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EFFECT OF COAL PROPERTIES AND PROCESSING CONDITIONS ON THE REACTIVITY OF METALLURGICAL COKES

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ABSTRACT

The reactivity of coke to CO_2 at high temperatures influences the energy efficiency and productivity of the blast furnace. Coal properties such as rank, ash chemistry, petrography, and thermal rheology have been related to coke reactivity. Also, coal processing variables during coke manufacture such as length of storage, heating rates, and final temperature have been related to coke reactivity. Generally, for coals from all geographical areas, ash chemistry is found to exert a dominant effect on coke reactivity. Those with high contents of Si and Al produce low reactivity cokes whereas those with large amounts of Ca, Mg, Fe, Na, and K produce high reactivity cokes.

This study examines the mineral forms in which elements appear in coal and the effect upon coke reactivity. Minerals commonly found in coal (and some other chemicals) were added to one steel plant coal blend before carbonization in a pilot coke oven. This circumvented problems associated with comparing coals from different geographical locations, having different minerals but also having different rank, petrographic composition, thermal rheology, etc. Additions were kept low (usually 1%) so as not to change significantly the physical properties of the coke made. Adding kaolin, quartz, plagioclase, orthoclase, muscovite, bauxite, rutile, apatite, gypsum, calcite, aluminum oxide magnesium oxide, lime, pyrite, siderite, hematite, magnetite, and sulphur caused coke reactivity to change (from 0 to 100%) relative to that of the base blend. The different mineral forms of iron and calcium were particularly critical to changes observed in coke reactivity, microtextures, and coal thermal rheology.

Processing variables also affect coke properties. Coal storage was found to markedly increase reactivity. Coal rheology decreased during storage but other physical properties of the coke remained unchanged. Coke reactivity from a second steel plant coal blend was found to decrease with an increase in coal bulk density during processing and also with increases in coking rate and final processing temperature. However, changes are relatively small with the range of conditions normally used for the production of blast furnace coke. More significant increases in reactivity occur when long coking times are used such as those employed for making foundry coke. This changes coke anisotropy to smaller units and the mean size of the pores, as measured by optical microscopy and image analysis.