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Chemical and physical structural studies on two inertinite-rich lump coals.

Malumbazo, Nandi

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ABSTRACT

Two Highveld inertinite-rich lump coals were utilized as feed coal samples in order to study their physical, chemical structural and petrographic variations during heat treatment in a packed-bed reactor unit combustor.

The two feed lump coals were selected as it is claimed that Coal B converts at a slower rate in a commercial coal conversion process when compared to Coal A. The reason for this requires detailed investigation.

Chemical structural variations were determined by proximate and coal char CO_2 reactivity analysis. Physical structural variations were determined by FTIR, BET adsorption methods, XRD and ^{13}C Solid state NMR analysis. Carbon particle type analysis was conducted to determine the petrographic constituents of the reactor generated samples, their maceral associations (microlithotype), and char morphology. This analysis was undertaken with the intention of tracking the carbon conversion and char formation and consumption behaviour of the two coal samples within the reactor.

Proximate analysis revealed that Coal A released 10 % more of its volatile matter through the reactor compared to Coal B. Unburnt carbon in the ash bed zone was observed for both coal samples (Coal A and B), and it was attributed to incomplete carbon conversion. Coal char CO_2 reactivity analysis showed that indeed Coal A is more reactive than Coal B.

ABSTRACT

Qualitative FTIR analysis showed that both coals follow similar trends when exposed to high temperatures. Coal structural characterization revealed that Coal A has higher surface area when compared to Coal B. XRD analysis revealed that Coal A has less aromatic crystallites and lower Lc values compared to Coal B. It was observed that the coal structural properties of Coal A became more ordered and aligned at lower temperatures (289 ^{0}C), whereas Coal B starts at higher temperatures (693 ^{0}C). ^{13}C Solid state NMR results showed that Coal B is more aromatic than Coal A implying that it is difficult to gasify/combust Coal B. Petrography analysis showed that Coal A has 34.6 vol % reactive macerals of which 78 % is from liptinite and vitrinite contents. Coal B has 53.6 vol % of reactive macerals of which 49 % was from liptinite and vitrinite, the other 51 % is from reactive semifusinite and inertodetrinite. The 49/51 split between reactive maceral value for Coal B may explain the lower reactivity compared to Coal A. Coal B appeared to produce more inert char particles, ran at higher temperatures in the ash bed because of its aromatic richness than Coal A. This was also attributed to the fact that Coal B has higher inertinite content than Coal A. The allocation of parent coal samples to "reactive" and "inert" macerals gave more in depth results that were able to show a possible reason behind reactivity difference occurring during the coal conversion process and support the structural analysis results obtained for these parent coal samples. The reactivity difference of these parent lump coal samples appears to be greatly influenced by the chemical reactions (structure) of these samples more than the kinetic reactions (pressure, temperature, reaction rates etc.) of these samples.