

ABSTRACT

The need for the research into the tribo-electrostatic separation of South African high ash coal had increased significantly due to the depletion in the reserves of high grade coal, increase in SO_x and NO_x generation of low grade coal and increase in the South African power utility's coal burn rate. Wet coal beneficiation techniques have been reported for the beneficiation of South African fine coal, no info is available on dry beneficiation of South African coal using tribo-electrostatic technique. Hence, the dry coal beneficiation method which serves as an alternative approach to wet coal cleaning processes must be studied, importantly, for the coal producing countries such as South Africa (SA) where fresh water is scarce and precious.

This research presents an experimental study of rotary tribo-electrostatic separation (RTS) as an alternative approach for beneficiating steam coal mainly used in South African power plants. An RTS with an octagonal charger has been used in beneficiating eight types of South African coals with a feed coal ranging between 22% and 40% ash content. The cleaning potential of the coal samples was first evaluated using sink/float and kinetic froth flotation test with the $-177\text{ }\mu\text{m}$ coal fraction and then using the rotary tribo-electrostatic separation in one and two stages. The RTS tests were conducted under different system parameters such as, applied charger potential, applied separating voltage, air injection velocity, particle feed rate, rotation speed of the copper plated rotor and splitter distances were investigated for their effects on the separation performance.

The two stage separation results with the $-177\text{ }\mu\text{m}$ size fraction show the RTS reduced Majuba coal containing about 30.10% ash to a clean product of 14.30% and 19.46% ash at a combustible

matter of 15.10% and 53.02%, respectively. The calorific value for the feed coal was increased from 20.15 MJ/Kg to 27.48MJ/Kg with combustible matter of 11.10% after the second stage of separation while the single stage separation produced a clean coal product with 25.67 MJ/Kg, 16.10% ash and 29.23% combustible matter for Majuba coal. The RTS process reduced the ash content of the -177 μm coal fraction by nearly 14.92% for the Klipfontein coal and 12.21% for the Liketh Townlands coal, with corresponding combustible matter values of 10.73% and 8.90%, respectively. Total sulphur content was also reduced from 2.10% to 0.92% for the Klipfontein coal and from 2.81% to 0.40% for the Liketh Townlands coal at corresponding combustible recovery values of 5.74% and 8.90%, respectively.

Under the same operating condition, one stage of RTS separation produced a clean coal product with 14.80% ash at a combustible recovery of 28.24% from a coal feed with 22.12% ash for the Koorfontein coal. Cleaner coal of about 14.50% ash and 17.43% combustible matter was obtained at 0.6 cm away from the negative electrode, and 15.72% ash with 28.12% combustible matter at splitter position of 1.0 cm away from the negative electrode. The total Power loss model (P_t) was used to analyze the experimental data for the energy consumption or required for octagonal rotary charger at a surface tangential speed of 2500 rpm. The X-ray diffraction analysis of the feed, single and second stage coal products confirmed a reduction in the mineral content with an improvement in the organic composition for all coal samples.

The studies showed that rotary tribo-electrostatic separation (RTS) technique can be applied for effective dry coal cleaning of South African coal.