CCSD Communiqué

FACTSHEET :

COAL EFFECTS ON BED AGGLOMERATION IN PFBC

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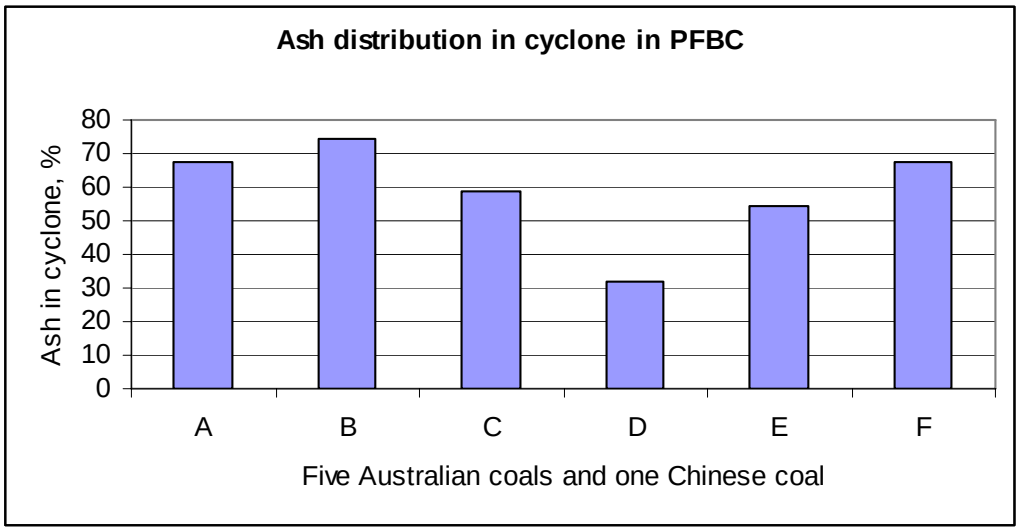
The problem of bed agglomeration has occurred with some Australian black coals in industrial Pressurised Fluidised Bed Combustion (PFBC) in Japanese power plants. This problem was identified as being coal-specific and could significantly limit the operation of the plant. Coal ash is known to leave the combustor either as smaller particles of fly ash in the exit gas stream or as larger particles of bed ash with the bed material drain. Jiangang Xu's PhD thesis from Project 3.3 studied 2 coal-specific factors that could affect bed agglomeration:

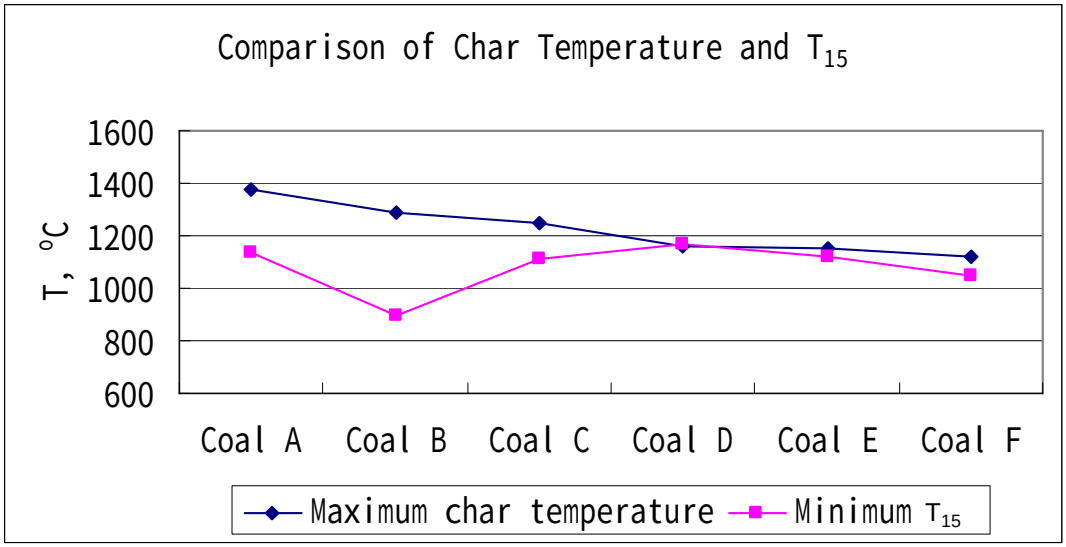
1. The distribution of coal ash and ash components between bed ash and fly ash and the ash formation process under PFBC conditions, and
2. The temperature at which char particles burn in PFBC.

For 5 selected Australian coals and one competitor Chinese coal (coal F), significant differences in the distribution of coal ash between bed ash and fly ash were found. The different distributions of coal ash were explained by the formation of an ash layer on the external surface of some char particles as a result of ash coalescence during the char combustion process, eventually leading to the formation of large ash particles which were too heavy to be elutriated from the bed and therefore reported to the bed ash. The coal ash distribution and ash layer formation on char correlated with the ash content of the coal and the mineral particle size in the coal. The formation of a sticky ash layer on the external char surface would facilitate the hollow-egg type of bed agglomeration reported from industrial PFBC operation.



The ash component distributions between fly ash and bed ash were also different for each coal. It was argued that the layer of coal ash formed on bed particles would have a similar composition to fly ash, since the larger bed ash particles were much less likely to remain attached to bed particles after collisions. The temperatures at which the fly ash layer would become sticky were predicted from thermodynamic analyses using FactSage and differed for the different coals. T_{15} was defined as the temperature at which 15% of the ash would become liquid (calculated for the fly ash mixed with varying amounts of bed material, limestone). The minimum value for T_{15} was determined for each of the 5 coals. However, these temperatures did not correlate with reported bed agglomeration propensities for different coals in industrial PFBC.

A char temperature model was developed to predict char temperature in industrial PFBC, and was validated in both AFBC and PFBC conditions. This mathematical model was used to predict the maximum char particle temperature under industrial PFBC conditions, using measured char properties for the 5 coals. The difference between the maximum char temperature and the minimum T_{15} for each coal was found to correlate with the tendency towards bed material agglomeration in industrial PFBC burning different coals.



Therefore to ameliorate the potential problem of bed agglomeration in PFBC, both char properties and ash properties should be considered during the coal selection process. Consideration of the fly ash composition or char temperature alone should not be used, since both need to be considered together to correctly predict the propensity for bed agglomeration with different coals.