Fraunhofer CBP

Fraunhofer Center for Chemical-Biotechnological Processes CBP

Chemical processes

High-Pressure Synthesis Plant

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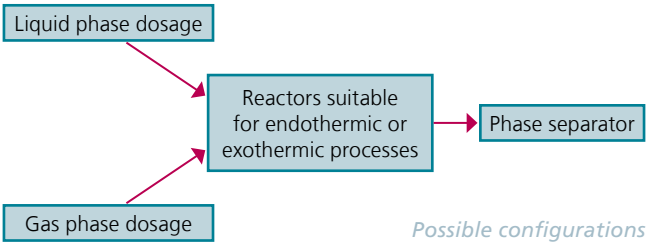
The Fraunhofer Center for Chemical-Biotechnological Processes CBP in Leuna, central Germany, develops and scales up chemical and biotechnological processes for the utilization of renewable raw materials. By providing infrastructure, pilot plant facilities and a staff of highly qualified experts, the CBP closes the gap between laboratory and industrial implementation and enables partners from research and industry to scale up processes to production-relevant dimensions, and thus accelerate process developments.

The Chemical Processes working group focuses on the process-technological development of chemical processes to produce biobased basic and fine chemicals for further processing in the chemical, pharmaceutical or food industries. In addition to new process concepts, the optimization of the resource and energy efficiency of existing processes also plays an important role here. Established processes can be adapted and optimized from the ecological and economic viewpoint. In doing this, we both consider biobased raw materials and also examine conventional processes for manufacturing petrochemical products.

Portfolio

The pilot plant is designed to perform chemo-catalytic reactions under pressures of up to 100 bar and temperatures of up to 380 °C (716 °F). It can, however, be adjusted to higher pressure and temperature levels. The plant consists of two upstream racks, one for the precise dosage of gases and one for dosing fluids. Furthermore, two reactor racks, equipped with different reactor types, are available, which are suited for both endothermic and exothermic processes. To process the product fractions, a downstream rack to phase separation follows.



Possible configurations of the pilot plant

Technical data

- ATEX-compliant unit (zone 2c, T3/T4)
- Dosing gas through mass flow meters: max: 17 kg/h
- Reactor rack with 3 tubular reactors, each 1.9 liters – in total: 5.7 liters
- Reactors can – if needed – be cooled through three pinching points
- Pressure: max. 100 bar
- Temperature: max. 380 °C (716 °F)
- Single-stage structured phase separator with adjustable pressure- and temperature sectors
- Gas phases analytics via online-GC or manually
- Continuous product filling in IBC-containers

Process

Configuration possibilities (optional)

After adjusting the unit, a liquid dosing as well as the following configurations can be depicted:

- Operating pressure of up to 300 bar
- Operating temperature of up to 500 °C (932 °F)
- Liquid dosing through the dosing pump: max. 20 kg/h
- Reactors
  - 4 (double jacket) flow tube reactor, volume: 2.15 liters for exothermic processes, or
  - 1 tubular reactor in the split tube oven, volume: 2.15 liters for endothermic processes
- Residence times approx. 5–30 min
- Multistage connected phase separators with adjustable pressure and temperature ranges
- Continuous product filling in pressurized gas cylinders

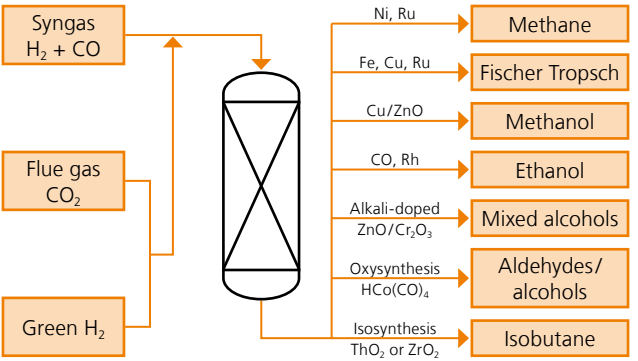
Gas phase reaction

Process of methanol synthesis
First, the plant is rinsed with N_2 and then pressurized to a maximum of 100 bar. In the second step, hydrogen (up to 1 kg/h), carbon dioxide (up to 12 kg/h), and carbon monoxide (up to 6 kg/h) are dosed through MFCs (mass flow controller) and then pressurized by a compressor.

After that, the feed gas is preheated to a reaction temperature between 250 and 270 °C and fed into the reactor, which is filled with catalyst material. The three reactors are heated separately, each by two radiators. Additionally, cooling the reactors is possible through three points per reactor. After the synthesis, the mixed-phase mixture is cooled to ambient conditions and separated in the high-pressure separator.

Unconverted synthesis gas is added to the feed gas through a recycling pipe, while the liquid product is sent to the IBC-container.

Monitoring of the gas phase is provided by means of GC and can either be done offline through manual sampling or online through automated sampling.



Possible gas phase reactions of the synthesis unit

Liquid phase reaction

Process: oligomerization of isoalkenes
First, the plant is rinsed with N_2 and then pressurized to a maximum of 25 bar. In the second step, the liquid form of isoalkenes is transferred from the gas bottles to the high-pressure dosing pump and a mass flow between 5 and 20 kg/h is selected.

After that, the feed gas is preheated and brought to a reaction temperature between 25 and 50 °C and fed into the reactor, which is filled with catalyst material. The four reactors are tempered separately, using either coolant or thermostats.

After the synthesis, the mixed-phase mixture is cooled to ambient conditions and separated in the high-pressure separator.

Contact

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