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INTERIM REPORT

MONTHLY HIGHLIGHTS
May 1980*

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*This work was performed under the auspices of the United States Nuclear Regulatory Commission.

Machining of graphite specimens has been resumed now that the precision Swiss lathe has been refurbished. A new tooling lathe has also been ordered to support these efforts.

Atomic absorption analyses of 20-gram portions of oxidized PGX graphite specimens are almost complete. Silicon is the only element which needs to be determined. The Large Uniform Flow Apparatus (LUFA) will be used to ash additional 20-gram portions of the original specimens; this ash will be fused with $NaHCO_3$ and complexed prior to analysis.

H451 specimens 3/4" x 1-1/2" in size have been oxidized in the chemical reaction control regime. As with PGX graphite, no effect on the ultimate compressive strength was observed when stress was applied prior to oxidation. The compressive strength of oxidized H451 graphite appears to be independent of the choice of oxidizing gas (H_2O or O_2) in contrast to the strength of oxidized PGX graphite. The reader will note that in the latter case, at any fixed bulk burnoff level, oxidation with O_2 led to a greater decrease in strength than oxidation with H_2O or CO_2. To date, all studies dealing with the effect of oxidation on the strength of graphite have been concerned with compressive strength. This month we initiated a program to investigate the effect of oxidation on tensile strength. Preliminary data indicate that the decrease in tensile strength of PGX graphite brought about by oxidation in the chemical reaction control temperature regime is consistent with results from burnoff/compressive strength experiments.

The stress apparatus is operational. Gas chromatography is being used to monitor the oxidation rate of PGX graphite specimens exposed to various compressive and tensile stress levels during oxidation. Ultimate strengths of these specimens are also being measured after appropriate burnoffs are obtained.

During this reporting period all in-helium fatigue testing was carried out in the new 5-10 μatm. H_2O environment. Emphasis continued on Incoloy 800H and Hastelloy-X. Compared to testing in air and the old 2500 μatm. H_2O test environment there appears to be a slightly larger amount of scatter in the measured fatigue strengths for cycles-to-failure in excess of about 5×10^6. This could reflect a high sensitivity of fatigue behavior to oxidation in low water environments. Possibly, high water or oxygen levels lead to the rapid formation of stable oxides on the surface so that fatigue life is not influenced by constantly changing oxide morphology. A large number of tests is being carried out in an effort to examine the extent of the scatter in the 5-10 μatm. H_2O environment. Despite the scatter, however, it is clear that low oxidizing environments enhance fatigue life, especially for Incoloy 800H. In this material there is strong evidence for an accelerated loss in strength for fatigue cycles in excess of about 10^7. Experiments are proceeding to pre-expose some fatigue specimens in the test helium prior to fatiguing to determine whether extended corrosion significantly reduces the fatigue strength.

One of the Incoloy 800H long term creep specimens which was loaded to 6.0 ksi in air at 760°C has ruptured after 14,809 hours. The same testing conditions in the old wet helium environment (water level 2500 μatm.) showed a 12,395 hour rupture life. No clear effect of test environment is therefore apparent from these two tests.

Optical and scanning electron microscope/microprobe analyses of two Hastelloy X specimens which ruptured in times less than 1600 hours in the new drier atmosphere (water level 5-10 μatm.) revealed no significant changes of morphology and chemical composition of the oxide scales when compared to equivalent tests in the wet helium.

Continuing our sensitivity evaluations of the existing HTGR safety codes, the exponential solid heat conduction algorithm used in the ORECA code was compared against a conservative finite difference algorithm. The current algorithm was found to be very fast. However, its non-conservatism in stored energy as well as in inter-nodal heat fluxes can induce significant inaccuracies in some transients of interest due to the strong temperature dependence of the material properties. A memorandum summarizing our evaluations of the ORECA code is currently under preparation.

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