Quarterly Management Report

WBS Element	Project Title	Contract Number	Contract Start	Contract End
	Metallic Filters for Hot Gas Cleanup	W-7405-Eng-82	10/01/99	09/30/04

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

Prior Year Funds [$K]	39
Total Current Year Commitment $K]	150
Projected Current Year Costs [$K]	150

	O	N	D	J	F	M	A	M	J	J	A	S
Planned Costs	12	25	37	50	63	75	88	100	112	125	138	150
Actual Costs	10	19	36	47	58	76	0	0	0	0	0	0
Variance	2	6	1	3	5	(1)	88	100	112	125	138	150

MILESTONE REPORT

Milestone Designation	Milestone Description	Due Date	Revised Due Date	Completion Date
FY04-1	Select IGCC alloys after highly sulfidizing corrosion testing at 650°C	11/30/03	12/31/03	12/31/03
FY04-2	Test IGCC alloys in simulated downtime corrosion conditions at 650°C	12/31/03	02/27/04	02/27/04
FY04-3	Produce ultrafine powder as baseline of modified Fe3Al for H2 membranes	03/31/04		03/31/04
FY04-4	Determine HPGA tilt furnace and tundish design to obtain quotes for costs	06/30/04		
FY04-5	Produce thin porous sheets with 1-2 µm pores from ultrafine powders	09/30/04		

TECHNICAL HIGHLIGHTS

The final round of laboratory hot (650°C) corrosion testing was designed to simulate 4 cycles of downtime corrosion (due to acidic condensation) in a total of 500 h of exposure by application of an HCl-water solution (pH=2) spray after every 100 h hot exposure interval, during ambient temperature handling (for weighing). The hot exposure was conducted in a simulated IGCC atmosphere with an enriched (2000 ppm) SO2 content and involving 6 bulk (cast) alloys (in wt.%): (1) Ni-16Cr-4.5Al-3.0Fe (Haynes 214), (2) Fe-15.8Al-2.2Cr-0.2Zr (Fe3Al), (3) Ni-16Cr-9.0Al-3.0Fe (Haynes 214+2xAl), (4) Ni-16Cr-9Al (two-phase ternary), (5) Ni-16Cr-7.9Al (single-phase ternary), and (6) Ni-Cr-Al-10Mo (ternary+10Mo). All alloys were tested both with and without the HCl spray exposure. In general, all alloy samples gained weight ,where the samples exposed to HCl spray gained more weight than the unsprayed alloy partners. The alloys 1, 4, and 5 gained the most weight (>30 mg/cm2) in the HCl spray after 500 h, compared to alloys 2,3, and 6, which gained <10mg/cm2. Without HCl spray, the alloys 4, 5, and 6 gained the most weight (>6mg/cm2) after 500 h, compared to alloys 1, 2, and 3, which gained <1mg/cm2. In the baseline sample, 1, that ran in this test and the previous test, the HCl spray effect appeared to be much greater, an increase of about 30mg/cm2, compared to about 12mg/cm2, respectively, illustrating the importance of relative measurements within one test. Of the best, the alloys 2 and 3 seem to be essentially equivalent in superior resistance to HCl spray (downtime) corrosion resistance, with the alloy 6 is clearly reduced in resistance, but having some promise. These results suggest that an elevated Al content provides a clear advantage in resistance to downtime corrosion, but that the influence of minor alloying additions to modify the initial alumina oxide scale remains to be studied in the single-phase ternary with reduced Mo (alloy 6). Thus, alloys 2 and 3 can be recommended for future trials in powder form for IGCC applications (<650°C) with significant downtime corrosion problems and alloy 3 would be preferred (due to high temperature strength) if higher temperature excursions may be encountered. The enhanced ductility of alloy 3 may lead to a preference for IGCC applications in some hot gas filter configurations, as well. An invited presentation was delivered at the TMS Annual Meeting in Charlotte in March on this work, including o-ring sample test results from the coal/biomass-fired SFS unit at EERC. A presentation and conference proceedings publication will be delivered at the APMI/MPIF annual meeting in Chicago in June on this work, as well.

The enhanced production of ultra-fine powders of high temperature alloys with dia. < 10 µm was chosen for an initial objective of the new research thrust involving improved powder processing for various fossil energy applications, Such powders can be used for development of porous sintered metallic support structures for inorganic (ceramic) hydrogen separation membranes, in a laminate type of composite structure, that are used in coal-fired IGCC applications. Since a physical separation principle is the primary mechanism for this type of composite membrane, it is critical in the metallic support structure to promote permeability (through pore contiguity and reduced wall thickness), while reducing pore size to provide sufficient mechanical support for the thin (less than 2 µm), porous (less than 2 nm pore dia.) ceramic membrane phase. With a properly designed porous ceramic layer coupled to the metallic support structure, the composite membrane can exhibit a maximum permeance for hydrogen with a maximum separation factor for other contaminating gases, e.g., COx, NOx, and SOx. These requirements indicate that spherical ultra-fine metallic powders of high temperature, corrosion resistant alloys would be preferred, but this type of powder is a commercial rarity. Thus, a simplified iron aluminide alloy, Fe-16Al-2Cr, was selected for experimental powder production as a model system for use in membrane support structures because of its resistance to IGCC environments and compatibility with current ceramic membrane choices. Gas atomization nozzle developments for this purpose have focused on bench testing of a new nozzle with twice the previous gas flow of previous nozzles, especially for moderate pressure (<3MPa) operation, typical of commercial operations. Also, a novel melt pour tube shape has been developed for improved melt filming and atomization uniformity. To provide a baseline for testing the future nozzle developments, a current atomization nozzle was used for high pressure (5.5MPa) He gas atomization of the iron aluminide alloy with a high pressure gas atomization nozzle in common use in our laboratory. Size distribution analysis of the resulting powder revealed that the d(50) or average particle dia. (by wt.) was 14.4 µm, but with a fairly broad geometric standard deviation of >15, as calculated by d(84)/d(50). Commercial yields of dia. < 15µm dia. powders of such alloys are often far less than 10%, for comparison, using either Ar or N2 atomization gas. Air classification and sieving were used to obtain several size fractions for subsequent experiments on partial sintering of porous samples, e.g., 1-5µm and 3-10µm. SEM analysis permitted verification of the spherical shape and size of the size classified powders. While some small quantities of the initial powder samples can be provided to ORNL and others for preliminary testing, a larger run (6X) under similar conditions is planned for the next quarter to provide more useful trial quantities of size classified powder. This initial work will be reported as part of a presentation and conference proceedings publication at the APMI/MPIF annual meeting in Chicago in June.

ISSUES

In this second report on our redirected ARM project entitled, “Improved Atomization Processing For Fossil Energy Applications,” results on final completion of the milestones for the hot gas filter work are reported, along with new efforts to develop atomization processing for a selected fossil energy application involving ultrafine powders. The coming quarter will involve the design and specification of a significant upgrade of the alloy melting capacity of our existing high pressure gas atomization system to enable assembly of an accurate estimate of the equipment funding needed to complete the upgrade. Preliminary discussions with equipment vendors suggest that an amount in excess of $400K will be needed, but several options need to be researched.

Report Prepared By	**Date**
I.E. Anderson	05/28/04