

Recovery and Recycling of Valuable Feedstock From Plant Reactor Purge Gas

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Environmental Problem

Oxygen-oxidation processes are used to produce a number of important chemical intermediates by selective catalytic oxidation of hydrocarbons in a reactor. Products include ethylene oxide, propylene oxide, vinyl acetate, and vinyl chloride, which are used to make major commodity and engineering polymers. All of these processes include an inert gas purge stream from the reactor. This purge stream is required to remove argon, which enters the reactor as a contaminant in the oxygen feed. Because argon does not react, the concentration in the reactor builds up unless it is purged. Currently, the purge gas is flared, resulting in a loss of approximately 450 million lb/year of the hydrocarbon feedstocks used in these processes in the United States.

For example, during the production of ethylene oxide, about 16 lb of ethylene are lost in the argon purge stream per ton of ethylene oxide produced (about 3.5 million tons of ethylene oxide are produced annually in the United States, representing a loss of 56 million lb/year of ethylene at a value of \$8.4 million per year). Incineration of the purge stream produces 440 million lb/year of carbon

dioxide plus the accompanying amounts of nitrogen oxides (NO_x). The argon purge stream clearly represents an important resource recovery and pollution reduction opportunity.

SBIR Technology Solution

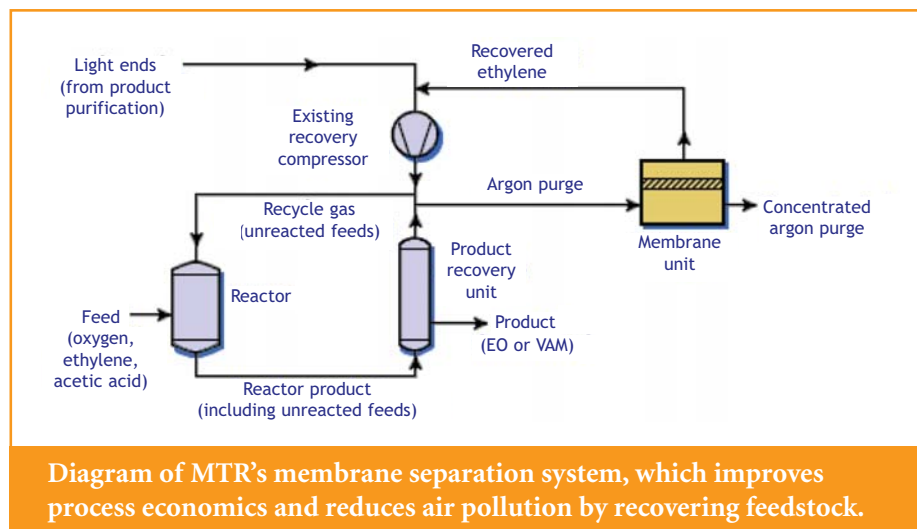
With support from EPA's SBIR Program, Membrane Technology and Research, Inc. (MTR), developed a membrane separation system to improve process economics and reduce air pollution by recovering feedstock. Selective membranes were developed to separate the hydrocarbon feedstock from the argon, so that the feedstock can be recycled to the reactor. The value of the recovered hydrocarbon is high, so a process payback time of 1-2 years is possible.

Ethylene-selective and argon-selective membranes can be used to economically recover ethylene from the argon purge stream from oxygen-oxidation reactors. Processes based on MTR's ethylene-selective silicone rubber membrane are superior to those using argon-selective membranes and can achieve 80% ethylene recovery with a system payback time of less than 1 year, provided sufficient compressor capacity is available in the plant. If additional compressors

are required, MTR's novel perfluorinated, argon-selective glassy membranes could be used to achieve a shorter payback period.

Commercialization Information

The annual revenue generated (ethylene value minus operating costs) by the membrane system is between \$200,000 and \$400,000 per year for a typical ethylene oxide plant. The addition of the membrane system is a simple retrofit and payback time typically is less than 2 years. To date, the development of this technology has resulted in the sale of three systems worldwide to recover ethylene from the argon purge stream in ethylene oxide and vinyl acetate plants. The current installed ethylene recovery capacity in these three systems is 2,100 tons/year.



Company History and Awards

MTR develops membranes, membrane modules, and membrane processes for industrial separations. The company was founded in 1982 as a research and development company and has been supplying membranes for commercial applications since 1990. Capabilities include membrane and module manufacturing, process and system design, project engineering, and commissioning services. MTR's administrative, research, and manufacturing facilities are located in Menlo Park, California. The company has sales offices in Houston, Texas, and Brussels, Belgium.

MTR's custom-designed membrane systems are employed at more than 100 petrochemical and natural gas processing plants throughout the world. The company's primary product lines include: VaporSep® technology for separating hydrocarbons from air and nitrogen, membrane-based natural gas treatment processes to control the hydrocarbon dewpoint of natural gas by removing higher (C3+) hydrocarbons, and PerVap® water treatment technology to recover flavor and aroma compounds in the food industry and to remove residual organic solvent contaminants from fine chemical process streams.



MTR received the 1997 Kirkpatrick Chemical Engineering Achievement Award for the successful commercialization of Vapor-Sep® membrane technology. The award, which is sponsored by *Chemical Engineering* magazine, honors

the best chemical engineering technology commercialized during the preceding 2 years.

SBIR Impact

- The purge stream from industrial reactors represents an important resource recovery and pollution reduction opportunity.
- Membrane Technology and Research, Inc. (MTR) developed a membrane separation system to improve process economics and reduce air pollution by recovering and recycling feedstock from the purge stream.
- The annual revenue generated by using the membrane system to recover feedstock is between \$200,000 and \$400,000 annually for a typical ethylene oxide plant.
- Three MTR systems are in use worldwide to recover ethylene from the argon purge stream in ethylene oxide and vinyl acetate plants, with an ethylene recovery capacity of 2,100 tons per year.