High efficiency SNG production from biomass and electricity by integrating gasification with pressurized solid oxide electrolysis cells - DTU Orbit (14/03/2019)

High efficiency SNG production from biomass and electricity by integrating gasification with pressurized solid oxide electrolysis cells

Co-electrolysis of CO₂ and H₂O in pressurized solid oxide electrolysis cells (SOEC) results in internal methanation when the fuel electrode contains nickel, as nickel catalyzes the methanation reaction. Recent SOEC stack experiments operated at 19 bar and 700 °C produced a gas with a methane content of 18 vol% (dry). The exothermic methanation reaction is a perfect match for the endothermic electrolysis reactions, enabling an overall slightly exothermic stack operation at a moderate polarization voltage. When using a pressurized SOEC for biomass syngas upgrading to synthetic natural gas, it is possible to achieve very high energy efficiency because a high share of the exothermic methane formation can occur inside the SOEC. The production of waste heat from the downstream methanation reactor is therefore reduced significantly. In this paper, such an integrated system design is proposed and evaluated by thermodynamic modelling and analysis. The analysis shows that the proposed system can reach 84% energy efficiency from wood pellets and electricity to synthetic natural gas. This is substantially higher than the ~70% efficiency than can be achieved with steam electrolysis based systems. If steam drying is integrated to allow the use of wet wood chips, the efficiency drops to 82%.

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