

Bachelor / Master Thesis

## The Effect of Water Vapour and Pressure on the Catalytic Methanation of Synthesis Gas in a Two-Stage Laboratory Plant

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### Content:

In industry, fossil fuels – particularly natural gas – continue to be the primary source of (high-temperature) process heat. As part of the BioProcessHeat research project, a CO<sub>2</sub>-saving process route is being investigated in which natural gas is replaced by climate-friendly, biogenic synthesis gas produced through the thermochemical gasification of biomass. The aim is to develop efficient and economically competitive process chains for the provision of renewable process heat.

To this end, a process chain is being set up on a laboratory scale that converts biomass and catalytically conditions the resulting synthesis gas. Compared to the approach of replacing fossil natural gas with renewable natural gas substitutes (SNG) of natural gas quality, the combination of hot gas cleaning, (partial) methanation and direct combustion of the synthesis gas in a special FLOX burner offers simplified process control. This can improve the economic competitiveness of such systems.

This Master's/Bachelor's thesis focuses on the experimental investigation of a two-stage laboratory-scale methanation plant with a thermal capacity of 20 kW. The plant consists of a heat-pipe-cooled fixed-bed reactor as the first methanation stage, followed by an adiabatic fixed-bed reactor. A condenser is installed between the two reactor stages to remove the water vapour formed from the process gas. The plant is designed for a nominal pressure of 4 bar and is to be investigated during the project in the pressure range between 1 and 5 bar (abs.).

The aim of the work is to analyse the operating limits of the two-stage methanation process, particularly with regard to carbon formation under varying synthesis gas compositions. In the experimental part of the work, a steam generator will be connected to the first methanation stage, integrated into the existing plant control system and used for targeted steam dosing during operation. In addition, the catalyst in the first reactor stage is replaced. Subsequently, systematic test campaigns are planned and carried out to experimentally investigate the influence of steam content and operating pressure on the methanation behaviour. The measurement data obtained are evaluated, interpreted and clearly documented.

### Task Description:

- Literature review on catalytic methanation, carbon formation, and the influence of steam and pressure on methanation processes
- Determination of the steam requirements necessary to suppress carbon formation
- Integration of a steam generator into the existing laboratory setup, including connection to the plant control system
- Replacement of the catalyst in the first methanation stage
- Planning, execution and evaluation of experimental investigations into the influence of steam and operating pressure on methanation
- Analysis, processing and interpretation of the measurement data
- Written documentation of the work and clear presentation of the results



### Contact:

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**Requirements:**

- An interest in thermochemical processes and catalytic reactions
- A structured and independent approach to work
- An enthusiasm for practical, experimental work in the laboratory
- Basic knowledge of thermodynamics and reaction engineering would be an advantage
- Working language: German or English

**Start:** from April **2026**



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