CERAMIC MEMBRANE ENABLING TECHNOLOGY FOR IMPROVED IGCC EFFICIENCY

QUARTERLY TECHNICAL PROGRESS REPORT

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ABSTRACT:

This quarterly technical progress report will summarize work accomplished for Phase 2 Program during the quarter July to September 2003. In task 1 OTM development has led to improved strength and composite design. In task 2, the manufacture of robust PSO1d elements has been scaled up. In task 3, operational improvements in the lab-scale pilot reactor have reduced turn-around time and increased product purity. In task 7, economic models show substantial benefit of OTM IGCC over CRYO based oxygen production.

TABLE OF CONTENTS

A. Executive Summary

The objectives of the first 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
- Power recovery
- IGCC process analysis and economics

The major accomplishments this quarter were

- **Element production at Praxair's manufacturing facility is being scaled up**

- **Substantial improvements to the OTM high temperature strength have been made.**

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 are proprietary information and included in the Appendix.

B.4. 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

Improvements to composite element design have yielded improvement in strength. Continued development of the OTM has resulted in large increases in high temperature mechanical strength and robustness.

C.2. Element Manufacturing Results and Discussion

Production of high quality, robust composite elements of PSO1d has been scaled up at Praxair's manufacturing facility.

C.3. Systems Technology Results and Discussion

O-1 reactor testing has continued. Operational improvements have been made to decrease turnaround time and improve product purity.

C.4. Process Analysis and Economics Results and Discussion

Economic analysis has shown considerable cost of electricity advantage of OTM-IGCC over CRYO based systems.

D. Conclusion

Progress has been made in all tasks toward achieving the DOE-IGCC program objectives. In task 1, high temperature strength improvements to the OTM have been made. In task 2, manufacture of robust composite PSO1d elements has been scaled up. In task 3, the operation of the O-1 reactor has been improved. In task 7, modeling shows cost advantages of OTM-IGCC over CRYO based separation.

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.

F. List of Publications

[1] "Oxygen Transport Membranes for Future IGCC Power Plants", Ravi Prasad, Jack Chen, Hancun Chen, Jonathan Lane, James White, Joseph Corpus, Eric Shreiber, John Spero and Bart A. van Hassel. Presented at Session 19, Gasification-Advanced Technologies-1, Proceedings of the Twentieth Annual International Pittsburgh Coal Conference, September 15-19, 2003, Pittsburgh, Pennsylvania, USA, Copyright Pittsburgh Coal Conference, ISBN 1-890977-20-9.