CHEMICALS

Project Fact Sheet

Hydrogen Recovery Process Using New Membrane Materials

Benefits

- Energy savings of 100 Billion Btu per year per plant
- Achieves reuse value 2 to 3 times greater than fuel value
- Reduces waste from off-gas streams
- Decreases cost of production by $0.5 to 1.0 million per year for an individual plant

Applications

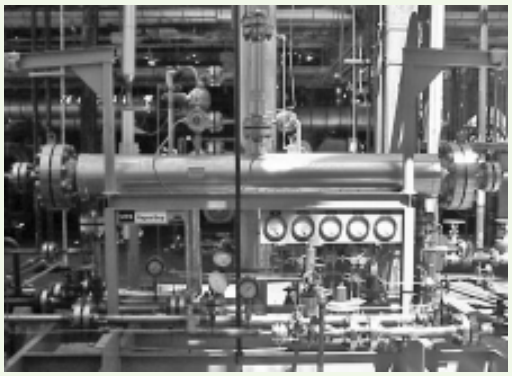
A new membrane for gas separation systems will be useful in several applications in the refinery and petrochemical industries. Its primary application will be the recovery of hydrogen from fuel gas streams in the 1-10 MMscfd range. A second application is hydrogen and olefin recovery from FCC (Fluid Catalytic Cracking) off-gas. A third, and more ambitious, application is the recovery of hydrogen from ethylene cracker product gas.

Novel membrane recovers hydrogen from refinery off-gas streams

Hydrogen is a necessary and valuable raw material used in the refining of crude oil. U.S. refineries are increasingly short of hydrogen, prompting refiners to search for untapped sources. Refinery off-gas streams that are currently flared or fired as low-grade fuel are a potentially viable source of hydrogen. However, the small volume and low hydrogen content of off-gas streams precludes economic recovery by conventional methods such as cryogenic separation or pressure swing adsorption. Membrane separation can provide cost-effective recovery from these streams. However, commercially available membranes in refinery applications are prone to irreversible fouling, plasticization, and condensation of hydrocarbon vapors on the membrane. To address the shortcomings of current membranes, project partners are developing a new perfluoro-based membrane with high hydrogen permeability and selectivity that is unaffected by the presence of condensable hydrocarbons.

In addition to hydrogen, the membrane can also recover valuable hydrocarbons such as liquefied petroleum gas and olefins from refinery off-gases. These hydrocarbons are generally used as low-value fuels. The developed perfluorinated membrane will allow the separated hydrogen and hydrocarbon components to be reused as chemical feedstock that is two to three times more valuable than reuse as fuel feedstock.

Membrane System



Front view

Back view

Membrane system connected to a hydrocracker plant in Bakersfield, CA.

Project Description

Goal: The goal of this project is to develop new high-performance, robust polymeric membranes for the recovery of hydrogen from refinery and petrochemical off-gas streams. All components of the developed composite membrane that will contact the feed gas are polymers that are stable in the presence of hydrocarbon vapors.

The membrane consists of three layers. A microporous support membrane made from polyvinylidene fluoride provides mechanical strength. This support is coated with a layer of an extremely permeable material. This intermediate or "gutter" layer provides a smooth, defect-free surface on which an extremely thin layer of the selective polymer is deposited. The selective layer performs the separation, and the "gutter" layer provides a conduit to transport the permeating gas to the pores of the microporous polyvinylidene fluoride support.

Progress and Milestones

Early-stage research showed that composite membranes can be formed into defect-free modules. Both the membranes and modules maintained physical integrity during exposure to high gas activity conditions, including the presence of liquid hydrocarbons. The permeation properties of the membranes were either maintained during exposure or fully recovered after exposure. Good selectivity in the presence of liquids was an unexpected and unique result of early testing. These results demonstrate the advantages of the developed membranes over existing commercial membranes.

Current research is focused on achieving the following milestones:

- Optimize membranes and create membrane permeability/selectivity database for predicting module performance
- Scale up membrane manufacturing and develop bench-scale spiral-wound modules
- Evaluate membrane modules in bench-scale equipment
- Survey potential industry users and make field test arrangements
- Design and build field test pilot system
- Operate and collect data from pilot system at field site
- Develop predictive model based on field data for membrane module performance
- Conduct technical/economic analysis and develop commercialization strategy

Commercialization

Membrane Technology and Research (MTR) will analyze specific plant applications and perform process design and economics calculations to determine the overall benefit to the end-user. The total number of potential users of this technology in the U.S. and worldwide will be estimated to determine market size. MTR will use this information to initiate the commercialization of the new membrane system.

Project Partners

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