CERAMIC MEMBRANE ENABLING TECHNOLOGY
FOR IMPROVED IGCC EFFICIENCY

QUARTERLY TECHNICAL PROGRESS REPORT

For Reporting Period starting January 1, 2004 and ending March 31, 2004

Praxair Program Manager: Ravi Prasad
DOE Program Manager: Jenny Tennant

Report Issue Date: June 2004

DOE AWARD NO. DE-FC26-99FT40437

Submitted by:

Praxair, Inc.
175 East Park Drive
Tonawanda, NY 14150

DISCLAIMER:

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

ABSTRACT:

This quarterly technical progress report will summarize work accomplished for Phase 2 Program during the quarter January to March 2004. In task 1 OTM development has led to improved strength and composite design for lower temperatures. In task 2, the measurement system of OTM element dimensions was improved. In task 3, a 10-cycle test of a three-tube sub-module was reproduced successfully. In task 5, sizing of several potential heat recovery systems was initiated. In task 7, advanced OTM and cryogenic IGCC cases for near-term integration were developed.

TABLE OF CONTENTS

A.	Executive Summary	Page 3
B.	Experimental Methods	Page 3
	B.1. OTM Element Reliability	Page 3
	B.2. Element Fabrication	Page 3
	B.3. Systems Technology	Page 3
	B.4. High Temperature Heat Exchange	Page 3
	B.5. Process Analysis and Economics	Page 3
C.	Results and Discussion	Page 4
	C.1. OTM Element Reliability	Page 4
	C.2. Element Fabrication	Page 4
	C.3. Systems Technology	Page 4
	C.4. High Temperature Heat Exchange	Page 4
	C.5. Process Analysis and Economics	Page 4
D.	Conclusion	Page 4
E.	References	Page 4
F.	Appendix – Limited Rights Data	Page A1

A. Executive Summary

The objectives of the second year of phase 2 of the program are to construct and operate an engineering pilot reactor for OTM oxygen. Work to support this objective is being undertaken in the following areas in this quarter:

- Element reliability
- Element fabrication
- Systems technology
- High temperature heat exchange
- Power recovery
- IGCC process analysis and economics

The major accomplishments this quarter were

- **Long term life test of OTM element passed six months**
- **Process cycle tests have been completed and reproduced successfully**

B. Experimental Methods

B.1. OTM Element Reliability Experimental Methods

Characterization of OTM and substrate materials has been undertaken using many different experimental procedures. These include permeation, crystallographic, thermomechanical, thermochemical and electrochemical measurements. Standard equipment such as XRD, SEM, dilatometry and TGA/DSC were used. In addition oxygen permeation testers were used to measure the oxygen flux of OTM elements. The permeation test facility was described in the DOE IGCC first annual report ¹.

B.2. Element Manufacturing Experimental Methods

Various fabrication routes have been developed to prepare composite OTM samples. The fabrication routes used are proprietary information and included in the Appendix.

B.3. Systems Technology Experimental Methods

Details of the O-1 pilot reactor operation and advanced reactor design are proprietary information and included in the Appendix.

B.4. High Temperature Heat Exchange Experimental Methods

The design and engineering methods utilized are proprietary information.

B.5. Process Analysis and Economics Experimental Methods

HYSIS simulations are used to model various process options.

C. Results and Discussion

C.1. OTM Element Reliability Results and Discussion

OTM life tests continued with one life test passing the six-month mark. Improvements to the OTM material continue to be made.

C.2. Element Manufacturing Results and Discussion

Consistency of both the powder and the element manufacturing process was demonstrated at Praxair's manufacturing facility. The measurement system of the OTM element dimensions was improved.

C.3. Systems Technology Results and Discussion

Testing of a three-tube sub-module has continued with the successful reproduction of a 10-cycle test. Operational improvements continue to decrease turnaround time and stabilize oxygen flux and purity. Sources of variation that affect the O-1 reactor seal performance were identified as part of a six sigma project.

C.4. High Temperature Heat Exchange Results and Discussion

A kick-off meeting was conducted for the heat recovery task of the Foster Wheeler subcontract. Sizing of several potential heat recovery systems was initiated.

C.5. Process Analysis and Economics Results and Discussion

OTM processes were developed and cryogenic processes for integration with near-term IGCC processes were updated.

D. Conclusion

Progress has been made in all tasks toward achieving the DOE-IGCC program objectives. In task 1, OTM development has led to improved strength and composite design for lower temperatures. In task 2, the measurement system of OTM element dimensions was improved, and consistency of the powder and element manufacturing process was demonstrated. In task 3, a 10-cycle test of a three-tube sub-module was reproduced successfully, and sources affecting O-1 seal performance were identified. In task 5, sizing of several potential heat recovery systems was initiated. In task 7, advanced OTM and cryogenic IGCC cases for near-term integration were developed.

E. References

- [1] Prasad, Ravi, "Ceramic Membrane Enabling Technology for Improved IGCC Efficiency" 1st Annual Technical Progress Report for US DOE Award No DE-FC26-99FT40437, October 2000.