CERAMIC MEMBRANE ENABLING TECHNOLOGY FOR IMPROVED IGCC EFFICIENCY

QUARTERLY TECHNICAL PROGRESS REPORT

For Reporting Period starting January 1, 2003 and ending March 31, 2003

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ABSTRACT:

This quarterly technical progress report will summarize work accomplished for Phase 2 Program during the quarter January to March 2003. In task 1 detailed modeling has identified preferred architectures. In task 2, PSO1d and PSO1x 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 6, power recovery simulation has identified preliminary machine configurations. In task 7, HYSIS models continue to be developed to optimize the process for a future demonstration unit.

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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

- **Preferred OTM architectures have been identified through stress analysis.**

- **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. Power Recovery Experimental Methods

HYSIS simulations are used to model power recovery options.

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

Modeling of the OTM elements and conditions has produced a preferred range of architectures to use for commercial operation.

C.2. Element Manufacturing Results and Discussion

High quality composite elements of PSO1d and PSO1x have been routinely prepared in large numbers. These elements have been used successfully in O-1 to yield target flux and purity.

C.3. Systems Technology Results and Discussion

The O-1 reactor has been operated for 1000 hours for the third time at the operating temperature and pressure, producing the target oxygen flux and purity.

C.4. Power Recovery Results and Discussion

A HYSIS model has been generated and preliminary machine configurations have been designed.

C.5. Process Analysis and Economics Results and Discussion

Development of two process models continues to enable heat and power integration of a future demonstration unit.

D. Conclusion

Progress has been made in all tasks toward achieving the DOE-IGCC program objectives. In task 1, modeling has produced a preferred range of architectures to use for commercial operation. In task 2, composite elements of PSO1d and PSO1x can be routinely prepared in large numbers. In task 3, the O-1 reactor has been operated for 1000 hours. In task 6, power recovery work has enabled design of preliminary machine configurations. In task 7, process analysis continues to optimize heat integration and power recovery for a future demonstration plant.

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.