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# Beneficiating high ash coal using wind sifter

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## ABSTRACT

The concept of wind sifting for particle separation has been successfully implemented for various concentration purposes. Separators of diverse configuration have been fabricated for many decades based on this principle in various fields such as the food and furniture industries, waste management (sorting municipal solid wastes) to name a few. The wind-sifter principle is very effective for particle separation as it is based on the separation of lighter particles from heavier ones. This present study entails an investigation using a computer simulation technique, with the aid of the Lagrangian particle tracking method to observe the effectiveness of wind-sifter principle in the designing and fabrication of a dry separator. This present study details the novel application of the principle in designing and fabricating the wind sifter separator for dry coal beneficiation.

The separator was designed with the aid of Autodesk Inventor, and simulated using Star-CCM+$^{TM}$. The simualtion tests were performed for different particle sizes (-6.7 mm + 3.36 mm), (-3.36 mm + 1 mm) and (-1 mm), at different feed rates and air velocities. The simulation test results show that at a cut-point of 1.5 RD, a yield of 29.1%, 54.3% and 99.4% were attained at different optimum velocities for -6.7+3.36 mm, -3.36+1 mm and -1 mm particle size fraction, respectively. The optimal velocities for this study at a cut point of 1.6 g/cm$^3$ were 6.0 m/sec, 4.2 m/sec and 1.7 m/sec for the -6.7 + 3.36 mm, -3.36 + 1 mm and -1 mm, respectively. It was also observed from the simulation test that the size and particle density play a significant role in the separation process. To that effect, the designed separator showed great flexibility to cut at any desired relative density.

A laboratory scale wind sifter separator was fabricated based on the results from the simulation test, which served as the first applied prototype in the field of dry coal beneficiation. It was observed from both the experimental and simulation studies that most of the material feed were recovered for all particle sizes from the 4$^{th}$ and the 6$^{th}$ bin of chamber 1 and 2, respectively. The major reason for this constraint was finding an appropriate air jet angle into the first chamber, whilst maintaining adequate sifting of the incoming air to transport the lighter particles. The study had shown that with a proper air jet angle, particles can settle in their designated bins, as they achieved their terminal/settling velocities based on their size and density. It was also observed that the cumulative yield (%) from the experimental test for all fractions were higher when compared

to the simulation. This was because of the assumption made during the initial design that all the particles are perfectly spherical. A clean coal product of 16.75% ash and 27 MJ/kg was producedfrom a feed coal of about 31% ash content and calorific value of 21 MJ/kg dry (adb) using this separator. A novel wind-sifter separator based on the results obtained from the simulation test has been fabricated with its schematic provided in this dissertation.