CERAMIC MEMBRANE ENABLING TECHNOLOGY FOR IMPROVED IGCC EFFICIENCY

QUARTERLY TECHNICAL PROGRESS REPORT

For Reporting Period starting April 1, 2003 and ending June 30, 2003

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Report Issue Date: July 2003

DOE AWARD NO. DE-FC26-99FT40437

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ABSTRACT:

This quarterly technical progress report will summarize work accomplished for Phase 2 Program during the quarter April to June 2003. In task 1 OTM development has led to improved flux and strength performance. In task 2, robust PSO1d elements have been fabricated for testing in the pilot reactor. In task 3, the lab-scale pilot reactor has been operated for 1000 hours with improved success. In task 7, economic models substantial benefit of OTM IGCC over CRYO based oxygen production.

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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

- **Robust elements are being produced at Praxair's manufacturing facility**

- **The O1 reactor was operated at target flux and target purity for 1000 hours.**

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 25% improvement in flux performance. Continued development of the OTM has resulted in large increases in mechanical strength and robustness.

C.2. Element Manufacturing Results and Discussion

High quality, robust composite elements of PSO1d have been prepared. These elements are expected to pass life cycle requirements.

C.3. Systems Technology Results and Discussion

The O-1 reactor has been operated for 1000 hours for the fourth time at the operating temperature and pressure, producing the target oxygen flux and 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. Opportunities for further improvement were identified.

D. Conclusion

Progress has been made in all tasks toward achieving the DOE-IGCC program objectives. In task 1, flux and strength improvements to the OTM have been made. In task 2, robust composite elements of PSO1d have been prepared. In task 3, the O-1 reactor has been operated for 1000 hours. 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.