

Reactions of Calcium During Coal Combustion

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ABSTRACT

Calcium is one of the most abundant elements found in low rank coals and it occurs in significant amounts in many bituminous coals. It can play a major role in ash fouling and slagging processes that result in reduced boiler efficiency during combustion. The form of occurrence of calcium in the parent coal and its interaction with other mineral matter and with gaseous components during combustion have a major influence on the forms of calcium in the resulting combustion ash. This, in turn, has important ramifications regarding fouling and slagging processes and regarding the utilization of ash in cement and concrete. This paper presents a comparative investigation of the behavior of different forms of calcium during pulverized combustion of several low-rank and bituminous coals. The principal analytical methods used in the investigation were computer-controlled scanning electron microscopy (CCSEM) and x-ray absorption fine structure (XAFS) spectroscopy. The reaction of calcium with clay minerals, SO_2 , and volatile sodium is presented in the form of binary, ternary, and volume percent - ternary diagrams and particle size distributions (PSD) derived from the CCSEM analysis of the ash. It is shown that the composition and PSD of Ca-aluminosilicate glassy ash particles reflect the forms of occurrence of calcium in the coals. Alternatively, calcium may react with SO_2 and volatile sodium to form Ca-Na-sulfates. Combustion tests on Beulah lignite were carried out in furnaces of several different sizes (drop tube, combustion rig, and pilot scale). The comparative CCSEM analyses of the ash indicate that the scale of the facility is of secondary importance in determining the fate of calcium to its form of occurrence of in the coal and combustion conditions.