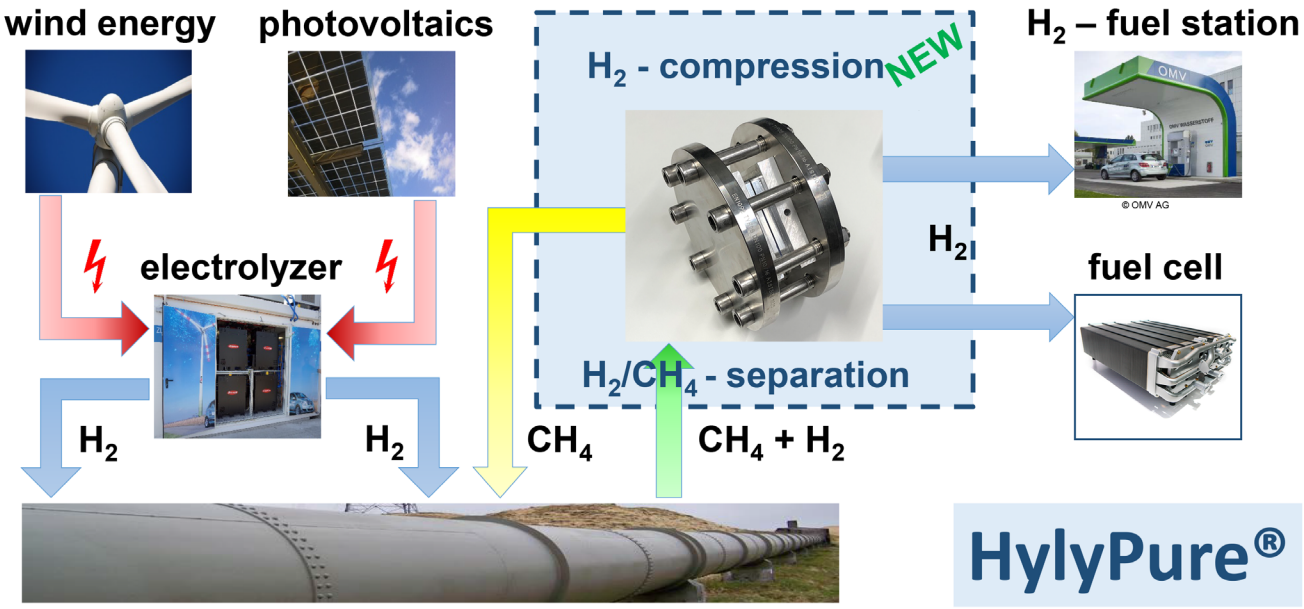
TECHNISCHE UNIVERSITÄT WIEN
Vienna | Austria

Institute of Chemical, Environmental
and Bioscience Engineering
Getreidemarkt 9
1060 Vienna, Austria
www.vt.tuwien.ac.at

Pure hydrogen from the natural gas grid

with the energy-efficient HylyPure® filter and compressor system



The storage of excess electric produced from renewable resources (eg. wind, solar) is a key challenge of the energy transition. The Power-to-Gas concept is considered as a promising solution for this problem. In this case, excess power is used to produce an energy carrier which can be stored easily and utilized later. Hydrogen is of interest because of its high end use efficiency in fuel cells, and – in addition – hydrogen from alternative resources is CO_2 neutral. Due to the fact of a regional mismatch of production and consumption of electric power highly efficient and flexible hydrogen transport systems are of utmost importance. In case of the existance of an extraction technique of hydrogen from a mixture of natural gas and hydrogen the existing natural gas pipeline infrastructure can be a favorable option.

Objectives

The “Separations Engineering and Simulation” research group at TU Wien aimed for the development of technology components which allow recovery of hydrogen transported through natural gas grids to be recovered in highly pure form and on-site compression to provide fuel-cell ready hydrogen for local supply. Important goal was to develop an energy-efficient and robust technology which can be applied to a wide range of H_2 concentrations and natural gas pipeline pressure levels.

Solution

Legally, the addition of H_2 to natural gas as an extra fuel is already permitted now – net dependent at levels of 2 percent up to 20 percent. This level might increase in the future if the demand for decentral hydrogen supply will rise.

HylyPure® provides a membrane gas separation in the first stage for the separation of H_2 from the natural gas grid which acts as an initialconcentrator for the gas mixture and drastically reduces the volume flow rate. This separation stage does not require additional energy because of the high sytem pressure in natural gas pipeline of up to 70 bar. Starting from e.g. 4% H_2 in the natural gas, the H_2 concentration can be increased to up to 50% H_2 in this first stage.

In the second stage, hydrogen will be further enriched

and simultaneously compressed applying a newly developed electrochemical membrane stage. Water vapor content in this process stage needs precise control by a newly developed water management. The compressed product – the hydrogen – is dried and further purified to eliminate trace components according to process needsin industry, H_2 fuel stations or fuel cells. The residual gas mixture is re-compressed and fed back into the natural gas pipeline system. If the electric power for the compression is provided by renewable resources, the separation may be considered is CO_2 neutral.

Results

HylyPure® allows a safe H_2 transport and a fuel cell grade recovery, as extensive model calculations for various application scenarios have shown. Based on the design tool developed at TU Wien, the plant can be customized to the process requirements of the specific local application.

The developments at TU Wien show that the specific electric energy consumption including separation and compression can be reduced to 0,5 – 0,8 kWh/m³ STP hydrogen. This corresponds to 10% and up to 15% of the hydrogen energy content. In addition, the hydrogen transport over typical distances between a few kilometers and up to a few hundred kilometers requires up to 1% of the hydrogen energy content.

In addition, the investment of one mechanical compressor stage can be saved compared to conventional separation technologies. Highest ecological and economical efficiencies can be achieved with HylyPure® while at the same time local regulations regarding the injection of hydrogen into the natural gas grid can be met.

Notes

Advantages

The new HylyPure® technology using electrochemical hydrogen compression is very compact in design. It requires only one mechanical component for the re-compression of the residual methane from the second separation stage. This results in higher availability and longer service intervals.

The process is highly modular and can be easily scaled from 1 m³/h up to several 100 m³/h. As such, HylyPure® is perfectly suitable for H_2 transport in gas grids.

The specific energy demand for on-site separation and compression of hydrogen by HylyPure® is between 10% and 20% of conventional water electrolyzer technologies for H_2 production. Thus HylyPure® could become a major contribution to decentralized energy and primary materials supply to fuel stations, utilities and chemical industry of the future. In 2023, HylyPure® received an award from the Austrian Patent Office at the *Staatspreis Patent*.

HylyPure® and the know-how from TU Wien offer for production processes and hydrogen mobility of the future:

- energy efficient transport of hydrogen using well established natural gas grids
- separation and compression by optimal combination of hydrogen recovery, minimized energy consumption and investment costs
- highest hydrogen quality of the H_2 recovered from the natural gas grid – 99,97% H_2 quality according to ISO 14687:2019
- CO_2 neutral H_2 separation
- simple, safe, economical and flexible supply of decentralized hydrogen fuel stations
- supply of block power stations based on fuel cells
- efficient supply for the metallurgy, basic materials, and chemical industries of the future, which will no longer be based on fossil feedstock and fuel

Contact

Prof. Dr. Michael Harasek
TU Wien – Research Unit Thermal Process Engineering and Simulation
membran.at
+43 1 58801 166202
michael.harasek@tuwien.ac.at, rema@tuwien.ac.at