Environmental and Techno-Economic Assessment of Co-Generation of Power and Fuels Based on Fluidized Bed Gasification

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Abstract

In the context of increasing energy supply from intermittent renewable power generation, conventional power plants struggle with low capacity factors as well as decreasing prices for base load electricity. A promising approach for future power plants is the polygeneration concept based on integrated gasification combined cycle. This allows for an on-demand supply of electricity while keeping main parts of the plant, i.e. gasifier and gas treatment, running at full load for production of chemicals or fuels. Furthermore, an efficient pre-combustion CO_2 capture can be implemented into the process.

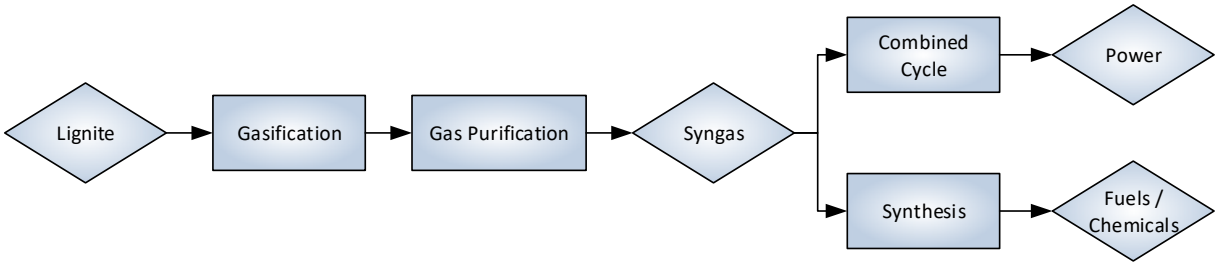

Figure 1 Polygeneration concept based on IGCC

In this work, a validated ASPEN Plus process model of a 350 MW_{el} combined cycle power plant is extended with a fluidized bed dryer, a fluidized bed gasifier, a gas purification unit, a CO-Shift unit, a RECTISOL-type acid gas removal, and a synthesis reactor array for methanol synthesis. The model is used to investigate the specific CO_2 emissions and the process efficiency for different operation points. These operation points include power generation, with and without carbon capture, and methanol production. The correct ratio of carbon monoxide to hydrogen for the methanol synthesis is achieved either by means of a CO-Shift or by introducing excess electricity from renewable sources into the process via hydrogen from electrolysis. The results of the simulations are then used to assess the economics of the different operation points based on their marginal cost. The model yields the lowest specific CO_2 emissions of around 110 g/kg_{coal} in power generation mode with CCS. In methanol production mode, around 210 g/kg_{coal} are released.