Solid-liquid separation

Solid-liquid separation processes play an important role in the processing of bio-based products. For example, digestate has to be separated from fermentation broths, and sludges as well as microalgae need to be dewatered. For that purpose, continuous, mechanical processes like decanter centrifugation and filtration are the established methods in industrial applications. At DBFZ, the following equipment for solid-liquid separation is available in pilot scale:


Decanter centrifuge

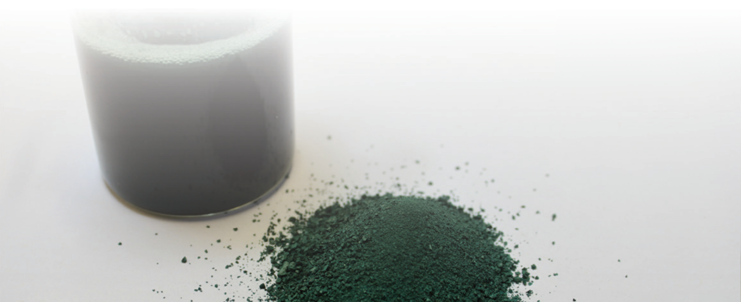

Hydraulic filter press

Decanter centrifuge:

- Centrifugal accelleration up to 4.400 *g*
- Capacity up to 100 L h^{-1}
- Complete mass and energy balances

Hydraulic filter press:

- Compacting pressure up to 60 bar
- Pressure chamber approx. 2 L



Liquid-liquid separation

Biorefinery products, such as fuels or fine and platform chemicals, are often present as liquids. The DBFZ uses liquid-liquid separation processes to separate and concentrate these products from their aqueous environments as well as fractionate them from each other. For practical investigations, pilot plants for membrane filtration, liquid-liquid extraction, and adsorption are available. High-quality products or very similar components can furthermore be purified with a preparative high-performance liquid chromatography (HPLC).


Membrane filtration


Liquid-liquid extraction

Membrane filtration:

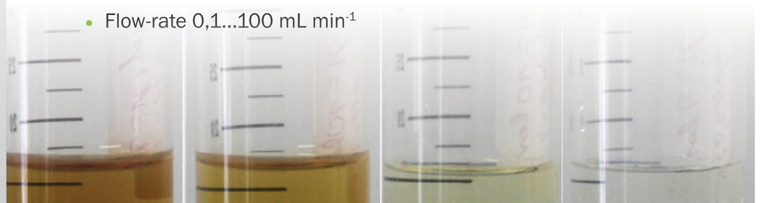
- Micro-, ultra-, nanofiltration and reverse osmosis
- Polymer and ceramic membranes
- p_{max} = 60 bar, T = 20...90 °C, CF = 5...31 L min^{-1}

Liquid-liquid extraction:

- Stirred and heated countercurrent extraction
- h = 1600 mm, d = 25 mm, V_{Feed} = 15 L

Preparative HPLC:

- Separation of sugars, furan derivatives, phenols and organic acids etc.
- Flow-rate 0,1...100 mL min^{-1}



Contact person

Dr.-Ing. Franziska Müller-Langer
Head of Department Biorefineries
Phone: +49 (0)341 2434-423
E-Mail: franziska.mueller-langer@dbfz.de

Dr.-Ing. Marco Klemm
Team leader Chemical Biomass Upgrading
Phone: +49 (0)341 2434-537
E-Mail: marco.klemm@dbfz.de

Dipl.-Ing. Arne Gröngröft
Team leader Fuel and Separation Technologies
Phone: +49 (0)341 2434-446
E-Mail: arne.groengroeft@dbfz.de

Prof. Dr.-Ing. Stefan Rönsch
Team Leader Syngas Technologies
Phone: +49 (0)341 2434-451
E-Mail: stefan.roensch@dbfz.de

Further information

Further information can be found at www.dbfz.de

funded by:

Federal Ministry of Food and Agriculture

Federal Ministry of Education and Research

Federal Ministry for Economic Affairs and Energy

SAB Sächsische AufbauBank

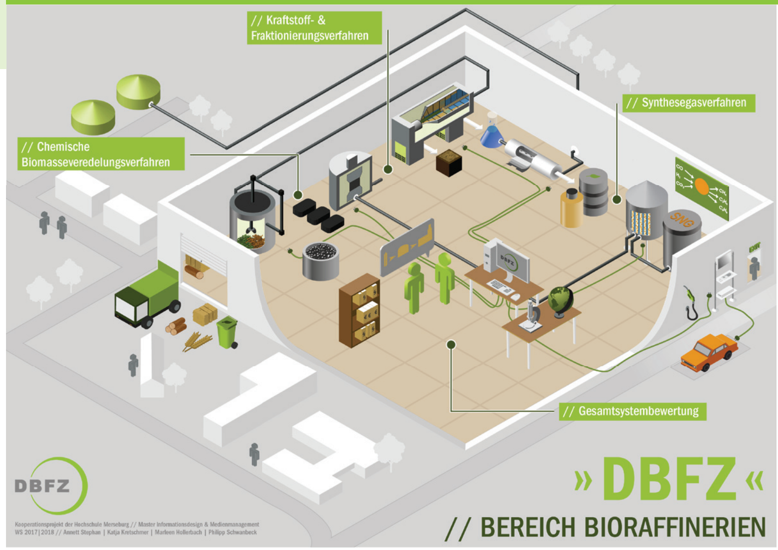
Europäische Union

Europa fördert Sachsen.
EFRE
Europäischer Fonds für regionale Entwicklung

Pictures: DBFZ, Jan Gutzeit, Schulz und Schulz Architekten GmbH, Hochschule Merseburg

Deutsches Biomasseforschungszentrum
gemeinnützige GmbH
DBFZ

Biorefinery Laboratory



Hydrothermal processes, Gasification, Gas cleaning, Synthesis, Separation processes

Hydrothermal processes


HTP stirred tank reactor

Hydrothermal processes (HTP) are generally defined as thermochemical transformations in hot compressed water (180 – 350 °C / 20 – 200 bar). Water is im-portant for such processes, since it acts as solvent and reaction medium at the same time. Biomasses, such as sewage sludge, digestate, as well as hydrolysates from lignocellulosic residues, contain large amounts of water. Therefore, HTP are a promising technology in biorefinery concepts for the conversion of wet feedstock's to high-value solid, liquid and gaseous products. For hydrothermal investigations, the following laboratory plants are available:

Discontinuous stirred tank reactors (DSTR):

- 500 mL / electrcally heated
  T_{max} = 300 °C, p_{max} = 200 bar, Q_{el} = 3 kW
- 500 mL thermostatically heated
  T_{max} = 270 °C, p_{max} = 200 bar, Q_{th} = 3,5 kW
- 10 L thermostatically heated
  T_{max} = 300 °C, p_{max} = 150 bar, Q_{th} = 7 kW

Continous laboratory plants:

- Tube reactor (l = 860 mm, d_i = 20 mm)
  T_{max} = 350 °C, p_{max} = 200 bar
- 2-stage hydrothermal laboratory plant
  1st stage: T_{max} = 350 °C, p_{max} = 200 bar
  → hydrothermal biomass decomposition
  2nd stage: T_{max} = 300 °C, p_{max} = 100 bar
  → refining

Biomass gasification

Solid and dry biomass can be converted to synthesis gas by means of biomass gasification. This thermo-chemical process needs high temperatures as well as sub-stoichiometric addition of gasification agents, e.g. air or steam, and is characterized by maximum carbon conversion. The recovered synthesis gas, which consists of the main components carbon monoxide, hydrogen, carbon dioxide and methane, can be used for combined heat and power generation and for the production of various chemical energy carriers/fuels and basic chemicals after cleaning. Various reactors with extensive measurement technology are available for the gasification of biomass.


Fixed bed-/ entrained flow gasifier

Entrained flow gasifier:

- T_{max} = 1200 °C, p = 1 bar
- Up to 3 kg h^{-1} fuel

Fixed bed gasifier:

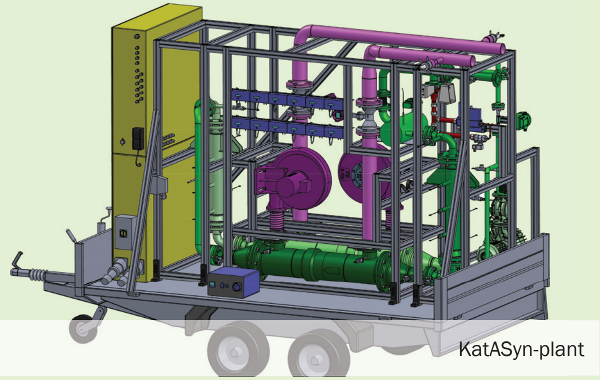
- T_{max} = 950 °C, p_{max} = 20 bar
- Gasification agent: Air, N_2/O_2, steam, CO_2

Gas analytics:

- Gas chromatography (GC-TCD, GC-FID), FTIR spectrometry

Gas cleaning

To be able to use product gases of the biomass gasification for the provision of power and heat (cogeneration of heat and electricity) or fuels / chemicals (synthesis), is a gas cleaning necessary. Pollutants to be separated, are here solid particle (dust), hydrocarbons (tar), sulfur and halogenide /nitrogen-components (H2S, HCl, HCN) and alkalis. According to application different gas quality different limit values must to be observed. For gas cleaning the following test states are available:


KatASyn-plant

KatASyn-plant:

- T_{max} = 900 °C, p = 1 bar
- Gasflow up to 15 m^3 h^{-1} (STP) (correspond to 20 kW fuel power)
- 2-stage: reforming and adsorption
- Mobile installation in car trailer

Adsorptiv cleaning plant:

- T_{max} = 350 °C, p = 1 bar
- Gasflow Up to 5 m^3/h (STP)
- 3 fixed bed for hydrogenation catalyst, impregnated activated carbon plus Zinc- and Copper-sorbents.

Syngas technologies

Cleaned and conditioned synthesis gas is converted catalytically into synthetic natural gas (SNG), light alkene (ethane, propene) or synthetic fuels in our lab. The test rigs displayed below allow to compare different reactor concepts as well as commercial and newly developed catalysts at industrially relevant conditions. Two test rigs with two reactors each are applied to develop new synthesis processes, study the kinetics of catalysts and analyse the non-stationary operation of synthesis reactors. New catalysts are developed in cooperation with an industrial catalyst manufacturer.

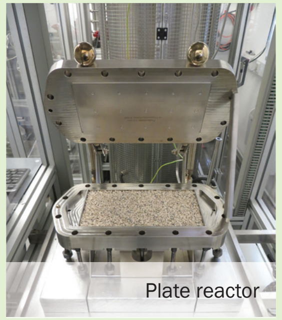
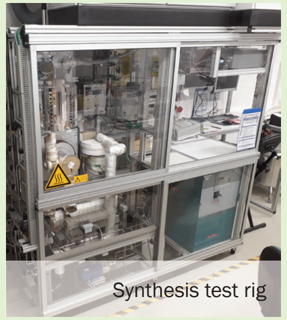


Plate reactor


Synthesis test rig

Three tube reactors with recycle cooling:

- Electrically heated: T_{max} = 850 °C, p_{max} = 60 bar
- Electrically heated: T_{max} = 550 °C, p_{max} = 10 bar
- Oil tempered: T_{max} = 350 °C, p_{max} = 1,5 bar

Plate reactor:

- T_{max} = 350 °C, p_{max} = 20 bar
- Heating and cooling with thermal oil

Gas analytics:

- Gas chromatography (GC-TCD, GC-FID), FTIR spectrometry