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INTERIM REPORT

MONTHLY HIGHLIGHTS
April 1980*

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Experimental burnoff profiles of PGX graphite specimens oxidized in $H_2O/H_2/He$ are being fitted to expressions incorporating two reaction zones. Two parallel reaction/diffusion pathways (pore networks) are assumed, which leads to expressions of the form

$$B_i = \frac{a}{r_i} I_1(r_i/L_1) + \frac{b}{r_i} I_1(r_i/L_2)$$

where B_i is the total burnoff of the machined specimen reduced to a radius r_i, L_1 and L_2 are the diffusion lengths of the reactant gas in the two pore networks, I_1 is the hyperbolic Bessel function of the first kind of order 1, and a and b are constants. Nonlinear least squares analyses of the data give reasonably good fits to this expression in most cases. The large scatter in the data, however, suggests that larger specimens (e.g. 8 cm ϕ x 8 cm) be oxidized to extend the tails of the profiles and that lower temperatures be used to increase the precision of the burnoff values near the surface. Weighting of the data to compensate for inequalities in their uncertainties will also be done in subsequent calculations.

The large Uniform Flow Apparatus is under construction. Up to eight specimens cm ϕ x 8 cm can be accommodated and oxidized uniformly (for several months if necessary) at a temperature as high as 1000°C. The first experiments are expected to begin near the end of May.

Atomic absorption analyses of large oxidized specimens of PGX graphite were halted after numerous delays and revisions in cost estimates. Quantitative analyses for sulfur, silicon, titanium and aluminum are being carried out in the BNL Analytical Chemistry Group; barium, calcium, copper, iron, potassium, magnesium, nickel, and strontium will be determined elsewhere.

Scanning electron microscope/microprobe analyses were recently completed on a series of aged 2-1/4 Cr - 1 Mo steel specimens which had been fatigue tested in the "old" wet helium environment at 538°C (1000°F). This material is particularly interesting since it has only a small amount of chromium to impart corrosion resistance, and is not expected to form a very protective chromium oxide scale on the surface. In the presence of an applied stress it was expected that spallation of iron oxide scale could give accelerated corrosion and early fatigue failure. It was found that for short term tests in the wet helium an iron oxide does form with little chromium oxide present. For samples preaged for 3000 h at 538°C in the test helium prior to fatiguing, two oxides are present - an inner thin chromium oxide and a porous iron oxide. For samples preaged for 6000 h, the iron oxide is lost through spallation and a protective chromium oxide is formed. Hence, it may be concluded that although initial corrosion rates in fatigued material are high, long term testing is likely to result in the formation of more stable protective chromium oxides.

Some preliminary data on the high cycle fatigue of Incoloy 800H in the "new" helium test gas which contains 5-10 µatm. of water were recently obtained. The data clearly show that as the test environments get drier the fatigue life is enhanced. There is about one order of magnitude increase in

the fatigue life at 760°C (1400°F) in this environment compared to the old test gas which contained 2500 μatm. of water.

For test times up to about 1400 hours in the new drier helium environment (H_2O level is 5-10 μatm.) no deleterious effects on the creep behavior of Incoloy 800H and Hastelloy X were detected when compared to the old wet environment and air.

A significant improvement in the rupture property has been noted on the Hastelloy X specimen being tested at 760°C at 8 ksi level. This test has been running for over 1400 hours, while the air and the wet helium test ruptured after 637 hours and 617 hours, respectively, for the same temperature and stress level.

This month, continuing with our Fission Product Migration studies, two molybdenum diffusion experiments have begun. Run 41680 was held at 2850°C for 4 hours and Run 42380 was held at 2950°C for 2 hours. These runs are presently undergoing wet chemical analysis.

Continuing our evaluation of the available HTGR safety codes, further sensitivity evaluations have been made with the ORECA code. For these runs the computation algorithm for the flow distribution, during reverse flow in some channels, was revised to account for the appropriate sign in the momentum pressure drop term. Changing the temperatures used in the evaluation of the friction, buoyancy and orifice pressure drop terms, very significant changes of the peak coolant and graphite temperatures were observed for the test case received with the code, exceeding 200F during parts of the transient.

Currently, further runs modifying the solid temperature balance algorithm to use thermal conductivities based on the average temperatures between nodes are being prepared. Upon completion of those runs our results will be presented to ORNL with suggestions for code improvements, and a summary, outlining the limitations of the code.

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