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USAEC - AECL COOPERATIVE PROGRAM AND HEAVY WATER REACTOR PROGRAM MONTHLY PROGRESS REPORT

June 1968

Compiled by:

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Technical Information Service

This document is furnished pursuant to the memorandum of understanding of June 7, 1960, between the U. S. and Canadian Governments establishing a Cooperative Program on the development of heavy water moderated power reactors.

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Savannah River Laboratory
Aiken, South Carolina 29801

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REACTOR PHYSICS EXPERIMENTS

B. C. Rusche

USAEC/AECL COOPERATIVE PROGRAM

Temperature Coefficients Measurements (TAC 5.2)

INTRODUCTION

Measurements of the temperature coefficient of reactivity for organic-cooled lattices with natural uranium oxide and simulated burned-up UO_2 fuel will be made in the SE in June 1968.

SUMMARY

Measurements of the uniform temperature coefficient of a simulated burned-up UO_2 lattice at pitches of 12.12 inches and 9.33 inches have been completed as well as foil irradiations at 23 and 80°C.

DISCUSSION

Measurements of the uniform temperature coefficient of reactivity have been performed for a D_2O-cooled lattice of simulated burned up UO_2 fuel in the SE. The fuel assembly consists of 31 fuel rods with Pu/U weight fraction of 0.00259. The lattice contained 19 assemblies on a 12.12-inch- and a 9.33-inch-triangular pitch. Results of the measurements on the 12.12-inch pitch have been reported and analysis of the 9.33-inch pitch measurements is underway.

Detailed foil activation measurements have been performed at both 23 and 80°C for both the 12.12-inch and 9.33-inch pitches. Analysis of the data obtained is currently underway.

U. S. HEAVY WATER REACTOR BASE PROGRAM

INTRODUCTION

The experimental HWR program for FY-68 consists of measurements in the SE on assemblies with simulated boiling H_2O coolant. Evaluations of control rod strategies for coping with xenon oscillations are scheduled for the PDP.

SUMMARY

Measurements have been completed for the simulated boiling H_2O cooled assemblies in the SE at pitches of 12.12 inches and 9.33 inches.

DISCUSSION

Material buckling measurements have been performed using four coolant materials to mockup boiling light water coolant. The fuel assembly consists of 31 rod clusters of a burned-up fuel mockup with Pu/U weight fraction of 0.00259.

The measurements made on a lattice pitch of 12.12 inches have been reported. Measurements made on a lattice pitch of 9.33 inches were completed using 19 of the above fuel assemblies in a host lattice of 12 natural UO_2 assemblies in the SE. Analysis of the data obtained is currently underway.

SECTION II

DEUTERIUM EXCHANGE PROCESS

M. Benedict
Nuclear Engineering Department
Massachusetts Institute of Technology

INTRODUCTION

The object of the work is to find promising leads for processes by which heavy water can be produced at a cost substantially below $20/lb. During the first part of this program, a preliminary engineering and economic analysis will be made of variants of the three following exchange processes for concentrating heavy water:

a) ammonia-hydrogen exchange.

b) water-hydrogen exchange.

c) water-hydrogen sulfide exchange.

This work is being carried out under a subcontract to the Du Pont Company.

Ammonia-Hydrogen Exchange

The three principal sections of a chemically refluxed ammonia-hydrogen exchange plant for concentrating deuterium are the ammonia-synthesis section for making ammonia liquid reflux, the ammonia-hydrogen exchange section, and the ammonia-cracking section for providing hydrogen vapor reflux.

Work on the ammonia-synthesis section has been completed, for the time at least, with issuance of a memorandum by Chow and Benedict, in which the cost of producing ammonia at minimum reflux ratio was estimated to be:

	Cost of making reflux, $/lb D_2O	
Tower pressure, psig	366	2000
Fixed charge rate, per year		
0.10	4.26	2.76
0.15	5.15	3.51
0.20	6.05	4.25
0.25	6.95	5.02

For the ammonia-hydrogen exchange section, literature data on liquid-vapor equilibrium in the system $3H_2$:$1N_2$-ammonia has been correlated and presented in a form for convenient use in process calculations in a memorandum by Mr. E. Chow. Procedures for estimating the plate efficiency in an exchange tower in which HD is to be absorbed in a solution of potassium amide in ammonia are being developed and checked against literature experimental data. Provisional tower calculations are being made at 150 atm.

For the ammonia-cracking section, literature data on the dependence of the ammonia-synthesis equilibrium constant on temperature and pressure have been worked up, and enthalpy data on mixtures of ammonia synthesis gas and ammonia are being developed.

Chemical Reflux for Water-Hydrogen Sulfide Process

Mr. Jeffrey Bromberg, a first-year graduate student, has elected to undertake a Master's thesis on the thermodynamic properties of inorganic oxides and sulfides. The object of this work is to determine the equilibrium constant for inorganic reactions of the type

$$MS + H_2O \rightleftharpoons MO + H_2S$$

over a wide temperature range. The best pair of inorganic sulfides and oxides would be those for which the equilibrium constant was appreciably greater than unity at one temperature and appreciably lower than unity at another; they could then be used to provide reflux at both ends of a chemically refluxed water-hydrogen sulfide exchange tower for concentrating deuterium. First results are not encouraging, as all inorganic sulfides for which thermodynamic data are readily available are either too stable in the presence of steam or too unstable to be useful for this purpose.

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