Bavarian Hydrogen Center

CO2free SNG 2.0

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Performance and efficiency of the Heatpipe Reformer gasification system

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Motivation

The Heatpipe Reformer (HPR) provides an allothermal gasification process for the generation of a hydrogen-rich synthesis gas. Liquid metal heat pipes transport the heat required for fuel gasification from a fluidized bed furnace to the steam-blown fluidized bed gasification reactor. This allows the generation of a synthesis gas with a hydrogen content of up to 50% and very low nitrogen content.

Technology description

Figure 1 and 2 show the EVT HPR system: In contrast to other dual fluidized bed gasification processes, it takes place in a pressurized reformer chamber (1) at 2-10 bar and 800°C.

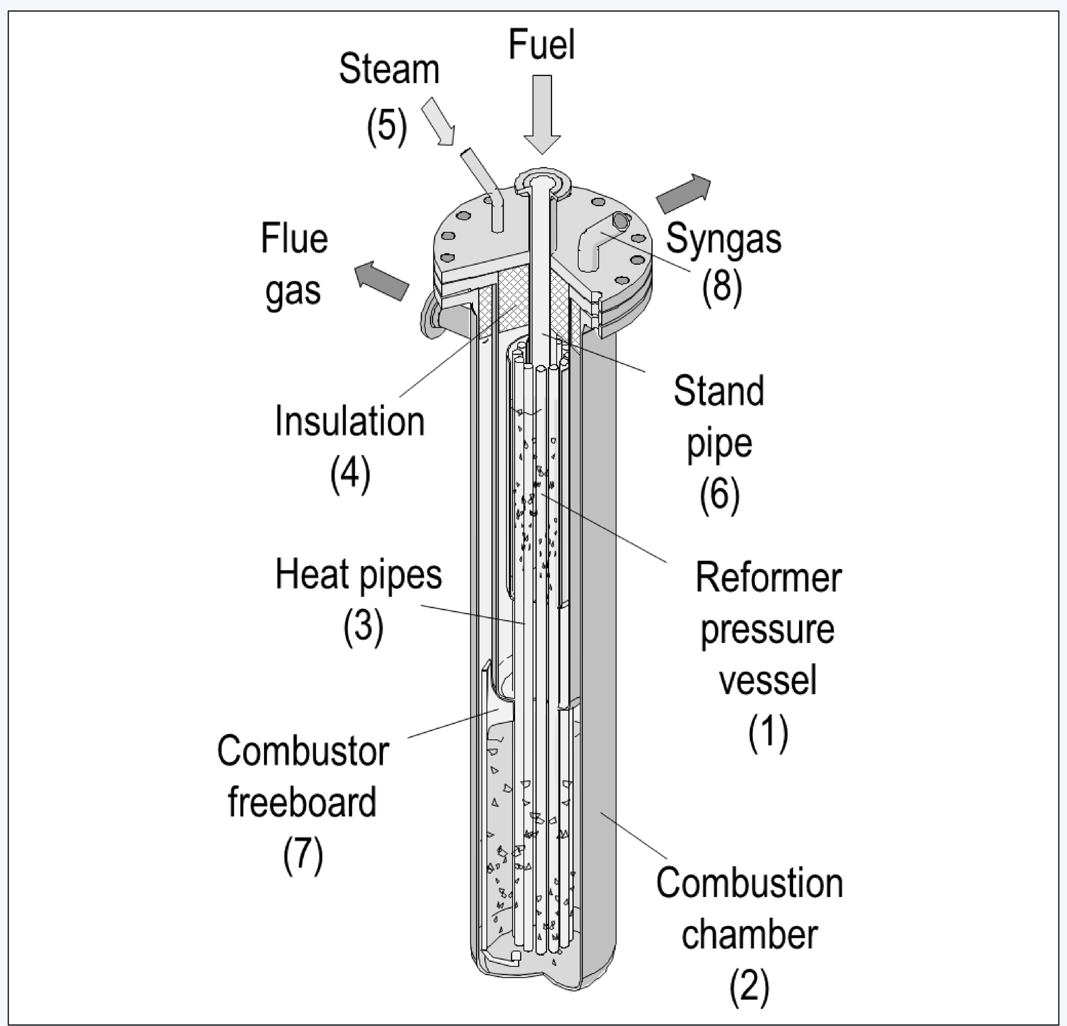

Fig. 1: Heatpipe Reformer system

The pressurized synthesis gas allows usage for SNG synthesis, combustion in engines or gas turbines. The heat for the process is supplied by a combustion chamber (2) located beneath the reformer. Heat pipes (3) connect the two processes and transport the heat from furnace to gasifier. To ensure a high heat transfer coefficient to the heat pipes both the gasification and combustion take place in fluidized beds. To reduce heat losses and temperature stress on the top flange the reformer is insulated at the top end (4). Steam (5) and fuel are fed from the top, the fuel enters the fluidized bed with a stand pipe (6).

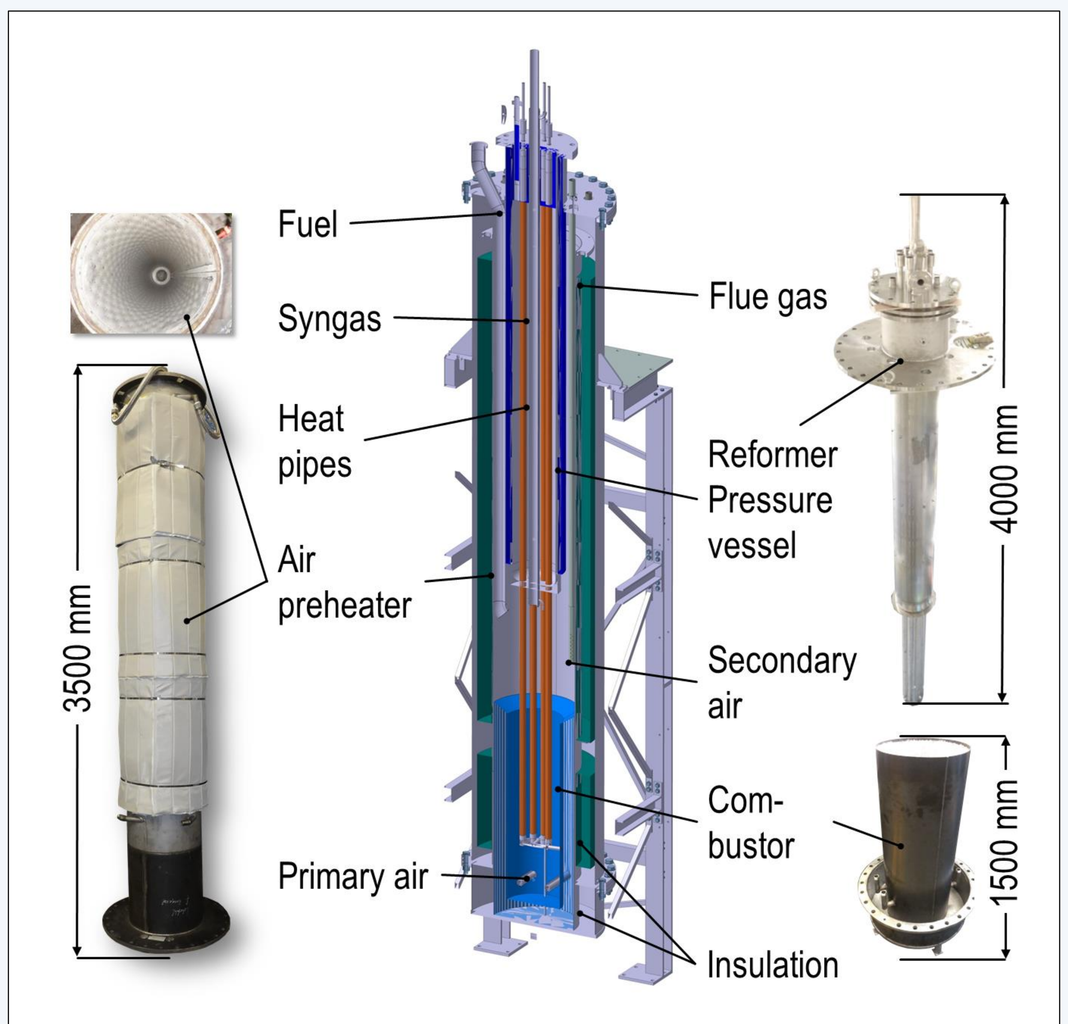

Fig. 2: CAD sketch and pictures of EVT Heatpipe Reformer

Results

After a candle filter an insulated split stream is depressurized for tar content and primary gas components analysis. A sampling port for solid phase adsorption (SPA) samples is installed in an insulated section to avoid preliminary tar condensation. The test procedure is more extensively described in a previous publication on the Heatpipe Reformer [2].

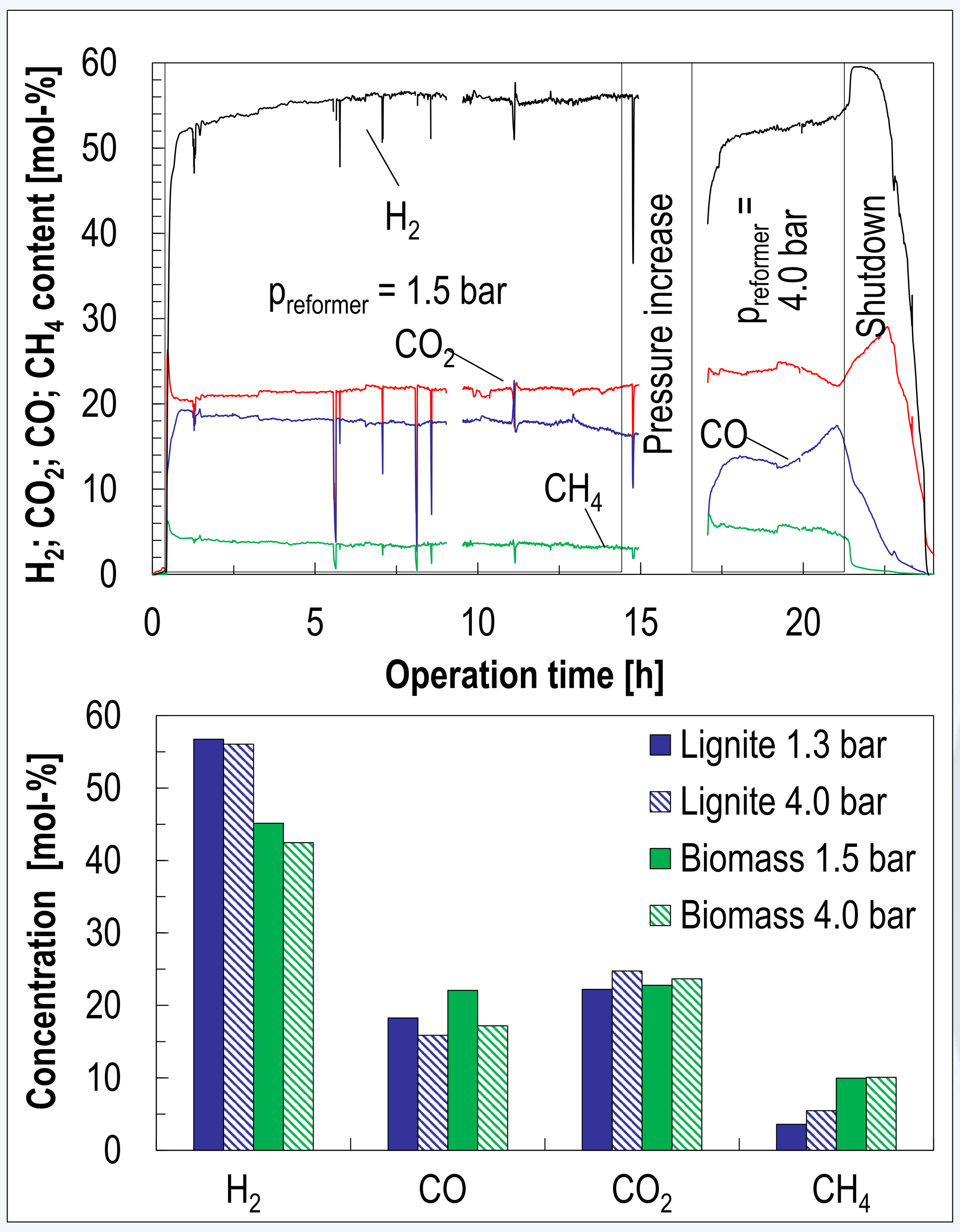

Fig. 3: Concentration of the main gasification products during gasifier operation and for different feedstock

Figure 3 shows the volumetric concentration of the main gasification products, namely H_2, CO_2, CO and CH_4 as well as chronological sequence of the different operation points during a complete gasification campaign. The concentrations remain stable after reaching steady state after approx. 5-10 h, as seen from the H_2 content.

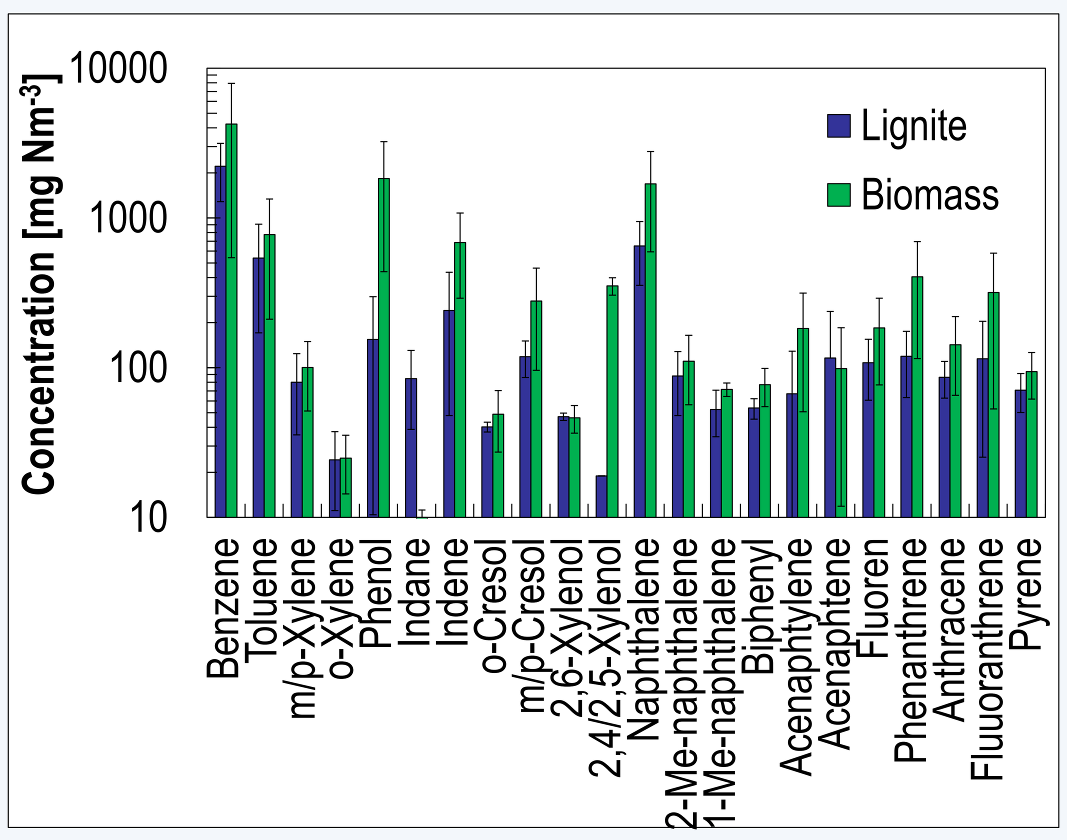

Fig. 4: Content of tar components in biomass and lignite derived syngas

Figure 4 shows the tar content of synthesis gas derived from biomass and lignite. The overall tar content ranges from 2000 to 8000 g/Nm³, biomass having higher tar contents. Due to the higher sulfur content of lignite, also the gaseous sulfur species are present in considerable concentrations.

Energy balance and efficiency

It is possible to calculate an energy balance from the results of the lignite experiments to evaluate the gasification process in terms of efficiency and optimization potential. The cold gas efficiency can be calculated by dividing the chemical energy content of the synthesis gas by the overall heat duty of the process. It rises strongly with the Heatpipe Reformer capacity utilization due to a decreasing share of sensible heat loss on the overall heat duty.

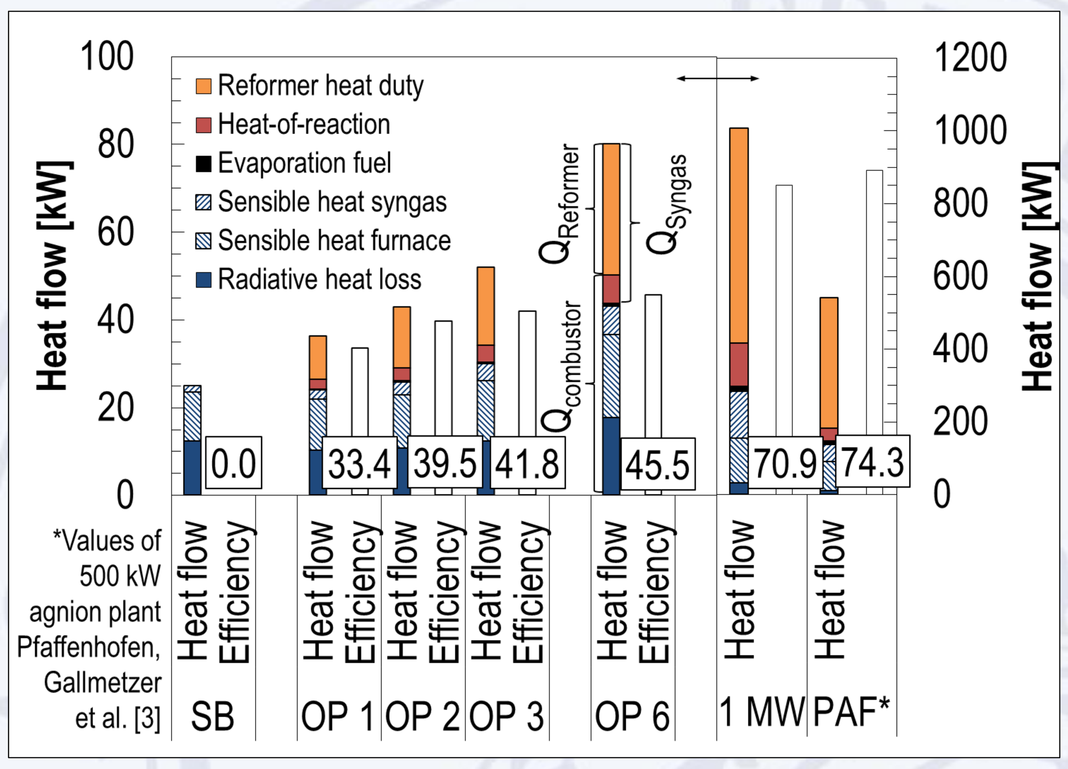

Fig. 5: Heat balance and efficiency of the EVT Heatpipe Reformer and comparison with 1 MW scale-up

Conclusion

The poster presents experimental results from the operation of a 100 kW Heatpipe Reformer with biomass and lignite. The findings were also used to characterize the process in terms of efficiency, resulting in a cold gas efficiency higher than 70 % for a 1 MW scale-up.

Ongoing development at EVT concentrates on SNG and hydrogen generation based on the Heatpipe Reformer.

[1] KARL, JÜRGEN: Biomass heat pipe reformer - design and performance of an indirectly heated steam gasifier. In: Biomass Conversion and Biorefinery Bd. 4 (2014), Nr. 1, S. 1–14

[2] LEIMERT, J.M.; TREIBER, P.; NEUBERT, M.; SIEBER, A.; KARL, J.: Performance of a 100 kW Heatpipe Reformer operating on Lignite. In: Energy and Fuels. Accepted proof, (2017)

[3] GALLMETZER, G.; ACKERMANN, P.; SCHWEIGER, A.; KIENBERGER, T. et al.: The agnion Heatpipe-Reformer: operating experiences and evaluation of fuel conversion and syngas composition. In: Biomass Conversion and Biorefinery (2012), Vol. 2, pp 207-215

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