Abstract

In the present investigation, a microwave oven is designed and few modifications fabricated to study the effect of microwave pre-treatment on coal and mineral such as, iron ore and bauxite ore at 900 W power and 2.45 GHz. The investigation has two distinct parts; the first part describes the detailed coal and mineral characterization, their beneficiation, comminution and slurry rheology characterization using microwave pre-treatment under various operating conditions. The second part deals with the establishment of optimum values for different critical process parameters to improve the viscosity of solid-liquid suspension. The beneficiation study of coal indicated reduction in ash content by an average of 2.5% and 4% for float and sink, respectively. An increase in HGI up to 9% was achieved for coal. A substantial decrease in the work index of 15.4% was obtained at an increase in microwave exposure time of 120 s. The specific rate of breakage of coal increased by an average of 55% and, of iron ore and bauxite ore increased more than 100% significantly as a result of microwave pre-treatment. All values for n for all slurries deviated from one, indicating shear-thinning or pseudo-plastic behavior. The value of n varies from 0.31-0.64, 0.42-0.82 and 0.41-0.67; k varies from 0.16-0.82, 0.16-1.20 and 0.23-1.01 $Pa{\cdot}s^n$ for coal, iron ore and bauxite ore slurry, respectively. The predicted optimum conditions for coal-water slurry were: particle diameter 194.33 µm, solid concentration 38.05 %, microwave exposure time 56.14 s and shear rate 131.97 s^{-1}; under these conditions the apparent viscosity was 22.83 mPa·s, for iron ore-water slurry were: particle diameter 122.32 µm, solid concentration 30.91 %, microwave exposure time 90 s and shear rate 413.78 s^{-1}; under these conditions the apparent viscosity was 21.31 mPa·s, for bauxite ore-water slurry were: particle diameter 201.98 µm, solid concentration 29.40 %, microwave exposure time 87.02 s and shear rate 133.17 s^{-1}; under these conditions the apparent viscosity was 43.18 mPa·s. Mathematical models have been developed and subsequently these model predictions are validated against experimental results. The results obtained are found to have good agreement with the experimental values. The apparent viscosity values predicted by ANN model were found more close to the experimental data as compared to RSM model.

Keywords: Beneficiation of coal; Coal technology; Coal cleaning; Coal; Iron ore; Bauxite ore; Microwave pre-treatment; Grindability; Specific breakage rate; Slurry rheology; Viscosity