Methanol synthesis

Methanol is one of the most important bulk chemicals. In addition, it can be used either as an admixture to fuels or as energy source for direct methanol fuel cells. On these grounds methanol is regarded as a very important basic chemical for a sustainable energy and material industry. Nowadays, methanol is produced in a matured technology preferred from natural gas or coal based synthesis gas. In future, it is conceivable to generate methanol from carbon dioxide and hydrogen made by water electrolysis.

The DBI-group is involved in research activities, which are targeted at a combined process, which is characterized by the direct coupling of CO_2-scrubbing with methanol synthesis step. Therefore it is possible to run the methanol synthesis under milder process conditions, increase the turnover rates and the process efficiency and enable the utilization of diluted CO_2-streams (e.g. flue gas) for methanol synthesis. Experimental investigations at lab scale has shown the feasibility of this innovative process.

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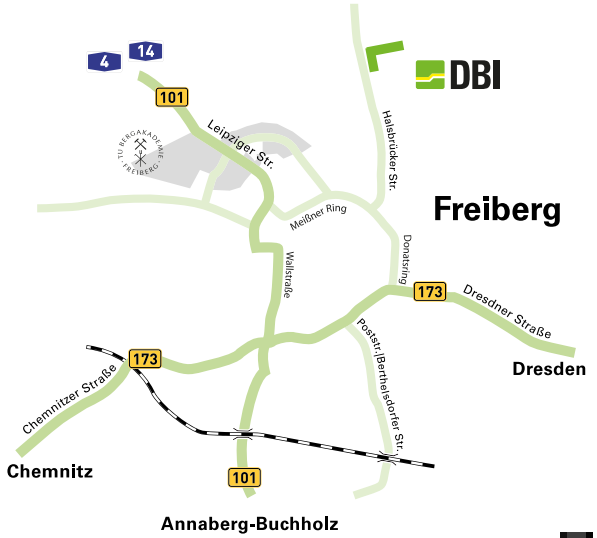

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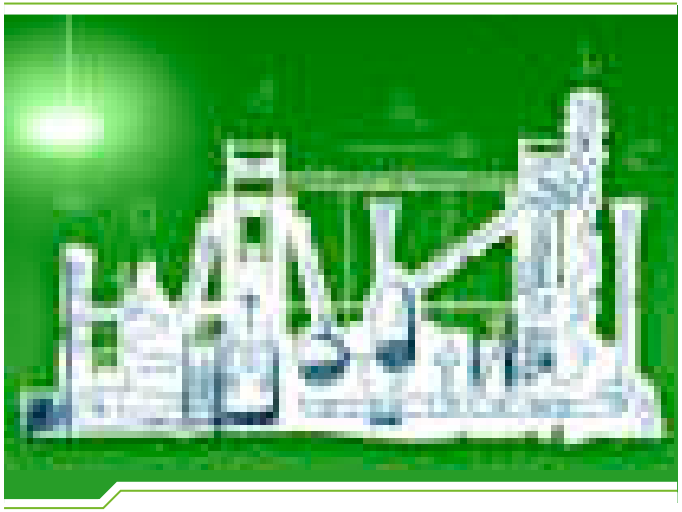
Sustainable synthesis gas

Synthesis gas is a mixture of hydrogen and carbon monoxide, which is used as intermediate for many chemical synthesis. In industrial practice, synthesis gas is produced via different thermochemical processes like steam reforming or partial oxidation of natural gas, residual oil or coal. Since fossil fuels are exhaustible and a rise of the price for natural gas and crude oil is expected for the next decades, we are engaged in the generation of sustainable syntheses gas by dry reforming of biogas or reverse water gas shift reaction (rWGS) using carbon dioxide and hydrogen.



By combining the rWGS with an subsequent separation of water and non-reacted hydrogen and carbon dioxide it is possible, to obtain pure carbon monoxide by this process. Carbon monoxide is an important and valuable raw material of the chemical industry, which is used for diverse syntheses. This technology could be applied in decentralized units, because the supply with pure carbon monoxide by trailer is expensive.

Methanation

Power-to-gas means the conversion of electric power from renewable energy sources like wind power or photovoltaic into hydrogen via electrolysis. The objective of this technology is the feed-in of hydrogen into the existing natural gas grid, whereby the natural gas infrastructure will be opened for the transportation and storage of volatile electric power. The maximum hydrogen content in the natural gas grid is limited to a few percent by volume due to sensitive consumer and infrastructural facilities. If larger amounts of energy should be injected in the gas grid, the conversion of hydrogen to methane will be unavoidable.

The feed-in of methane in the natural gas grid is not limited. Today there are a few demonstration plants for the methanation of carbon dioxide, though the used technologies are highly complex, quite expensive and vulnerable to catalysts poisons, which are present in typical CO_2-containing streams. Therefore the DBI-Group is active in the investigation of innovative processes and materials for the methanation of carbon dioxide. Exemplary topics are:

- Development of new, low-cost catalysts (e.g. iron based materials)
- Development of innovative, load flexible processes
- Innovative reactor concepts in combination with hydrogen storage materials

Direct DME synthesis from biogas

Dimethylether (DME) has similar physical properties like Liquefied Petroleum Gas (LPG) and therefore it is considered to be a long term alternative to LPG (propane, butane) for instance in the transportation sector. In contrast to C_3/C_4 hydrocarbons, DME is relative easy to synthesize. State of the art for the production of DME is the dehydration of methanol. The DBI-Group research for a single step synthesis of DME out of sustainable synthesis gas under mild process conditions. The technology is characterized by the flexibility of the feed composition. In times of high supply of renewable electricity (wind, PV), electrolytic hydrogen can be admixed to the feed stream. In this case, the usage of carbon of biological origin is maximized and the by-product is water only.

$$CO_2 + CH_4 + 2\,H_2 \rightarrow C_2H_6O + H_2O$$

In times of marginal supply of renewable energies, pure syngas generated by dry reforming of biogas is used.

$$1{,}5\,CO_2 + 1{,}5\,CH_4 \rightarrow C_2H_6O + CO_2$$

As a result, this plants can offer negative balancing energy on the market. One important objective of this project is to demonstrate the explained flexible operation, which faces catalysts and process control to special requirements.