STATE OF RESEARCH IN THE FIELD OF DUAL FLUIDIZED BED STEAM GASIFICATION OF BIOMASS WITH IN-SITU CO_2 CAPTURE

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INTRODUCTION

The process of dual fluidized bed steam gasification is a well-known technology for the thermochemical conversion of biomass. Several industrial plants have been built during the last two decades (e.g. in Güssing/AT, Villach/AT, Oberwart/AT, Senden/DE and Gothenborg/SE). The main objectives of these plants are the production of heat and electricity from the produced product gas. Since the increasing prices for wood pellets led to economic troubles of the technology, research activities on the one hand focused on the utilization of cheaper fuels like low grade wood or other residues from agriculture and industrial wastes [1]. On the other hand research focused on further development of the process. Therefore the dual fluidized bed steam gasification with in-situ CO_2 capture (sorption enhanced reforming process or SER) is an innovative evolution, which allows the in-situ adjustment of the product gas composition and therefore is highly suitable for utilization of the product gas as raw material for synthesis processes like methanation or Fischer-Tropsch.

EXPERIMENTS

The SER process uses limestone (mainly $CaCO_3$) as bed material. **Figure 1** shows the basic principle of SER [2], [3]. The combustion reactor supplies heat for the overall endothermic gasification reactions through the circulation of hot bed material particles. Residual char is transported from the gasification reactor to the combustion reactor together with the circulating bed material, where it is burnt to heat up the bed material. Steam is used as a gasification agent and leads to the production of a nitrogen-free and hydrogen-rich product gas. The calcination of the bed material to calcium oxide (CaO) and the release of CO_2 take place ($CaCO_3 \rightarrow CaO + CO_2$) in the combustion reactor at high temperatures. The gasification reactor operates on a lower temperature level. Thus, an in-situ CO_2 capture out of the product gas by carbonation reactions with CaO bed material particles occurs ($CaO + CO_2 \rightarrow CaCO_3$). The decreased CO_2 concentration in the gasification reactor leads to a more intensive water-gas shift reaction ($CO + H_2O \leftrightarrow H_2 + CO_2$) and enhances the production of hydrogen (H_2) in the gasification reactor. Suitable temperature ranges during the SER process depend on the equilibrium partial pressure of CO_2 in the wet product gas and the wet flue gas. **Figure 2** shows a sketch and a picture of the 100 kW_{th} dual fluidized bed gasification pilot plant at TU Wien. All experimental results presented in this work were gained with the pilot plant and validated by mass and energy balances. Therefore all results are highly representative for scale-up of the process.

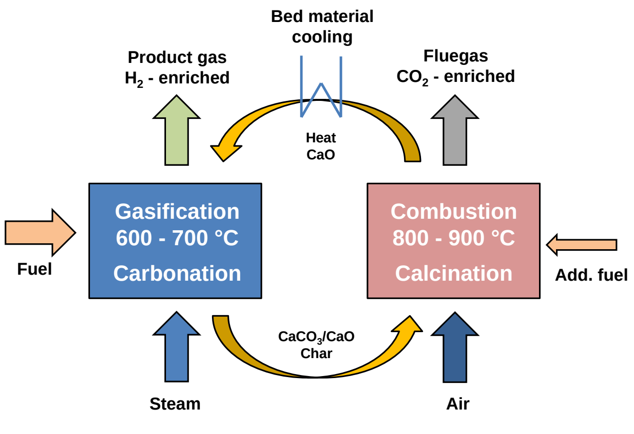

Figure 1: Basic principle of the sorption enhanced reforming process

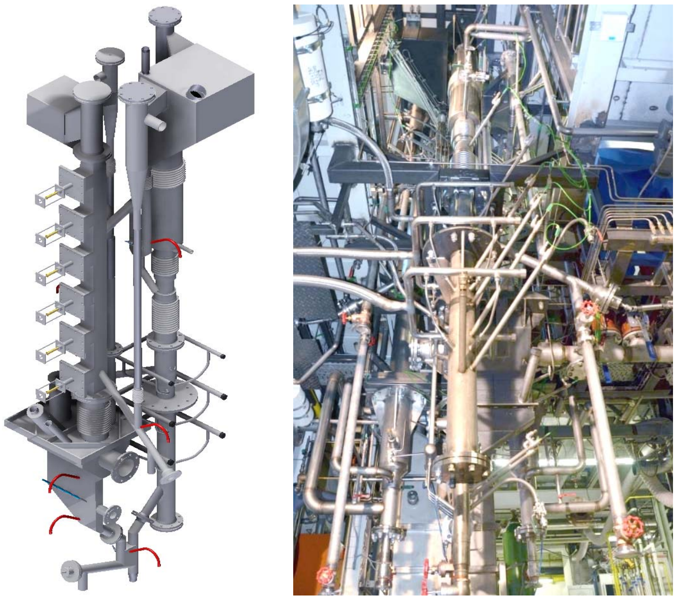

Figure 2: Sketch (left) and picture (right) of the 100 kW_{th} dual fluidized bed gasification pilot plant at TU Wien without insulation

RESULTS AND DISCUSSION

Former research activities mainly focused on the temperature influence of the process. In **Figure 3** (left) it can be seen that for temperatures around 650 °C the lowest CO_2 contents and therefore the highest H_2 contents in the product gas can be observed. However, recent research activities showed that other influencing factors of the process cannot be neglected: The bed material cycle rate is a major factor which influences the product gas composition. **Figure 3** (right) shows that a low cycle rate leads to high H_2 contents in the product gas as well. This points out that also the residence time of the bed material in the reactors is a key factor for the process.

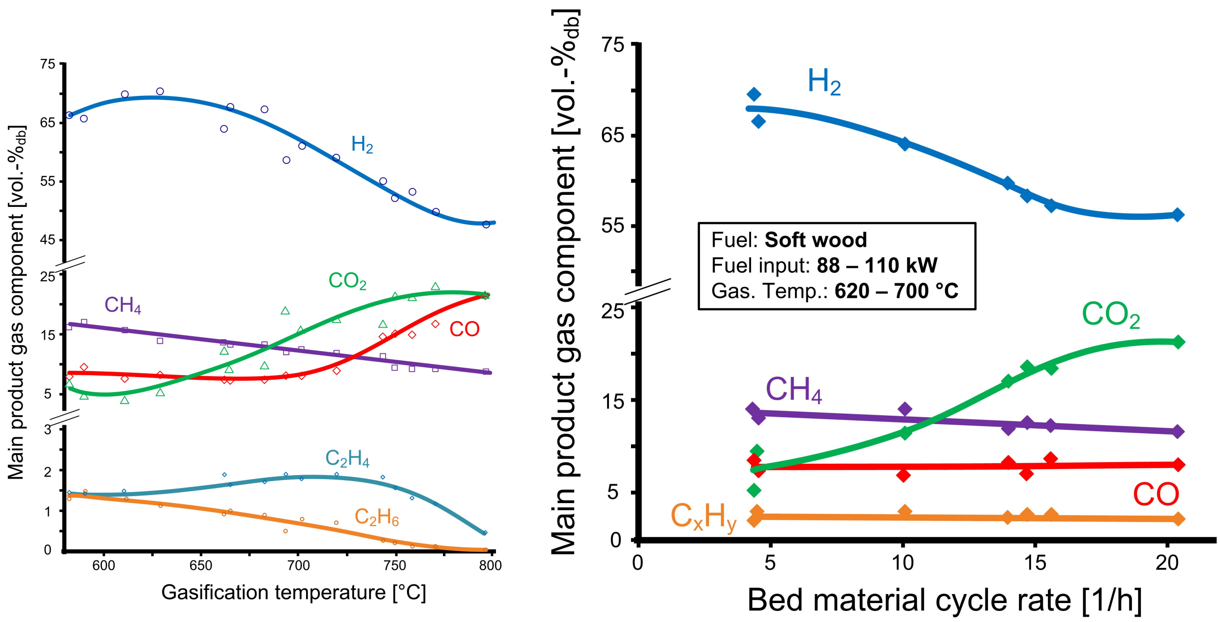

Figure 3: Temperature dependency (left) and bed material cycle rate (right) dependency of the SER process

CONCLUSION

It has been shown that the sorption enhanced reforming process is influenced by different factors. Especially temperature dependency and dependency on bed material cycle rate have been identified. Further investigations will focus on kinetic modelling of the CO_2 sorption of the bed material to identify the limiting factors of the process in more detail.

REFERENCES

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