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Catalytic Cracking of Gaseous Heavy Hydrocarbons by Ceramic Filters

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Objectives and Approach

The use of syngas from waste or biomass gasification to generate electricity is a way which is attracting increasing attention especially with regard to the demands of regenerable energy consumption and to the reduction of waste disposal. In order to feed the syngas to a gas motor or a gas turbine the gas has to be cleaned. In future also the coupling of biomass gasification with a fuel cell will be applied, which needs a very efficient gas cleaning. The decomposition of tars and the removal of particles from the gas are the key issues of gas cleaning. Up to now these two steps are performed in two separate units. Normally, the tars are decomposed in catalytic beds or honeycomb structures. The catalytic decomposition is achieved at temperatures between 750 °C and 900 °C depending on the catalyst used. Particles are removed by filtration of the hot gas. Filtration at high temperatures and with high efficiencies is possible when using ceramic filter elements. Ceramic hot gas filters are well established in advanced coal gasification, such as the integrated gasification combined cycle process, as well as in waste and biomass gasification and pyrolysis processes.

Since the catalytic reaction requires high temperatures the gas has to be reheated after the particles are removed in the filter or the hot unfiltered gas has to flow through the catalytic unit. If the gas is filtered first, reheating of the gas stream is an additional cost factor.

Furthermore, pipes downstream of the filter can be plugged, if the temperature of the gas falls below the condensation temperature of the heavy hydrocarbons. Using the second way of hot unfiltered gas flows through the catalytic unit, there is the problem of deactivation of the catalyst by deposition of dust at higher dust concentrations. At worst the catalytic unit can be plugged by dust deposition.

Results and Conclusions

Technically and economically the best way is the combined removal of particles and tars in a catalytic filter. Combination of dust separation and catalytic decomposition of tars in one unit considerably reduces the investment costs of a plant, since only one apparatus is necessary instead of two separate gas cleaning units. This reduces also the size of the whole plant and saves space. Furthermore, filtration as well as the catalytic reaction can be performed at a high temperature without any reheating which saves energy and additionally eliminates the risk of plugging of parts of the plant.

In this paper the development of ceramic filter elements with an integrated catalytic system for the decomposition of heavy hydrocarbons will be presented. The catalytic filters were tested for different operating conditions, such as filtration velocity, different hydrocarbons and inlet concentrations of the hydrocarbons. The advantages and possibilities of the newly developed filter elements will be shown by results obtained under oxidizing and reducing conditions.