

Industrial Scale Biosynthesis of Methane

Biomethane for the Gas Grid of Municipal Utility Companies

At Pirmasens-Winzeln Energy Park the Test and Research Institute Pirmasens (PFI) is operating Germany's largest methanation unit. The Power-to-Gas plant processing biogas and regeneratively produced hydrogen has been in operation since September 2016.

The expansion of renewable energies is currently being held back by limited grid capacities and lack of energy storage facilities. Inadequate storage capacities affect above all those energy sources which are subject to wide fluctuations. Power surpluses inevitably lead to the shut-down of wind turbines and photovoltaic installations or to price erosion at the energy exchanges, frequently entailing cheap exports to European neighbours. Power storage can make an important contribution to the security of power supplies and price stability, particularly in view of the planned expansion of wind energy.

PFI's Proposed Solution

The pressurised trickle bed reactor developed by PFI together with the Schmitt Company has a number of advantages over various fermentation processes in classical stirred-tank fermenters. This is especially true when gaseous substrates (e.g. hydrogen, carbon dioxide) are involved. Countercurrent operation enhances mass transfer between the liquid phase and the gas phase and thus significantly improves the uptake of gaseous substrates by the microorganisms. This effect could even be further enhanced by combination of the trickle bed process with a pressurised reactor.

In this process a nutrient solution flows down from the top of the column while biogas and hydrogen flow upward from the bottom. In order to maximise the contact area between the gas and liquid phases, the special methanogenic bacteria are localised on a column packing. This consists of small plastic bodies of irregular structure. The methane gas generated by the bacteria is ultimately removed from the top of the column. The greater the pressure in the plant, the better the bacteria can process the gas blown in.

Industrial Scale Operation

Two 25-m high columns, each with a volume of 40 m³, have been built close to the biogas plant. The plant has a capacity of up to 100 Nm³/h, corresponding to a thermal equivalent of the generated gas of about 1000 kW h. A fivefold increase in gas production is planned for the next expansion phase of the P2G plant.

Alongside the two columns, the PFI site also accommodates a large storage unit for hydrogen, containers for gas and nutrient solution conditioning, and a control centre housing all the necessary electrical measurement and control equipment. Since there is currently no on-site electrolysis unit, hydrogen is supplied by Mainz Energy Park.

The project was funded to the tune of €1.55m through the European Regional Development Fund (ERDF) by the State of Rhineland-Palatinate. The siting of the project is ideal because the biogas plant can serve as a free source of CO₂.



PFI biogas conditioning unit (back left) and the biogas feed-in unit of the Pirmasens municipal utility company (front right) at Pirmasens-Winzeln Energy Park

After a construction period of about one year, the biogas feed-in unit, consisting of gas analysis, gas conditioning with gas odourisation, and pressure control technology, came on stream in September 2016 when it fed the first biomethane into the natural gas grid. Experience gained so far by PFI researchers with the Winzeln plant has been good: feed-in functions smoothly and the trickle bed reactor technology has proved effective. The next step is to refine the plant engineering to facilitate economic biotechnological methanation at other favourable locations (water electrolysis plants and chlorine production plants).

Technological Development and Future of the Energy Park

“In the future, we intend to increase the overall efficiency of the trickle bed reactor by raising the process temperature from the current level of 60 °C to 80 °C”, is one of the principal challenges cited by Stefan Dröge (Head of Microbiology and Biotechnology at PFI). The goal is to further increase the rate of reaction in order to keep the size of reactors at a reasonable level. There is also room for further refinement of process control.

An important component is still missing: A concept for the electrolysis unit is currently under development at the Institute. "This could become operational by 2018", hopes Benjamin Pacan (Head of Research Plant Department at PFI and Project Manager for the P2G plant at the Energy Park). The system would then be complete and additional reactors could be built to increase the production of biomethane.

A further highly ambitious goal is to expand the Energy Park to a biorefinery. "It would then be possible to produce basic chemicals such as biopolymers or the sugar substitute xylitol", according to Stefan Dröge. But that is all highly dependent upon the availability of funding. Dr. Kerstin Schulte, Managing Director of PFI, confirmed: "We have already submitted an application for LIFE funding. PFI is prepared to continue investing in future technologies and the necessary research in order to strengthen the standing of Pirmasens as a research centre."

Products for the Market

In one or two years PFI would like to collaborate with regional plant construction companies in launching a marketable product for biotechnological methanation on the market. The Pirmasens Municipal Utility Company and Pfalzgas GmbH are two of the companies interested in the practical utilisation and marketing of biomethane. However, attainment of these ambitious goals will require more support from the federal government: "If we had free access to the surplus electricity generated, which cannot be used anyway, methanation would become economically viable much sooner", is the firm persuasion of Benjamin Pacan. "At the current low price level of natural gas we are not competitive. We shall have to come down to a current market price of 6 to 7 cents per kWh for biomethane."

Further information:

Dipl.-Ing. (FH) Benjamin Pacan
Technical Development, Research Plants, Project Management
Tel: +49 (0)6331 24 90 840
E-Mail: benjamin.pacan@pfi-germany.de

Dr. Stefan Dröge
Biotechnology and Microbiology, Project Management
Tel: +49 (0)6331 24 90 846
E-Mail: stefan.dröge@pfi-germany.de