Gas separation by using membranes

SIHI

Membrane technology … the innovative solution

In process technology, there are various techniques that can be used for separating gases. One successful field is membrane separation technology. Individual components can be separated from gas mixtures using membranes. For example, pollutants can be separated from the air to meet national regulations on exhaust air and/or recover valuable components with the aim of feeding them back into the production process.

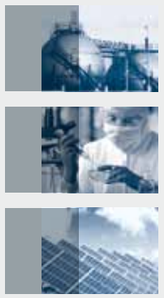
SIHI has not only manufactured high-quality vacuum and compressor systems for 90 years, but also has more than 20 years' worth of experience in developing customer-specific solutions for waste-air purification and the recovery of solvents using membranes.

Application-oriented knowledge and advice from our expert team provide excellent foundations for this process, as well as problem-free integration and long-term reliability of the module.

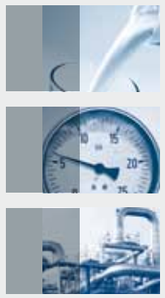
Continuous innovations guarantee that our customers can benefit from the advantages of new developments. Our experts will be happy to advise you about new possibilities for separation and recovery, and they also make use of external resources in order to provide you with an optimal solution.

Project-based expertise: Our competence centre will design processes together with you that are optimized for your needs. To do so, we will normally use current process simulation software in order to find the optimal solutions for you and then consult with you to decide which approach is right for you.

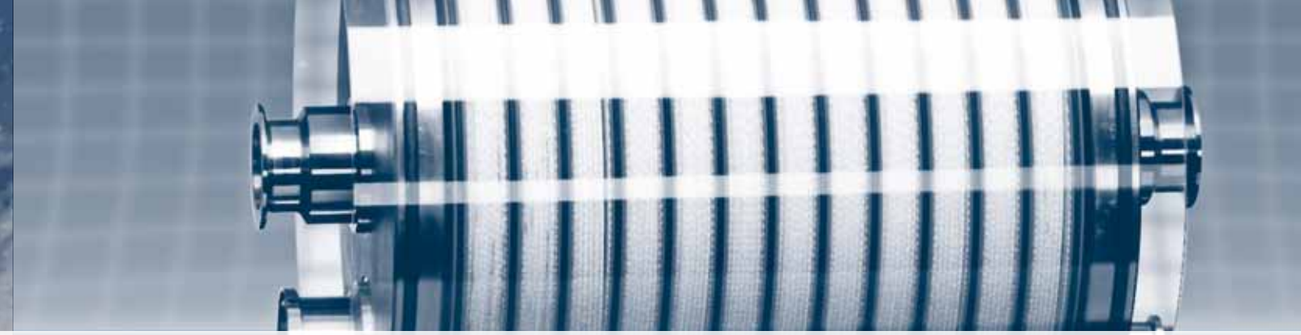
DIN, ISO, ASME, API and **NACE** are regulations that we have in-depth knowledge of, and we can ensure that our units are built to these specifications. We would also be happy to investigate other national guidelines and build systems that adhere to these.



Industries/markets
Chemistry
Petrochemicals
Fuel depots
Pharmaceuticals
Foodstuffs
Environmental technology



Typical applications
Solvent recovery
Monomer recovery
Product recovery
Natural-gas conditioning
Gas loop processing
Vapour recovery units



Recovery systems with membrane technology

… compact, simple and effective

Membrane technology is a simple and highly effective technology used to recover solvents or ensure adherence to emissions limits (for example: Germany's National Regulation – TA Luft) for exhaust gases.

The highly effective separation process ensures that the pure substance can be recovered without the need for subsequent regeneration and/or cleaning.

The desired components permeate through the membrane and can therefore be recovered, while the scrubbed inert gas can be released into the atmosphere or retained for further use.

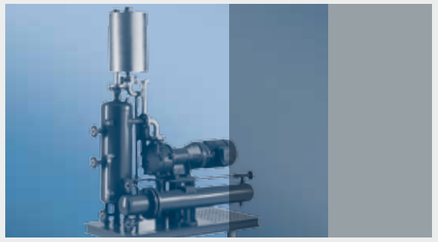
How does a membrane work?

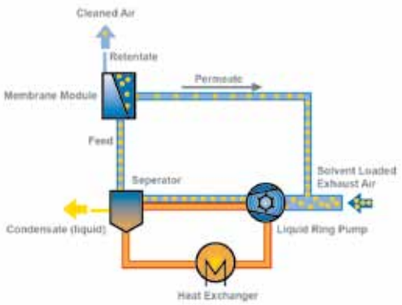
Membrane modules have been specially developed to ensure effective and safe separation, with the aim of separating, recovering or utilizing solvents from process gases.

Process gases and/or vapours are guided to a special polymer membrane. The components to be separated permeates through the membrane and can therefore be recovered, while the scrubbed inert gas remains on the high pressure side and can be released into the atmosphere or retained for further use.

The result is a simple and highly effective system for recovery or reduction of emissions. One example is the separation of volatile organic compounds from permanent gases such as N_2 or air.

Components that can be recovered:
+ Vinyl chloride monomers
+ BTX
+ Hexane
+ Ethylene and propylene derivatives
+ Fuels
+ And many more …





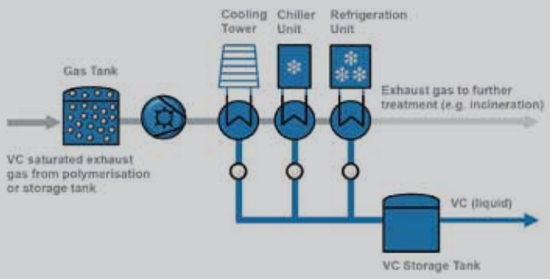
Benefits

✓ Simple, compact
✓ Long lifetime
✓ High level of efficiency
✓ No regeneration necessary
✓ Pure material recovery
✓ Suitable for several solvents and monomers, as well as a number of organic components

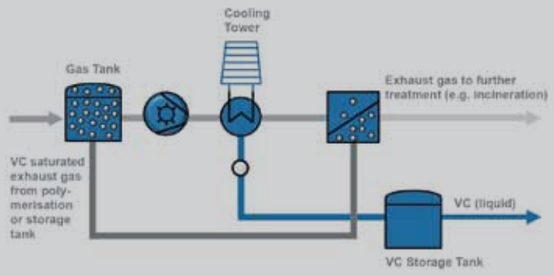
More economical than cryo-condensation

One advantage of the membrane technique versus pure condensation is the fact that the membrane process can be carried out at higher cooling-water temperatures. With a membrane, pure substances can be obtained at normal condensation temperatures that would render cryo-condensation necessary if no membrane were used. Membrane technology allows you to reduce your operating costs and recover your product!

Conventional VCM recovery

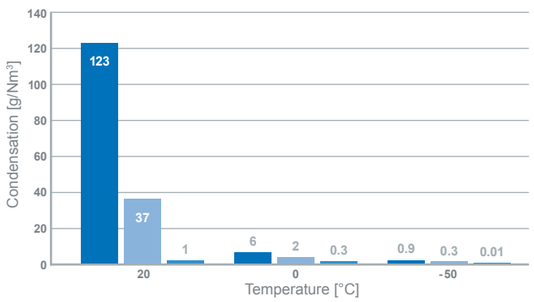


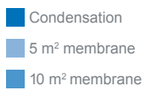
VCM recovery with membranes

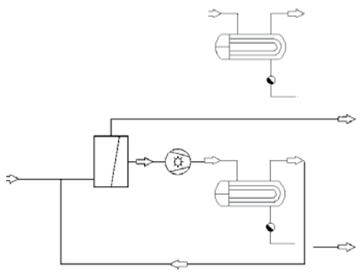


One example of this is VCM (vinyl chloride monomer recovery). The VCM-saturated exhaust gas, which comprises mainly monomers, is fed through a compressor and multiphase condensation process. Condensation temperatures increase incrementally from the first to the last stage. The first stage is performed at normal cooling-water temperatures, while the subsequent stages have discharge temperatures that are considerably below freezing.

The membrane replaces the multistage condensation process and therefore reduces operating costs in production. The investment has a payback period of less than one year for converted production processes. With a new installation, the condensation stage, membrane and compressor can be coordinated optimally right from the start. In this case, the payback period is approximately six months.







More environmentally friendly than adsorption

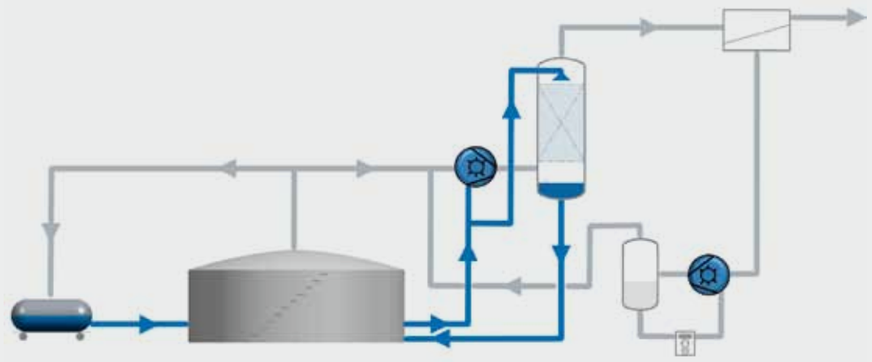
A membrane module comprises the process of cleaning exhaust gas and product recovery.

There are no disposal costs for contaminated adsorbents. Solvents are condensed and separated in order to feed them back into the production process. Monomers are separated from the exhaust gas and can be fed back into the polymerization process. No expensive equipment is required, and there are no problems with high enthalpies of adsorption.

A membrane module has a small footprint and can be used immediately after installation. The membrane is a safe and cost-effective alternative. One example is the vapour recovery unit (VRU) in storage tanks.

Membrane modules for vapour recovery work according to the following principle: Intake and compression of the exhaust gas, adsorption of the vapour in a gas scrubber and separation of the remaining hydrocarbons using membranes. If liquid ring machines are used in the modules, the compression pressure for the gas scrubber and membrane is between three and six bars.

This pressure is maintained right up to the discharge from the membrane. This is to ensure that the gas scrubber achieves the optimal cleaning results and also because the membrane requires the positive pressure in order to obtain the required pure substances. For this reason, the membrane is supported with an additional vacuum pump.



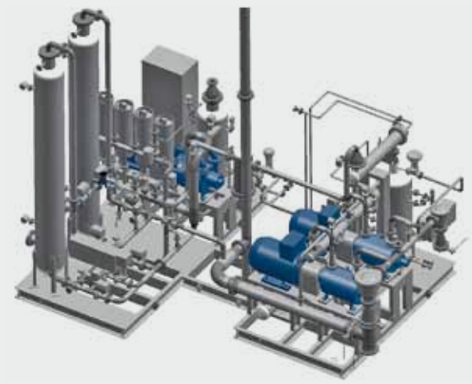
Vapours to recovery modules	Possible adsorption liquids (in the tank)
Petrol	Petrol
Petrol components (e.g. MTBE)	Petrol
Various hydrocarbon compounds	Naphtha, pyrolysis gasoline
Aromatic compounds	Aromatic compounds
Pure individual components (e.g. hexane)	Similar components

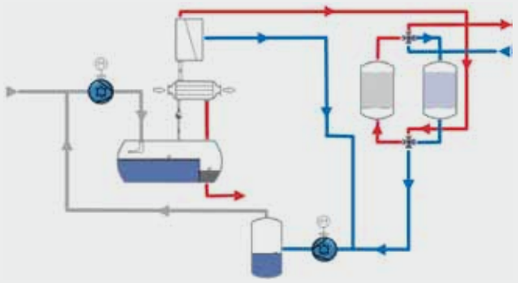
Hybrid plant with the smallest exhaust concentrations

A successful combination of two processes: the hybrid plant with a membrane stage and pressure swing adsorption (PSA).

One example of a successful combination of two processes is that of membrane technology and adsorption technology. This process combination is advantageous primarily because recovery using a membrane can be highly cost-effective.

The stream of exhaust gas from the membrane contains very low residues of the incoming feed. Any water contained within is also separated by the membrane. This ensures that a constant dry stream of exhaust gas with a consistent low concentration is fed through to the adsorption stage, where it undergoes further cleaning.





While one adsorber cleans the exhaust gas from the membrane stage, a second adsorber undergoes the regeneration process and is desorbed with the help of purging gas and negative pressure in the installed vacuum pumps. The volume of purging gas required for this is a fraction of the overall volume of gas fed into the system as a whole.

The adsorber is therefore fed a constant, dry, pre-scrubbed stream of exhaust gas, regardless of the original concentration of the gas. This prevents problems such as high temperatures in the activated carbon bed caused by high input concentrations and the activated carbon being saturated by water.

The operational safety and ease of use when starting up and shutting down this hybrid module has contributed to its success. A hybrid module achieves outflow concentrations in the single-digit ppm range.

Your process partner

Understanding the process

+ 100 years of experience
+ Staff trained to communicate at all levels
+ Deep application knowledge

… Solutions with minimal customer effort

Optimum product range

+ Unique process can be treated with simplicity
+ Reduced cost of design, manufacture, and documentation
+ Predictable site testing and commissioning

… Customised solutions for standard capital costs

Design

+ Advanced design tools
+ Highest level of machine efficiency
+ Long lasting reliability

… Reduced energy, maintenance, and environmental costs

Manufacturing

+ Centre of excellence structure
+ High level of skill and competence
+ Ongoing people and process development

… Reduced integration costs

Testing & documentation

+ Factory and Site Acceptance Tests
+ Certified documentation
+ Witnessed customised testing

… Reduced validation and commissioning costs

Quality assurance

+ Total Quality Management
+ ISO9000
+ Rigorous health and safety culture

… Long term security

Aftermarket – a local approach

+ Dedication to process uptime
+ Locally positioned service & technical centres
+ Easy access to support, on a worldwide level

… Highest level of customer care

Competence Centre

+ Centralised design, purchasing, production, compliance, and local support
+ De-centralised (local) quotation and project management teams

Benefits

✓ Achieves outflow concentrations in the single-digit ppm range
✓ Hybrid module has smaller footprint than a PSA
✓ No hotspots due to high intake concentrations are possible as the membrane takes over the function of “preliminary cleaning”
✓ Easy to use even when starting up and shutting down

SIHI*detect* – Condition based monitoring

Detect wear before damage occurs
+ Cavitation and process turbulence
+ Simple to connect
+ LED display
+ Available Ex
+ All rotating machinery
+ DCS integration and continual monitoring

Noise *and* Vibration analysis allows this compact device to diagnose the (often hidden) symptoms of longer term damage *even* before vibration occurs.

For further address details please visit:
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