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NOVEL SELECTIVE SURFACE FLOW (SSFTM) MEMBRANES FOR THE
RECOVERY OF HYDROGEN FROM WASTE GAS STREAMS

Phase I : Exploratory Development

Final Report

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PREFACE

This report documents Phase I, Exploratory Development, which was performed over the period April 1993 through October 1994. It is the first phase of a four phase project for the development of Selective Surface Flow (SSFTM) membranes for the recovery of hydrogen from off-gas streams from various chemical/refinery operations.

In Phase I of the work, the architecture of the membrane and the separation device have been defined and demonstrated. The system consists of a shell-and-tube separator in which the gas to be separated is fed to the tube side, the product is collected as the high pressure effluent and the permeate constitutes the waste/fuel stream. Each tube, which has the membrane coated on the interior surface, does the separation in the system. The tube preparation, tube characteristics, membrane preparation and membrane separation characteristics were developed in this work. It was demonstrated that the separation characteristics vastly exceed those set as the benchmark for this work. A multi-tube separator device containing 1 ft² of membrane area was built and tested. The engineering data were used for design of a process for hydrogen recovery from a fluid catalytic cracker (FCC) off-gas stream. First-pass economics demonstrated that the overall cost for hydrogen production is reduced by 35% vs on-purpose production of hydrogen by steam-methane reforming. The hydrogen recovery process using the SSF membrane results in at least 15% energy reduction and a significant decrease in CO₂ and NO_x emissions.

In Phases II and III, the technology will be demonstrated in the field and scaled up to a semi-commercial unit.

This is a cost shared project between Air Products and Chemicals, Inc. and the U.S. Department of Energy, Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Industrial Technologies, under DOE Albuquerque Field Office Cooperative Agreement DE-FC04-93AL94461. Bruce Cranford and Charles Russomanno have been the Program Managers for the DOE Office of Industrial Technologies. Porter Grace and Ken Lucien have been the Project Managers for the DOE Albuquerque Operations Office. Frank Childs, the Project Technical Monitor for DOE, is on the staff of Sciencetech, Inc., Idaho Falls, ID.

For Air Products and Chemicals Inc., Madhu Anand is the Program Manager and Principal Investigator. Barry Halper is the Contracting Manager. Jim Yang is also a Principal Investigator for Phase I of the program. Additional technical contributors to the program are Beth Campion-Louie, Sheila Wirth and Sherri Lilienfeld. Shivaji Sircar and Madhukar Rao have been active consultants in this work.

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