Fuel Particle Properties In Biomass Fired Power Plants

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Introduction

In Europe and worldwide, there is an increasing need for small scale (< 20 MW_{th}) power plants which are fired with biomass and biogenic fuels preferentially for reasons of sustainability. At KIT, the combustion characteristics of such fuels is investigated in a fixed bed reactor (KLEAA). Therefrom, characteristic numbers are derived which allow to estimate the combustion behaviour on reciprocating grates. The procedure has been confirmed at a pilot scale grate (TAMARA) and model calculations have been validated by the experimental results.

Results

Both the fuel composition and the particle geometry were investigated for their relevance on the combustion behaviour and on characteristic numbers like reaction front velocity, ignition rate and mass conversion rate. The most important parameters were found to be

- the fuel moisture which slows down the combustion process; this may lead to higher operating costs
- the bulk density which is inversely proportional to the reaction front velocity; although favourable for fast combustion, the operation at low bulk density may require a large plant size and high capital costs
- while the particle shape was found to be unimportant for the combustion behaviour, the plain specific surface was found to be highly important for convective and radiative heat transfer; therefore, the fuel particle size is recommended to be kept around 20 mm or smaller.

Discussion

In addition to fast and complete combustion, the formation of undesired by-products is an important criterion for power plant operation. Waste wood and low rank biogenic fuels may contain significant amounts of alkalines, alkaline earths, halogens etc. which may give rise to the formation of bulky deposits and to corrosion. As example, **Figure 1** shows the mineralogical composition of boiler ashes during the combustion of wood chips (HHS) and two solid recovered fuels [1]. Additions of elemental sulphur were found to suppress the chlorine induced corrosion significantly.

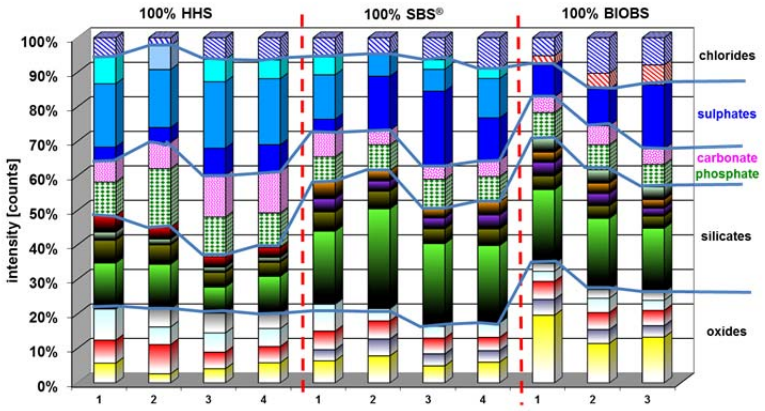

Figure 1: Composition of boiler ashes from the combustion of wood chips (HHS) and two SRF.

Conclusions and Outlook

Fixed bed experiments were used to study the combustion behaviour of several types of biogenic fuels in dependence of chemical composition and particle geometry. The results were used for the validation of model calculations and, they are applicable for the design of reciprocating grates. Studies on the formation and properties of corrosive by-products have led to the development of efficient remedies. This provides a solid basis for the development of optimized small scale power plants.

References:

[1] Pfrang-Stotz G, Bergfeldt B, Reichelt J, Gehrmann H-J, Nowak P, Seifert H; Mineralogical-chemical characterization of residues (dust, boiler ashes, filter ashes and bottom ashes) after combustion tests of Solid Recovered Fuels combined with Biomass; Sardinia 2013: 14th Int. Waste Management and Landfill Symp.; Sept. 30 - Oct. 04, S. Margherita di Pula, Italy.