

Making our world more productive



HISELECT[®] H2NG Membrane + HIPURE[™] PSA Technology

Two pioneering technologies are combined to obtain high-purity hydrogen from the existing natural gas grid.



Jump-start the hydrogen economy

Hydrogen is an essential component on the path to net-zero emissions. The good news is that technologies already exist for the entire hydrogen value chain, with Linde in a leading position. Yet the issue of how to best transport hydrogen from its place of production to consumers must be addressed. From an economic standpoint, pipeline is the best option. By contrast, transporting hydrogen in cylinders and tankers by road, rail or ship always requires additional energy input for compression or liquefaction as well as for transport. Pipelines also have lower operational and maintenance costs than vehicles and vessels. Moreover, pipelines can transport large quantities of hydrogen continuously.

Against this background, many industrial countries are looking at developing and expanding their hydrogen pipeline networks. However, construction from scratch will take time. European transmission system operators estimate that if they were to start building a pipeline in 2030, it would be operational in 2050 at the earliest. To jump-start the hydrogen economy, the focus is increasingly on repurposing the existing natural gas network.

Blending hydrogen with natural gas

Hydrogen can be injected into the natural gas pipeline. Different concentration levels are possible. For example, in the UK, starting in winter 2024, pipeline grids must be capable of transporting up to 20 percent hydrogen. At the point of use, the hydrogen has to be extracted. This is where the combination of Linde's HISELECT® H2NG membrane + HIPURE™ PSA technology enters the picture.

The path to high-purity hydrogen

In the first step, hydrogen is extracted from the gas mixture using HISELECT® H2NG membranes. The purity level of the gas is around 90%. In the second step, Linde's HIPURE™ PSA technology is used to further purify the hydrogen. The hydrogen product has a purity suitable for fuel-cell applications according to ISO 14687 or even higher purity requirements. After hydrogen extraction, the natural gas is redirected into the pipeline.

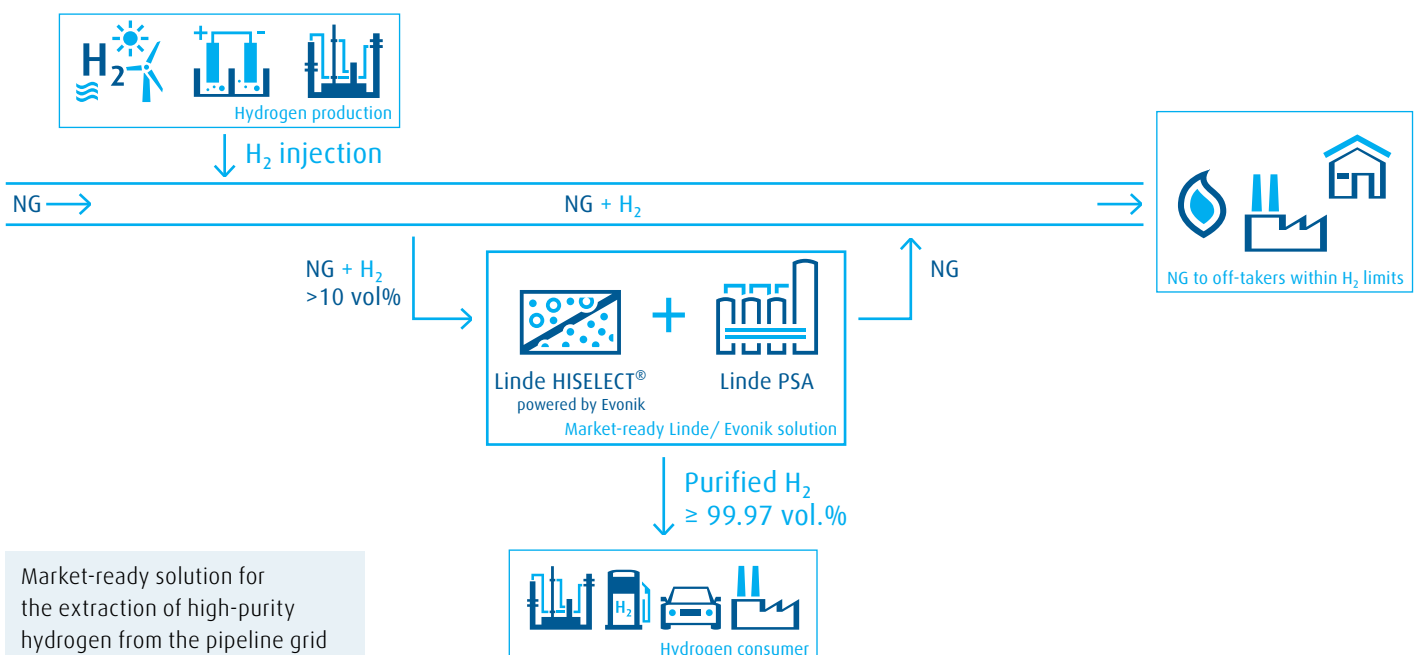
For applications that are sensitive to hydrogen, such as chemical plants, gas power stations and CNG stations, hydrogen levels in the gas mixture can be lowered to below 0.1 mol % using the same combination of HISELECT® H2NG membrane and HIPURE™ PSA technology. In this case, the separated hydrogen can be supplied to applications where hydrogen is required, or it can be rerouted into the pipeline.

Other uses of HISELECT® membranes

- CO₂ removal from natural gas (natural gas sweetening)
- Decarbonization in combustion applications
- Helium recovery and separation

Main advantages

- High flexibility for delivery of hydrogen via the natural gas pipeline, for refueling stations to industrial sites
- Suitable for hydrogen concentrations ranging from below 10% all the way to 98%
- Very high availability of more than 99.5%
- Low operational effort, as HISELECT® H2NG membrane + HIPURE™ PSA technology requires minimum operator intervention
- Long-term experience and proven track record, especially with HIPURE™ PSA technology





Demonstration plant in Dormagen, Germany

A full-scale demonstration plant at the Linde site in Dormagen, Germany, showcases the efficiency and cost effectiveness of HISELECT® H2NG membranes. Linde is the first company to demonstrate this technology on a commercial scale.

A closer look at HISELECT® membranes

HISELECT® membranes work by separating gas molecules according to their size. They consist of asymmetric hollow fibers made of polyimide with a nanometer-scale selective layer on the fiber outer shell. The fibers are coiled up in a cross-counter winding pattern, forming a structured packing for optimal flow distribution. The membrane system delivers robust performance even under high pressures and harsh pressure fluctuations. This makes HISELECT® modules more resistant to pressure shocks and reversal of transmembrane pressure than conventional flat-sheet modules. As hydrogen is a very small and fast molecule, it permeates very quickly through the membrane to the low-pressure side. Natural gas behaves differently; it is quite a large molecule, so it stays outside the membrane fiber, and is thus retained on the high-pressure side.

A closer look at PSA

The pressure swing adsorption step raises the hydrogen purity from around 90% to fuel-cell grade, which is 99.97% or higher. Here, the hydrogen and natural gas molecules attach with different strengths to the inner surface of adsorbents (porous solid materials). The methane attaches to the small adsorbent particles and the hydrogen remains more or less in the free volume around this solid. The pure hydrogen gas stream is then extracted from the top of the vessel. When the adsorbent is saturated with methane, the process stops. The vessel on the bottom opens, relieving the pressure. The methane is withdrawn from the bottom of this vessel. The system then switches to the next pressurized vessel with the regenerated adsorbent, and the process starts again.



Your partner for the production and processing of gases

Delivering reliable process plants for maximum capital efficiency

Linde has been optimizing gas processing technologies for 140 years, successfully delivering more than 4,000 plant engineering projects around the globe. Favoring trusted, lasting business relationships, the company collaborates closely with customers to enhance plant lifecycle productivity and innovate process flows. The company's proven gas processing expertise plays an indispensable role in the success of customers across multiple industries – from natural gas and oil refining through petrochemicals and fertilizers to electronics and metal processing.

Operational excellence along the entire plant lifecycle

We work closely with our customers to gain an in-depth understanding of individual needs. Building on the unique synergies of Linde as an integrated plant operator and engineering company, Linde offers innovative process technologies and services to exceed our customers' reliability and profitability expectations. This commitment to innovation extends along the entire plant lifecycle. The LINDE PLANTSERV® service team supports customers every step of the way – from maintenance and repairs to full revamps. Leveraging the latest digital technologies to offer on-site and remote operational and support services, we consistently take asset performance to the next level.

Making the impossible possible

From the desert to the Arctic, from small- to world-scale, from standardized to customized designs, Linde's engineering specialists develop solutions that operate under all conditions. The company covers every step in the design, project management and construction of gas processing plants and components. Customers can always rely on Linde to deliver the plants, components and services that fit their needs best – anywhere in the world.

Discover how we can contribute to your success at www.linde-engineering.com

Get in touch with our natural gas plants team:

Phone +49 89 7445-3434, inquiry: www.linde-engineering.com/contact

Core competencies at a glance

Plant engineering

- Air separation plants
- LNG and natural gas processing plants
- Petrochemical plants
- Hydrogen and synthesis gas plants
- Adsorption plants
- Cryogenic plants
- Carbon capture and utilization plants
- Furnaces, fired heaters, incinerators

Component manufacturing

- Coldboxes and modules
- Coil-wound heat exchangers
- Plate-fin heat exchangers
- Cryogenic columns
- Cryogenic storage tanks
- Liquefied helium tanks and containers
- Air-heated vaporizers
- Water bath vaporizers
- Spiral-welded aluminum pipes

Services

- Revamps and plant modifications
- Plant relocations
- Spare parts
- Operational support, troubleshooting and immediate repairs
- Long-term service contracts
- Expert reviews for plants, operations and spare part inventory
- Operator training

