

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 October to December 2002. In task 1 improvements to PSO1x have shown increased performance in strength and stability. 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. In task 6 initial power recovery simulation has begun. In task 7, HYSIS models have been 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

- **Methods to improve the strength and stability of PSO1x were identified.**
- **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

Improvements to the strength and stability of PSO1x continued. Modifications to processing and other additions have produced a 20% increase in strength and improved tolerance to various process gases and contaminants.

C.2. Element Manufacturing Results and Discussion

High quality composite elements of PSO1d and PSO1x have been routinely prepared. 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 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 a preliminary design established based on one of the processes considered for a future demonstration plant.

C.5. Process Analysis and Economics Results and Discussion

Two models have been developed for a future demonstration plant to begin optimization of heat integration and power recovery.

D. Conclusion

Progress has been made in all tasks toward achieving the DOE-IGCC program objectives. In task 1, improvements to the membrane material have increased the strength and stability of PSO1x. In task 2, composite elements of PSO1d and PSO1x can be routinely prepared. In task 3, the O-1 reactor has been operated for 1000 hours. In task 6, initial power recovery work has begun. In task 7, initial process analysis has begun 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.

F. List of Publications

- [1] “OTM – An Advanced Oxygen Technology for IGCC”, Ravi Prasad, Jack Chen, Bart van Hassel, John Sirman, James White, Eric Shreiber, Joe Corpus, Joshua Harnanto, Presented at the Gasification Technologies 2002 Conference, San Francisco, October 30, 2002.