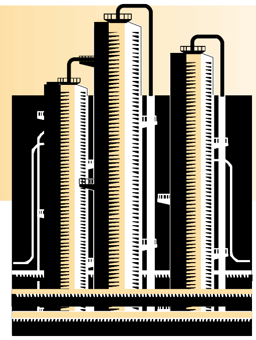
PETROLEUM

Project Fact Sheet



Energy-Saving Separation Technology for the Petroleum Industry

Benefits

- More energy-efficient process
- Lowered manufacturing costs
- Greater hydrogen recovery efficiency
- Reduced carbon released into the atmosphere

Applications

If successful, membrane processes could replace some of the existing energy-intensive distillation operations in the petroleum refining industry. Membranes with tunable selectivity can also potentially be applied to separation processes in other industries.

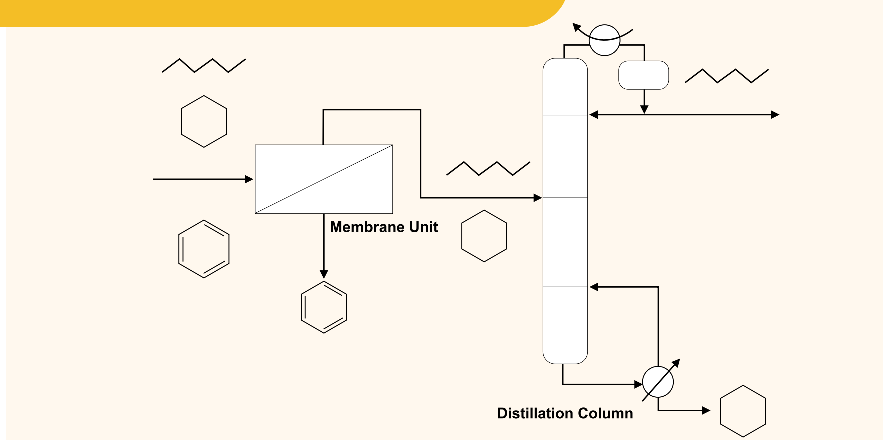
Membrane Separations Will Help Petroleum Industry Achieve 20% Energy Reduction in Separation Operations

In 1994 the petroleum industry used 6.3 quadrillion Btu, making it the nation's most energy intensive industry. Within the refining industry, separation processes, primarily distillation, account for nearly 40% of the industry's energy use. Distillation entails heating the fluids (crude oil) until boiling, resulting in high energy costs. An alternative to distillation is the use of membranes which could potentially save 40% of the energy currently used in distillation separation. Membrane separation does not require heating and boiling off the fluids. Instead, it relies on differences in the rate at which components pass through the membrane material.

This project will focus on pervaporation separation of hydrocarbon mixtures and the use of reverse selectivity membranes for hydrogen recovery. Pervaporation is a process in which the liquid phase contacts one side of the membrane and the permeate side contacts a reduced pressure gas phase. The biggest hurdle facing pervaporation in refinery operations is the inability of membranes to withstand severe operating conditions. Membranes undergo physical and chemical changes as a result of exposure to organic liquids and elevated temperatures. This project seeks to develop membranes with improved selectivity, permeability and superior physical, thermal, and chemical durability.

As demand for high quality, low sulfur fuels has increased, hydrogen management has been placed in a crucial position. Distillation is the major method used to separate hydrogen from hydrocarbon streams because conventional membranes, cryogenic separation and adsorption require additional steps of de-pressurizing and re-pressurizing the gas stream before and after processing. Reverse selectivity membranes will eliminate the de-pressurizing and re-pressurizing steps.

Figure 1.0



Schematic of Membrane - Distillation hybrid process to separate aromatic and aliphatic hydrocarbons.

Project Description

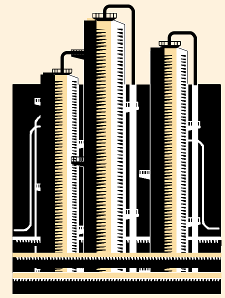
Goal: To develop membranes for hydrocarbon separations so that a 20% improvement in the efficiency of the energy-intensive unit operations of atmospheric and vacuum distillation may be realized.

This research combines the expertise and facilities of the Colorado School of Mines and the Idaho National Engineering Laboratory with the industrial knowledge of Chevron and Marathon-Ashland. Research will be conducted in the following two areas: 1) use of pervaporation to replace distillation in separating liquid organic streams, and 2) gas separations such as ethylene and ethane or propylene, or the recovery of hydrogen through the removal of hydrocarbons using reverse selectivity membranes.

Polymer blend membranes will be used in pervaporation separation of organic liquids as well as gas separation (excluding hydrogen). Ceramic and hybrid organic-ceramic membranes will be developed for hydrogen recovery.

Progress and Milestones

- Fabricate, characterize, and test polyphosphazene, surface modified ceramic, and polymer blend membranes.
- Select most promising membrane materials based on selectivity, permeability, and robustness.
- Scale-up for the three different material systems and identify obstacles to unit operations design and construction. Materials that do not provide sufficient flexibility for commercial-scale deployment will be eliminated.
- Collect long-term feasibility data while running pilot plants.
- Commercially viable technologies will be patented and licensed with industrial partners receiving royalty free licenses.



Project Partners

Colorado School of Mines
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Chevron Research and Technology Company
Richmond, CA

Idaho National Engineering Laboratory
Idaho Falls, ID

Marathon-Ashland
Littleton, CO

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