Optimisation of catalysts and process conditions for biomethane production from biogenic waste materials on a pilot scale

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Project goal

In the Pilot-SBG project, a possible process chain has been set up as a pilot-scale biorefinery to produce methane as a fuel from biogenic residues. Biogenic residues and waste materials are first converted into biogas, which essentially consists of methane (CH_4) and carbon dioxide (CO_2). Catalyst-damaging components such as hydrogen sulphide (H2S) are then separated and the CO_2 is catalytically hydrogenated by adding hydrogen (H_2) without prior separation. This refines the biogas into biomethane and achieves a significantly higher biomethane yield and CO_2 reduction compared to conventional methods.

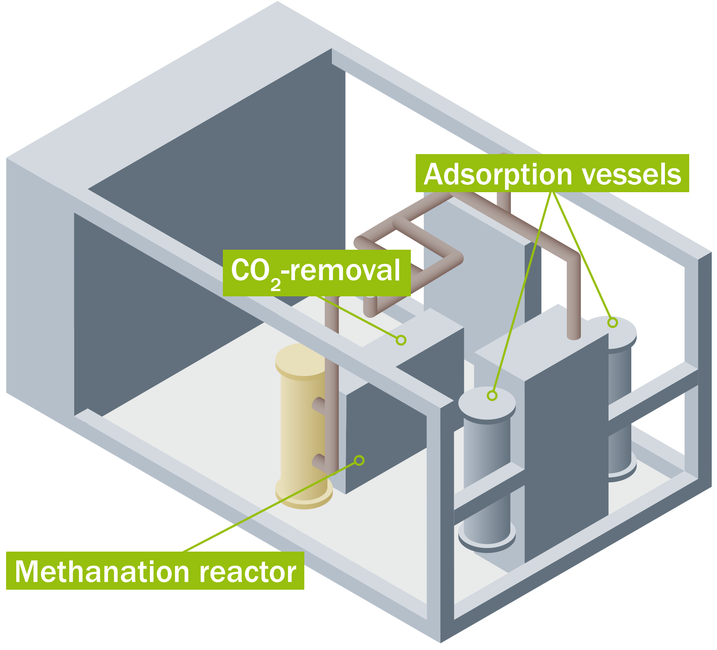

Fig. 1: Methanation module in the pilot plant with two adsorber vessels and a methanation reactor

Reactor design

- Reactor type: Fixed bed
- Volume: 570 ml
- Temperature: up to 500 °C
- Pressure: up to 20 bar(g)
- Electrical heating and air cooling in three segments

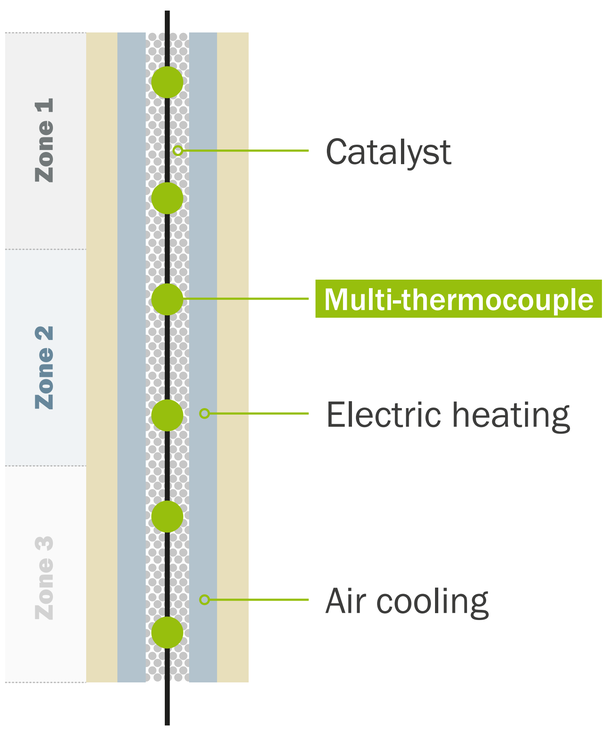

Fig. 2: Schematic structure of the methanation reactor

Scan the QR code and find our focus booklet 'Methanation' with more information on the topic and a direct comparison of biological and catalytic methanation.

www.dbfz.de/en/pilot-sbg

Start-up process

Operating parameters: Catalyst: Ru on Al_2O_3

- Biogas volume flow = 50 L/h
- Reactor pressure = 18 bar(g)
- Reactor target temperature = 320 °C
- H_2/CO_2 ratio = 4

Measurement of the product gas composition using an on-line micro gas chromatograph.

Biogas composition

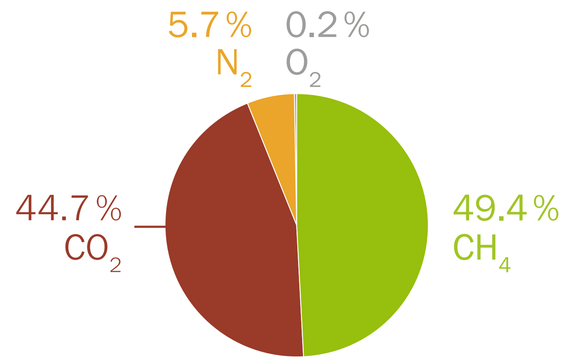

Fig. 3: Biogas composition in the storage tank at the start of the experiment

Temperatures in the reactor

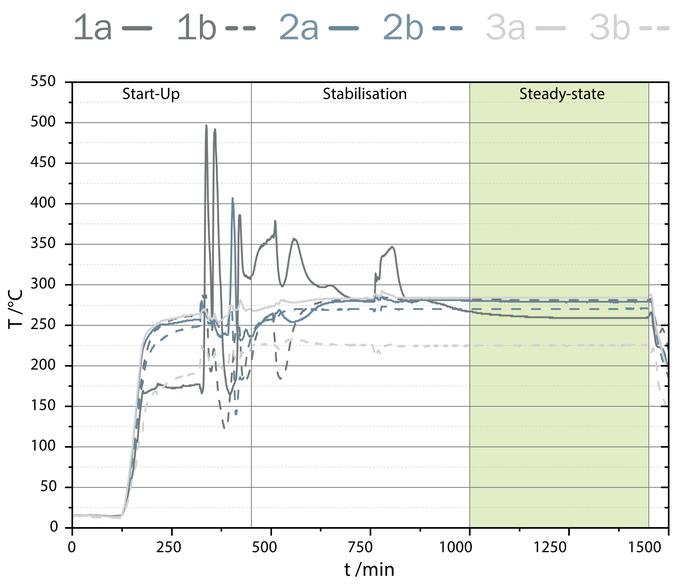

Fig. 4: Course of the reactor temperatures in the start-up process of the catalytic methanisation of biogas

Product gas composition

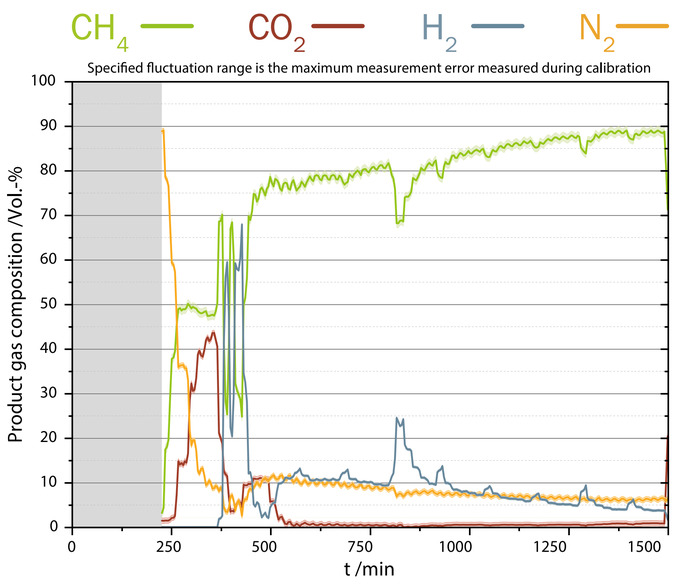

Fig. 5: Course of the product gas composition in the start-up process of the catalytic methanisation of biogas

Outlook

As part of a statistical test programme, the optimum operating conditions are determined for two selected catalysts as a function of temperature, room speed and H_2/CO_2 ratio. Whether the catalysts are also economically viable is analysed on the basis of an economic and ecological assessment, taking into account the H_2S tolerance of the catalysts.

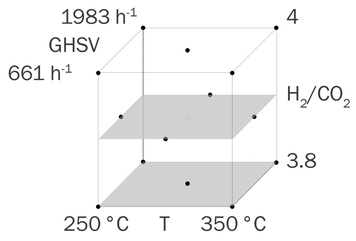

Fig. 5: Design of experiment for the catalyst evaluation

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