Industrial Applications for Permylene™ in the Petrochemical Industry
INTRODUCTION

Imtex Membranes Corp. is an advanced membrane separation technology company that is focused on providing innovative membrane technology for the separation of olefins from paraffins to the refining and petrochemical marketplace. Imtex's Permylene™ membrane systems are the result of several years of dedicated development, testing and performance validation. The technology under development is applicable to the separation of purified ethylene, propylene and butenes streams, providing significant capital cost, operating cost and environmental emissions reductions versus conventional distillation technology.

OLEFINS PRODUCTION AND BACKGROUND

The use of olefins has expanded exponentially during the 20th century from arguably its first use in commercial production in the late 1930s (for polyethylene and butyl rubber). Olefin uses have continued to develop over time to include plastics (polyethylene, polypropylene, styrene etc.), fibers, surfactants, detergents, automotive antifreeze as well as higher intermediates for a range of other chemicals and processes that are now an inherent part of modern industry. All of these processes are driven by consumer demand for everyday products, clothing, automobiles, chemicals, packaging (containers, film, bags) construction materials, and various other goods. The worldwide demand for ethylene in 2015 was over 150 million tons per year and propylene over 90 million tons. Demand for ethylene alone is expected to grow by over 30% to 200 million tons by 2025.

An olefin is a hydrocarbon molecule with at least one double carbon–carbon bond (as opposed to just single bonds as would be present with their associated paraffins). Typical mainstream examples are ethylene (two carbon atoms), propylene (three carbon atoms) and butenes (four carbon atoms), but many other isomers and heavier olefins exist. Olefins are critical to modern society as they allow us to produce the wide range of materials that we use in our daily lives.
The majority of olefins (especially ethylene) are produced from steam cracking natural gas or liquids such as naphtha (naphtha is produced as a byproduct from refineries which typically focus on the production of transport fuels). The process of cracking has been in existence for decades and has been continuously refined for improved productivity and efficiency. The product stream from the cracking process inherently includes paraffins, and it is the separation of olefins for their corresponding paraffins that is a critical step in the process for the production of high purity olefins required for the majority of uses. Steam cracking is an energy intensive process that involves high temperatures for the reaction and then cold temperatures for separation.

Fluid catalytic cracking (originally developed for increased gasoline production from heavier, low value feed) produces olefins as a byproduct, predominantly propylene, but increasingly refiners have adjusted their operations to specifically target the higher value olefins. FCC production now accounts for over 30% of propylene production (vs. just over 50% for steam cracking).

Olefins are also increasingly produced by on purpose production to meet increases in demand and suit feedstocks from the various natural sources available in different regions. Some examples are Metathesis, Methane to Olefins, Coal to Olefins and Paraffins dehydrogenation. Several companies are developing new technologies to meet increasing global demand within this changing landscape, focusing especially on propylene. Propane Dehydrogenation, Metathesis, Methane to Olefins and others account for over 15% of propylene production, and this is expected to rise to nearly 30% by 2023. Several other companies are also focusing on alternatives to steam cracking such as catalytic cracking which could be more efficient and tailored to market needs.
INDUSTRIAL APPLICATIONS FOR PERMYLENE™ MEMBRANE TECHNOLOGY

**INDUSTRY**

**OIL AND GAS INDUSTRY**
- Natural gas
- Crude oil
- Oil sands upgrader offgas

**PETROCHEMICAL INDUSTRY - OLEFINS**
- Steam cracker
- Gas and liquid feeds
- Recycle streams
- Waste streams
- Olefins: Ethylene (C2), Propylene (C3), 1-Butene, 2-Butene, Isobutylene, Butadiene

**CONSUMER PRODUCTS**
- Metathesis
- Methane to olefins
- Coal to olefins
- Paraffin dehydrogenation
- New production technologies

**Permylene Applications**

- **Mainstream Olefin Paraffin Separation** - This is currently achieved through distillation involving high capital and operating costs. Permylene can be a more cost effective alternative or can enhance these systems to improve production efficiency.

- **Recycle Streams** - The drive for feedstock utilization and reduction in waste streams has led to numerous recycle streams being sent back to upstream plant. Many of these streams contain valuable olefins which, if recovered using Permylene, would improve the product yield and margins for many petrochemical facilities.

- **Waste Streams** - Recovery waste or purge streams are inevitable given the high purity levels required by the olefins industry. Extracting valuable olefins from these streams would both improve margins and reduce waste stream volume.

- **Feed Conditioning** - Permylene can be used to improve certain feed streams that would benefit from a shift in olefin/paraffin or olefin isomer concentration such as metathesis, monomers and some specialty chemicals that utilize mixed feeds.

- **Oil Sands Upgrader** - Recovery of olefins from oil sands upgrader offgas.

- **On Purpose Olefin Production** - Permylene can be used to enhance production efficiency or cost effectiveness.

For more information, please visit https://www.imtexmembranes.com/applications
Olefin-Paraffin Separation and Permylene Applications

Mainstream
Nearly all of these processes require olefin/paraffin separation in order to produce the high purity olefins required by downstream processes such as polyolefins, ethylene oxides and a range of other products. Currently the annual global production of mainstream olefins (ethylene and propylene) is over 240 million tons per year. If we assume that a typical separation system* for a world scale facility of 1 Million tons per year costs $500 million USD then the estimated total installed capital for this separation process is over $130 billion USD (assuming a cracker feed to olefin conversion of 90%). Demand led capacity growth over the next decade could add another $40 billion to this total. This indicates a significant market for Permylene as a cost effective, efficient alternative for olefin/paraffin separation.

*note in reality there is a wide range of installed plant capacities from several hundred kta to over 1500 kta.

Recycle Streams
While olefins produced via mainstream production are an obvious focus area for Permylene, there are a number of other types of streams within the industry that would benefit from Permylene’s application. The complexity and continuous refinement of the industry in search of ever greater efficiencies have led to numerous recycle streams. The value of these streams could be significantly enhanced if the valuable olefins could be extracted prior to being routed back into the mainstream process. Recycle streams are present in both front end (purification sections) and back end (purge streams) of the downstream processes and can be recycled back to the separation section or straight back to the cracker depending on the facility process design and stream composition.

Waste Streams
Although industry has recently focused on reducing waste and environmental impacts, waste streams are an inherent result of the need for high purity product. Some of the streams are not suitable for recycle due to a number of factors and are often disposed of in a controlled manner via flare. Some of these streams contain valuable olefins which, if they could be extracted using Permylene, would simultaneously enhance production and reduce the environmental impact.

Feed conditioning
Some processes such as on-purpose production technologies and some specialty applications require olefin feed conditioning to meet certain criteria that are essential for the plant to run effectively. The application of Permylene may also enable these plants to source lower grade (lower priced) feedstock.

Oil Sands Upgrading
Oil sands off-gas upgrading is a specific application that could be of vital importance in value enhancement for production of hydrocarbons from oil sands.

There are a wide range of other potential applications for Permylene membrane technology. These include specialty processes and niche markets that use olefins and could benefit from an efficient olefin/paraffin separation process.
For any enquiries related to this article, Imtex Membranes or Permylene, please do not hesitate to contact us below.

**CONTACTS**

**Addresses**

**Imtex Membranes Corp. Headquarters**
2596 Dunwin Drive
Mississauga, ON L5L 1J5
info@imtexmembranes.com
Tel: +1 (905) 363-0111

**North America Business Development**
Dale Kline
dkline@imtexmembranes.com
Tel: +1 (803) 554-1002

**International Business Development**
Jamie Hughes
jhughes@imtexmembranes.com
Tel: +1 (345) 815-3986

**Web**

[www.imtexmembranes.com](http://www.imtexmembranes.com)
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