MEMBRANE SOLUTIONS FOR NATURAL GAS TREATMENT

Advanced technology for purification of natural gas and associated gas

www.medal.airliquide.com
Air Liquide Advanced Separations (ALaS) manufactures a comprehensive line of membrane products for natural gas and associated petroleum gas treatment. Our product portfolio includes the most robust and efficient hollow fiber membranes in the industry. Whether you need to simply dehydrate your natural gas stream for re-injection, adjust the BTU value for fuel use, recover NGLs, or meet export pipeline specifications, Air Liquide has a membrane solution for you. Our Solutions Development team will work with you to design the most efficient process that meets the gas treatment requirements.

APPLICATIONS
Air Liquide’s MEDAL and PoroGen PEEK-Sep product portfolio provides for natural gas conditioning solutions from the wellhead to the pipeline. Our All-Membrane Solution™ greatly simplifies the gas purification process by removing multiple contaminants in fewer steps than conventional processes.

NATURAL GAS MEMBRANE SOLUTIONS—WELLHEAD TO PIPELINE
All-Membrane Solution™

The end result may either be an All-Membrane Solution™ or hybrid offering, combining our membrane technology with absorption, adsorption, or cryogenic-based unit operations, to provide the lowest CAPEX and OPEX solution compared to conventional purification methods.

ADVANTAGES OF ALL-MEMBRANE SOLUTION™

THE AIR LIQUIDE ADVANTAGE
OUR SOLUTIONS
ONSHORE OR OFFSHORE

Purification Capabilities

NATURAL GAS MEMBRANE SOLUTIONS—WELLHEAD TO PIPELINE
All-Membrane Solution™

Our All-Membrane Solution™ offers distinct advantages over conventional multi-step unit operations and spiral-wound cellulose acetate membrane alternatives. The benefits are magnified for offshore platforms and FPSO applications where multiple contaminants must be removed from the gas stream.

PoroGen PEEK-Sep membranes can operate in condensing mode with minimal pre-treatment.

Air Liquide offers the most robust, reliable and cost effective gas treatment solutions for your onshore or offshore applications through a global network of engineering and system fabrication partners.
The MEDAL membranes are asymmetric polyimide-based hollow fibers comprised of a core which is optimized for mechanical strength and a sheath optimized for gas separation.

POROGEN PEEK-SEP TECHNOLOGY

PEEK exhibits “best in class” thermo-mechanical properties and chemical resistance. PEEK membranes are not affected by solvents and chemicals present in the natural gas and can operate without extensive pretreatment. Membranes from PEEK are extremely robust with exceptional properties:

- Superior combination of strength and flexibility
- High temperature operating limits with almost constant mechanical properties over a wide temperature range
- High chemical resistance in all kind of aggressive media
- High wear resistance

The hollow fiber dimensions and pore size are tailored towards the target gas purification. The hollow fiber surface chemistry is optimized to enhance target separation by chemical modification or coating.

As compared to other membrane technologies, MEDAL large diameter 12” membranes fit more surface area into a given volume, which requires less steel, thereby lowering system cost. Membrane modules may contain over 1 million individual hollow fibers. Fiber bundles are formed in cross flow and counter flow designs allowing for flexibility in meeting all pressure drop and performance constraints.

Hollow fiber membranes are formed using high performance materials to allow operation at elevated temperatures and extreme pressures. Residue gas collection tubes, with orifices custom drilled for each application, ensure even gas distribution and consistent performance from each MEDAL bundle.

A 12-inch module contains 0.5-1.0 million fibers. Laid end-to-end, the fibers would stretch for 750 miles (1200 km).

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Air Liquide membranes exploit the pressure difference between the feed gas and waste (permeate) gas, where impurities are concentrated, as the driving force for the separation. The hollow fiber membrane materials allow certain selective removal of impurities that permeate membrane walls as fast molecules while the product is collected at high pressure as the non-permeate stream. Membrane material and configuration are tailored to each application to achieve the optimum trade-off between purity and recovery.

Target product purity and recovery is economically achieved utilizing our high selectivity and high productivity membranes. Unique module designs enable meeting of these targets even at low trans-membrane pressures.

GAS PERMEATION HIERARCHY

Our MEDAL and PoroGen PEEK-Sep product lines are highly complementary. Natural gas product purity targets can be achieved and process economics optimized using either conventional or non-conventional gas permeation hierarchy, or a combination of both.

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<thead>
<tr>
<th>Fast Gases</th>
<th>Slow Gases</th>
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<td>H₂O</td>
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PEEK-Sep hollow fiber membrane modules use proprietary computer controlled winding technology that enables construction of membrane cartridges with uniform predetermined packing density, which in turn provides superior flow dynamics, minimizes pressure drop and improves separation efficiency. Hollow fiber devices operate in counter-current mode for enhanced separation efficiency.

UNIQUE MEMBRANE FEATURES

- Efficient heat and mass transfer in the same device
- Structured hollow fiber configuration for optimal thermodynamic separation efficiency
- Low pressure drop and low hydrocarbon losses
- In case of liquids flooding, membrane performance is restored after liquids are drained and membrane returned to gas phase operation
MEDAL and PoroGen PEEK-Sep membranes are manufactured in hollow fiber configuration, small diameter porous tubes made of polyimide and PEEK polymers. The small contained volume of the hollow fiber membrane is advantageous for offshore separation applications where space is limited and the natural gas product is of high value. ALAS hollow fiber module designs are configured for counter-current flow for most efficient hydrocarbon recovery.

HOLLOW FIBER CONFIGURATION PROVIDES THE MOST OPTIMAL PACKAGING CONFIGURATION

Counter-current flow characteristics achieve high purity and recovery
High membrane area in given module volume
Compact system footprint

SUPERIOR GAS SEPARATION EFFICIENCY

The membrane cartridge is installed into a pressure housing and sealed with o-rings. The cartridge can be installed and removed easily. Multiple membrane modules are packaged into a separation system tailored towards a customer separation application. The high pressure feed gas is introduced on the shell side of the hollow fibers and impurities are removed as a low pressure permeate gas on the bore side of hollow fibers. Membranes are tailored towards target gas purification and multiple impurities can be removed simultaneously in a single process step.

The MEDAL PX membrane is highly efficient for CO$_2$ removal applications where high methane recovery is required. The high selectivity of this polyimide-based membrane maximizes recovery of CH$_4$ in the high pressure product stream, meaning more sales gas in the pipeline. Selectively permeable PoroGen PEEK-Sep membranes with ultra-thin separation layers are tailored towards removal of heavy hydrocarbons (C$_3$+), H$_2$S, and water vapor from raw natural gas to improve gas quality.

FLEXIBLE MEMBRANE MODULE DESIGN

- Simple, flexible and cost effective membrane module design
- Compact packaging with small footprint
- Adjustable purge used to enhance separation efficiency by purging membrane permeate conduit with fractional volume product gas
- High pressure operating capability, 1000-1500 psig ΔP differential pressure

From individual hollow fibers to complete separation systems, Air Liquide membrane modules are incorporated into packaged systems to provide a complete natural gas purification solution.

The feed gas to be purified is pretreated to remove bulk liquids and particulates using a coalescing filter. The feed gas is processed in our PoroGen and MEDAL membranes with interstage heat applied to achieve optimal membrane performance and desired natural gas purity and recovery.

Typically each membrane module operates in parallel; however, multiple membrane configurations (parallel or series) and stages are available to optimize client’s CAPEX and OPEX requirements.
Founded in 1902 and now present in 80 countries with 51,500 employees, Air Liquide is the world leader in industrial and medical gases and related services. The Group offers innovative solutions based on constantly enhanced technologies to help manufacture many indispensable everyday products and preserve life. NOTE: This brochure is intended for general information purposes only and is not intended as a representation or warranty of any kind, or as a statement of any terms or conditions of sale. The information herein is believed to be correct, but is not warranted for correctness or completeness, or for applicability to any particular customer or situation. © AIR LIQUIDE ADVANCED BUSINESS & TECHNOLOGIES
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OVER 40 NATURAL GAS MEMBRANE SYSTEM REFERENCES WORLDWIDE

OVER 1000 ALaS NATURAL GAS MEMBRANE MODULES IN OPERATION WORLDWIDE

ALL MEMBRANE MODULES MANUFACTURED WITHIN THE USA

WORLDWIDE SYSTEM FABRICATION CAPABILITIES

NATURAL GAS SYSTEMS IN OPERATION UP TO 530MMSCFD
(Systems can be designed to handle any feed flow since membranes are modular)

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