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)
Albany Research Center 1450 Queen Ave. SW Albany, OR 97321	Cynthia Powell James Bennett

BUDGET AND COST REPORT

Prior Year Funds [$K]	
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	10	10	20						
Variance	5	10	15	10	30	40	70	80	85	90	95	100

MILESTONE REPORT

Milestone Designation	Milestone Description	Due Date	Revised Due Date	Completion Date
ARC-4-1	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
ARC-4-2	Develop laboratory tests to evaluate critical low-chrome/no-chrome oxide refractory properties needed for use in slagging gasifiers.	03/31/04		03/31/04
ARC-4-3	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		
ARC-4-4	Evaluate the laboratory performance of 1st generation low-chrome/no-chrome refractories in simulated coal gasifier environments.	09/30/04		

TECHNICAL HIGHLIGHTS

High chrome oxide materials currently used as liners in coal and pet-coke slagging gasifiers have been found through experience to have the longest service life of any refractory material. The evaluation and development of refractory liner materials for slagging gasifiers has taken place over more than thirty years, with a minimum chrome oxide content of 75 pct thought necessary to achieve the best material performance. Even utilizing chrome oxide materials, refractory failure occurs in some locations of a gasifier in as short as 3 months, with other areas lasting no more than 18-24 months. Gasifier users would like a lining with a service life of at least 3 years. The primary causes limiting refractory service life are corrosion and spalling. Refractory failure by spalling is exasperated by frequent gasifier shutdowns related to other downstream issues. Refractory materials that do not contain chrome oxide or are low in chrome oxide are being considered as a replacement for high chrome oxide refractories for a number of reasons, including: 1) the high cost of chrome oxide refractories, 2) the potential for the formation of hexavalent chrome during service, an environmental carcinogen that may cause the spent refractory to be classified as a hazardous waste, 3) the difficulty in sintering high chrome oxide materials, and 4) the fact that high Cr_2O_3 refractories have not met the performance requirements of gasifiers. An increased understanding of high temperature material science, an increased understanding of how to design and use refractory materials in gasifiers, and better control and understanding of the gasifier and its operation should lead to improved non-chrome oxide /low chrome oxide refractories replacements for the Cr_2O_3 materials currently used in gasifiers.

A number of refractory compounds have potential for use as hot face liner materials in gasifiers. Material selection is being made through a combination of literature reviews, phase diagram research, and an evaluation of thermodynamically stable materials at gasifier service temperatures/conditions. Some of the specific oxide compounds identified as having potential as either aggregate or matrix materials include ZrO_2, TiO_2, Al_2O_3, SrO_2, phosphates, and/or mixtures of them. Other materials including nitrides are being considered. The goal of this research is to form new or improved refractory compounds with controlled and/or advanced microstructures. Samples with low Cr_2O_3 content (less than 30 wt %) will be evaluated only after non-chrome containing materials have been considered.

After the above "paper" study identifies candidiate materials, the test sequence for evaluating materials involves the laboratory manufacture of small "cups," which are used to study interactions between slag and refractory material at elevated temperatures. Scale-up testing to larger and more traditional cup tests will be conducted on materials identified as having good refractory/slag interactions in the small scale sample studied. The goal of cup tests is to initially evaluate sample composition in the form of a fine grain matrix, with later emphasis focussed on controlling overall grain size and composition of the refractory components for particle packing, densification, and the interactions between the fine grained matrix and the coarse grain aggregate with slag. Samples that have encouraging properties will be scaled-up into full sized refractory samples for evaluation of physical properties. Physical property testing will include density, porosity, crushing strength, creep under load at elevated temperature, and slag resistance testing in the rotary slag test.

The small "cup" test evaluation is currently underway to evaluate material interactions with coal gasifier slags at elevated temperatures. Interactions between the slag and the test material are being evaluated by visual observations (degree of slag/refractory interaction by melting), by slag penetration, and by x-ray crystalline phase identification of new compounds or mineral phases that are created. Mixtures of two or more refractory materials are made to produce new refractory microstructures with a controlled coarse size fraction and a fine particle microstructure to help control slag attack and slag penetration of the matrix. Some materials with encouraging results have already been identified for further testing. Earlier work on Al_2O_3/MgO spinels that showed low penetration curing cup tests but poor wear resistance during rotary slag testing are being evaluated to determine if compositional changes or changes in the microstructure are possible to improve the performance of these materials.

ISSUES

Report Prepared By	Date
James Bennett and Cynthia Powell	05/25/04