Funding Programme
Biomass energy use

Enhancing the fuel flexibility of biomass furnaces

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Motivation

Slagging and fouling are major problems in solid biomass combustion. Deposition of inorganic matter on superheater tubes and boiler walls lead to down-times and prolong maintenance periods in biomass fueled power plants. While combustion of alternative biofuels offer the highest economic benefit, slagging occurs preferential due to high ash content and low melting temperatures. Thus, (co-)combustion of those residues is risky, yet potentially profitable.

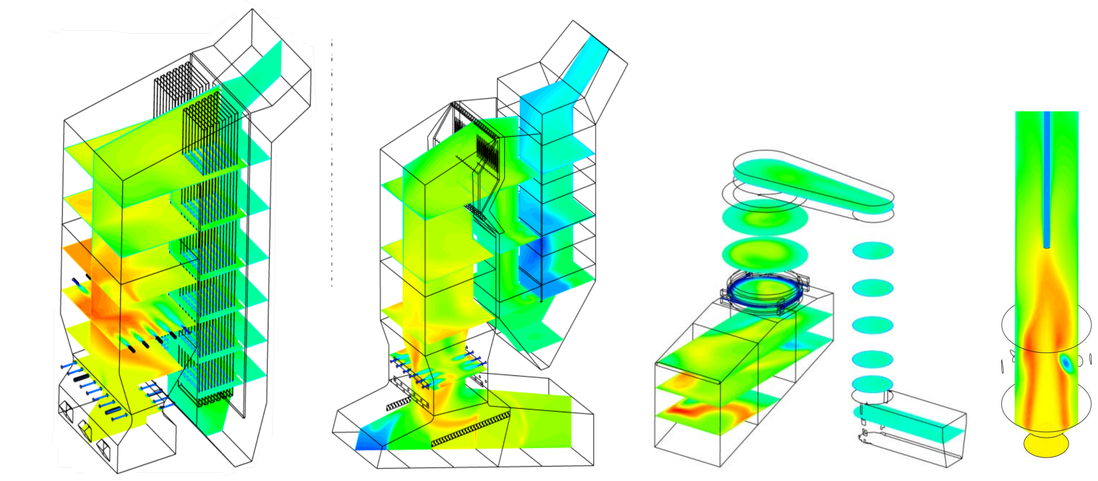

Fig. 1: Simulated gas phase-temperature in a 50 MW_{th} fluidized bed, a 25 MW_{th} grate furnace, 5 MW_{th} grate firing and the 100 kW_{th} experimental plant at FAU-EVT (*left* to *right*)

Approach

We developed a prediction tool for slagging in commercial scale biomass boilers, based on CFD simulations and verified through lab-scale experiments of biomass particle combustion. The focus lies on collision-induced deposition of molten ash particles carried away from fuel bed, thus burning in the flue gas canal. Key parameters for the occurrence of slagging are the ash melting temperature, particle residence time and – a novelty compared to existing models – fuel's fine particle fraction.

As a first step, we performed CFD simulations of gas phase combustion in four biomass furnaces in the megawatt range and a 100 kW lab scale fluidized bed combustor (fig. 1.). After validating these results, we developed a comprehensive slagging model based on thermodynamic calculations of ash melting and particle combustion behavior and implemented into a CFD solver. Figure 2 shows predicted slagging in the a grate furnace for the actual and one alternative fuel. These simulation results could be verified during power plant inspection works.

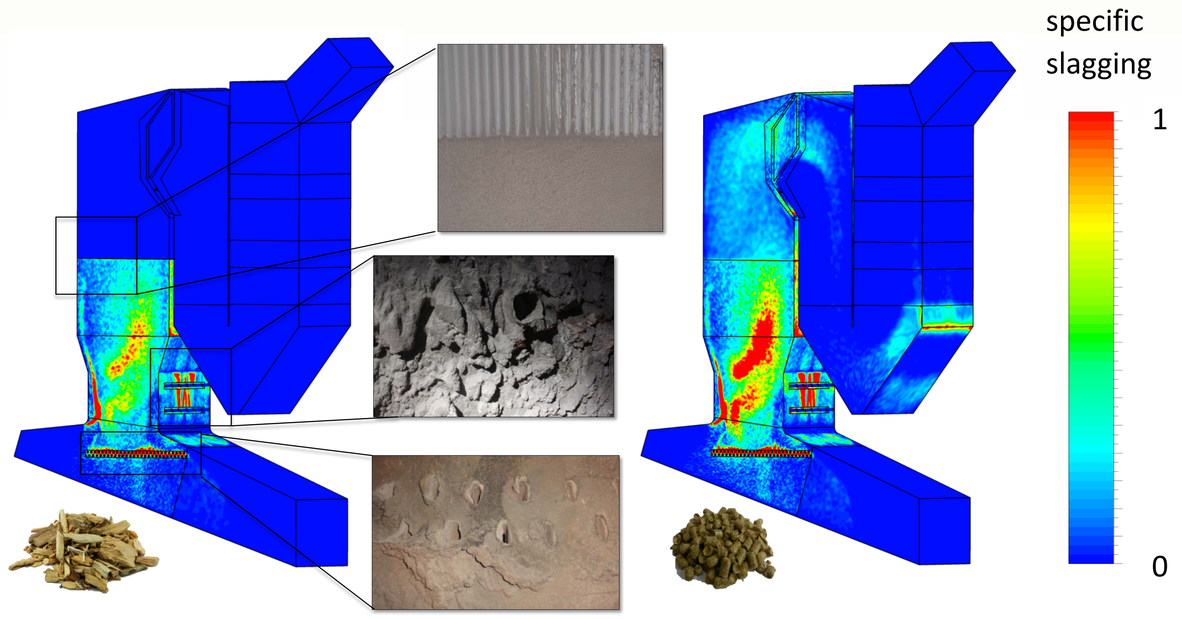

Fig. 2: simulated slagging for combustion of wood chips (*left*) and straw (*right*) in the 25 MW_{th} grate furnace and comparison to real depositions

Conclusion

We applied this model to all furnaces and aggregated the data in characteristic deposition diagrams (fig. 3), showing very similar behaviour in spite of different boiler geometries and operating conditions. These diagrams thus offer an easy and fast possibility to decide on alternative biofuels in existing plants as well as for future furnace developments.

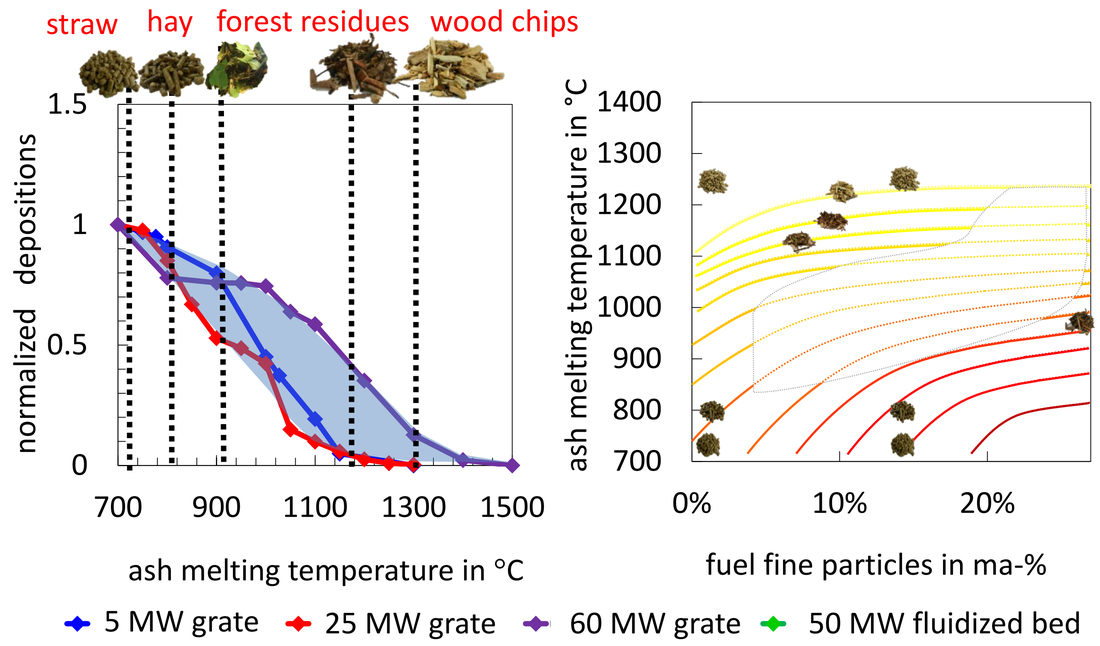

Fig. 3: exemplary characteristic deposition diagrams for various fuels in different boiler sections (*left*: grate, *right*: evaporator tube banks)

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