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Short Communication

Cleaning of Dulmial-Punjab Coal by Froth Flotation

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Abstract. This study was undertaken to assess the cleaning potential of Dulmial-Punjab coal by froth flotation. Release analysis was performed to determine the optimum flotation response of the coal. Number of batch flotation tests were performed to investigate the effects of various parameters such as particle size, impeller speed, collector dosage, frother dosage and conditioning time on clean coal yield and ash content. It was found that maximum yield of 51.25% with 39.5% ash content was achieved at impeller speed, collector dosage, frother dosage and conditioning time of 1600 RPM, 1200 g/t, 200 g/t and 10 min, respectively.

Keywords: froth flotation, release analysis, Dulmial-Punjab coal

In recent years, froth flotation has been investigated extensively with major focus on studying the effects of various operation and design parameters on product yield and recovery (Cheng *et al*., 2016; Liao *et al*., 2016; Patil *et al*., 2010; Mondal and Mohanty, 2009; Jena *et al*., 2008; Dell, 1964). Various parameters such as solid percentage, impeller speed, air flow rate, particle size, collector type and dosage, frother type and dosage, pH of coal slurry and conditioning time affect the flotation process (Xia *et al*., 2016; Oney *et al*., 2015; Chaudhuri *et al*., 2014; Gui *et al*., 2013; Cheng *et al*., 2013; Jena *et al*., 2008; Dey and Bhattacharya, 2007; Jia *et al*., 2002).

In this study, the floatability of Dulmial-Punjab coal was assessed by Dell release analysis and the effects of various flotation parameters such as coal particle size, impeller speed, collector and frother dosage, and conditioning time were investigated. The gross sample was crushed and divided into four quarters by coning and quartering. One quarter was further crushed and divided into two parts. One part was prepared according to ASTM standards (ASTM, 2004) to perform proximate analysis and the results are tabulated in Table 1.

The other part was ground to -0.50 mm and sieve analysis was performed on it. The distribution of ash in various size fractions along with their weight percentages are given in Table 2. The lowest fractions with smallest particle size (-0.074+0.044 and -0.044 mm) and the coarsest fraction (-0.500+0.250 mm) contained the highest amount of ash. The remaining intermediate fractions contained relatively lower amounts of ash.

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Table 1. Proximate analysis of coal

Characteristic	Value
Moisture content (%)	2.6
Ash content (%)	47.6
Volatile matter (%)	22.4
Fixed carbon (%)	27.4

Table 2. Sieve analysis and ash tests results on each size fraction

Size fraction (mm)	Weight (%)	Ash content (%)
-0.500+0.250	30.70	48.1
-0.250+0.177	10.57	43.5
-0.177+0.105	11.31	45.3
-0.105+0.074	11.65	44.7
-0.074+0.044	27.63	49.5
-0.044	8.14	52.1

Release analysis was performed on -0.250 mm sample in Denver flotation cell. Kerosene oil was used as collector and methyl iso-butyl carbinol (MIBC) was used as frother. The release curve of Dulmial coal is shown in Fig. 1. It is clear from the curve that the coal has poor floatability. Theoretically 60% coal can be floated with clean coal ash of approximately 36%.

The batch flotation tests were conducted in Denver flotation cell. A 10% feed slurry was used and mixed for 5 min before addition of collector. Kerosene oil and methyl iso-butyl carbinol (MIBC) were used as collector and frother, respectively.

The effect of particle size on clean coal yield and ash was investigated by performing flotation tests on the following size fractions; -0.250+0.177, -0.177+0.105, -0.105+0.074, -0.074+0.044 and -0.044 mm. The results of these tests are shown in Fig. 2. Both clean coal yield and clean coal ash showed a decreasing trend with increasing particle size. The maximum yield of 72.61% was obtained at the smallest particle size e.g. -0.044 mm.

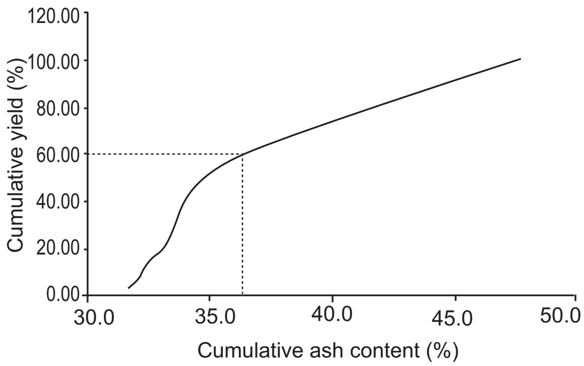

Fig. 1. Release curve for -0.250 mm particles of Dulmial coal.

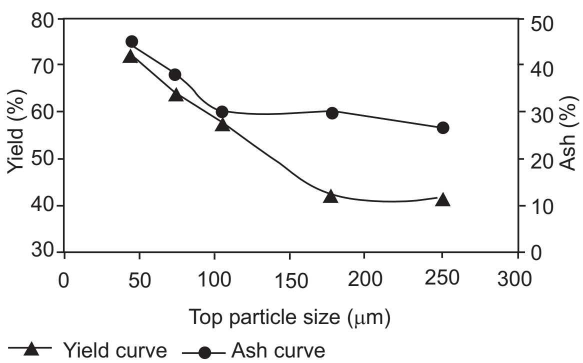

Fig. 2. Effect of particle size on concentrate yield and ash content (Impeller speed, 1200; pH, 7.3; collector dosage, 1000 g/t; frother dosage, 400 g/t; conditioning time, 2 min).

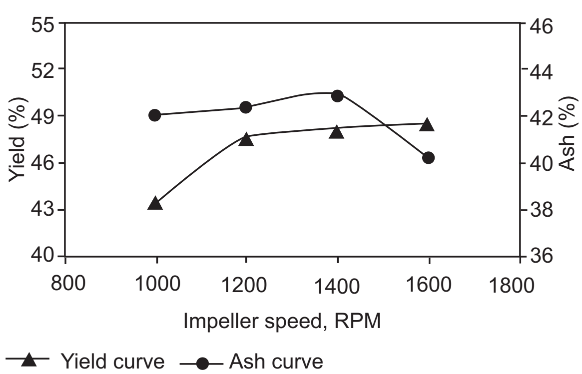

Fig. 3. Effect of impeller speed on clean coal yield and ash (particle size, -0.250 mm; pH, 7.3; collector dosage, 1000 g/t; frother dosage, 400 g/t; conditioning time, 2 min).

Minimum clean coal ash of 26.9% was obtained for particle size range of -0.250+0.177 mm with yield of 41.40 %.

The impeller speed was varied from 1000 to 1600 rpm. The effect of impeller speed on clean coal yield and ash is given in Fig. 3. High agitation rate increased the yield. The clean coal ash was increased first and then decreased. Maximum yield of 48.6% was achieved at 1600 rpm. The clean coal ash was minimum at this rpm which was 40.3%. This optimum rpm was set for next sets of flotation tests.

The collector dosage was varied from 400 to 1600 g/t. The effect of collector dosage on the concentrate yield and ash is shown in Fig. 4. The concentrate yield was increased initially and then decreased. The ash contents were decreased by increasing the collector dosage and then slightly increased by further increase in collector quantity. The optimum collector dosage was 1200 g/t at which the clean coal yield and ash were 50.63% and 39.4%, respectively.

The results of tests performed with variation in frother dosage are shown in Fig. 5. The frother dosage was varied from 200 to 800 g/t. Both clean coal yield and ash contents were increased initially and reached maximum at frother dosage of 600 g/t resulting in 52.08% clean coal yield with 42.2% ash. After this point, a decrease in trend was observed. The effect of frother dosage was more pronounced on ash contents than clean coal yield. The optimum frother dosage was 200 g/t at which the ash contents were found minimum e.g. 40.3% with a concentrate yield of 50.42%.

The effect of conditioning time on clean coal yield and ash are depicted in Fig. 6. The clean coal yield was increased

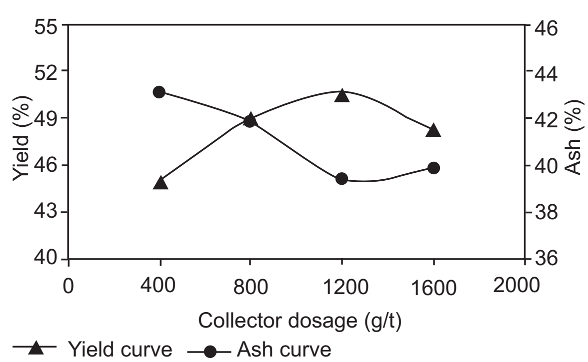

Fig. 4. Effect of collector dosage on clean coal yield and ash (particle size, -0.250 mm; pH, 7.3; rpm, 1600; frother dosage, 400 g/t; conditioning time, 2 min).

by increasing conditioning period. Maximum yield of 51.25% was achieved with 10 min conditioning. It was found that conditioning time did not impart a substantial effect on clean coal ash. Only slight variation was observed in clean coal ash with minimum of 39.5% at 10 min conditioning time.

It was concluded that maximum clean coal yield of 51.25% with ash content of 39.4% was found at 1600 rpm, 1200 g/t collector dosage, 200 g/t frother dosage with 10 min conditioning for particles less than 0.250 mm.

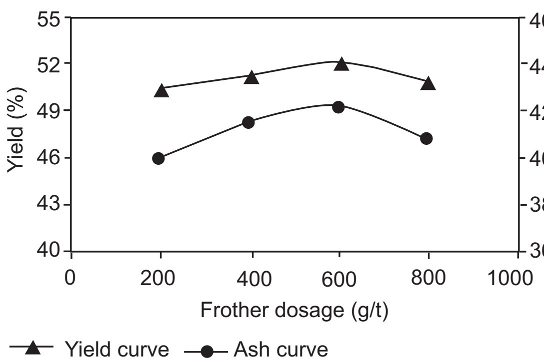

Fig. 5. Effect of frother dosage on clean coal yield and ash (particle size, -0.250 mm; pH, 7.3; rpm, 1600; collector dosage, 1200 g/t; conditioning time, 2 min).

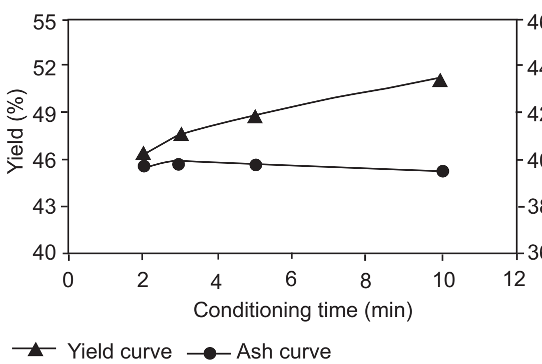

Fig. 6. Effect of conditioning time on clean coal yield and ash (particle size, -0.250 mm; pH, 7.3; rpm, 1600; collector dosage, 1200 g/t; frother dosage, 200 g/t).

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