PROJECT DATA

University of Dayton - 02GO12051

Monitoring of Refractory Wall Recession Using High Temperature Impact-Echo Instrumentation

Recipient:	University of Dayton	Instrument Number:	DE-FG36-02GO12051
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Subcontractor(s):		B&R Number(s):	ED190602
		PES Number(s):	02-2140
EERE Program:	Industrial Technologies	State Congressional District	OH - 3

PROJECT SCOPE: The objective ot the project is to design and build several high temperature impact-echo transducers to demonstrate their use for measuring the wall thickness of refractory walls used in glass furnaces. Equipment developed will be a pre-prototype system, which may be suitable for industrial trials with only minor refinements. Lifetime extension is hard to estimate but it is assumed an extension of ten percent in refractory life suggests savings of approximately 1.3 billion Btu per year, per unit and a ten percent reduction in landfill disposal of used refractories.

FINANCIAL ASSISTANCE

Approved DOE Budget	$39,939	Approved DOE Share	$39,939
Obligated DOE Funds	$39,939	Cost Share	$0
Remaining Obligation	$0		
Unpaid Balance	$0	**TOTAL PROJECT**	**$39,939**

Project Period: 9/15/02 - 9/30/03

TECHNICAL PERFORMANCE
DE-FG36-02GO12051
University of Dayton
Monitoring of Refractory Wall Recession Using Radar Techniques

PROJECT SYNOPSIS

The objective is to design and build several high-temperature impact-echo transducers and to demonstrate their use for measuring the wall thickness of refractory walls used in glass furnaces. The equipment developed under this effort will be a pre-prototype system, which may be suitable for industrial trials with only minor refinements.

Energy and cost savings are expected to result from this technology through the ability to actively monitor the health of refractory walls, leading to more efficient operation, longer in-service time and fewer unplanned equipment shutdowns. Lifetime extension is hard to estimate, but it will be assumed that an extension of ten percent in refractory life would suggest savings of around 1.3 billion Btu per year, per unit. Extending the life of a furnace undergoing balanced wear by ten percent results in a proportionally reduced need to landfill or otherwise dispose of used refractories.

SUMMARY OF TECHNICAL PROGRESS

Two basic configurations of piezoelectric film were evaluated for sensitivity as an impact-echo transducer. The first was very basic and designed as proof-of-concept. The second configuration was designed to be incorporated into a practical sensor. The test results were good for concrete and other materials with a relatively low wave speed.

This project was focused on developing a functional piezoelectric Aluminum Nitride (AIN) film for use in a high-temperature transducer. The elevated temperatures caused problems in film adhesion to titanium substrates. Therefore, tungsten carbide substrates were produced for use in the impact-echo sensors. A transducer was designed for continuous use up to at least 600^{o}C. Higher temperatures are likely possible, though the inconel springs may show some creep relaxation. Slabs of Alumina-Zirconia-Silica (AZS) refractory material were acquired by researchers at the University of Missouri-Rolla. The slabs varied in thickness from 40 to 80 mm. Impact-echo testing had similar results as those from the commercial transducer, possibly due to the high density material properties. It may still be possible to use impact-testing on AZS material if the sample is much larger.

The AIN transducer was tested at elevated temperatures, but the results were poor as the transducer failed to produce usable signals. With the current design, the desired operating range appears to be limited to 200^{o}C or below. The AIN sensor was then evaluated for use in traditional ultrasonic measurements due to the high density of the refractory material. Problems were found when the AIN transducer became lost in the noise during temperature increase. The University of Dayton concluded that high-temperature AIN transducers and an impact-echo method to monitor refractory wall recession does not appear to be practical. The impact-echo method does not work well for refractory materials such as AZS and the AIN transducers were inefficient for the reception of impact-echo energy. Future promise may be found using AIN transducers and ultrasonic methods.

SUMMARY OF PLANNED WORK

The project is complete. The Final Report was submitted in March 2004.

PROJECT ANALYSIS

The project is complete and in closeout.

ACTION REQUIRED BY DOE HEADQUARTERS

No action is required from DOE Headquarters at this time.

STATEMENT OF WORK
DE-FG36-02GO12051
University of Dayton
Monitoring of Refractory Wall Recession Using Radar Techniques

Detailed Task Description

Task 1. Completed Transducers

This task is the critical point at which the elevated temperature impact-echo transducers will be fully assembled and ready for testing. A number of tasks will be completed leading up to this point:

- Technology Survey
- Transducer Design
- AlN Film Deposition
- Parts Procurement
- Transducer Assembly

Task 2. Bench-Scale Testing Complete

This is the point at which the transducers have been tested at ambient and elevated temperatures in University of Dayton's laboratory. Testing will be extended to simulate the operating temperature expected at the oxyfuel furnace outer wall during:

- Room Temperature Testing
- Elevated Temperature Testing
- Final Configuration

Task 3. Furnace Testing Complete

This is the point at which the transducers have been tested at University of Missouri – Rolla's oxyfuel furnace.

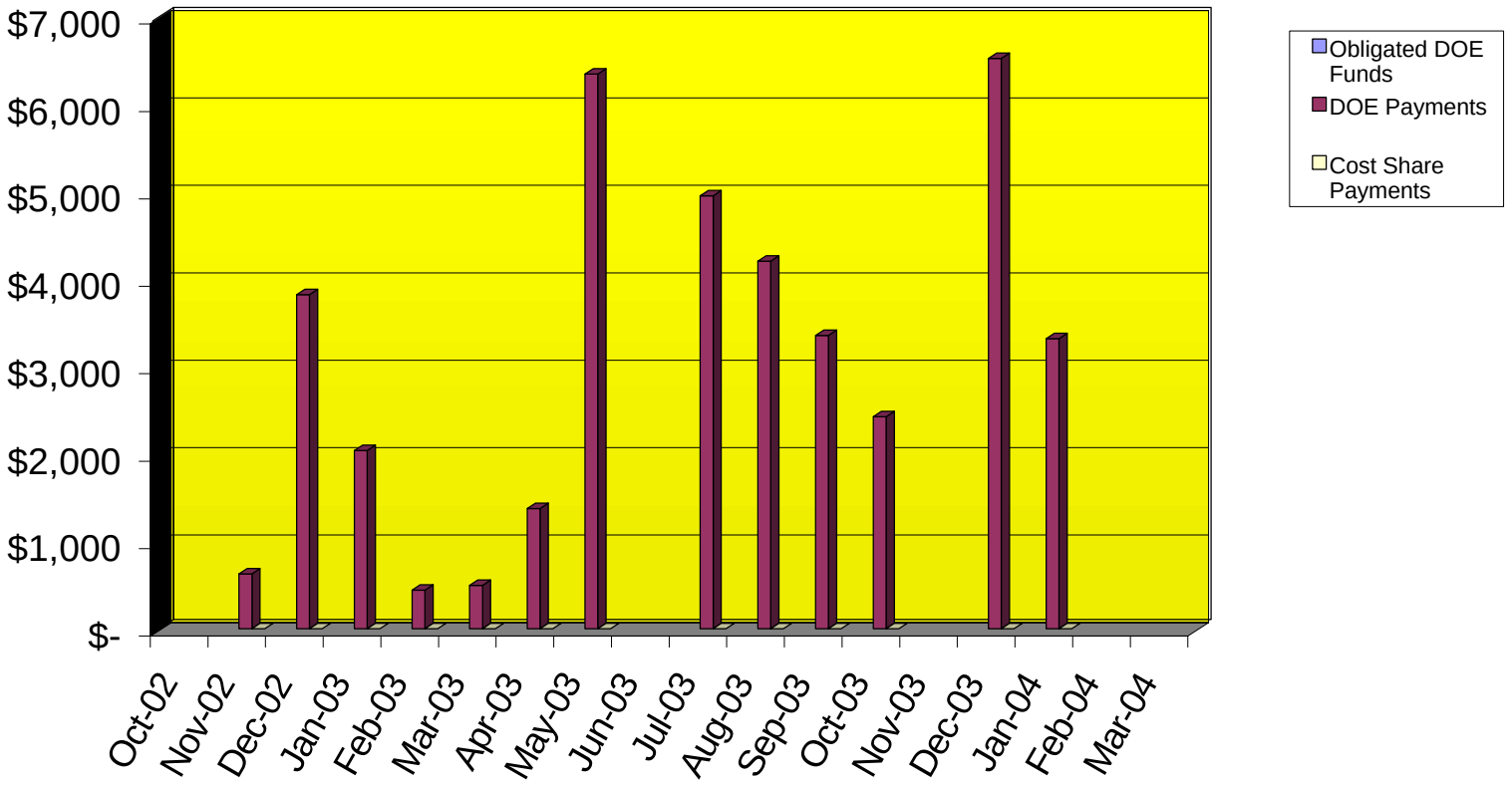
Task 4. Project Management & Final Report

The University of Dayton will complete the project by summarizing the work performed, data collected, and steps to a commercial implementation.

Project Cost Performance in DOE Dollars for Fiscal Year 2003

DE-FG36-02GO12051 **University of Dayton**

Monitoring of Refractory Wall Recession Using High Temperature Impact-Echo Instrumentation



	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03
Obligated DOE Funds	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
DOE Payment	$0	$629	$3,822	$2,039	$444	$497	$1,375	$6,347	$0	$4,954	$4,206	$3,357
Cost Share Payment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	PFY*	Cumulative
Obligated DOE Funds	$0	$0	$0	$0	$0	$0	$39,939	$39,939
DOE Payment	$2,426	$0	$6,524	$3,319	$0	$0	$0	$39,939
Cost Share Payment	$0	$0	$0	$0	$0	$0	$0	$0

Approved DOE Budget:	$39,939
Approved Cost Share Budget:	$0
Total Project Budget:	$39,939

* Prior Fiscal Years

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ID	Task Name	Start	Finish
1	Completed Transducers	Mon 9/16/02	Thu 5/1/03
2	Bench-Scale Testing Complete	Mon 9/16/02	Thu 7/31/03
3	Furnace Testing Complete	Mon 9/16/02	Fri 8/15/03
4	Project Management & Final Report	Mon 9/16/02	Tue 9/30/03