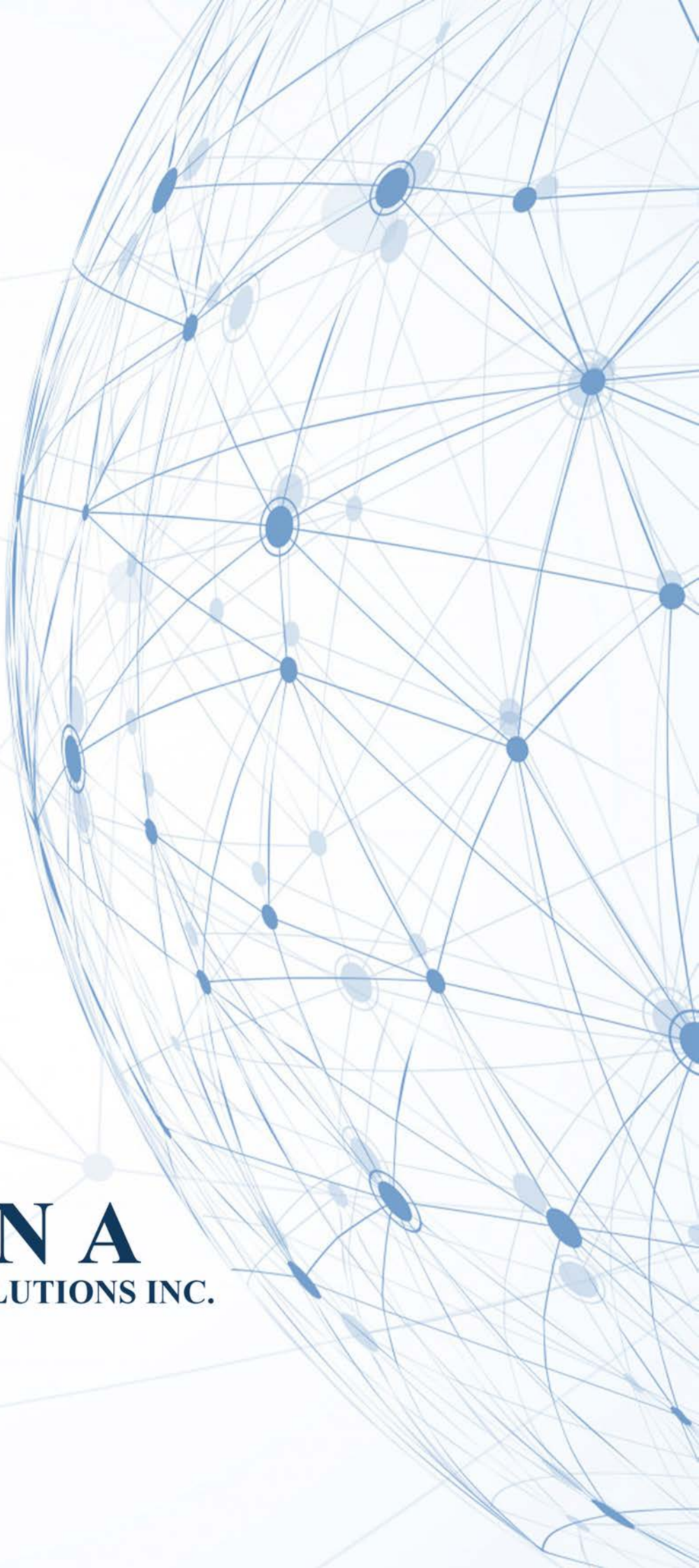
BORNA MEMBRANE SOLUTIONS INC.



BORNA

MEMBRANE SOLUTIONS INC.

About us

Borna Membrane Solutions is a knowledge-based company active in the field of gas separation based on membrane technology. BMS manufactures gas separation membrane modules and has proven itself as a reliable player with technical knowledge in the field of membrane separation processes. BMS takes steps towards meeting the needs of the oil, gas, petrochemical, refinery, steel, carbon capturing and vapor recovery industries by benefiting from its expert manpower and relying on its unique infrastructure in the fields of technical engineering and construction. Relying on years of research we are looking forward to a bright future, BMS strives to achieve business excellence through real value creation for its customers on a global scale.

2007

Academic Research

- Library Studies
- Laboratory prototyping

2012

Applied Research

- Identification of market needs
- Examining the status of international competitors
- Feasibility of product production
- Prodution of sample Membrane Composite

2017

SEED Capital Raise

- Attracting capital from the private sector
- Design and manufacture of composite membrane production line
- Design and manufacture of membrane module production line

2022

Establishment of Borna Membrane Solutions (BMS)

- Operation of the production line of composite membranes
- Operation of the production line of membrane modules
- Establishment of BMS

2023

Proof of Borna Membrane Technology

- Construction of the first Borna membrane unit in the petrochemical industry

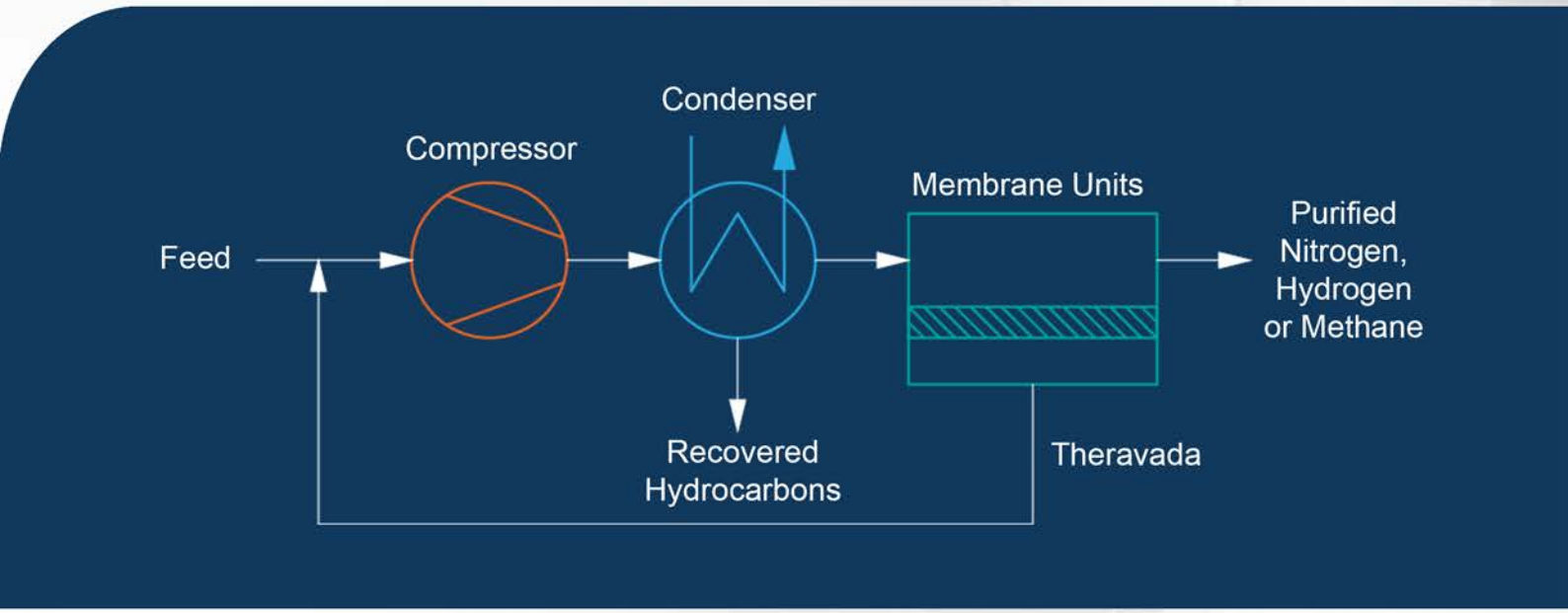
2024

Business Partnership in Oman

- Signing official long term (25 year) business partnership agreement with Muscat Gas in Sultunate of Oman for LPG Recovery thoughout Middle East

Technology of membrane gas separation

During the last 30 years, due to the advances made in different industries, membrane gas separation processes have grown significantly and turned into a market worth 150 to 230 million dollars per year with an annual growth of 15% (the highest growth among different membrane processes). nitrogen separation from air; separation of carbon dioxide from methane; Separation of hydrogen from nitrogen, argon, or methane, as well as separation of mixtures containing condensable gases from light gases, such as ethylene recovery in petrochemical complexes producing polyethylene, propylene recovery in petrochemical complexes producing polypropylene, recovery of vinyl acetate monomer and ethylene oxide In petrochemical complexes, the recovery of vinyl chloride monomer in petrochemical complexes producing poly(vinyl chloride), the concentration of waste gases in petrochemical centers with the aim of reaching the standard of fuel gases, the separation of nitrogen from natural gas with the aim of increasing the calorific value of natural gas in refinery industries, The recovery of heavy hydrocarbons in refinery industries and the recovery of gasoline vapors in transfer terminals are only part of the applications of membrane technology in the field of gas separation.



Without release of environmental pollutants

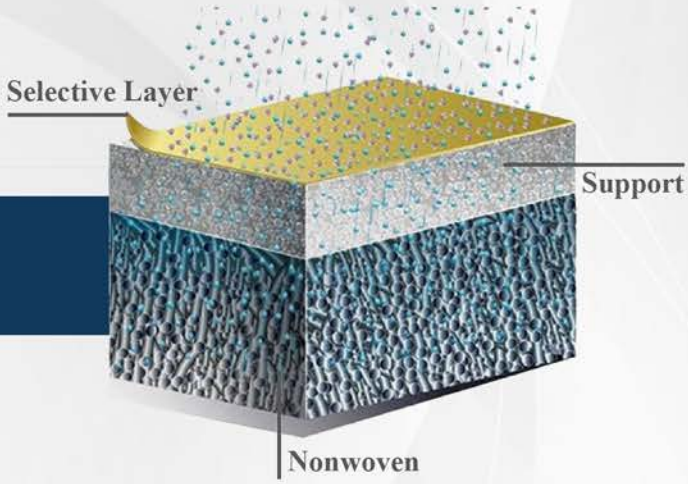
Without dangerous chemicals

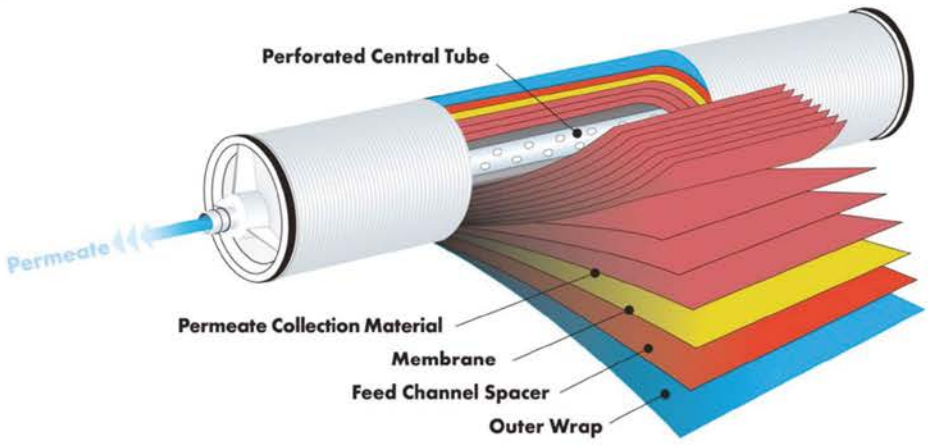
Without the use of fossil fuels

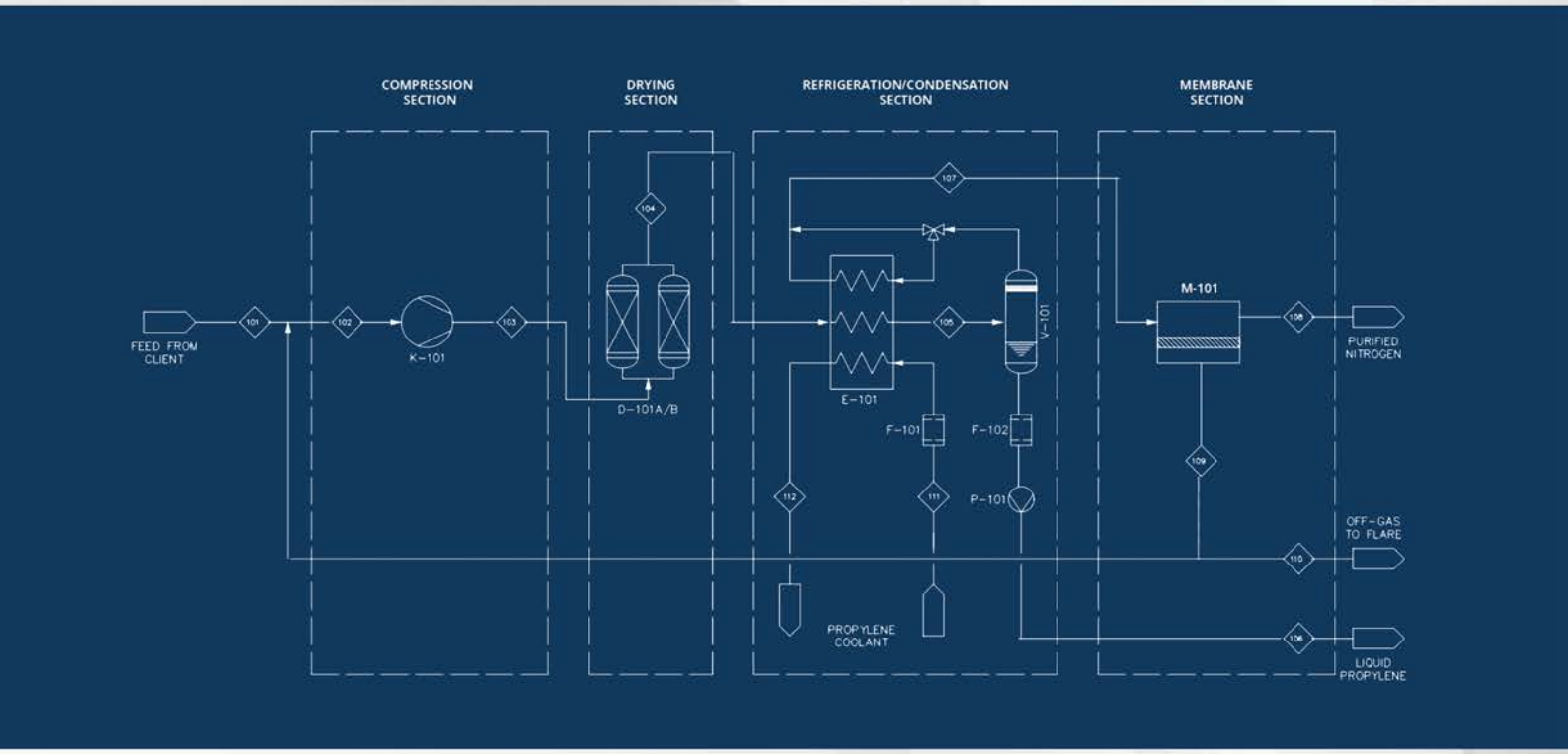
without water consumption

Membrane module

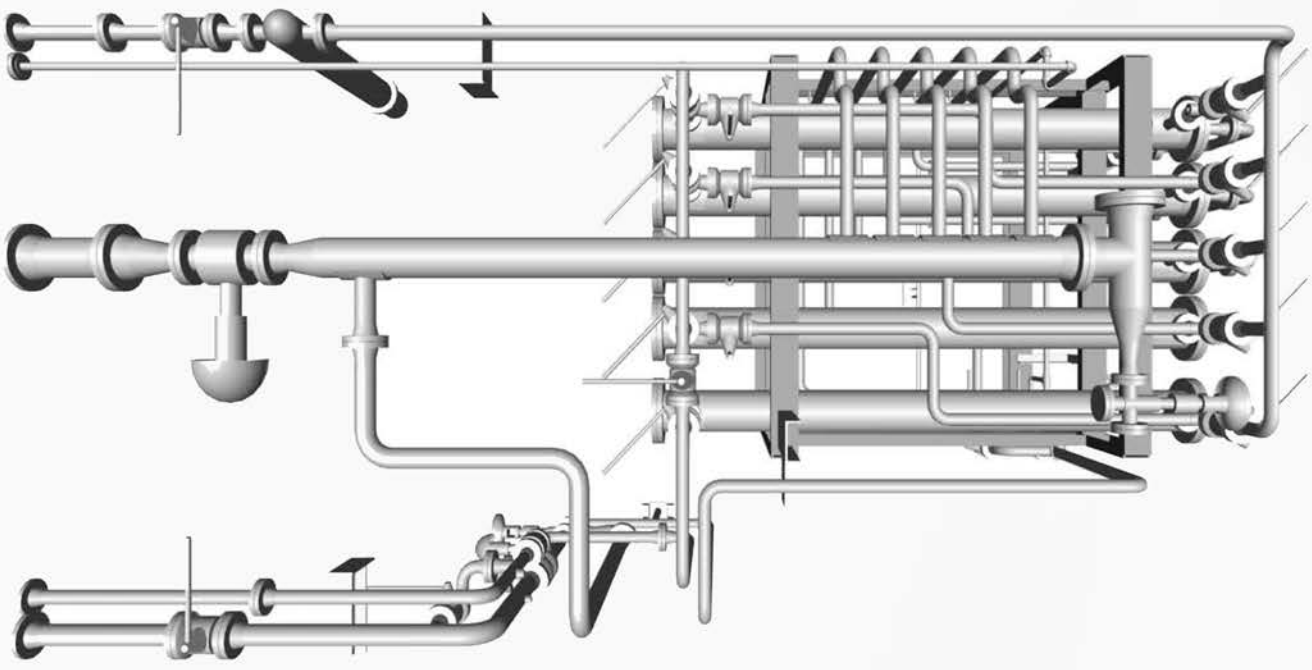
The membrane is a thin, semi-permeable barrier that is placed between two fluids and provides the possibility of separating some components between the two fluids. Today, membranes have a special place and extensive applications in different fields of separation. The key feature of membranes is the ability to pass one component and reject other components. Commercial membranes used in gas separation consist of five layers, which are: (1) non-woven fabric; (2) microporous support; (3) middle layer; (4) selective layer; and (5) protective layer. The non-woven fabric provides the substrate for making the membrane; The microporous support provides mechanical resistance; The middle layer fixes the surface defects of the porous layer; The selective layer is responsible for separation; And the protection layer fixes the possible defects of the selector layer.







Process diagram of a membrane unit



Membrane skid

PETROCHEMICAL INDUSTRY

NATURAL GAS INDUSTRY

EMISSION CONTROL

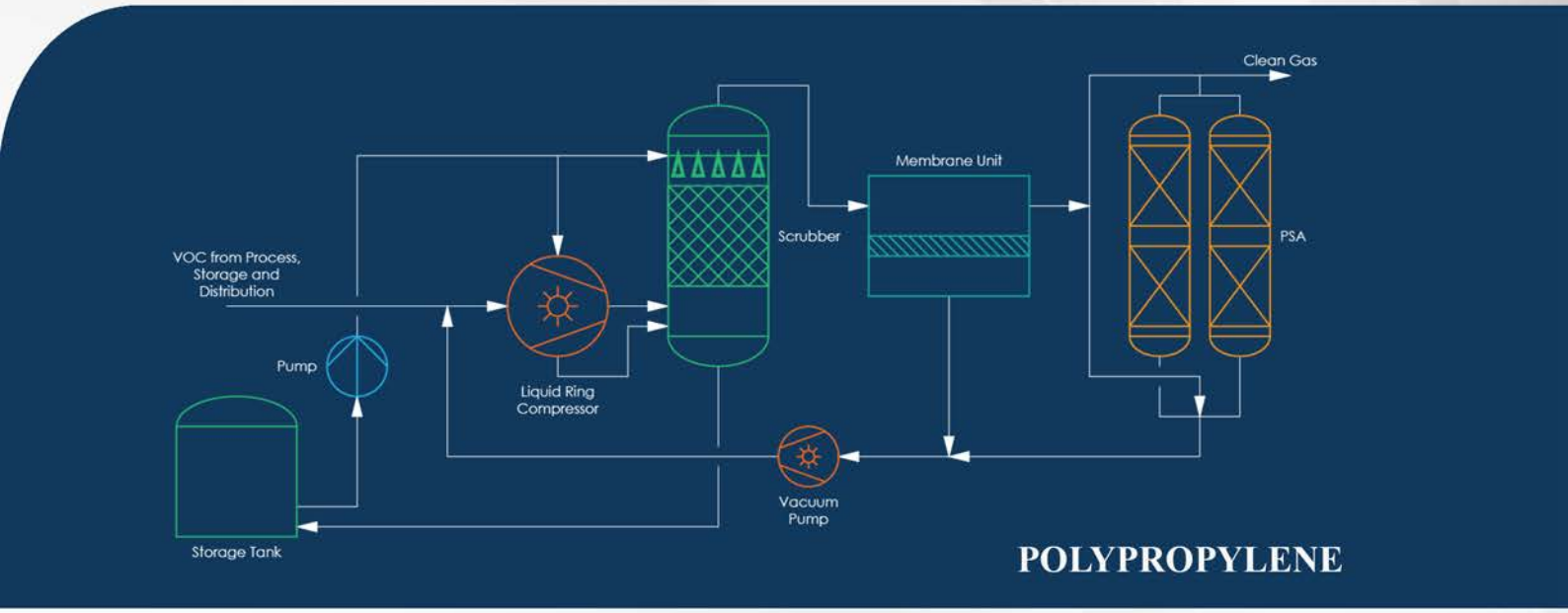
STEEL INDUSTRY

PETROCHEMICAL INDUSTRY

Polypropylene production

In general, in the polypropylene production process, between 2 and 5% of the consumed propylene is sent to the flare and burned through waste streams. The presence of these waste flows, in addition to the annual loss of several million dollars of valuable hydrocarbon resources, also leads to the release of a large amount of greenhouse gases.

By relying on membrane technology, BMS has made it possible to recover propylene and nitrogen from waste streams of polypropylene production units, which will achieve very positive economic and environmental benefits. Propylene and nitrogen recovery membrane units include condensation unit, temperature alternating surface absorption (TSA), cooling/condensation, membrane unit and pressure alternating surface absorption (PSA).

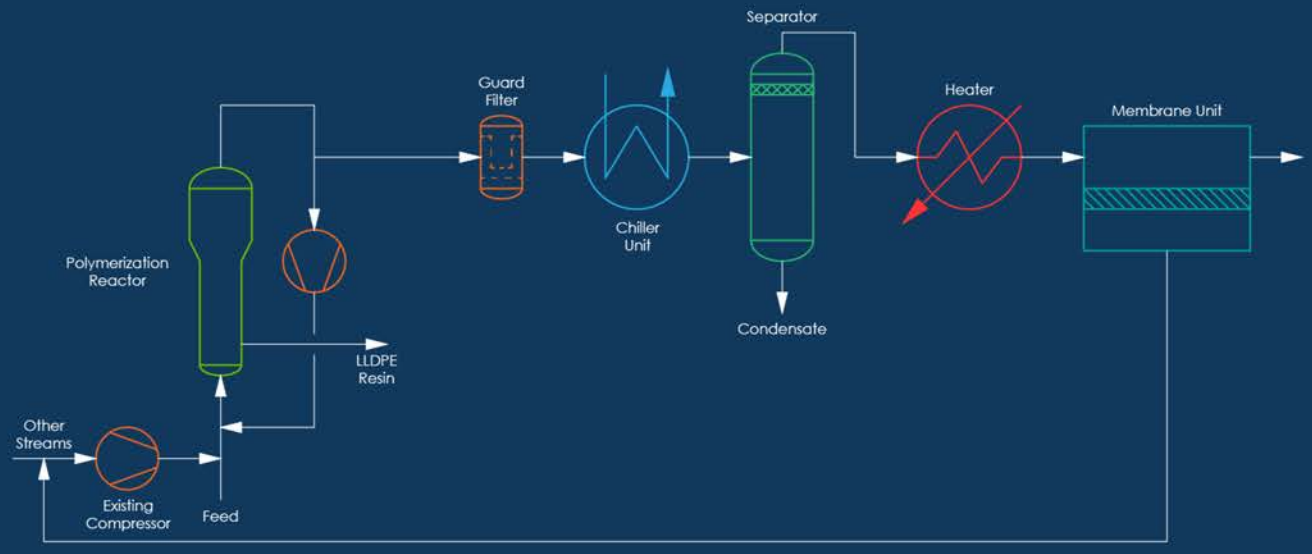


Advantages of membrane technology in polypropylene production units

- High process efficiency
- The possibility of recovering more than 90 to 95% of waste propylene
- The possibility of nitrogen recovery with a concentration of over 99% with the aim of reuse in process units
- Reducing flaring and significantly reducing greenhouse gas emissions
- Low investment and operating cost
- Ease of setup and operation
- Simple repairs and maintenance
- Requires little physical space
- Portable and portable structure
- Short payback time

Polyethylene production

The main operating cost in petrochemical complexes producing polyethylene is the cost of raw materials. In gas phase polyethylene units that produce heavy polyethylene (HDPE) or linear light polyethylene (LLDPE), the raw material is usually a combination of monomers such as ethylene, butene and 1-hexene. The overall efficiency of these units for converting monomer to polymer is between 95 and 98%, so 2 to 5% of the valuable feed of these units is lost through waste streams and flaring, which has significant economic and environmental harm. In the polyethylene production process, waste streams usually come from three areas: (1) the upstream output of the distillation columns in the ethylene recovery and purification stage, (2) the output stream from the reactor, and (3) the output of the degassing unit. By relying on membrane technology, Born has developed technology making it possible to recover valuable hydrocarbons from waste streams of polyethylene production units.



POLYETHYLENE

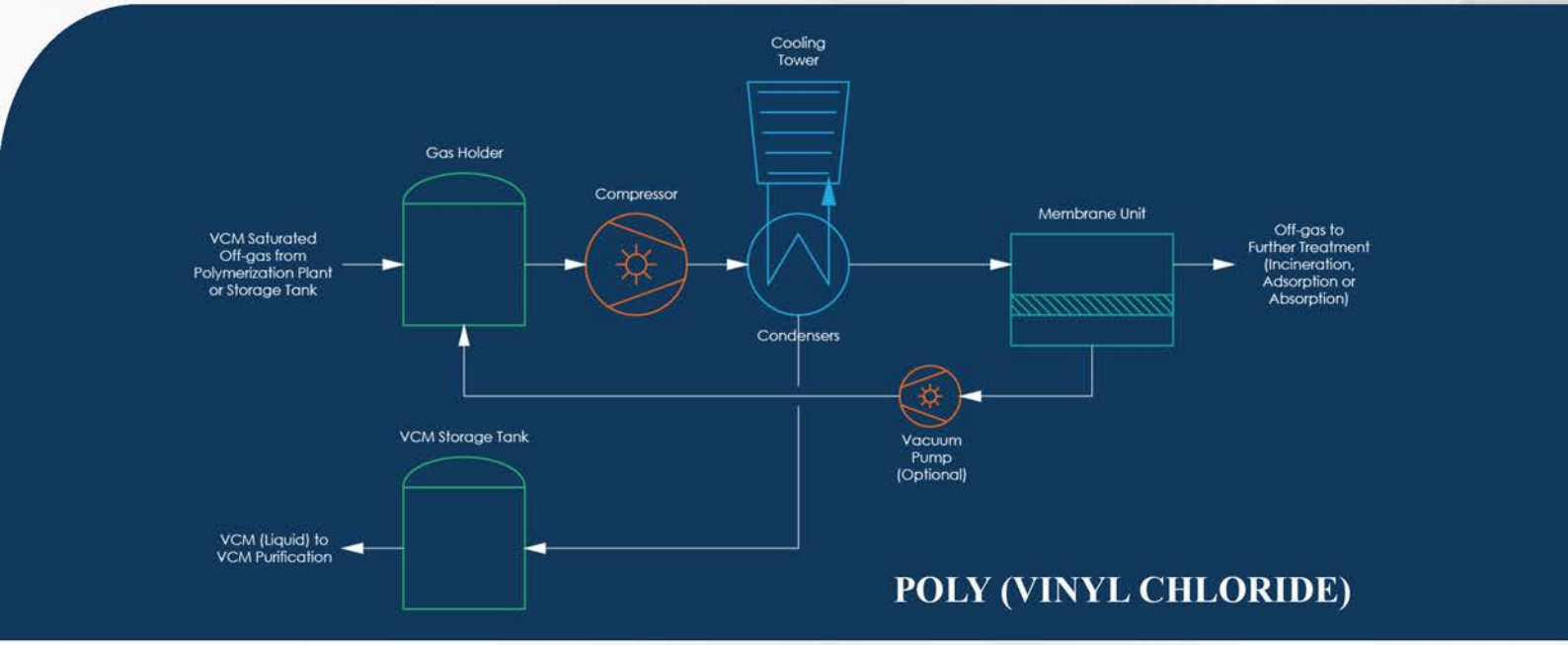
Advantages of membrane technology in polyethylene production units

- High process efficiency
- The possibility of recovering more than 90 to 95% of waste ethylene
- It is possible to recover nitrogen with a concentration of over 99%
- Reuse in process units
- Reducing flaring and significantly reducing greenhouse gas emissions
- Low investment and operating cost
- Ease of setup and operation
- Simple repairs and maintenance
- Requires little physical space
- Portable and portable structure
- Short payback time

Production of poly (vinyl chloride)

The production of polyvinyl chloride (PVC) from vinyl chloride monomer (VCM) is a well-known process. One of the important aspects of the economics of this process is the recovery and reuse of unreacted VCM from the waste streams of the unit. The conventional method for VCM recovery is based on condensation and refrigeration methods. Depending on the temperature and pressure of the condenser, the outlet stream from the condenser still contains a significant amount of VCM. Since the release of VCM faces many environmental restrictions and requirements, the need for technologies that enable the effective removal of VCM is strongly felt.

By using membrane technology, Borna's technology has made it possible to recover more than 99% of VCM in waste streams, which is very difficult to achieve this amount of separation using condensation and refrigeration methods. For example, to reach this level of recovery using condensation and refrigeration methods, the temperature of the condenser needs to be brought below -70 °C.



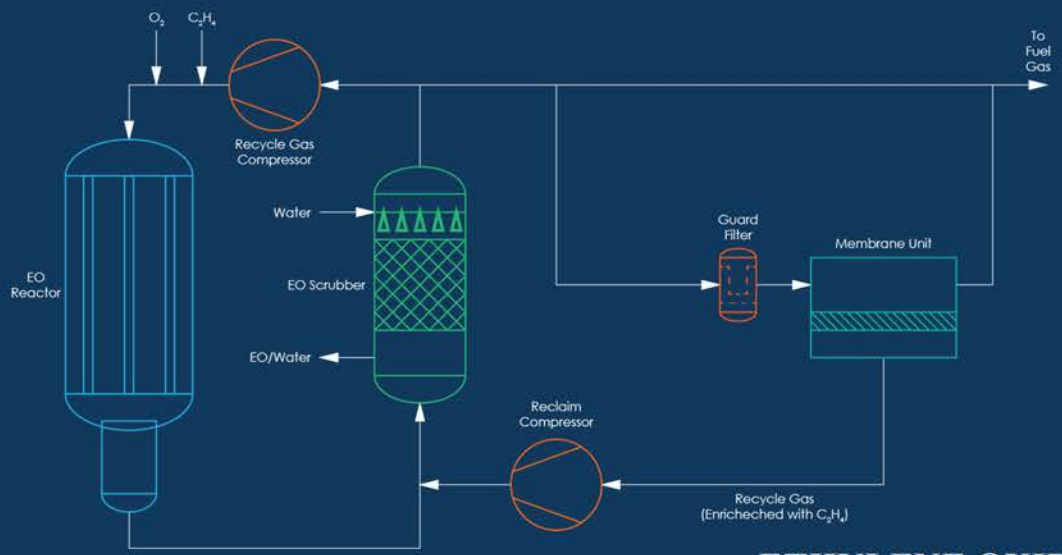
Advantages of membrane technology in poly (vinyl chloride) production units

- Very high process efficiency compared to condensation and refrigeration
- Achieving a high recovery level (99%) in accordance with environmental requirements
- No need for rotating equipment
- Low investment and operating cost
- Ease of setup and operation
- Simple repairs and maintenance
- Requires little physical space
- Portable and portable structure

Production of ethylene oxide (EO) and vinyl acetate monomer (VAM)

Ethylene oxide is produced from the reaction of ethylene and oxygen in a catalytic reactor. The production process of vinyl acetate monomer is similar, with the difference that vinyl acetate is also added to the reactor. The reactor of these processes works in a loop mode and the accumulation of impurities such as argon, which enters together with oxygen, can cause disturbances in the process, and therefore a part of the flow inside the reactor must be purged. A certain amount of feed ethylene is also lost along with this purge flow. The value of this waste raw material is considerable, so its recovery has always been considered.

By relying on membrane technology, Borna has made it possible to recover valuable hydrocarbons from the waste gas flow of the said reactor. This membrane unit includes a single-stage membrane system that separates ethylene from the return flow. The ethylene-rich Theravada stream is sent to the existing compressor of the unit and then returned to the process reactor. The neutral gases upstream of the membrane are also sent to the waste gas extraction section.



ETHYLENE OXIDE (EO)

Advantages of membrane technology in ethylene oxide (EO) and vinyl acetate monomer (VAM) units

- Achieving a high recovery level (more than 90%)
- Very high process efficiency
- Low investment and operating cost
- Simple repairs and maintenance
- Portable and portable structure
- No need for rotating equipment
- Ease of setup and operation
- Requires little physical space
- Short payback time

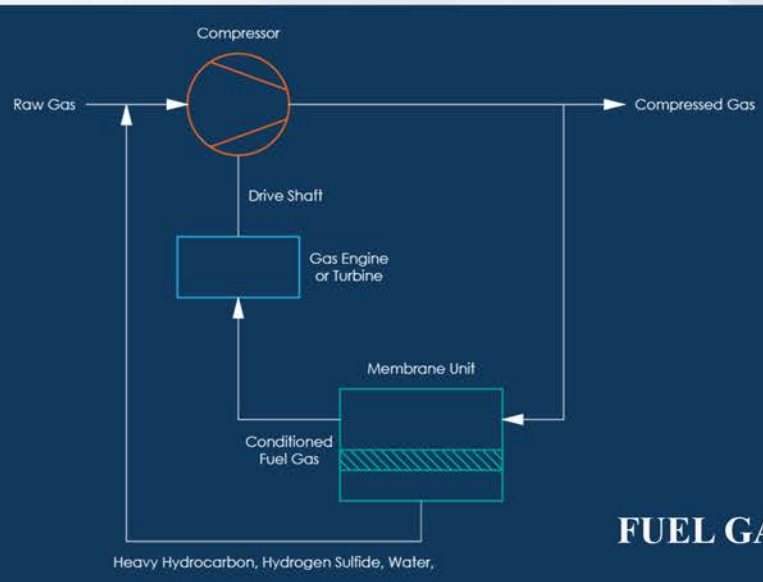
BORNA MEMBRANE SOLUTIONS INC.


NATURAL GAS INDUSTRY

Fuel Gas Conditioning

In some cases, it is not possible to use raw natural gas as a fuel for gas engines or gas turbines that supply the driving force for transmission line compressors due to the low quality of the gas. A significant concentration of compounds such as H_2 S or +C_3 causes corrosion and carbon accumulation in gas engines. On the other hand, the presence of CO_2 and N_2 will decrease the calorific value of the gas. In total, each of these impurities can reduce the functional efficiency of an engine. Therefore, the presence of these impurities makes the use of raw natural gas as a fuel unjustifiable.

By using membrane technology, BMS technology makes it possible to use this valuable and accessible energy source by purifying raw natural gas at the consumer's place.



FUEL GAS CONDITIONING

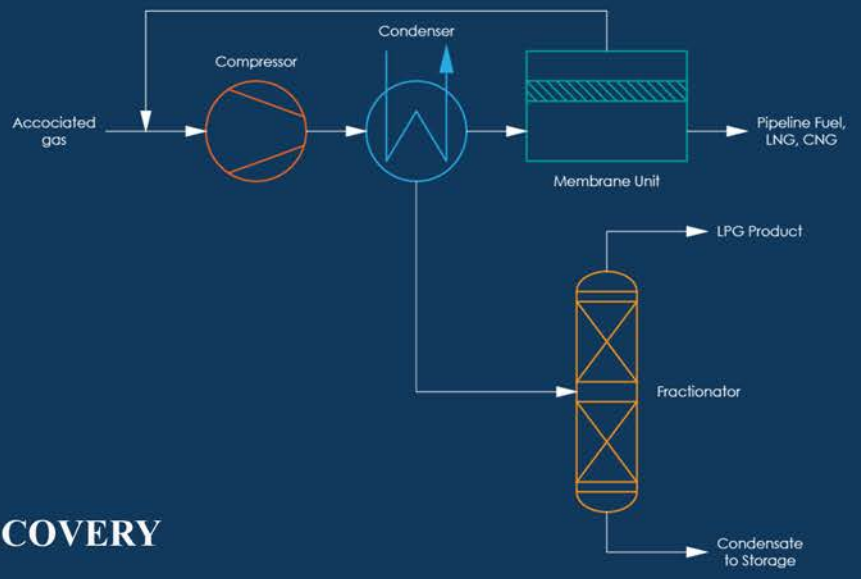
Advantages of membrane technology in Fuel Gas Conditioning

- Removal of heavy compounds such as +C_3 from the gaseous fuel stream
- Lowering the dew point of the gas stream
- Removal of a significant part of acid gases such as H_2 S and CO_2
- Increasing the useful life of engines and gas turbines
- Reducing maintenance costs and unplanned downtime
- Absence of moving parts in membrane units
- Ease of setup and operation
- Simple repairs and maintenance
- Requires little physical space

Gas condensate recovery

In many cases, associated gases cannot be used at the well installation site, so part or all of the gas flow must be burned. In addition to the waste of valuable energy resources, the process of flaring associated gases will also cause environmental pollution.

By using membrane technology, Borna's technology is able to effectively recover LPG from the flow of associated gases. Due to the fact that LPG has the possibility of easy storage and transportation, the product of these units can be placed in a liquid form at the place of use or even transported to consumers further away. In general, accompanying gases are rich in heavy hydrocarbons, so the recovery of LPG and heavier compounds from flare gas will greatly reduce carbon emissions. In addition, in some situations, the use of membrane technology in LPG recovery allows the residual methane to be sent to LNG or CNG units.



LPG RECOVERY

Advantages of membrane technology in LPG recovery

- Unit operation at ambient temperature and medium pressure
- Operation of the unit without the need for cryogenic agent, absorbent and chemicals
- Ease of setup and operation
- Simple repairs and maintenance
- Requires little physical space
- Portable and portable structure
- Short payback time


BORNA MEMBRANE SOLUTIONS INC.

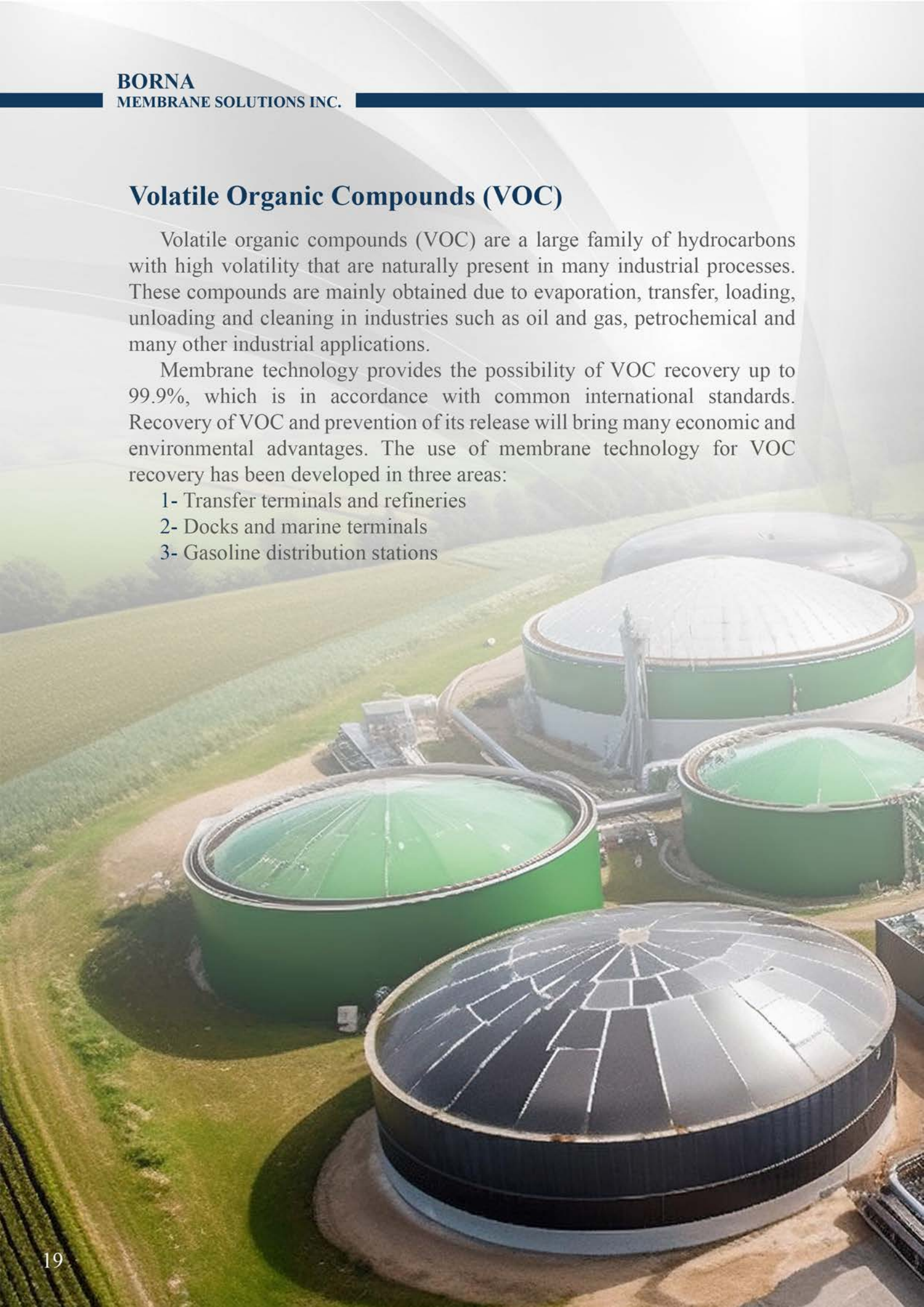
EMISSION CONTROL

Volatile Organic Compounds (VOC)

Volatile organic compounds (VOC) are a large family of hydrocarbons with high volatility that are naturally present in many industrial processes. These compounds are mainly obtained due to evaporation, transfer, loading, unloading and cleaning in industries such as oil and gas, petrochemical and many other industrial applications.

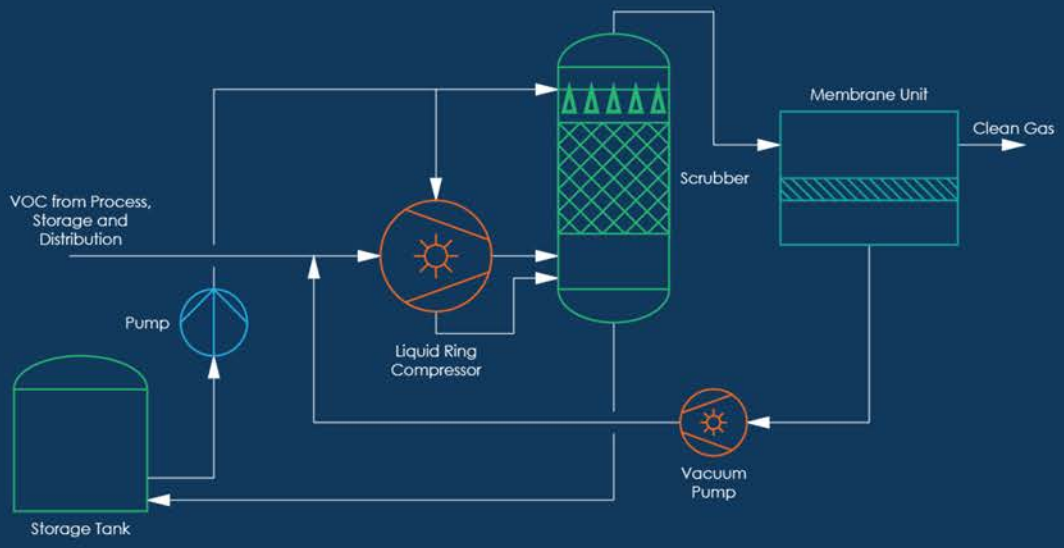
Membrane technology provides the possibility of VOC recovery up to 99.9%, which is in accordance with common international standards. Recovery of VOC and prevention of its release will bring many economic and environmental advantages. The use of membrane technology for VOC recovery has been developed in three areas:

1- Transfer terminals and refineries
2- Docks and marine terminals
3- Gasoline distribution stations



Use of membrane technology in steam recovery units

Vapor recovery units consist of an absorption/condensation section and a membrane separation section. These units have a compression system with liquid ring compressor, scrubber column, membrane skid and vacuum pump. Steam recovery units are made in a modular way and can have a unique design (customized) according to the needs of each industry.



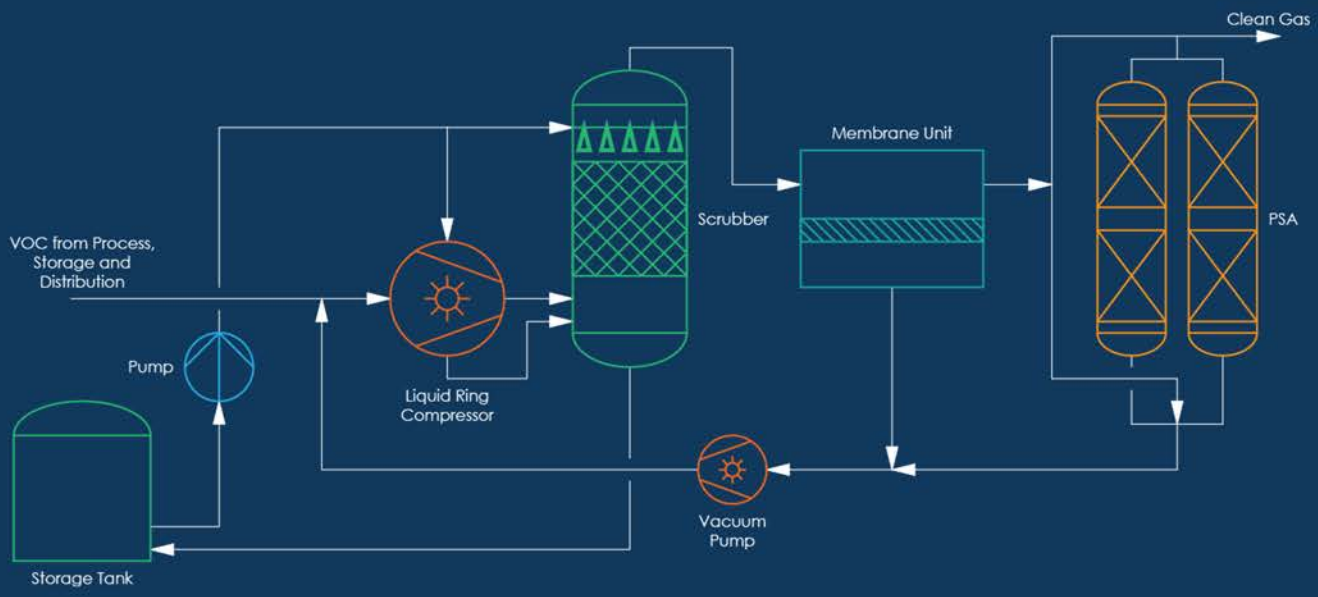
VAPOR RECOVERY

Advantages of membrane technology in VOC recovery units

- Compact and portable design
- High recovery efficiency
- Ability to design in a wide range of capacities
- Low maintenance cost
- Complying with global standards to control and reduce VOC emissions
- Solving the problem of saturation with aromatic compounds unlike gravity-based technologies

Using membrane technology in aromatic recovery units

Aromatics (benzene, toluene, xylene, etc.) are among the petrochemical products with the highest importance in terms of emission control. The release of aromatic compounds are considered carcinogenic, and therefore many countries have imposed special strict restrictions on the release of these substances. Borna company has made it possible to effectively recover aromatics by using membrane technology.



AROMATIC RECOVERY

Advantages of membrane technology in aromatic recovery units

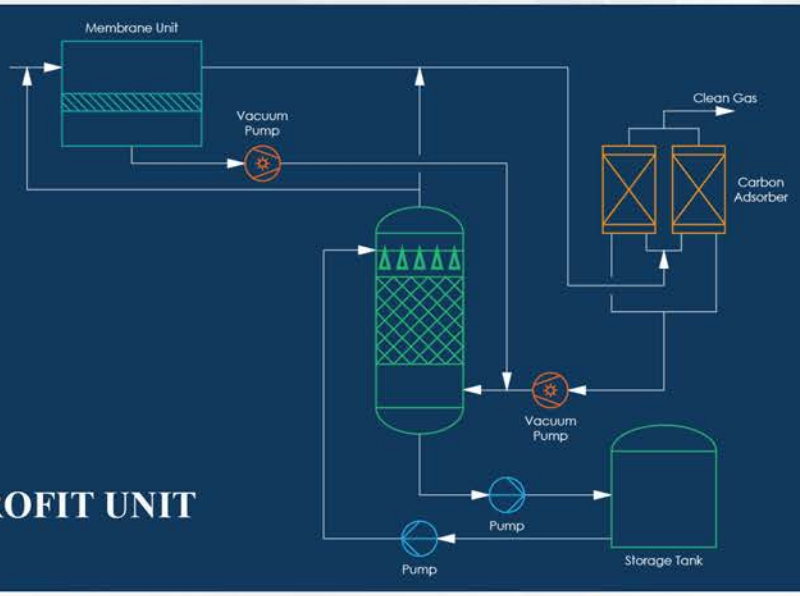
- Compliant with global emission limits
- Flexible and safe recovery of all aromatic product vapors
- Designing all process steps with the longest life in terms of stability and performance
- Aromatic unsaturation in absorbent materials such as activated carbon
- Safe storage - no contamination of process materials/fluids
- Superior technology proven in many applications

Upgrading absorption vapor recovery units using membrane technology

The quality and capacity of adsorption units based on activated carbon can be improved by using membrane technology. Absorption steam recovery units based on activated carbon generally face the following problems:

- The need to increase capacity by increasing the capacity of terminals and exceeding the design capacity
- Reduction of the performance of absorbent substrates due to the accumulation of heavy compounds, aromatic compounds or pollution by other impurities.
- Inability to achieve the level of environmental requirements and standards to reduce VOC emissions
- The risk of causing exothermic reactions in carbon absorbent beds

To upgrade the absorption unit, a membrane unit and a vacuum pump are added upstream of the unit. In this case, the steam exiting from the scrubber column is sent to the membrane unit, and the flow passing through the membrane unit, which is saturated with hydrocarbon compounds, is returned to the scrubber column, and the flow upstream of the membrane (rejected) is sent to the absorption units.



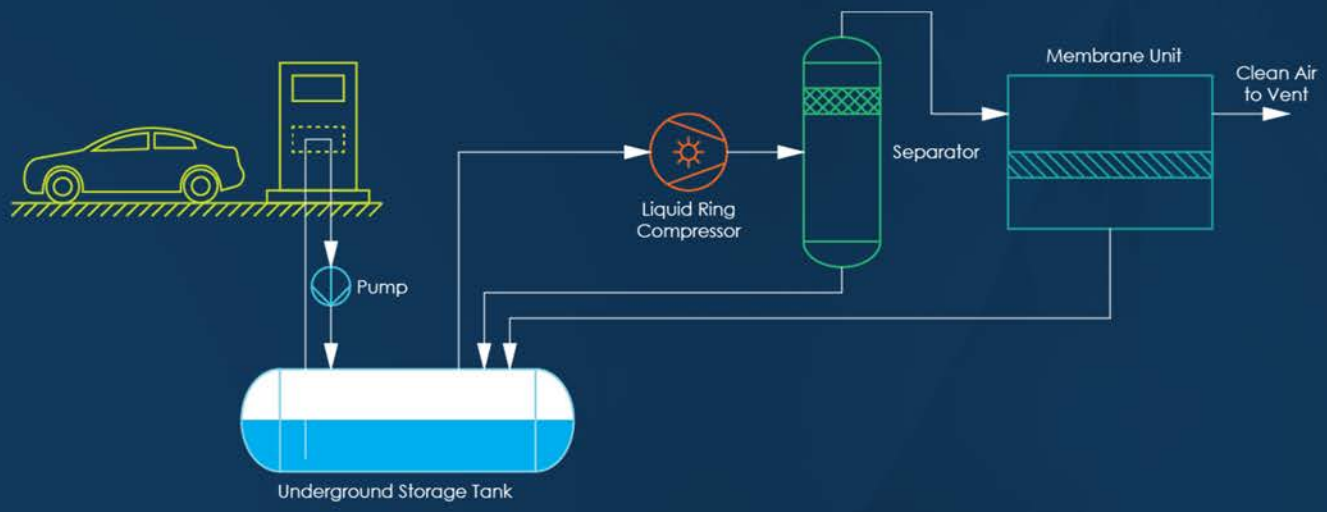
CARBON RETROFIT UNIT

Advantages of upgrading vapor recovery units based on activated carbon with membrane technology

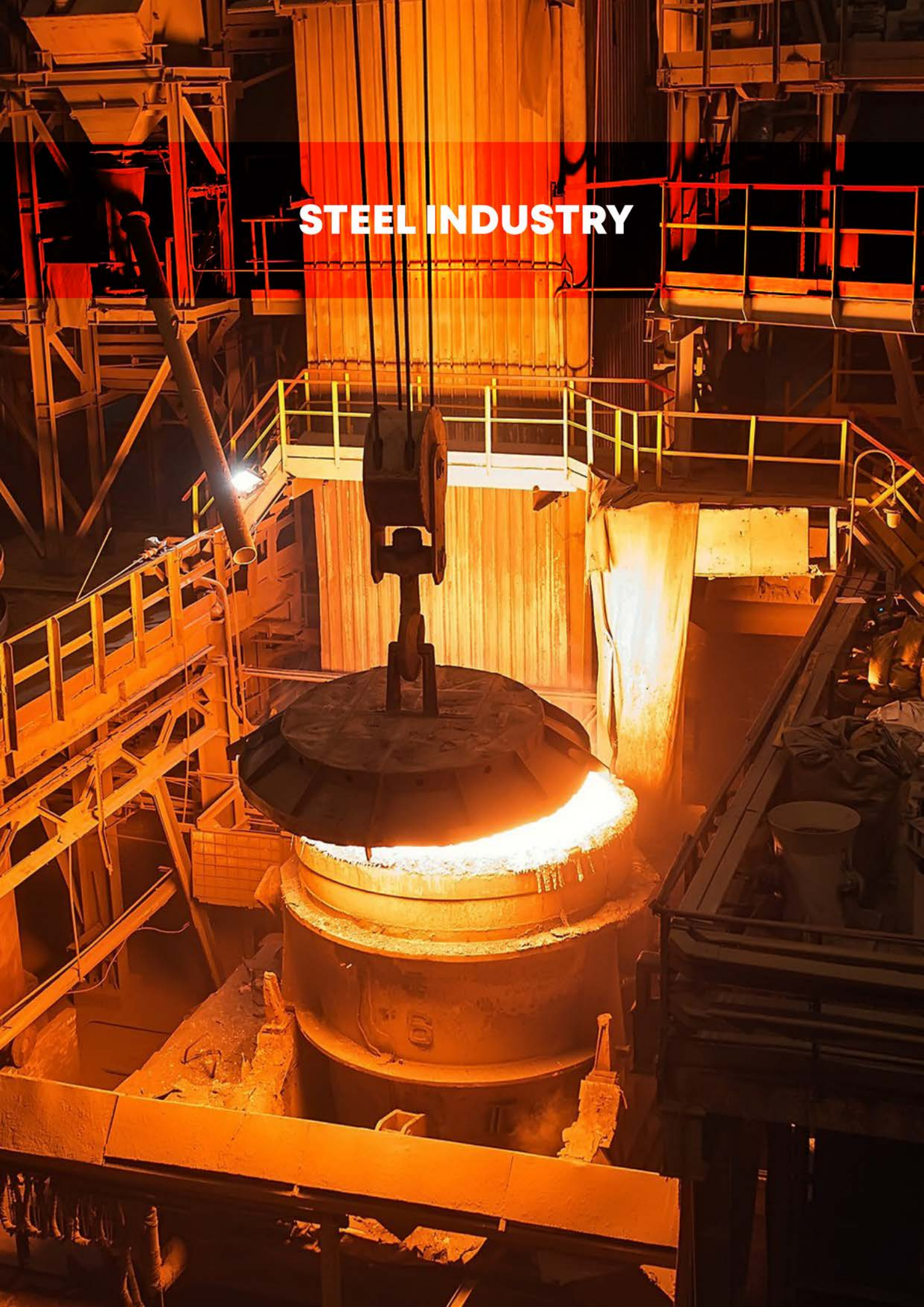
- A significant reduction in the amount of hydrocarbon mass entering the carbon absorbent bed
- De-bottlenecking of absorption units
- Increasing the safety of the absorption steam recovery unit due to the reduction of the possibility
- Creating exothermic reactions in carbon substrates
- Significant increase in the capacity of the upgraded system
- Easy and cost-effective integration with only minor changes to the existing absorption unit
- Pre-assembled and portable design
- Increasing efficiency and achieving lower emission levels
- Reduce electricity consumption
- Low maintenance

Control of VOC emissions in fuel distribution stations

Today, with the improvement of the environmental standards and also considering the economic issues, it is felt that all gasoline and oil product distribution points minimize the wastage of their hydrocarbon compounds in the form of VOC emissions. This waste is usually caused when charging the tanks of the stations and also when refueling the cars. Membrane technology provides the possibility of VOC recovery with a very high efficiency, which can reduce the adverse physiological, environmental and economic effects caused by the release of these compounds to the lowest level.



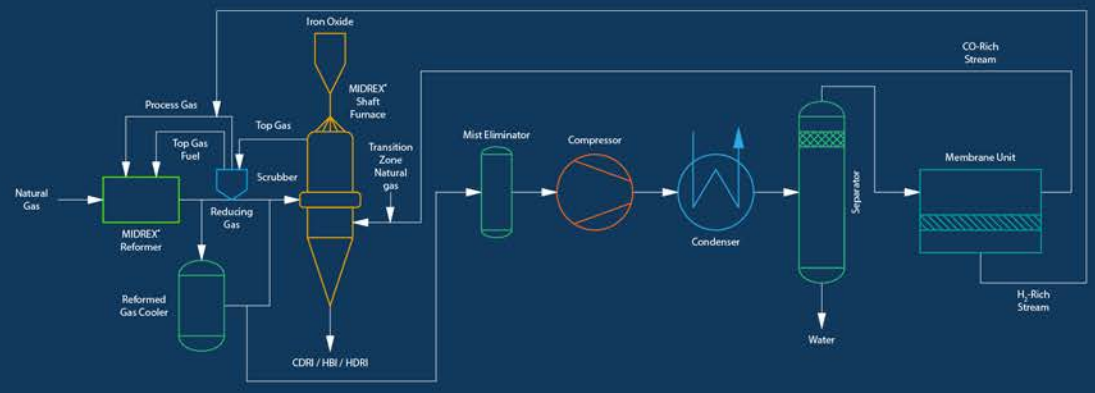
CAR FILLING STATIONS



STEEL INDUSTRY

Application of membrane processes to adjust the carbon content of steel

In MIDREX ADJUSTABLE CARBON (MIDREX-ACT) technology, it is possible to control the amount of carbon in steel. According to market needs, the amount of carbon in steel can vary between 0.5 and 4.5%. Generally, in the process of steel production, center gas (carbon monoxide and hydrogen) obtained from methane reforming is used to recover iron.
In MIDREX-ACT technology, the flow of synthesis gas after compression and cooling enters a membrane separation unit and is divided into flow rich in carbon monoxide and flow rich in hydrogen. The stream rich in carbon monoxide is sent to the transfer area (Transition Zone) of the reduction furnace and the amount of carbon in the steel is controlled by controlling the concentration of carbon monoxide. The membrane separation unit provides the possibility of adjusting the concentration of carbon monoxide sent to the transfer zone of the regeneration furnace in the range of 35 to 80%. In this technology, the flow rich in hydrogen is transferred to the output of the process gas compressor in the unit and is used.



MIDREX ADJUSTABLE CARBON TECHNOLOGY

Advantages of MIDREX-ACT technology

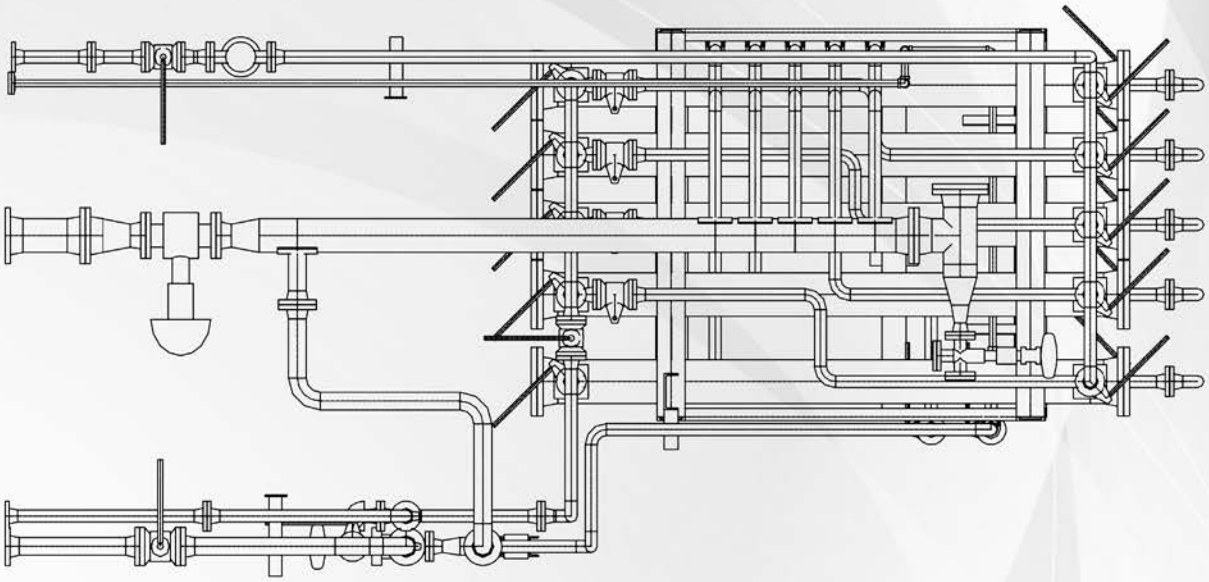
- Can be used in any type of MIDREX units (CDRI, HBI, HDRI and their combination)
- The ability to adjust the amount of steel carbon in the direct regeneration process
- The ability to add carbon without the need to cool the direct regeneration process
- The ability to convert 85 to 90% of carbon into iron carbide (Fe_3Ct) in the direct reduction process
- Can be added to existing MIDREX units

Borna Technical Support Service

- Holding technical engineering meetings before submitting a technical proposal
- Custom design of the membrane unit according to the needs of the client
- The possibility of compact design if there is a space limitation on the client's site
- Providing technical proposal in the shortest possible time
- Implementation of projects in a shorter time than international competitors
- Complying with all engineering standards in the construction stages of membrane units
- The possibility of inspection by the employer during the project
- The presence of Borna technical experts during the pre-startup and start-up
- Periodic inspection of the project after operation
- The possibility of adapting the membrane unit to the new operating conditions in case of increasing or decreasing the employer's capacity
- Providing membrane modules in the shortest time
- 30-year membrane unit support

Regal petrochemical project (polypropylene production)

In this project, more than 99% of the valuable monomers of the petrochemical waste gas stream sent to the membrane unit were extracted and returned to the polymerization unit. In addition, by installing the Borna membrane unit, the nitrogen in the waste gas stream was purified to a concentration of 99.5%, which is sent to other process units. This plan was implemented in August 2023 in Unit 20 of Regal Petrochemical Company.



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