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Combination of Power-to-Gas with Biogas Plant

Doubling of biogas production through the use of excess electricity for electrolysis and methanation

The increasing proportion of renewable energies, such as wind and photovoltaics, in the electricity supply brings challenges with it. The generation of electrical energy is getting more frequently out of sync with consumption. On the one hand, this requires reinforce-ment of the network and intelligent control strategies – smart grids – and, on the other hand, it also needs a new approach regarding storage and transportation of this energy.

Power-to-gas technologies could form a significant part of future energy systems. This refers to the use of (excess) electrical energy to split water molecules by means of electrolysis resulting in hydrogen with a variety of options for further use.

Objective

The aim of Prof. Harasek's research group in the research field of thermal process technology & simulation was to develop an energetically and economically efficient and ecologically sustainable overall concept for the power-to-gas approach. The research, advanced over many years by TU Wien's gas separation engineers, led to the development of new, highly efficient and integrated membrane gas filters separation technology with low energy requirements. This technology seems predestined for use in the newly envisaged power-to-gas concept.

Approaches

The newly developed system presents the following components and properties:

- Combination of the power-to-gas approach with existing or new biogas plants
- Direct use of the CO_2 separated from the biogas for conversion into methane with H_2 from water electrolysis – thus closing of the regional CO_2 cycle

Part of the future of energy: green energy stored in gas

- Conventional, one-step methanation
- Processing of the product gases from methanation by means of membrane technology using highly selective gas permeation membranes
- Recirculation of H_2 and CO_2 gases which are not converted within the system
- Flexibly usable gas storage tank
- During non-active methanation: use of membrane separation for the processing of biogas

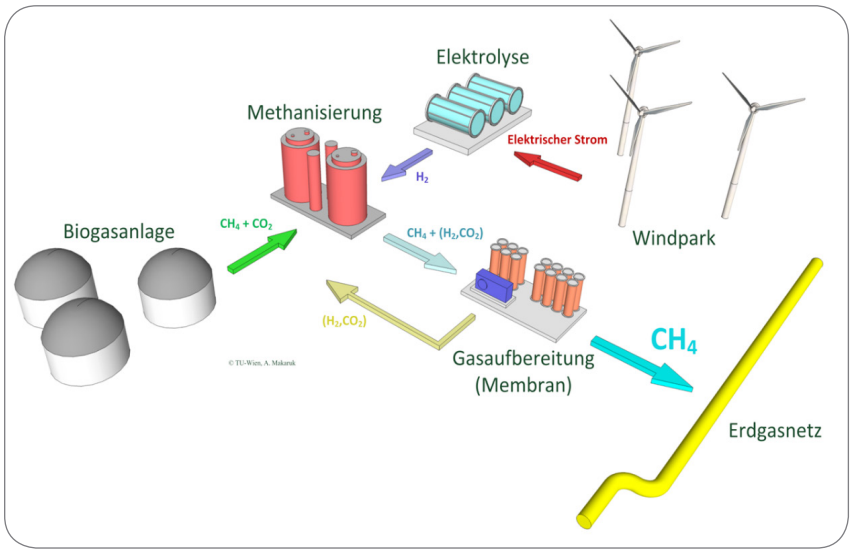
The new system is based on the following already well proven process components which can be combined and coordinated with each other very well: Biogas system, electrolysis, gas storage tank, methanation, gas processing with membranes and energy integration.

The essential key task is gas treatment undertaken by means of membrane technology. This separation technology can either be used to process the product gases from methanation to the pipeline specifications or,

alternatively, can be used to process all of the biogas from the biogas plant if no excess power is available for electrolysis and thus methanation is turned off.

As a result, H_2 and CO_2 which cannot be converted in a single methanation step are separated and recycled – whereby the gas flow is either added directly to the feed flow for methanation or temporarily stored in a gas storage tank.

Market proven technologies with high process efficiency can be used for the electrolysis and methanation process steps.



Flow chart of the power-to-gas system developed at TU Wien

Results

The research group has many years of experience and can offer a design model which was developed in-house for the concrete designing of the membrane separation system. Results from process modelling of the whole system have shown that the gas processing is indeed usable for both processing tasks.

Successful tests with a variety of gas mixtureses for both process variants are already available. Large scale pilot tests with the methanation / gas processing process combination as well as with biogas / methanation / gas processing will be carried out from June 2015.

Benefits for you

The new system for the flexible storage of electrical power offers the following advantages in comparison with existing power-to-gas systems:

- Easy to integrate into existing biogas systems (with membrane technology)
- Dual use of the membrane separation systems for biogas or gas from the methanation
- Doubling of biomethane production possible per biogas plant
- High process reliability even with fluctuating availability of cheap excess power
- Valuable process heat at a high temperature level from methanation usable for biogas operations
- Temporary storage of CO_2 and H_2 allows for flexible operating modes for methanation which varies with time
- Methanation can be switched on automatically
- Robust and thoroughly tested membrane separation technology ensures premium methane quality and high yields for supplying the gas grid
- Availability of highly efficient, dynamic and cost-effective desulphurisation technology (developed by TU Wien)
- Low investment and operating costs – e.g. single-step methanation with up to 25 % lower investment costs
- Compliance with strict EU standards for the production of bio-methane and other country-specific gas qualities up to 99.5 % methane content
- Easy compliance with the gas grid limits for H_2, CO_2 and CO in accordance with regional supply directives

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