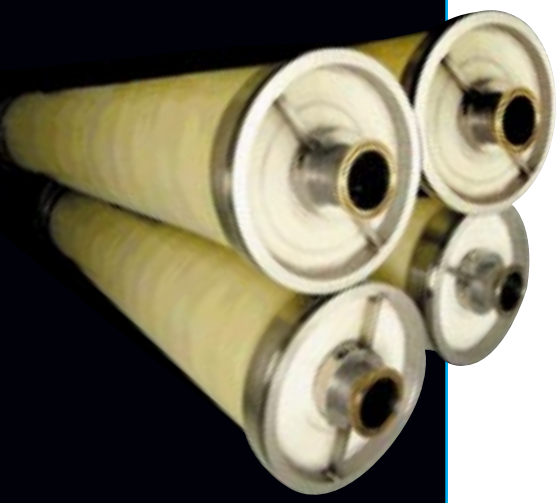
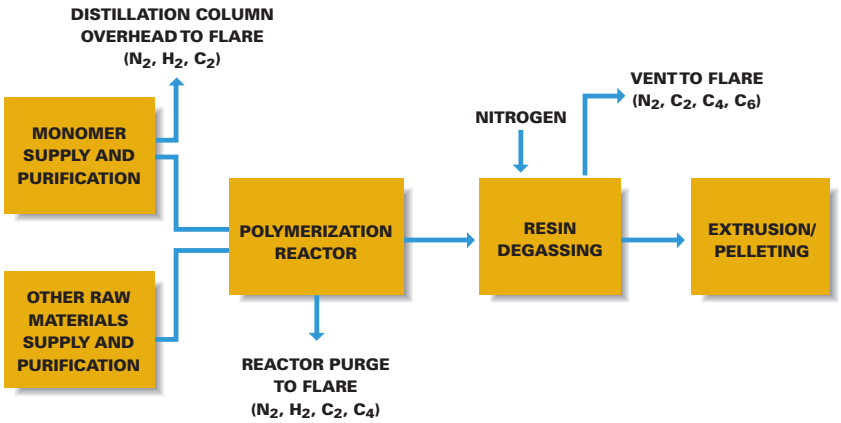


Polyethylene Producers

- Recovers valuable ethylene and other hydrocarbons with payback time of one year or less
- Minimizes installation cost with skid-mounted construction
- Simplifies operation with few or no moving parts

"VaporSep significantly lowered capital and operating costs compared to previous designs, and reduced emissions at the flare stack."



Problem

During the production of polyethylene (PE), a portion of the ethylene and other hydrocarbon feedstock is lost. This feedstock loss is substantial, ranging from $1 to 3 million per year for a typical PE plant. Losses occur primarily at three points in the production process: distillation column overhead vents in the ethylene recovery and purification step, reactor purge vents, and resin degassing vents.

VaporSep Solution

For resin degassing applications, the vent stream is compressed and cooled to condense hydrocarbons. The gas leaving the condenser, which still contains a significant amount of the hydrocarbons, is fed to the membrane which separates the stream into a hydrocarbon enriched permeate stream and a purified nitrogen residue stream. The permeate is recycled to the inlet of the compressor and then to the condenser where the hydrocarbon is recovered. The purified nitrogen stream is recycled to the degassing bin.

For distillation column overhead and reactor purge applications, the VaporSep unit is very simple, consisting of membrane modules only, with no moving parts. The stream leaving the column or reactor is typically contaminated with light gases such as N_2 and H_2. The VaporSep unit splits this stream into a hydrocarbon enriched stream and a light gas enriched stream. The hydrocarbon enriched stream is returned to the distillation column or reactor where the hydrocarbon is recovered, and the light gas enriched stream is vented or flared.

VaporSep units are currently used by major PE producers including Exxon, Formosa Plastics, Fina, Texas Eastman, and Elenac.

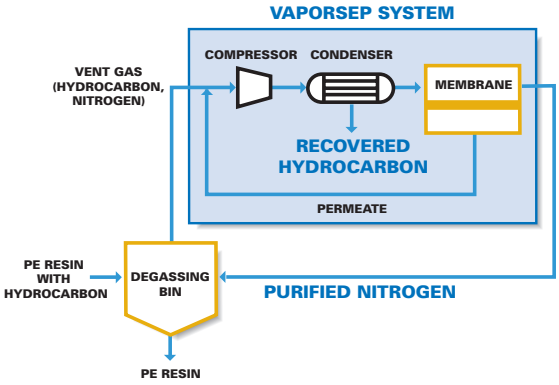
VaporSep® Systems for

Polyethylene Producers

This VaporSep system recovers ethylene and other hydrocarbons from a reactor vent, and returns them directly to the reactor. The unit recovers more than 500 lb/hr of ethylene and butene.

Benefits

- Recovers valuable monomers and other hydrocarbons with typical payback time of less than one year
- Purifies nitrogen for reuse in the process
- Minimizes installation time and expense with skid-mounted construction
- Reduces incineration and flare requirements
- Achieves significantly higher hydrocarbon recovery than possible by condensation alone
- Allows recovery at more moderate temperatures and pressures than condensation alone
- Minimizes footprint and weight
- Creates no secondary waste streams



VaporSep system for hydrocarbon and nitrogen recovery from degassing bins.

System Description

- Complete skid-mounted unit includes membrane modules, compressor, heat exchangers, piping, instrumentation and controls
- Unit dimensions: 15 ft (L) x 10 ft (W) x 10 ft (H); 5,000 to 15,000 lbs; compressor is mounted on a separate skid of similar size
- Conforms to typical petrochemical specifications (ASME, NEC, TEMA etc.)
- Control is by local PLC or through DCS

System Performance

- Suitable for vent streams from 300 to 30,000 pounds per hour, with hydrocarbon concentrations from 10 to 80 vol%
- Hydrocarbon recovery up to 95+%
- Nitrogen recovery up to 99+% with purities of 99+ vol%

Corporate Headquarters

Membrane Technology
& Research, Inc.
1360 Willow Road
Menlo Park, CA
94025-1516 USA
Tel: 650.328.2228
Fax: 650.328.6580
Email: sales@mtrinc.com

U.S. Gulf Coast Office

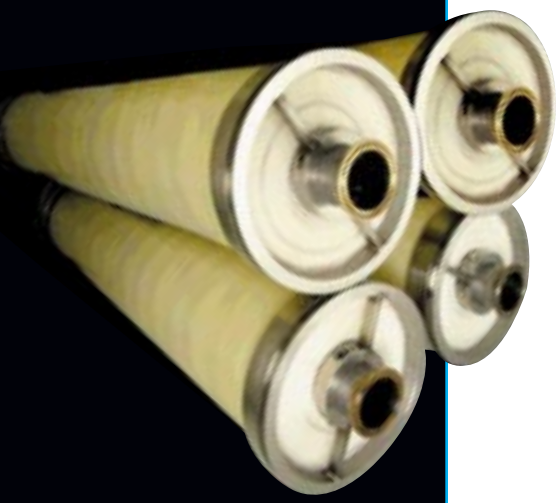
Houston, Texas USA
Tel: 713.466.7608
Fax: 713.466.9602

European Office

Brussels, Belgium
Tel/Fax: 32.2.633.6751

MTR MEMBRANE TECHNOLOGY & RESEARCH

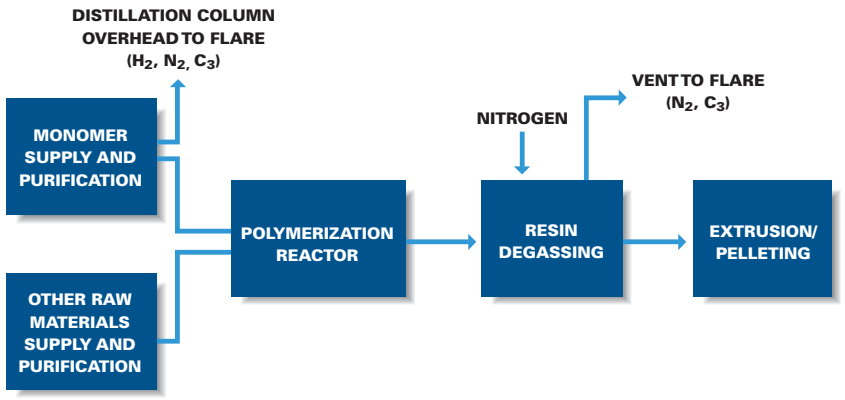
4/99



Polypropylene Producers

- Recovers valuable propylene and nitrogen with payback time of one year or less
- Minimizes installation cost with skid-mounted construction
- Simplifies operation with few or no moving parts

"The VaporSep unit has consistently surpassed the original design specification by recovering more than 95% of the hydrocarbons in the feed gas."



Problem

During the production of polypropylene (PP), a portion of the propylene feedstock is lost. This feedstock loss is substantial, ranging from $1 to 3 million per year for a typical polypropylene plant. Propylene losses occur primarily at two points in the production process: C_3 splitter column overhead vents in the propylene purification step, and resin degassing vents.

VaporSep Solution

For resin degassing applications, the vent stream is compressed and then cooled to condense the propylene. The gas leaving the condenser, which still contains a significant amount of the propylene, is fed to the membrane which separates the stream into a propylene enriched permeate stream and a purified nitrogen residue stream. The permeate is recycled to the inlet of the compressor and then to the condenser, where the propylene is recovered. The purified nitrogen stream is recycled to the degassing bin.

For C_3 splitter overhead applications, the VaporSep unit is very simple, consisting of membrane modules only, with no moving parts. The stream leaving the column overhead is primarily propylene, mixed with light gases such as N_2 or H_2. The VaporSep unit splits this stream into a propylene enriched stream and a light gas enriched stream. The propylene enriched stream is returned to the distillation column where the propylene is recovered, and the light gas enriched stream is vented or flared.

VaporSep units are currently used by major PP producers including Amoco, DSM, Formosa Plastics, Huntsman, and Targor.

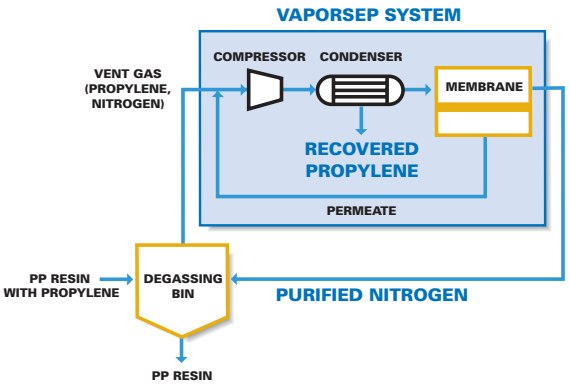
VaporSep® Systems for

Polypropylene Producers

This VaporSep system recovers more than 1000 lb/hr of propylene.

Benefits

- Recovers valuable propylene with typical payback time of less than one year
- Purifies nitrogen for reuse in the process
- Minimizes installation time and expense with skid-mounted construction
- Reduces incineration and flare requirements
- Achieves significantly higher hydrocarbon recovery than possible by condensation alone
- Allows recovery at more moderate temperatures and pressures than condensation alone
- Minimizes footprint and weight
- Creates no secondary waste streams



VaporSep system for propylene and nitrogen recovery from degassing bins.

System Description

- Complete skid-mounted unit includes membrane modules, compressor, heat exchangers, piping, instrumentation and controls
- Unit dimensions: 15 ft (L) x 10 ft (W) x 10 ft (H); 5,000 to 15,000 lbs; compressor is mounted on a separate skid of similar size
- Conforms to typical petrochemical specifications (ASME, NEC, TEMA etc.)
- Control is by local PLC or through DCS

System Performance

- Suitable for vent streams from 300 to 10,000 pounds per hour, with propylene concentrations from 10 to 80 vol%
- Propylene recovery up to 95+%
- Nitrogen recovery up to 99+% with purities of 99+ vol%

Corporate Headquarters

Membrane Technology
& Research, Inc.
1360 Willow Road
Menlo Park, CA
94025-1516 USA
Tel: 650.328.2228
Fax: 650.328.6580
Email: sales@mtrinc.com

U.S. Gulf Coast Office

Houston, Texas USA
Tel: 713.466.7608
Fax: 713.466.9602

European Office

Brussels, Belgium
Tel/Fax: 32.2.633.6751

MTR MEMBRANE TECHNOLOGY & RESEARCH

4/99