SECURITY INFORMATION

UNCLASSIFIED

ANL-4273

Reactors

This document consists of 10 pages.

No. 12 of 100 copies, Series A.

ARGONNE NATIONAL LABORATORY
P. O. Box 5207
Chicago 80, Illinois

REACTOR ENGINEERING DIVISION
REPORT FOR THE PERIOD DECEMBER 1, 1948
THROUGH FEBRUARY 28, 1949

W. H. Zinn, Director

April 5, 1949

Operated by the University of Chicago
under
Contract W-31-109-eng-38

UNCLASSIFIED

SECURITY INFORMATION

UNCLASSIFIED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Reactors

<u>Distribution</u>	<u>Copy No.</u>
Argonne National Laboratory	1-30
Atomic Energy Commission, Washington	31-32
Battelle Memorial Institute	33
Brookhaven National Laboratory	34-39
Bureau of Ships	40
General Electric Company, Richland	41-44
Hanford Operations Office	45
Iowa State College	46
Knolls Atomic Power Laboratory	47-50
Los Alamos	51-53
Massachusetts Institute of Technology (Kaufmann)	54
NEPA Project	55
New York Operations Office	56-57
North American Aviation, Incorporated	58
Oak Ridge National Laboratory	59-70
Patent Branch, Washington	71
Technical Information Division, ORE	72-86
University of California, Radiation Laboratory	87-90
Argonne National Laboratory, Inventory Unit	91-100

DECLASSIFIED

(S. Untermeyer, E. K. Falls, R. K. Winkleblack)

A study of a NaK-cooled Be-moderated naval reactor has been reported in ANL-4256. This reactor was slightly heavier than the comparable H_2O cooled reactor. The difference was due to poor nuclear properties of NaK and intense Na gammas.

Delete
A comparable study has been completed of a Bi alloy-cooled naval reactor. This plant was the lightest type studied; however, it is likely that the practical difficulties (i.e., Polonium production) associated with this coolant outweigh its slightly superior performance.

In connection with the study of Bi alloy-cooled reactors, a heat transfer loop has operated for about 350 hours (Figure 1) at a wall temperature of about $400^{\circ}C$. After initial difficulties due to water leaks into the system, the system has operated satisfactorily. Up to 20 kw of heat has been extracted from a 1/4-inch iron tube, 18 inches long. This corresponds to an average heat flux of $52 \text{ cal/cm}^2 \text{ sec}$. Ordinarily a heat flux of about $25 \text{ cal/cm}^2 \text{ sec}$ ($330,000 \frac{\text{btu}}{\text{sq ft hr}}$) has been used.

At full flow rate the velocity is 233 cm/sec (7.8 fps). At this velocity the heat transfer coefficient is $0.47 \text{ cal/cm}^2 \text{ sec}$ ($3,400 \frac{\text{btu}}{\text{sq ft hr } ^{\circ}F}$). At 57 cm/sec (1.9 fps) the coefficient dropped to $0.26 \text{ cal/cm}^2 \text{ sec } ^{\circ}C$ ($1900 \frac{\text{btu}}{\text{sq ft hr } ^{\circ}F}$).

An attempt is being made to rupture a 1/4-inch stainless pipe by repeatedly melting and freezing of Bi-Pb-Sn alloy. The apparatus has gone through 160 cycles without rupturing the tube.

Work continued on the research reactor (ANL-4221). Calculations were made which indicated that filling the 3 inch central thimble with D_2O would increase reactivity by 0.7 percent. A preliminary layout for a reactor building was drawn. Fuel rods were rearranged to approximate more closely a cylindrical core, and the additional facilities recommended by the research reactor committee have been added. A rough check of the flux distribution in the lattice indicates there will be a slight gain in maximum thermal flux over that predicted by calculations based on a homogeneous reactor. This is being checked by Dr. F. C. Hoyt.

A survey of all Hanford irradiation requests was made for the A.E.C. A report was submitted by letter to G. Weil (ANL-WPB-11, February 8, 1949).

Delete
DECLASSIFIED

市

In collaboration with W. M. Manning and J. J. Katz of the Chemistry Division a distillation process for separation of Zr and Hf was recommended to the A.E.C. Chicago Operations Office. Following this a contract was awarded to Foote Minerals Company by the New York Operations Office of the A.E.C. It is expected that several kilograms of pure Zr will be available within a few months.

Electromagnetic Pumps (A. H. Barnes, G. K. Whitham and F. A. Smith)

An a-c electromagnetic pump for liquid metals has been designed, constructed and tested. It employs a linear induction motor stator which is clamped to a thin-walled, flattened, inconel tube. A sliding magnetic field develops a longitudinal thrust in the liquid. The stator was wound with a three phase, 8 pole winding, giving a synchronous field speed of 37 ft/sec. The tube section was 4 inches wide by 1/4-inch in the field direction and was fabricated from 0.032-inch inconel sheet. The stator winding was placed on one side of the tube, the magnetic circuit on the other side being completed through a blank laminated core. Heavy copper bars were placed along the sides of the tube on the inside to reduce the resistance of the induced current paths. See Figure 2.

The device was placed in a pumping loop containing a throttling valve, expansion tank and electromagnetic flowmeter. The input voltage and current were controlled with a three phase variac and input power, current, voltage, and phase angle were recorded. Output power was calculated from the flow and pressure developed.

A maximum efficiency of 13 percent was obtained at a pumping rate of 80 gpm against a 33 lb/sq in. head. With the throttling valve wide open a flow of 120 gpm was attained. The highest static pressure recorded was 55 lb/sq in. The curves in Figure 3 show the variation of pressure and efficiency with pumping capacity.

The pump was very quiet in operation and the excessive vibration of thin wall sections which had characterized some other forms of a-c pumps was completely absent. It is planned to make some further tests with a lower synchronous speed and with windings placed on both sides of the tube in an effort to improve efficiency.

The homopolar generator for driving d-c pumps has been undergoing changes with a view to increasing its efficiency. The changes involve replacing the iron rotor with a copper rotor to reduce the internal resistance and remove the load on the bearings due to the large magnetic forces on the iron. Some rotating sections which had contributed to the eddy current losses are being removed. Difficulty was experienced with ball bearings

FIG. 2

FIGURE 3

A. C. PUMP

operating in a region of strong magnetic field and design changes had to be made on this account. The necessary shop work is now completed and the machine will soon be ready for testing.

Level Indicator

The electromagnetic level indicator for use in NaK storage tanks has been kept in continuous operation over a period of several months to check the constancy of its calibration. A constant current power supply unit has been constructed by the electronics group which maintains a current of 100 milliamperes constant to about 2 percent over a range of 10 volts. There has been no perceptible change in reading (for a fixed NaK level in the tank) over a period of two months. The testing will be continued at successively higher tank temperatures.

Valve Bellows Tester

A machine has been designed for flexing stainless steel bellows in order to determine the life which may be expected when operating in heated NaK alloy. Ten bellows at a time will be flexed at the rate of 10 cycles per minute in a tank through which heated NaK is flowing. Provision is made to detect the first incipient leak in any bellows by picking up the NaK vapor with hydrogen which is then burned -- a yellow flame indicating that a leak has developed. Bellows which leak can be capped off and the test continued until all have failed. It is planned to test the bellows of several manufacturers.

Creep Test

In an attempt to measure the creep of metals exposed to neutron irradiation an apparatus has been constructed for use in the central thimble of the heavy water pile (CP-3). The first material to be tested will be a 347 stainless steel sample which will be maintained at a temperature of 400°C by electrical heating and will be placed inside a hollow uranium slug to enhance the fast neutron flux. Stress sufficient to produce a small detectable normal creep will be applied by weight loading. An identical sample, outside of the pile, under the same temperature and stress conditions will serve as the control. Great care will be taken to keep the temperatures of both samples equal and as nearly constant as possible.

The unit which is to operate outside of the pile has been set up and is now in the process of being tested.

Changes in hardness and tensile strength will also be looked for when the sample is removed from the pile.

DECLASSIFIED

Quick Drop Blanket Plug (W. H. McCorkle)

The safety device described in ANL-4238, which is designed to support a cylindrical plug in the bottom of the external blanket cup of the experimental breeder reactor (CP-4) so that it may be quickly dropped approximately 7 inches below the surface of the cup bottom has been set up and tested to determine if the quickness of drop and the supporting mechanism will be satisfactory for operation in the CP-4 reactor.

The time of drop for the necessary distance, approximately 7 inches, is in the range from 0.25 to 0.30 second. The guide bearing arrangement for the block and the dash-pot piston appears to be satisfactory. The holding mechanism will need to be redesigned to fit into the space now available after modifications considered for the other components of the external blanket cup.

Fuel Rod Scanner (W. H. McCorkle and C. A. Benz)

The electrical scanning device, mentioned in ANL-4238, for examining liquid (NaK) bonded fuel rods has been equipped with a d-c amplifier and an Esterline Angus recorder to draw a graph of the variation of the voltage drop per 1/8-inch along the entire length of the liquid bonded portion of a fuel rod as a steady electrical current is run through the rod.

Comparisons and checks have been made with x-ray pictures of several liquid bonded fuel elements. Good agreement has been observed in all cases where the x-ray method has been sufficiently sensitive to show the position of a meniscus. This electrical scanning method is sufficiently sensitive to indicate reliably the position of a meniscus which may not be detectable by x-ray photography. This, it appears, will be true when the NaK meniscus is in the fluted bypass portion of a fuel rod.

An improved scanning head which has been designed will be built soon and installed to make the operation of this inspection means easier and more rapid.

Heavy Water Filter System for the CP-3 Reactor (W. H. McCorkle and C. A. Benz)

A stainless steel filter manifold has been fabricated and installed as a bypass in the heavy water circulating system of the CP-3 reactor.

The filter manifold is designed to hold six porcelain biological filter candles mounted in easily removable stainless steel baskets. The

six candles are arranged in parallel to obtain the desired flow rate at moderate operating pressures.

During the first week of operation of the filters three sets of filters were used and the spectroscopic analysis indicated that the aluminum content of the heavy water was reduced from 120 ppm to 50 ppm. Continued operation is steadily improving the aluminum content of the heavy water so that within a few weeks it should be possible to put in operation some columns containing ion exchange resins for removing the other contaminants from the heavy water. Preliminary work is underway on the ion-exchange resins application.

Operating Report on CP-3 (W. H. McCorkle and C. A. Benz)

During the 3 month period from December 1, 1948 to February 28, 1949 the heavy water pile of the Argonne National Laboratory was operated at an average power of 250 kw for 1268 hours to give a total energy developed of 317,170 kwh. Neutron beams were supplied for numerous experiments and, in addition, a total of 203 samples were irradiated, consisting of 168 samples for the Argonne National Laboratory and 35 samples for participating universities and other institutions.

During December an insidious leak was detected which had apparently taken air into the heavy water system since the early history of the pile. This leak was successfully stopped and the purity of the helium atmosphere above the heavy water is now easily maintained in the 96% to 99% range using little more than one cylinder of helium per month.

DECLASSIFIED