ABSTRACT

This study seeks to explore the behaviour of several different South African bituminous coals currently used as feed in local power stations and to establish their technical performance and structural changes in a fluidised bed gasifier. It is anticipated that this would also assist in optimising gasifier operations for the gasification of fine high ash coals for power generation. The research was conducted by correlating the gasification performance of the selected coals and their derived chars against a range of chemical, physical and optical characteristics including mineral and maceral (and specifically inertinite) contents after testing in a pilot scale fluidised bed gasifier. Of specific interest were the changes in chemical microstructures during the transformation of the various coal macerals to their relevant chars following gasification. Raman spectroscopy and XRD analyses were used to examine the chemical carbon structures and the minerals associated in the coal. The relationship between the organic components and their gasified products (macerals-to-char) and the inorganic components to their gasified products (minerals-to-ash) including their physical structure and behaviour was determined by petrographic analysis.

A higher loss of coal reactivity was obtained from vitrinites-rich coals due to a higher degree of structural transformation of carbon in the coal. Inertinite-rich coals experienced a lower loss of coal reactivity and lower degree of structural transformation even with longer residence time. The structural transformation of the macerals is due to realignment of the carbon molecules leading to substantial swelling (enhanced plasticity) in some macerals. Further modification was found to be due to proximity to melted minerals. Furthermore, the gasification performance of low grade coals can be optimised by varying the oxygen content used for coal gasification.