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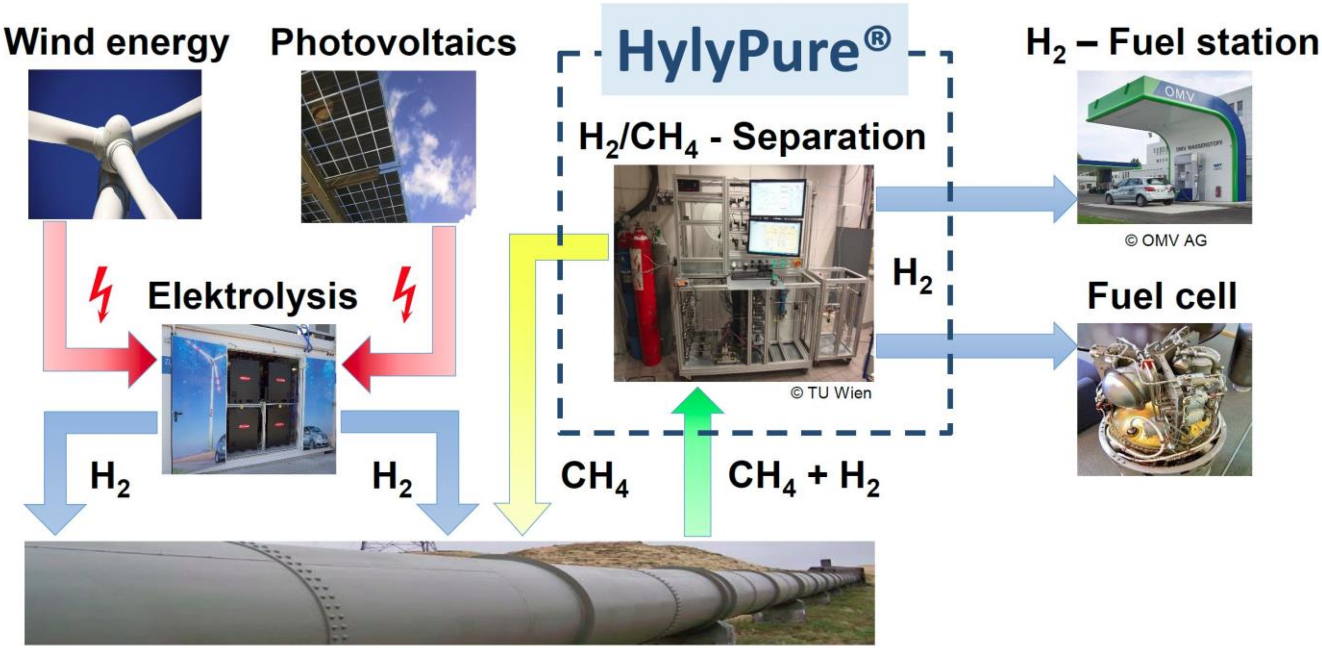
Cost-efficient Transportation of Green Hydrogen

HylyPure® – a customized process based on membrane-gas-permeation and adsorption



Supply of green hydrogen by means of HylyPure®

The storage of electrical surplus energy from alternative sources (e.g. wind, photovoltaics, etc.) is a key challenge of the energy transition.

The Power-to-Gas concept offers a promising approach. Electrical surplus energy is used to produce a storable energy carrier such as hydrogen or methane. Hydrogen is well suitable due to its CO_2 neutrality and the highly efficient end-use applications.

As the production of energy often takes place far away from the end-users, an energy efficient transport of the energy carrier is extremely important.

Idea

The idea of the proposed concept is to feed green hydrogen into the existing natural gas grid (existing infrastructure), transport it cost-efficiently and separate it with fuel cell quality at any desired location.

Regulatory Framework

Statutory regulations limit the hydrogen content in the Austrian gas grid to a maximum value of 4 vol%. Vehicles with fuel cells require, according to ISO 14678-2:2012, a hydrogen purity of 99.97%.

Implementation

Highest ecological and economical efficiency, under consideration of the framework conditions, will be realized by means of the following 3-step concept. As a first step, a membrane-based gas-permeation ensures both a highly energy-efficient pre-concentration and a significant mass flow reduction. As a second step, hydrogen is further enriched to the desired quality using pressure-swing-adsorption (PSA). Finally, as circumstances require, a third step can be added as a further adsorptive fine purification, thereby assuring the desired product quality.

Optimization

Based on the extensive practical know-how of the research group in the field of gas-separation, and in addition to existing experimental data regarding membranes and adsorption, a newly developed numerical model has been used for the optimization process.

The numeric method combines a finite difference solver for the simulation of the membrane gas-separation with a dynamic adsorption model – both are experimentally validated – in combination with a numeric Levenberg-Marquard procedure for the process optimization. This effective combination allows to develop and scale custom designed multi-stage plants.

This simulation-aided design enables the identification of an optimal interconnection and scaling of the individual process steps. Besides the optimization of the single steps, the entire concept is designed to achieve maximum energy efficiency and economic viability.

Results

The result of the developments at TU Wien in cooperation with OMV AG is a compact plant, which is able to separate hydrogen from a natural gas/hydrogen gas mixture with fuel cell quality.

The residual mixture of substances is compressed to the original pressure and re-fed to the gas grid. Provided that the required electrical energy is generated from renewable energy, this is a CO_2 neutral method for separation.

These results have been achieved with the support of the Austrian Climate and Energy Fund under the programe "Energy Mission Austria".

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Benefits

The know-how of TU Wien enables:

- Optimal hydrogen separation with optimal combination of hydrogen yield, required process energy and investment costs
- CO_2 neutral separation
- Hydrogen with fuel cell quality
- Solutions for process integration and automation

Notes

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