MASTER

Program:	Cover-Gas Seals	DOE/SF/71011--T9	
ERDA TASK:	11-LMFBR Seal-Test Program		
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I. PROJECT OBJECTIVES

The objective of the Cover Gas Seal Material Development Program is to perform the engineering development required to provide reliable seals for LMFBR application. Specific objectives are to verify the performance of commercial solid cross-section and inflatable seals under reactor environments including radiation, to develop advanced materials and configurations capable of achieving significant improvement in radioactive gas containment and seal temperature capabilities, and to optimize seal geometry for maximum reliability and minimal gas permeation.

DOE/SF/71011--T9

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II. MAJOR ACCOMPLISHMENTS DURING FISCAL YEAR 1977

The CRBRP Cell Penetration evaluation was completed and the Dow-Corning 93-104 silastic recommended for penetrations with potential exposures to 538C (1000F) and 10^7 J/Kg (10^9 rad) gamma. Additional silastics were found acceptable with gamma exposures of $\sim 10^6$ J/Kg (10^7 rad) or less. The 7000 h, 121C (250F) nitrile and EPDM jacketed U-shape spring seal dynamic tests were completed and demonstrated successful reduction of leakage values over solid cross-section seals. Subcontracts have been issued for EPDM and phosphazene compounding studies and for fabrication of gamma test inflatable seals.

III. PROGRESS DURING THE REPORT PERIOD

A. ADVANCED SEAL GEOMETRIES

The "ferrofluidic" seal test was terminated after 12000 h at 93C (175F). A post-test pressure check of the fixture showed leakage between the seal pole-block and outer housing, not across the "ferrofluidic" seal. This leak was detected during the test, when the chromatograph traces started showing oxygen and nitrogen contamination after ~ 300 h at temperature. The fixture seal was included to enable replacement of the carrier fluid and inner seal and would not be included on system hardware. Analysis of the chromatograph data will enable establishment of the O_2 and N_2 inleakage rate and a H_2 and Kr test gas correction factor. The true H_2 and Kr leakage rates across the inner "ferrofluidic" test seal can then be calculated.

B. ADVANCED MATERIALS

A purchase order was placed with Union Carbide for several 9.0 cm (~ 3.5 in.) x 0.15 cm (0.06 in.) thick slabs of their improved "UCARSIL" carborane-siloxane elastomer for gas permeation and simulated compression set tests.

The maximum use temperature is expected to be only slightly less than the final cure temperature of $\sim 300\text{C}$ ($\sim 575\text{F}$). The actual use temperature, where acceptable permeation and compression set is obtained, will be determined during testing, but may be considerably less than the maximum use temperature. Delivery has been quoted for $\sim 7/15/77$.

The glass reinforced static silicone seal test was terminated after 1200 h at 149C (300F). H_2 and Kr leakage rates were stable during the last ~ 800 h at temperature. A post-test ambient-temperature pressure check showed cross-seal leakage which was the result of seal compression set and the seal-fixture differential thermal expansion during cool down. Actual seal compression set was measured to be 100%. No additional testing is planned as the inability of the seal to provide a gas seal during thermal cycling is basically unacceptable. The low compression set resistance is the result of a high loading of inert fillers which are used to improve gas permeation resistance.

C. GAMMA IRRADIATION

A purchase order was issued to Presray, Pawling, N.Y., to fabricate two sets of nitrile and EPDM inflatable seals for gamma irradiation testing. Each set consists of a 32.0 cm (12.62 in.) and a 38.1 cm (15.0 in.) diameter seal in the configuration of Figure 1. Delivery of seals is scheduled for mid-August.

Tensile and elongation tests were run on control and post-irradiated silicone, nitrile, urethane, and EPDM elastomer O-rings. Consistent with generally available data, the percent elongation decreased as a function of gamma dose. Table I summarizes the change in elongation measured. The silicone O-rings exposed to 5×10^5 J/Kg (5×10^7 rad) and 10^6 J/Kg (10^8 rad) broke during removal from the test fixture.

GAMMA TEST INFLATABLE SEAL CONFIGURATION

Figure 1.

TABLE I
EFFECTS OF GAMMA IRRADIATION ON ELASTOMER ELONGATION

Material and Compound No.	Elongation Prior To Test (%)	Change in Elongation (%)			Temp.
		10^5 J/Kg	5×10^5 J/Kg	10^6 J/Kg	
Nitrile (Parker N741)	101	-20	-43	-58	66C (150F)
EPDM (Parker E692)	257	-35	-58	-78	66C (150F)
Urethane (Parker P642)	375	-65	-75	-13	66C (150F)
Silicone (Parker 5684)	120	-73	*	*	149C (300F)

* O-ring broke during removal from test fixture

D. CRBRP CELL SEALANT EVALUATION

This activity was completed last quarter and is discussed in AI-ERDA--13195.

III. IMPACT ON LMFBR PROGRAMS

The initial phases of this program have guided selection of materials and seals for the FFTF and CRBRP from information on permeability, compression set, and gland design published in progress and technical reports.

Designs of the FFTF IVHM inflatable and primary seals were verified. Other phases have verified the instrument tree inflatable seal design and are evaluating the use of inflatable seals for CRBRP. Effects of sodium vapors and aerosols and radiation on the sealing efficiency of elastomers will be delineated. Advanced seal geometries and materials will be developed to overcome the commercial seal deficiencies of excessive compression set (short maintenance cycle) and permeation. Specifications and design guide for use in the LMFBR industry will become available and will be updated as new information is generated.

IV. NEXT REPORT PERIOD ACTIVITIES

Test slabs of the improved carborane-siloxane elastomer will be received and gas permeation and compression set resistance tests initiated. Sub-contractor conducted compounding studies will be completed on the EPDM and polyphosphazene elastomers and performance evaluations will be initiated at AI. Gamma test seals will be delivered, test fixtures fabricated, and gamma exposure initiated.