

Correlation Between the Critical Viscosity and Ash Fusion Temperatures of Coal Gasifier Ashes

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Coal gasification yields synthesis gas, an important intermediate in bulk chemical manufacturing. It is also vital to the production of liquid transportation fuels through the Fischer-Tropsch process and electricity in Integrated Gasification-Combined Cycle power generation. Minerals naturally present in the coal become molten in entrained flow slagging gasifiers. Molten coal ash slag penetrates and dissolves refractory bricks, which leads to costly plant shutdowns. The extent of coal ash slag penetration and refractory brick dissolution are functions of the slag viscosity, operating temperature, and the composition of the coal ash and refractory bricks. We measured the viscosity of several synthetic coal ash slags with a high-temperature rotary viscometer and their fusion temperatures through optical image analysis of ash cones placed in a tube furnace. All measurements were made in a carbon monoxide-carbon dioxide reducing atmosphere. Samples were analyzed using scanning electron microscopy and x-ray analysis to verify their composition and to identify phases that are present. Thermodynamic phase-transition models were used to calculate the critical viscosity temperature based on the coal ash compositions. These values were then compared with those obtained from empirical correlation models based on ash fusion temperatures. An understanding of slag viscosity as a function of ash composition is important to reducing refractory wear in slagging coal gasifiers, an important step in reducing the economic and environmental cost of coal in the production of chemicals and electricity.