margin afforded by the delayed neutrons. This indicates that the reactor can be saved from catastrophe even if the holes fill up with water. In the present design the 8" holes are reduced to 6".

A critical assembly has been built with slab geometry and lateral Be reflectors. The critical mass is found to be 1260 grams; this was increased to 1940 grams when 210 cm² of poison was inserted. This amount of poison is a little more than will be present as a result of the Xe poisoning.

Reactor Physics

The cross section of Zr is still in doubt since a supposedly pure sample which gave a rather high cross section was found to contain about 1½% of Hf. It has been noticed that Zr⁹⁰, which has an abundance of 48% is a 50-neutron isotope, and according to the empirical rule recently discovered by M. Mayer, should have a low capture cross section. This is consistent with the observations to date on the Zr cross section. Work continues at the Bureau of Standards to obtain a sample of pure Zr.

Neutron Physics

The equipment for measuring the neutron half-life has been improved. At present it can be estimated that those counts which appear to be attributable only to decay protons are sufficient in number to give a mean life of somewhere between 25 and 40 minutes. Coincidences have been observed between decay protons and electrons.

Experiments on anthracene counters indicate that these counters are sensitive to fast neutrons. Further work is being done to determine to what extent they can be used as proportional counters.

Neutron diffraction patterns in oxides of Ni, Co and Cr have been measured during this month.

Solid State Physics

A blistered Hanford slug was stripped and hardness measurements on the surface have been made. There is no evidence that the blisters differ significantly from the remaining metal in hardness. A new batch of U-Al alloy samples have been prepared and have been measured very accurately before shipment to Hanford, where they will be irradiated and measured after irradiation. The loss of rectification in Ge and Si semi-conductors which Lark-Horowitz observed to follow deuteron bombardment has now been observed after 100 hours of pile irradiation.

POWER PILE DIVISION

Engineering Analysis

A survey of design specifications for the Navy water-cooled reactor has been nearly completed and a memorandum covering the work is in preparation. Although fixed values are not yet established, it appears that a reactor pressure of 1000 to 1200 psi with water entering at 400°F and leaving at 440°F will permit obtaining 150 psi saturated steam at the turbine throttle. An investigation of the size, weight and efficiency of engine room equipment with variation of turbine throttle pressure has indicated that on this basis alone there is little justification for going greatly over this supply pressure. The savings in weight and space by going to a higher steam pressure are small and the cost in terms of reactor pressure is high.

A cursory survey of the proposed research work on heat transfer to water and associated phenomena has been completed. Four research programs have been proposed in order to obtain the required information. They would be performed at M.I.T, U.C.L.A., N.A.C.A. and Clinton National Laboratory.

A report was prepared covering an evaluation of zirconium as a structural material for high temperature thermal reactors.

A survey of the corrosion problems associated with water-cooled power reactors was completed, and included a description of the experimental work which has already been done and is currently underway on these problems, and also proposed additional investigations which are required for the Navy reactor study.

Nuclear Engineering

Calculations of the control effect on the Navy water-cooled reactor of an array of seven, two and one-half inch diameter, control rods were made. Preliminary investigation of the effects of bubbling and of gaps on reactor reactivity was started. In addition, a preliminary analysis of the temperature and power level regulators required for automatic control of the reactor was begun.

A survey of the existing literature on shielding and methods of making shielding calculations was initiated. An attempt will be made to extend or modify existing methods to make them applicable for the calculations required in designing the shielding for the Naval reactor.

The experimental work on the transmission of thermal neutrons through a 5 inch diameter spiral duct penetrating the shield of the Clinton reactor was completed.

[REDACTED]

Two group calculations of critical mass of the unpoisoned Navy reactor as a function of reactor size were made. Two-group calculations of reflector savings for the reactor as function of poisoning (uniform distribution) and reactor temperature are 70 percent complete for the Be-H₂O reactor. Computations of Xenon and Samarium poisoning as functions of thermal flux have been made. The results of these computations will be used with the reflector-savings results to determine the operating flux and inventory of fissionable material for the reactor.

General study of the neutron flux space distribution simulator was continued.

Reactor Design

Design studies carried out thus far indicate that a reactor which is removable from the hull without removing the pressure shell is preferable to the removal of reactor and shell as a unit. The diameter of the closure thus obtained is larger than in the case of removing the pressure shell, but it is a simpler and more conventional design. A survey of available literature has disclosed several promising methods of achieving sealing of the closure without leakage. Study of this problem continues.

The design of the control rod drives continues with the investigation of the external drive arrangement. The major problem is one of providing a simple, rugged, and effective two-speed drive for operation of the shim rods. The slow speed drive must be provided for normal control operations and the high speed drive for safety shutdown. It appears at this point feasible to provide for complete insertion of the rods in about one-eighth second with an acceleration of the order of 3 g.

Testing and Experimental Work

Investigations on the recovery of U²³⁵ from graphite continued. The variables influencing the rate of electrolytic decomposition of graphite are being determined experimentally and correlated with data reported previously in the literature.

Radioactivity - Preliminary calculations made to determine the activity induced in the reactor water coolant yield the following results:

1. The $016 (n, p) N^{16}$ is the most significant reaction because of the possible high fast flux of 5×10^{14} .
2. As much shielding is required on ducts leading into the charging face of the reactor as on ducts at the discharge face because of the short cycle time of 8 seconds and also because of the 7.4 sec. half life of N^{14} .

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3. Four Mev gamma activity requires heavy shielding (about 14" iron). Shielding requirements are comparable to the shielding on crossheaders, risers and downspout at the discharge face of the Hanford reactor and also to the shielding on the 36" discharge duct of the high flux reactor.

The reactor experiments on the fast neutron and fission fragment damage to graphite and BeO operating at high temperatures were continued.

The preliminary measurements of thermal conductivity at room temperature made on reactor control samples were continued. Considerable work on the impregnation of low density BeO was done with the aim of eliminating the cracking of the samples during the drying procedure. A thermal expansion apparatus was built and tested on some samples obtained from the U. S. Bureau of Standards and was found to operate quite satisfactorily.

TECHNICAL DIVISION

Reactor Design

The design of the high flux reactor proceeded slowly during the month of January in view of the changes of program announced by the Commission late in December. Terminal reports from the Kellogg Corporation are in the process of preparation and some of these have been given a preliminary review.

The design work which is under way mainly concerns the details of the beryllium within the reactor and the design of the mock-up which has been given verbal approval by the Atomic Energy Commission and which it is understood will be built at Clinton National Laboratory. Consideration of the graphite structure around the reactor has shown the desirability of replacing a part of the graphite with pelleted graphite or beryllium oxide. This would make it unnecessary to put beryllium sleeves around the experimental holes as previously planned. Work on the water system, the site plan, the blasting tests, the reactor building, and related subjects has been discontinued in view of the change in program.

Reactor Engineering Development

Experimental work on the reactor went ahead without major interruption. During the month the tests of magnet holding power and release time were completed, which showed that the holding power of the safety rod magnet will be satisfactory, amounting to about 1,000 lbs. with a current of 165 milliamperes. The magnitude of the release time, desired to be 20 milliseconds or less, is in doubt, due to failure of the electronic timing unit used for measuring the release time.

Tests on the dropping and deceleration of the shim-safety rod show that its rate of fall is considerably faster than is necessary but not as fast as was expected. The reason for the discrepancy is being sought.

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A full-sized working model of the shim-safety rod drive mechanism has been set up and has been in continuous operation for a number of weeks. In this model it is possible to determine the travel speed, the over-travel, the backlash, the lifetime of the working parts and the effectiveness of the packing glands connected with the shim-safety rods. So far, performance has been generally satisfactory.

Work on heavy aggregate shielding continued and a summary of the work of the Technical Division on this problem has been issued. In general, it seems likely that magnesium oxychloride cements or others similar to it will be very useful in shielding, since the hydrogen content of these shields is high.

Reactor Metallurgical Development

The Preliminary Process Manual for Fabrication of Uranium aluminum Alloy Fuel Rods has been completed and issued. This Manual gives in detail the operations and specifications for fabrication of the fuel assemblies.

Studies on rolling and cladding carried on this month have shown that the formation of blisters at the edge of the alloy core during the heating incident to brazing can be prevented by making the inactive aluminum frames fit very accurately around the core.

Further development has been made in the fabrication of the fuel assemblies by a change in the method of jiggging during brazing. Formerly, a single graphite block hollowed out to the shape of the assembly was used. At present this block is built up of three graphite slabs, the dimensions of which can be accurately and easily adjusted, and the graphite can be protected with sheets of aluminum.

In addition to the new method of jiggging, protection of the graphite is found to be possible by the use of a mixture of colloidal aluminum oxide and phosphoric acid. This mixture is rubbed into the graphite and then fused to a glass when the temperature is raised during brazing. This aluminum phosphate glass seems to give better protection than the Calgon (sodium hexametaphosphate) previously used and better than the sodium silicate also tried this month.

The joining of pieces of beryllium with aluminum-silicon alloy which had been sprayed onto the beryllium pieces by the Metalizing Corporation was not successful, due presumably to too much oxide in the sprayed coating, however, the coating adheres tightly to the beryllium. Bolted beryllium assemblies are being made up also.

The protection of aluminum by dipping it in molten zinc prior to exposing it to corrosion under reactor conditions in contact with stainless steel has been tried and it is found that the pitting type of corrosion is to a large extent inhibited by this procedure.

[REDACTED]

The coating of the thorium plates proposed for the shim-safety rods with aluminum continues to give considerable trouble. During the month a number of thorium plates were provided with 1/16" diameter holes prior to cladding with aluminum. It was found that the cladding made a continuous connection through each of the holes, but that the aluminum tends to be reduced unevenly during the rolling process. There is still some trouble from the brittle aluminum-thorium layer between the two metals. The possibility of using other intermediate coatings is being investigated.

The preparation of a large number of aluminum-uranium alloy slugs containing enriched uranium which will be bombarded at Hanford and used in the hot pilot plant was started during the month.

Chemical Plant Development and Design

The item of principal interest in the chemical development program during the month was the beginning of operations in the hot pilot plant using radioactive materials. Two runs were completed, using slugs having 10% of Clinton activity and 2 more runs were completed through the first cycle using full Clinton activities. The results are summarized in the following table.

<u>RUN NO.</u>	<u>1X</u>	<u>2X</u>	<u>3X</u>	<u>4X</u>
1st Cycle ✓ d.f.	500	570	580	810
2nd Cycle " "	7.3	2.7		
Overall " "	3600	1500		
Fract. X Activity	10%	10%	Full	Full
Uranium Loss	.018%	.016%		

It is seen that the decontamination factors attained are considerably less than the factor of 10^5 , which is desired of these two steps in combination. The decontamination obtained is also considerably less than 10^6 , which has been reported by the Semi-works Group of the Technical Division. The discrepancies seem to be due partly to an actually smaller decontamination in the pilot plant and partly to the method of analysis used as the basis of the results reported from the Semi-works. Reconciliation of these two sets of data is under way and further runs are planned for the pilot plant. Reliable decontamination data in the second cycle will be unavailable until Hanford slugs can be processed.

The extraction columns in the pilot plant have now operated for more than 600 hours continuously without the formation of any crud and without any other indication of plugging up. All liquids entering the process are carefully filtered, and it is primarily to this that the freedom from crud is attributed. The filtration step in the pilot plant continues to give some trouble, although it has been found possible to carry it out in two stages, with a flush of sodium hydroxide between the stages to remove alkali-soluble impurities from the filter disc.

[REDACTED]

From the Semi-works it is now reported that some free acid must be present in order to attain good extraction of neptunium in the 25 recovery process. However, the presence of free acid is detrimental to decontamination from fission products, so that it may be necessary to forego the recovery of neptunium or to alter the process in such a manner that both efficient neptunium recovery and good decontamination are attained.

Miscellaneous

The development of plans for a program along the lines of the Commission's December 31 announcement was started and a list of problems upon which the Division might profitably work has been issued. It has not been found possible to obtain fuller information regarding these programs to determine whether or not a real motivation exists for working on them here. At present, some preliminary planning is being done regarding space for the Technical Division in a permanent building.

Instruments to monitor the flow of air to each tube in the reactor have been briefly investigated with the result that it does not seem likely that a sufficiently sensitive instrument can be made available soon. This is because the air flow through the reactor fluctuates normally by about 10%. The area of any given channel would have to be reduced by about 75% before a 20% decrease in air velocity through the channel would take place. The sensitivity required of the instrument is fairly high and the difficulty of distinguishing between a real stoppage of the channel and an apparent one which might be inferred from a simple fluctuation in air flow makes the problem even more difficult.