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OAK RIDGE NATIONAL LABORATORY

SPECIAL PROGRESS REPORT

PROGRAM 4700

FEBRUARY 1958

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SPECIAL PROGRESS REPORT
PROGRAM 4700

February 1958

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SPECIAL PROGRESS REPORT

TABLE OF CONTENTS

	Page
PROGRAM 4700 - REACTOR DEVELOPMENT	4
AIRCRAFT NUCLEAR PROPULSION PROJECT	4
Tower Shielding Facility (TSF)	4
Lid Tank Shielding Facility (LTSF)	4
Bulk Shielding Facility (BSF)	4
Metallurgy - Niobium-Lithium Systems	5
Metallurgy - Ceramics	5
Experimental Engineering	6
Heat Transfer	6

Reports in this series issued during the past year:

February 1957	ORNL-2282
March 1957	ORNL-2300
April 1957	ORNL-2317
May 1957	ORNL-2343
June 1957	ORNL-2356
July 1957	ORNL-2371
August 1957	ORNL-2394
September 1957	ORNL-2412
October 1957	ORNL-2427
November 1957	ORNL-2438
December 1957	ORNL-2459
January 1958	ORNL-2472

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OAK RIDGE NATIONAL LABORATORY

SPECIAL PROGRESS REPORT

February 1958

PROGRAM 4700 - REACTOR DEVELOPMENT

AIRCRAFT NUCLEAR PROPULSION PROJECT (AEC Activity 4701)

Tower Shielding Facility (TSF)

Operation of the Aircraft Shield Test Reactor (ASTR) at the TSF has been severely limited in the past month because of unusually cold weather. The reactor cannot be operated when the ambient temperature is below 34°F, since water lines in the cooling and moderator systems are exposed to the atmosphere. However, a few checkout runs were made to insure proper operation of the ASTR.

Lid Tank Shielding Facility (LTSF)

The investigation of the secondary gamma rays produced by neutron capture in stainless steel was continued in support of the GE-ANP program. The thermal-neutron flux and fast-neutron and gamma-ray dose rates were measured behind configurations containing 4 in. of stainless steel through which various thicknesses of boral (up to 1 in.) were distributed. Other configurations included 4 in. of beryllium in front of the stainless steel and 12 in. of lithium hydride behind the stainless steel. All the configurations were placed in a medium of oil.

Bulk Shielding Facility (BSF)

The heating in a laminated shield mockup was investigated at the request of GE-ANP in order to obtain experimental data for comparison with their calculated values of radiation energy absorption in a reactor shield. The mockup, which covered one face of the BSF reactor, consisted primarily of 4 in. of beryllium, approximately 3 in. of a gamma-ray shielding material, and 16 in. of lithium hydride. The entire configuration was submerged in a medium of oil contained in an aluminum tank. The materials used as gamma-ray shields were lead (3 in.), iron (3 in.), and Mallory 1000 (2 in.). The heating in the gamma-ray material, as well as in the beryllium and the lithium hydride, was determined by attaching thermocouples to heat-insulated plugs of the shielding materials. In addition, flux measurements were made at the interface of the beryllium and the gamma-ray shield and the interface of the gamma-ray shield and the lithium hydride, as well as within the lithium hydride slab. The analysis of the experiment is not yet complete.

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PROGRAM 4700 - REACTOR DEVELOPMENT (Continued)

Metallurgy - Niobium-Lithium Systems

A series of static tests of welded niobium capsules containing molten lithium was conducted with the capsule surrounded by various atmospheres. It was thought that the severe attack of the weld zones and heat-affected areas of thermal-convection loops operated previously in vacuum (1 to 5 μ) might have resulted from the pickup of residual nitrogen and oxygen by the tube wall. In the static tests, however, capsules surrounded by (1) a very good vacuum, (2) a mediocre vacuum, and (3) flowing argon gas, failed to show any differences in the extent of attack on the niobium. The weld zones and heat-affected areas of all the capsules showed 20 to 25 mils of intergranular attack. No further loop tests for obtaining information on mass transfer will be conducted until seamless niobium tubing is available. Studies of the effect of welding on intergranular penetration will be continued.

Metallurgy - Ceramics

The investigation of methods for the production of boron compounds to be added to BeO as capture gamma-ray suppressors was continued in support of the GE-ANP program. Specimens of BeO mixed with ZrB_2, TaB_2, TiB_2, CrB_2, HfB_2, and BN equivalent to 1 wt % boron were exposed to static air at 1300°C for about 300 hr. The ZrB_2 and HfB_2 mixtures had almost negligible changes in weight, and thus exhibited oxidation resistance much superior to that of the other mixtures. X-ray patterns of the ZrB_2-BeO mixture made before and after the oxidation test were identical. In future work with borides, ZrB_2 will be used as the poison because of its stability in air and its relative availability.

Specimens of the BeO-ZrB_2 mixture are being fabricated for determining the modulus of rupture, the compressive creep, and the thermal conductivity. Irradiation tests in the ETR are to follow. Laboratory syntheses of boride compounds for addition to beryllium oxide bodies was completed. The compounds produced satisfactorily were TiB_2, ZrB_2, HfB_2, TaB_2, VB_2, CrB_2, and CeB_2.

Three different mixtures of BeO and boron-containing additives are being investigated from the standpoints of density achievable and of boron retention under various conditions of atmosphere and temperature. The mixtures being studied have the following compositions:

94 wt % BeO-5 wt % MgO-1 wt % B_4C

98 wt % BeO-1 wt % Fe_2O_3-1 wt % B_4C

94.8 wt % BeO-5.2 wt % ZrB_2

Shapes formed from these materials will be fired in oxidizing atmospheres and compared with others fired in inert atmosphere in order to determine density and boron retention properties.

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PROGRAM 4700 - REACTOR DEVELOPMENT (Continued)

Experimental Engineering

In order to obtain information on the effect of radiation on an oil-lubricated bearing and seal, testing of the rotary elements of a fused-salt pump was resumed in the MTR canal. The initial performance of the equipment was satisfactory, and the rate of future progress of the irradiation will be dependent on the availability of spent fuel elements.

The mechanical design features of high-temperature valves continued to be investigated through experiments with a fused-salt dump valve. The latest test was terminated by excessive seat leakage which inspection revealed to have been caused by foreign particles of Inconel on the valve seating surfaces. The seat and plug surfaces have been refinished, and the valve is being prepared for another test.

Heat Transfer

The study of the effects of surface thermal cycling on cracking was continued with Inconel tubing in the presence of the fuel mixture NaF-ZrF_4-UF_4 (56-39-5 mole %) in the pulse pump system. One additional experiment (test 9) was completed in which the test section was a thick-walled Inconel tube (0.485 in. ID, 1.315 in. OD). Except for the run duration, the test conditions for this experiment were identical with those of test 7; namely, fluid flow of 6.2 gpm at a mean fluid temperature of 1409°F, an estimated temperature amplitude at the inside wall of ±65 to 85°F, and a cycling frequency of 0.4 cps. The fluctuation amplitude reported does not include possible entrance corrections. Test 7 was run for 155 hr (230,000 cycles), and the test section showed no evidence of cracking; while the test section used in test 8, which lasted 352 hr, showed heavy intergranular cracks to a depth of 85 mils in the entrance region. The severity of the cracking decreased regularly along the length of the test unit. In the center region the cracks were 42 mils deep and, at the exit, 16 mils deep. Beyond the exit of the test section (divergent region in which tube inside diameter increased to 1.049 in.) metallurgical examination showed moderate intergranular void formation to a depth of 3 mils.

Edited by A. W. Savolainen

Approved by Alvin M. Weinberg, Director

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