Triboelectric Separation of Fine Coal Using an Electric Field Fluidized Bed

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Background

- Significant role of coal in China
- Bring about environmental problems
- Clean Coal Technology
- Conventional vs. Dry method
- Triboelectric Separation by fluidized-bed

Fig.1 Energy consumption in China (2017 & 2018)

Fig.2 Environmental problems in China
Testing system

Fig. 3 Working principle

a) Without electric field
b) With applied electric field

Fig. 4 Experimental setup

1-Roots blower  2-Air tank  3- Flowmeter  4-Fluidized bed
5-High voltage plate (positive)  6-High voltage plate (negative)
7-Windpipe  8-Air distributor
9-Air distributor plate 10- Electrode plate 11-Cover board
Experimental

Materials

1. Raw coal ash content, 15.61%
2. Low ash coal + quartz (3:1, wt%)

Operating condition experiments

1. High voltage
2. Gas velocity
3. Fluidization time

Charging property test

Fig. 5 Charging property test system

Enrichment of raw coal

Fig. 6 Diagram of product collector
Results & discussion

Charging property

Particle size of 45-74 μm gains larger tribocharging.

High voltage

Increasing voltage results in better separation effect.

Fig. 7 Quartz with different size charging with coal

Fig. 8 Separating coal-quartz mixture at different high voltages
(gas velocity: 16.53 cm/s; Fluidization time: 30 min)
Results & discussion

Higher gas velocity leads to better separation result.

No visible separation difference after 15 min.

Fig. 9 Separating coal-quartz mixture with different gas velocities
(high voltage: 60 kV; Fluidization time: 30 min)

Fig. 10 Separating coal-quartz mixture at different fluidization time
(gas velocity: 16.53 cm/s; high voltage: 60 kV)
It is feasible to remove minerals from coal using fluidized bed with applied electrical field. Ash content can reduce from 15.61% to 7.29%. More than a quarter of yields were high ash content products.

Fig. 11 Separating raw coal using fluidized bed with applied electric field
Conclusions

(1) Tribocharging quartz with coal: Quartz can easily be given a negative charge; it should be easy to give coal a positive charge.

(2) A novel device that integrating fluidized bed and high voltage plate was proposed to separate coal from its gangue minerals.

(3) The conditions of 60 kV voltage, 16.53 cm/s gas velocity and 15 min fluidization time were found to be feasible operating parameters for separating coal-quartz mixture.

(4) Ash content could be reduced from 15.61% to 7.29%, and more than a quarter of yields were high ash content products.
In situ method to quantitatively characterize the triboelectrification at nanoscale via a combination of atomic force microscopy (AFM) and Kevin probe force microscopy (KPFM).
Thanks for your attention