High temperature ceramic heat exchanger for heat recovery in coal and biomass gasification processes

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Gasification processes for coal and biomass will be very important for future production of energy and of feedstock in organic chemistry. Thereby coal and biomass are converted into a raw gas which can be afterwards used in syntheses processes to provide material use. In this process chain there is the unsolved problem of heat extraction out of the raw gas for the following synthesis processes. This can be realized with a corrosion- and temperature-resistant high temperature heat exchanger. Due to that the waste energy can be used to augment the efficiency of the overall process. Therefore a new concept, which is shown in Fig. 1, has been developed to use this energy. It consists out of a ceramic high temperature heat exchanger, an indirectly heated gas turbine and a heat recovery boiler.

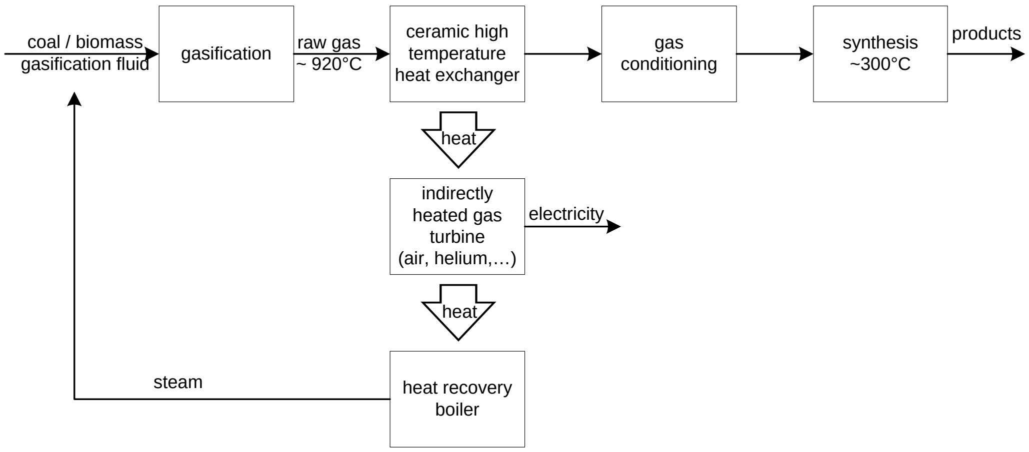

Figure 1: Concept of waste heat recovery for the material use of coal/biomass (applied for a patent).

The optimum operating point of this conception depends on the chosen type of gas turbine (closed or open cycle), the used working fluid (e.g. air or helium) and the adjustable pressure ratio of the compressor. By considering those parameters, different possible variations have been calculated and compared under ideal conditions by energy balances. In every case study the basic condition is the preparation of the total amount of steam, which is needed for the gasification process (at least 32,6 MW). Beside that up to 9,6 MW of mechanical power can be achieved at the gas turbine for a 500 MW gasifier as boundary condition. For the implementation of this concept there is a heat exchanger technology needed, which is resistant to temperatures over 900 °C and to the high corrosive atmosphere of the raw gas containing alkali components especially by using biomass. High durability under these conditions can be performed by a heat pipe heat exchanger of SiC, which has been recently built as a test rig at the TU Dresden. For this geometrically simple ceramic heat pipes with regard to the manufacturing process have been developed and tested. Sodium and zinc are used as working fluids for the targeted temperature range. After several tests of single heat pipes they will be used to validate a mathematical model of heat pipe heat exchanger performance.