Biomass Fly Ash Deposition in an Entrained Flow Reactor

Fly ash deposition on boiler surfaces is a major operational problem encountered in biomass-fired boilers. Understanding deposit formation, and developing modelling tools, will allow improvements in boiler efficiency and availability. In this study, deposit formation of a model biomass ash species (K2Si4O9) on steel tubes, was investigated in a lab-scale Entrained Flow Reactor. K2Si4O9 was injected into the reactor, to form deposits on an air-cooled probe, simulating deposit formation on superheater tubes in boilers. The influence of flue gas temperature (589 – 968°C), probe surface temperature (300 – 550°C), flue gas velocity (0.7 – 3.5m/s), fly ash flux (10,000 – 40,000g/m²h), and probe residence time (up to 60min) was investigated. The results revealed that increasing flue gas temperature and probe surface temperature increased the sticking probability of the fly ash particles, thereby increasing the rate of deposit formation. However, increasing flue gas velocity resulted in a decrease in the deposit formation rate, due to increased particle rebound. Furthermore, the deposit formation rate increased with probe residence time and fly ash flux. Inertial impaction was the primary mechanism of deposit formation, forming deposits only on the upstream side of the steel tube. A mechanistic model was developed for predicting deposit formation in the reactor. Deposit formation by thermophoresis and inertial impaction was incorporated into the model, and the sticking probability of the ash particles was estimated by accounting for energy dissipation due to particle deformation. The model reasonably predicted the influence of flue gas temperature and fly ash flux on the deposit formation rate.

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