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Comparative Energetic Assessment of integrated H2- and CH4- Production via Biomass Supercritical Water Gasification

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The gasification of biomass in supercritical water is an emerging technology which offers the opportunity to produce methane and hydrogen from high-moisture biomass and waste streams. The obstacles of the technology owe to an early development stage but can also be attributed to the mechanically and chemically challenging process conditions (>375 °C, > 220 bars) and the high heating load for the reaction medium, water. In this work we developed a reaction model that can sufficiently well describe the process' mass and species balance for different real-life feedstock. This model is used to describe the SCWG process within a fully heat and power-integrated plant model. Two conceptual plant models have been developed that represent the power- and heat integrated production of hydrogen and methane via SCWG, respectively. The main parameters influencing the product yield are feedstock concentration and reaction temperature. Both hydrogen and methane production require complex downstream processing in order to achieve reasonable production rates and high purity. Therefore different process lay-outs, aiming for energetic self-sufficiency have been synthesized and compared to each other. The most promising options have been further scrutinized by means of pinch analysis. Simulation results show that the overall process efficiency of methane and hydrogen production via SCWG can be as high as 0.61 and 0.46, respectively. For hydrogen a lean feedstock solution with a solid content around 5% should be used, whereas for methane production the feedstock concentration is only limited by pump ability. Although the energetic efficiency of the SCWG favors methane production, for economic feasibility other factors such as equipment size and cost and feedstock and product market prices will play an important role. With the mass- and energy balances established in this work, our future work will assess the economic feasibility of the proposed processes.

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