Deposit Shedding in Biomass-Fired Boilers: Shear Adhesion Strength Measurements

Ash deposition on boiler surfaces is a major problem encountered in biomass combustion. Timely removal of ash deposits is essential for optimal boiler operation. In order to improve the understanding of deposit shedding in boilers, this study investigates the adhesion strength of biomass ash from full-scale boilers, as well as model fly ash deposits containing KCl, K₂SO₄, CaO, CaSO₄, SiO₂, K₂CO₃, Fe₂O₃, K₂Si₄O₉, and KOH. Artificial biomass ash deposits were prepared on superheater tubes and sintered in an oven with temperatures ranging from 500 to 1000 °C. Subsequently, the deposits were sheared off by an electrically controlled arm, and the corresponding adhesion strength was measured. The effect of sintering temperature, sintering time, deposit composition, thermal shocks on the deposit, and steel type was investigated. The results reveal that the adhesion strength of ash deposits is dependent on two factors: ash melt fraction, and corrosion occurring at the deposit–tube interface. Adhesion strength increases with increasing sintering temperature, sharply increasing at the ash deformation temperature. However, sintering time, as well as the type of steel used, does not have a significant effect under the investigated conditions. Addition of compounds which increase the melt fraction of the ash deposit, typically by forming a eutectic system, increases the adhesion strength, whereas addition of inert compounds with a high melting point decreases the adhesion strength. Furthermore, the study indicated that sulfation of ash deposits leads to an increase in adhesion strength, while cooling down the deposits after sintering decreases the adhesion strength. Finally, it was observed that adhesion strength data follow a log-normal distribution.

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