ALTERNATIVE FUELS

(701) - INFLUENCE OF ADDITIVE SINTERING ON FINE PARTICLE FORMATION DURING BIOMASS PULVERISED-FUEL COMBUSTION

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The use of biomass as energy carrier for medium to full-scale pulverised-fuel fired Combined Heat and Power (CHP) plants will play an increasing role in future energy systems. As power demand will be met predominantly by wind and solar plants, high temperature process steam will be still produced by thermal plants. Biogenic fuels increase the share of renewable primary energy sources and decrease the emission of fossil carbon dioxide. With the use of low-quality biomass as fuel such as agricultural or forest residues ash-related challenges arise especially forming inorganic combustion aerosols in the boiler leading to high deposition rates on superheater tube surfaces. Additives such as coal fly ash and kaolin decrease the fine particle formation by capturing gaseous alkali species, predominantly potassium. For these adsorption reactions, the available surface area plays an important role.

In this study, the sintering effects of additives and the resulting performance on fine particle reduction properties of coal fly ash and kaolin as additives in a pilot scale real flame combustion test rig with a maximum thermal input of up to 200 kW is investigated. The combustion chamber has a height of four meters and an inner diameter of 70 centimeters. Eight ports with a distance of 50 cm to each other allow the access to the reactor at different heights. Initial experiments focus on understanding sintering phenomena under pulverised-fuel conditions. The sintering is investigated by injecting the additives at different reactor heights into a natural gas flame. The sintered additive particles are collected at the combustion chamber outlet. Surface area analysis by nitrogen adsorption (BET) of the collected material indicates the degree of sintering.

The fine particle reduction performance of the additives during the injection on different reactor heights into the biomass flame is assessed by an electrical low-pressure impactor (ELPI). For these experiments, woody biomass is combusted in the top-down swirl burner test rig. The burner can be adjusted vertically enabling the determination of the optimal axial distance for the additive injection by performing online measurements with the ELPI system.

The flame shape and flame stability can be evaluated by a video system and an infrared camera. The gas temperatures in the combustion chamber is measured by using a suction pyrometer (type IFRF). The fluegas composition (CO_2, CO, SO_2, NO_x) is measured at the reactor outlet. The bottom- and cyclone ash composition is analysed by XRF and ICP-OES.

Main goal of the investigation is the evaluation of the additive sintering effects and corresponding particle reduction performance. Preliminary results are promising and show that the amount of kaolin can be halved achieving similar fine particle concentrations by using the optimal injection position for the additive. This work aims to contribute to the understanding and optimize biomass combustion in CHP plants.

Palavras-chave : biomass combustion, additives, woody biomass, fine particles, swirl burner