Use of Petrography as a Surrogate of Coal Reaction Kinetics Behavior.

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ABSTRACT

Many power producers are retrofitting their boilers with low-NOx firing systems to comply with the regulations of Title I of the 1990 Clean Air Act Amendment (CAAA). It is important to understand what impact changes to the firing regime can have on operational performance when retrofitting low-NOx burner systems. One critical area is the potential for an increase in the unburned carbon content (UBC) in boiler fly ash. Suppliers of low-NOx firing systems are often required to guarantee the performance of their low NOx systems, with respect to both emissions and UBC.

The generation of detailed coal/char kinetic data is currently required to predict combustion performance; this analysis is costly and time consuming. Attempts to correlate information from the parent coal's ASTM analyses with UBC performance have not proven to be a reliable prediction method, for the accuracy required. Application of a method that uses a fundamental coal property analytical technique, such as coal petrography, to extrapolate from current kinetics databases could be a very cost-effective means of expanding predictive capabilities.

Coal petrography has typically been used to tailor coal blends for coke making purposes. Work by Pennsylvania State University, Brown University, and ALSTOM's Power Plant Laboratories indicates that coal petrography may lend itself as a tool for evaluating the combustion kinetic behavior of coals and coal blends for the power industry. It is postulated that following the disposition of reactive and inert macerals during the combustion process could provide an effective indicator of the kinetic behavior of the parent coal and coal blends. Petrography may prove to be a simple and inexpensive method of obtaining the necessary fundamental properties. This information could be used to supplement the ASTM data and therefore enable more rapid generation of UBC predictions.

Several coals, ranging in rank from subbituminous PRB to medium volatile bituminous, and coal blends were evaluated in this study. Each coal and coal blend was fully characterized both for its petrographic and ASTM properties. ALSTOM's Drop Tube Furnace System-1 and TGA (Thermo-Gravimetric Analysis) apparatus were the principal equipment for measuring the coal/char reactivity parameters. The experimental variables in this evaluation were coal nature, temperature/time history, and stoichiometry. Resulting solid and gaseous emissions from the combustion testing were correlated with known petrographic and ASTM fuel properties.

The impact of combustion extent on the morphological, physical, chemical, petrographic, and reactivity characteristic of the residual carbon was also examined. Advanced equipment such as CCSEM (Computer Controlled Scanning Electron Microscopy) apparatus was used to measure the morphological and physical characteristics of coals and residual carbons. This information is important for understanding the relative degree of deactivation a char particle may exhibit during staged combustion. The resulting chemical, petrographic, and kinetic properties of the char were correlated with the parent fuel's petrographic and ASTM fuel properties.

The bench-scale data derived from some of the parent coals and resulting chars were compared with UBC emissions from several commercial field units and ALSTOM's 15MWth Boiler Simulation Facility. The resulting trends indicate that with further development, coal petrography may be a valuable tool to the power industry for predicting performance of various coals in boiler applications.