



**PRISM<sup>®</sup> Membrane Systems**  
**for petrochemical applications . . .**  
**tell me more**

**AIR**  
**PRODUCTS** 



## Air Products PRISM Membrane Systems are found in petrochemical plants around the world operating efficiently and economically.

PRISM Membrane Systems recover hydrogen and adjust synthesis gas streams to provide maximum efficiency at petrochemical processing plants. The membrane separators use selective permeation to recover and purify valuable hydrogen or reject inert byproducts from high-pressure petrochemical streams.

Petrochemical processes include: hydrogen recovery from methanol plant purge streams, synthesis gas ratio adjustment, carbon monoxide purification, hydrogenation purge streams, and hydrogen recovery from PSA purge gas.



## How membrane separators work in petrochemical plants

Removing impurities from gas streams saves money by recycling and reusing valuable gases. Gas mixtures may even be cycled through multiple times to achieve the desired reaction.

### Hydrogen recovery from methanol purge

Methanol is produced by introducing a synthesis gas stream into a catalytic reactor. The synthesis gas is comprised of hydrogen, carbon monoxide, carbon dioxide, and inert byproducts like methane, nitrogen, and argon. Methanol conversion does not completely synthesize in the first pass, so the process requires the components to be looped through a cycle. This process causes the inert byproducts to accumulate and purge.

The resulting purge gas contains high concentrations of the synthesis gas components. It also includes methanol, which is not removed by the liquefaction step. If not reclaimed, this methanol can be a costly waste of product.

PRISM Membrane Systems treat the purge stream by separating methanol as the product gas and returning the hydrogen to the synthesis loop. The system usually includes a water scrubber to recover methanol lost in the purge. PRISM Membranes recover 90% of the hydrogen and 60% of the carbon oxides. The system is easily adjusted to meet fluctuating production of the methanol plant.

### H<sub>2</sub>/CO Synthesis Gas Ratio Adjustment (SynGas)

The very first PRISM Membrane System was built for this exact application in 1977. PRISM Membrane separators adjust the hydrogen to carbon monoxide ratio in oxo-alcohol synthesis gas streams. Membrane separation is a good fit for this application since the feed gas is treated at essentially the same pressure as the synthesis loop pressure. The hydrogen/carbon monoxide ratio can be easily adjusted to meet specific process requirements.

# Petrochemical applications of PRISM Membrane Systems

## Hydrogenation Purge Streams

Recovered hydrogen from the membrane system feeds the hydrogenation process and can also be used elsewhere in the plant. PRISM Membrane Systems are designed to upgrade hydrogen from 60–70 mol% purity up to 85–90 mol% with recovery rates exceeding 80%. If the purity requirement is flexible, higher recovery rates can be achieved. PRISM Membrane Systems handle widely fluctuating purge flow rates and conditions where other hydrogen recovery systems falter.

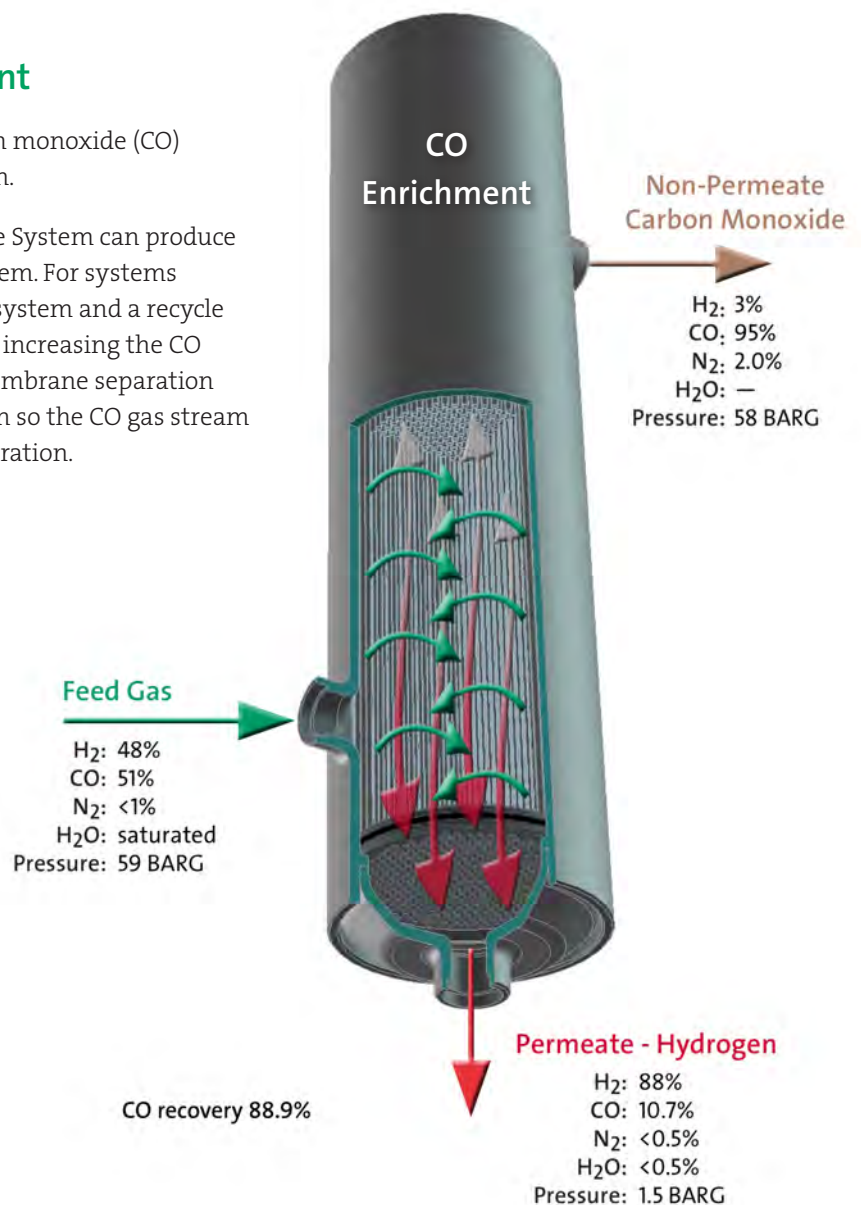
## Hydrogen Recovery from PSA Purge Gas

When paired behind a PSA system, PRISM Membrane Separators can recover up to 97% of the hydrogen by compressing and upgrading the tail gas.

## Carbon Monoxide Enrichment

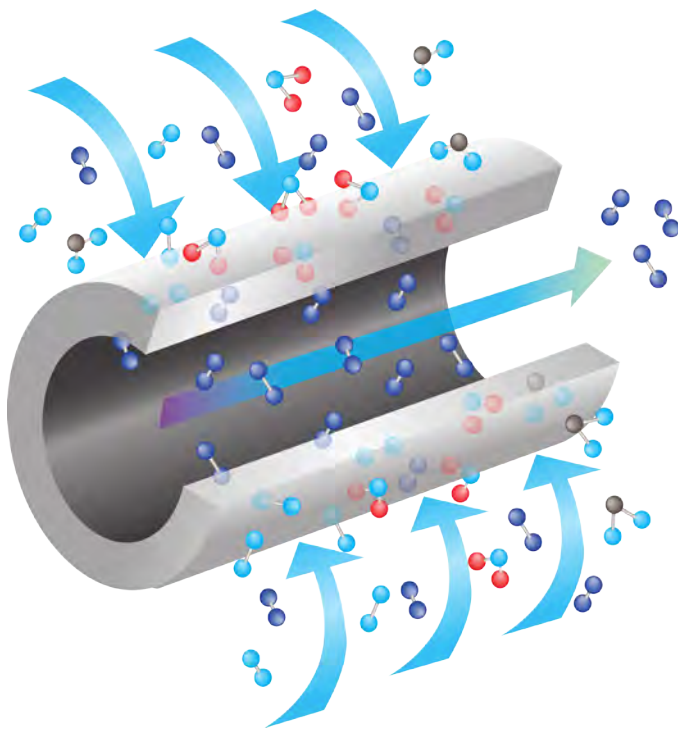
PRISM Membrane Systems purify carbon monoxide (CO) from feed streams that contain hydrogen.

In this application, the PRISM Membrane System can produce 85 mol% purity CO in a single stage system. For systems requiring higher purity CO, a two-stage system and a recycle compressor will improve the separation, increasing the CO product purity to 95 mol% or greater. Membrane separation removes water vapor as well as hydrogen so the CO gas stream is ready to use without additional dehydration.



## How membranes work for gas separation

Gas molecules permeate across the thin skin of the hollow fiber wall driven by a partial pressure difference. The permeation rate is specific to the gas-polymer pair. The transport mechanism is a combination of solubility into and diffusion through the membrane. Separation capability is determined by the relative permeation rates of the individual gas components. The greater the difference in permeability, the greater the effective separation by diffusion.



Membrane separators contain thousands of hollow fibers.

**Air Products' PRISM membranes: experience, performance, and value.**



## Membrane separator design

- Easy installation of single membrane bundle in each pressure vessel.
- Simple and durable differential pressure seal design.
- Axial packed fibers (rather than tightly wound configuration).
- Pressure vessels built to: ASME, PED, GOST, GB, and other international codes.
- Available in 4-inch (100mm) and 8-inch (200mm) diameter.

## Membrane arrangements

### Series and parallel

- Series arrangement allows easy capacity turn up and turn down while protecting downstream separators from pretreatment upsets.
- Parallel configurations accommodate larger flow volumes.

PRISM Separators have no ramp-up requirements so they can be activated immediately when process volumes increase.



## Features:

### Flexible

PRISM Membrane Systems provide operating flexibility when planned or unexpected process changes occur. Some turndown is absorbed by the flexibility of the system, and increased capacity requirements are met by the addition of more separators. Additional turndown is accomplished by valving off separators which maintains recovery and purity. Multiple takeoffs from the permeate manifold provide streams of different purities and flow rates. Some applications require feed gas pre-treatment.

### Compact

The compact membrane system fits into small or crowded plants. Its efficient and modular design will minimize site installation time and expense. Site preparation is minimal, requiring only a simple concrete support pad plus process and utility lines. Tie-ins to the pre-assembled system usually require no special shutdown. PRISM Membrane Systems can be moved because the separator assembly is skid mounted.

### Efficient and economical

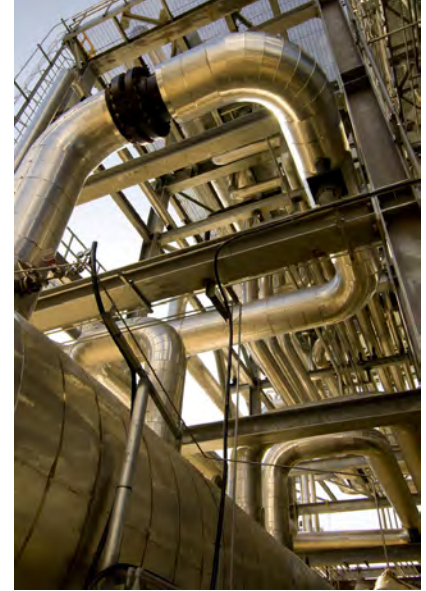
PRISM Membrane Systems have high recovery rates for Hydrogen, CO<sub>2</sub>, and hydrocarbons with efficiencies of 80–95% for most applications. Utility consumption is normally limited to instrument air with steam (or water) used for temperature control. Typical purge systems operate at pressures suitable for generating the required separations, so no compression power is needed. Start-up and shutdown is simple: no cool down or preconditioning is required and recovery begins immediately after gas is fed into the system.

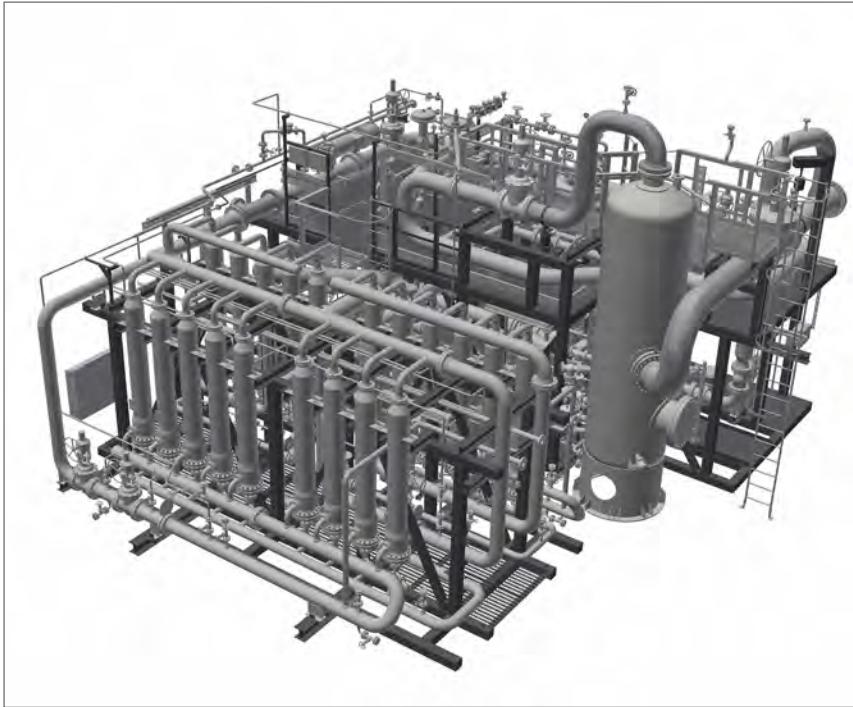
### Low maintenance

The PRISM Membrane separators have no moving parts to monitor, repair, or replace. They are virtually maintenance-free when properly installed and operated within design conditions. PRISM Membrane separators require virtually no adjustments or operator attention. They will maintain proper operation under varying process conditions and tolerate small concentrations of contaminants like water, ammonia, hydrogen sulfide, carbon dioxide, hydrocarbons and aromatics.

### Long life

The robust design and construction ensure long service life in petrochemical applications. PRISM Membrane separators have been operating in a wide variety of services—some since 1977.





## Why choose Air Products?

We have the most experience in designing and building spec-compliant systems for petrochemical applications. Some of the first PRISM Membrane separators were commissioned in 1977.

Over 500 PRISM Membrane Systems for Process Gas applications are operating around the world. These include 230 systems in ammonia purge gas recovery, 90 systems in oil refinery applications, 60 systems for carbon monoxide purification, 50 systems for methanol purge gas recovery and 50 in other petrochemical applications.

For more information regarding Air Products PRISM Membrane Systems for petrochemical applications, please contact one of our technical sales specialists.

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