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MATERIALS RESEARCH FOR THE CLEAN UTILIZATION OF COAL

Quarterly Progress Report

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I. SUMMARY OF PROGRESS TO DATE

Brief Summary

1. Materials Performance and Properties (H. M. Ondik, B. W. Christ, and A. Perloff).

Completed sections of the book, "Construction Materials for Coal Conversion--Performance and Properties Data", have been submitted to readers, and corrections and changes are being made in the manuscript. Several remaining subsections are being completed. Normal activities of the Data Center with regard to handling of reports and data and responding to queries have been conducted.

2. Creep and Related Properties of Refractories (N. J. Tighe, C. L. McDaniel and S. M. Wiederhorn)

Specimens from the five fused cast refractory bricks were tested under unit creep to determine the upper temperature limit for use without appreciable creep.

TABLE OF CONTENTS

II. DETAILED DESCRIPTION OF TECHNICAL PROGRESS

1. Materials Performance and Properties (H. M. Ondik, B. W. Christ, and A. Perloff)

Progress:

Major emphasis this quarter has continued to be the compilation of the book, "Construction Materials for Coal Conversion--Performance and Properties Data." The present version of the manuscript (over 600 pages) has been reviewed by readers who are well qualified in metallurgy and refractory science. Suggested changes and corrections have been made. The current status of the subsections mentioned in the last quarterly report as being in progress is as follows: the two refractories subsections are complete and are being reviewed by the readers; the discussion of materials tested for aqueous corrosion resistance is half finished; the subsections dealing with in-plant service performance of materials in various components of coal gasification pilot plants is only partially complete. Preparation of the final version of the index is dependent upon completion of these subsections. A cover design for the looseleaf binder of the book was submitted to the DoE sponsor, and approval has been given for the use of the design.

Appreciable time was spent in performing a number of searches of the plant performance computer data base, not only in order to respond to queries received this last quarter, but also to update and maintain an office file of copies of the various sort lists which can be obtained from the computer. Ten different variations of the data base contents have been printed and filed.

The regular activities of the Data Center, as outlined in previous reports, have continued: receiving and cataloging of DoE materials research contractors' reports, answering queries, and abstracting data.

Plans:

The complete manuscript of the book, "Construction Materials for Coal Conversion--Performance and Properties Data," will be sent to the sponsor. The regular activities of the Data Center will continue.

2. Creep and Related Properties of Refractories (N. J. Tighe, C. L. McDaniel and S. M. Wiederhorn)

Progress:

The slabs of the five fused cast refractories were cut into bars 5 X 10 X 50 mm. Because of porosity in the refractories, the number of bars cut from each slab varied from 50-100. The bars were ground longitudinally and were numbered according to their position in each slab. They were chosen for testing in accord with a set of generated random numbers. The bars were tested in four-point bend configuration using alumina fixtures. For the dynamic modulus of rupture tests, six specimens were broken at 25 °C; and three specimens were held at 1000 °C or 1100 °C for one hour before breaking. For the initial creep tests, bars were held under static load of 10 MPa (1400 psi) for 24 hours at temperatures from 800 °C to a maximum of 1400 °C. The temperature was increased 100 °C after 24 hours until at least one of three specimens showed rapid creep or failed by creep rupture. This mode of testing was used to establish quickly the maximum use temperature.

The data are summarized in Table 1. The creep behavior of the alumina-zirconia-silica (AZS) (CS-3) samples was discussed briefly in the last report. The AZS samples failed at 900 °C when the glassy silicate phase softened. Thus, although the material has high strength under rapid loading conditions, it has essentially zero strength under static load conditions at temperatures $\geq$ 900 °C. The other four refractories in Table 1 retained some strength under static load of 10 MPa at temperatures up to 1400 °C.

Table 1. Summary of Strength and Static Load Tests

Material	Modulus of Rupture, Dynamic MPa		Creep Failure Temperature °C	Creep Failure Static Load MPa
	25 °C	1000 °C		
AZS Monofrax CS-3	93.0 ± 7.5	109.0 ± 13.8	900	10
	25 °C	1100 °C		
α + β Al_2O_3 Monofrax M	38.1 ± 1.9	36.2 ± 3.0	1400	10
α Al_2O_3 Monofrax A	64.6 ± 5.6	52.3 ± 1.8	1300	10
Cr-Aℓ Spinel Monofrax E	37.0 ± 2.4	47.5 ± 4.3	1400	10
Cr-Aℓ Oxide Monofrax K-3	42.2 ± 3.4	27.3 ± 10.0		

Plans:

The creep rates will be obtained using different static loads near the maximum use temperatures. The microstructure will be examined by light and scanning electron microscopy to identify the failure sites.