Quarterly Management Report

WBS Element	Project Title	Contract Number	Contract Start	Contract End
ARC-1	Low-Chrome/Chrome Free Refractories for Slagging Gasifiers	FE-04-02	10/01/98	09/30/04

Performer Name and Address	Principal Investigator(s)
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BUDGET AND COST REPORT

Prior Year Funds [$K]	0
Total Current Year Commitment $K]	100
Projected Current Year Costs [$K]	100

	O	N	D	J	F	M	A	M	J	J	A	S
Planned Costs	5	10	15	20	40	60	70	80	85	90	95	100
Actual Costs	0	0	0									
Variance	5	10	15	20	40	60	70	80	85	90	95	100

MILESTONE REPORT

Milestone Designation	Milestone Description	Due Date	Revised Due Date	Completion Date
	Identify potential low-chrome/no-chrome oxide refractory materials with a high probability of success for laboratory testing in simulated gasifier environments.	12/31/03		12/31/03
	Develop laboratory tests to evaluate critical low-chrome/no-chrome oxide refractory properties needed for use in slagging gasifiers.	03/31/04		
	Fabricate 1st generation test samples of low-chrome/no-chrome oxide materials identified as having a high probability of success in slagging coal gasifiers.	06/30/04		
	Evaluate the laboratory performance of 1st generation low-chrome/no-chrome refractories in simulated coal gasifier environments.	09/30/04		

TECHNICAL HIGHLIGHTS

Refractory liner materials currently utilized in slagging gasification systems are composed of dense firebrick with a composition of Cr_2O_3 (60 to 90 wt pct) and a second refractory oxide (typically Al_2O_3, ZrO_2, or MgO). Experience indicates that the high Cr_2O_3 content is necessary for the best refractory service life, with high-wear areas in the gasifier requiring a minimum of 75-wt pct Cr_2O_3. Refractory compositions used by industry fall into three specific types: Cr_2O_3 – Al_2O_3, Cr_2O_3 – Al_2O_3 - ZrO_2, and Cr_2O_3– MgO. Refractory failure is typically by spalling and/or corrosive wear. Early attempts to develop effective non-chrome oxide refractories for this application were hampered by a lack of understanding of the failure mechanisms in slagging gasifiers, by raw material purity issues, and by the superior performance of existing Cr_2O_3 refractories. However, high Cr_2O_3 refractories are expensive and the potential health problems associated with exposure to Cr-containing materials make long-term use of these refractories less desirable. In addition, the service life of current generation high-Cr_2O_3 refractories is far less than that desired by the gasifier industry.

A review of historical research on non-chrome slagging gasifier refractories indicates problems with slag corrosion, and/or reactions between the slag components and the refractory, as service limiting issues. At ARC thermodynamic studies are being used to evaluate the relative potential of refractory oxide/non oxides as hot-face liner materials in gasifier environments, although information gathered in this type of study must be interpreted with caution because it does not take into account reaction kinetics, only what is thermodynamically possible. Existing phase diagram information is also being used to help identify possible candidate liner materials. Samples of several types of refractory materials were obtained from refractory manufacturers to validate performance data predicted by thermodynamic and/or phase diagram information. Candidate materials evaluated to date include refractories provided by Minteq (MgO/Al_2O_3 spinels) and by A.J. Weller (high Al_2O_3 materials with/without SiC). Other possible materials have been identified for preliminary testing, including ZrO_2 with different secondary additives, Al_2O_3 with secondary additives such as ZrO_2, and other oxide/non-oxide materials with/without secondary additives. Fabrication and testing of several refractory compositions identified as having good potential is currently underway. Completed studies of two candidate materials are described below.

The performance of refractory samples from Minteq consisting of a second generation MgO/Al_2O_3 (MA) were evaluated by rotary slag testing for 8 hours at 1650oC, using a commercial coal-based gasifier slag. Samples containing MA spinel experienced severe wear of the intergranular bonding material, resulting in the release of large aggregate grains (approximately 7 mm in size) into the slag during testing. Approximately 10-15 pct of the hot face refractory depth was removed from the MA refractory surfaces during testing. In contrast, no slag wear was observed in the high-Cr_2O_3 materials included in the test as a reference. Based on these results, refinements are being made to the MA refractories to reduce grain size and to identify different bond matrices that will be less susceptible to the gasifier slag. No thermal shock cracking was observed in the MA material, whereas extensive cracking was detected in many of the chrome-based refractories.

Cup tests were conducted on two types of high alumina materials produced by A.J. Weller. Samples with a high alumina composition exhibited significant slag penetration into the refractory and high sample dissolution into the slag. Tests of high alumina materials with SiC grain exhibited severe slag foaming, caused by the interaction of FeO in the slag with the SiC, releasing CO gas. This reaction also produced additional SiO_2 in the slag, which would increase its corrosivity with respect to the high alumina matrix. Because both types of samples exhibited high wear when exposed to the gasifier slag, and because the formation of CO is not desirable, further studies of these materials were discontinued.

ISSUES

Report Prepared By	Date
Cynthia Powell Dogan and James Bennett	01/21/04