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In the Lab

Research and Development in the Field of (Renewable) Gas Processing Technology at DBI Group

***Johnson Matthey Technology Review* features new research**

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DBI Group's field of activity covers the complete process development of chemical processes, starting with the process balancing and testing of catalysts including the determination of catalyst-specific reaction kinetics, up to lifetime investigations, ageing tests and other reaction engineering investigations. With the data obtained, complex mathematical models can be generated which can be used for the design of reactors or the optimisation of operating regimes. In addition, the company also applies its know-how in the field of mathematical models in application-oriented simulations of thermal processing plants, heat exchangers and gas treatment plants. On the basis of these models, it designs demonstration plants which provide important design fundamentals and technical-scientific correlations for large-scale applications.

About the Research

Individual Solutions for Complex Challenges

The use of renewable gases as well as the integration of regenerative energies offer great ecological and economic potential, provided the applied methods take the application-specific boundary conditions into account. DBI Group's research and development therefore is focused on innovative technologies that tap new raw materials and applications or make a significant contribution to increase the efficiency of existing processes. These include: development of reformer systems for decentralised hydrogen production; on-site production of technical gases (carbon monoxide, hydrogen); hydrogen utilisation (heat and power); power-to-X technologies (dimethyl ether (DME), methanol); usage of biogas as raw material for chemicals, fuels and pharmaceutical products; catalytic gas treatment; and hydrogen recovery.

Services Provided by DBI Group

DBI Group's activities are focused on the development of innovative processes and the optimisation of existing processes (**Figure 1**). It supports its customers in the scope of research, development and engineering from basic research to the design of process equipment and

Fig. 1. DBI Group's fields of activity

the development of complete processes. These include: design and construction of process plant equipment; high-temperature heat exchangers; evaporator/condensers; reactors/adsorbers; post-combustion chambers; catalyst testing; screening of catalyst materials; performance and ageing tests; kinetic analysis; modelling and simulation; process modelling; simulation of apparatus; process and technology development from idea to semi-technical plants; thermal engineering; load management gas; feasibility and potential studies.

Direct Synthesis of Dimethyl Ether from Renewable Resources ("FlexDME")

The production of synthetic fuels from renewable resources such as biomass and sustainably produced energy is an important step on the way towards sustainable energy supply. Especially, DME is a promising fuel because of the excellent combustion properties and high energy density. Therefore it can be used as a first 'green' admixture for liquefied petroleum gas and as a substitute for diesel with low-pollutant exhaust. In addition, DME is already applied as a propellant in aerosol cans of high-priced mass products such as hair or paint spray as well as a basic material in the chemical industry. The developed process is characterised by continuous operation with biogas and optional addition of hydrogen, which can be obtained from surplus electricity by electrolysis of water (**Figure 2**).

An innovative reactor concept was developed based on a self-developed kinetic model for

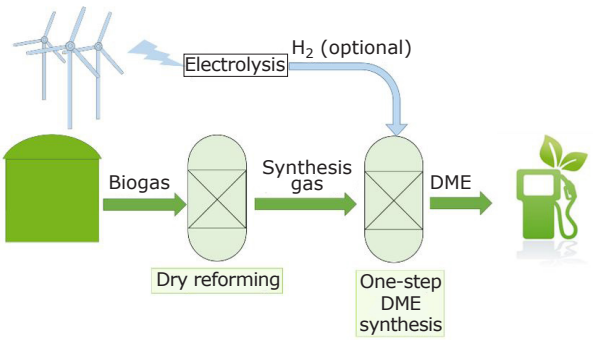

Fig. 2. Scheme of DME-production from renewable resources

single step DME synthesis. With the results of the simulations, a small-scale demonstration plant was developed (**Figure 3**).

The experimental investigations have shown that biogas and additional hydrogen from electrolysis can efficiently be converted into the biofuel DME. Because of the promising results it is planned to build and run a demonstration plant directly connected to a biogas plant in a larger scale.

Hydrogen Generated for Industry ("HydroGIn")

The aim of this project is the development of a demonstration plant for the on-site generation of purified hydrogen from natural gas for industry and electrical mobility with a nominal capacity of 100 m^3 h^{-1}.

The system comprises all modules required for the entire hydrogen production process (**Figure 4**): natural gas and process water conditioning (desulfurisation, deionisation); gas conversion reactor (steam reforming, carbon monoxide conversion); and hydrogen purification (pressure swing adsorption).

In order to meet today's requirements of system mobility and flexibility, the process plant can be integrated into a standard container. The system is designed to perfectly fit all operators of facilities that require a decent but continuous amount of hydrogen below the capacities of traditional process plants. More than the economic advantage, the on-site production drastically reduces emissions due to reduced transportation.

Characteristics of the on-site hydrogen production system include: 100 m^3 h^{-1} hydrogen production rate; hydrogen purity: 99.95%; fuel: natural gas or biogas; process: steam reforming; operating pressure: 20 bar. Fields of application include:

Fig. 3. Small-scale pilot plant for the production of DME from biogas and hydrogen

reducing or protective atmospheres for industrial furnaces, electrical industry, semiconductor industry, welding, cutting and hydrogen fuel stations.

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