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Short Communication

Cleaning of Dalwal-Punjab Coal by Using Shaking Table

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Abstract. The aim of this research is to evaluate the cleaning amenability of Dalwal-Punjab coal by using tabling technique. Total eighteen tabling tests were performed on two size fractions; 3.327 × 1.168 and 1.168 × 0.295 mm. The effects of table tilt (0 to 10 mm/m) and water flow rate (14 to 36 l/min) on clean coal yield and ash were investigated. It was found that both clean coal yield and ash were increased with increasing table tilt and water flow rate.

Keywords: Dalwal coal, shaking table, coal cleaning, gravity concentration

Gravity separation methods being cheaper and simple in operation are commonly used worldwide for cleaning various size ranges of coal (Shahzad *et al*., 2015). Shaking table is one of the most versatile gravity concentration device and is found in most types of gravity concentration plants (Lee *et al*., 2012). Tables are characterised by low power consumption and low costs of operation, installation and maintenance but suffer with disadvantages of low capacity and occupying more floor space (Sivamohan and Forssberg, 1985). The probable error of shaking table is less as compared to spiral and water only cyclone, which makes it relatively more efficient separation technique (Gupta and Yan, 2006; Bethell and Moorhead, 2003). It is generally applicable on coal particles ranging in size from 0.075 to 15 mm (Wills and Napier-Munn, 2006; Gupta and Yan, 2006) but preferably employed on the size ranging from 0.5 to 5 mm (Anastassakis, 2004).

In this study, coal sample was collected from the coal mine of Iqbal Sons Coal Company situated in Dalwal Coalfield of Punjab, Pakistan. The gross sample amounting over 240 kg was collected from a coal pile according to the guidelines described in ASTM D-2234 and ASTM D-6883 then crushed to -38.00 mm and divided into four parts after mixing properly. One part was prepared according to ASTM D-2013 for proximate analysis. Sieve analysis was performed on the second part while the remaining portion was used for cleaning tests. Deister shaking table was used for coal cleaning. Total eighteen tests were performed on two different particle size ranges; 3.327 × 1.168 and 1.168 × 0.295 mm. Stroke frequency and stroke length were kept at 260 stroke/min and 15 mm, respectively. The values of diagonal tilt were kept at 0, 5 and 10 mm/m while water flowrate was maintained at 14, 24 and 36 l/min. Only two products were obtained; concentrate at the transverse end and tailings at the longitudinal end. The products were dried and analysed for ash content.

Proximate analysis showed that Dalwal coal was consisted of 2.9% moisture, 29.7% ash, 28.8% volatile matter and 38.6% fixed carbon. Table 1 shows the results of sieve analysis and ash determination tests performed on each size fraction. It was found that crushed coal was mostly consisted of coarse particles. The largest (-38.00+26.67 mm) and smallest fraction (-0.295 mm) contained the highest amount of ash contents while the fraction (-26.67+13.33 mm) containing the largest amount of material possessed the smallest amount of ash. It may be safely concluded that the mineral matter was attached with organic matrix at different size levels. The cumulative ash contents were become almost equal to that value found in proximate

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Table 1. Results of sieve analysis and ash distribution in various size fractions

Fraction size	Individual		Cumulative	
	Weight	Ash content	Weight	Ash content
	(%)			
-38.00+26.67	19.53	34.4	19.53	34.4
-26.67+13.33	47.30	26.8	66.83	29.0
-13.33+6.67	17.09	28.9	83.92	29.0
-6.67+3.327	8.40	33.5	92.32	29.4
-3.327+1.168	4.44	33.1	96.76	29.6
-1.168+0.295	2.06	30.9	98.83	29.6
-0.295	1.17	36.2	100.00	29.7

analysis when the size of the coal became smaller than 3.327 mm. Therefore, the coal size less than 3.327 mm was selected for performing tabling tests.

The effect of water flow rate on clean coal yield and ash content is shown in Fig. 1-3. At 0 mm/m tilt, both clean coal yield and ash content were increased by increasing water flow rate. The clean coal yield and ash content were found higher for coal size of -1.168+0.295 mm at low water flow rate but at higher values of water flow rate, the yield of -3.327+1.168 mm coal size became higher with lower amount of ash content. At low water flowrate, the density difference between coal and mineral matter becomes more apparent and light particles (coal) report to the concentrate launder. The role of stroke frequency and stroke length becomes significant at low water flow rate which causes large particles to move along the longitudinal axis and report to the tailing launder resulting in lower concentrate yield. At high water flow rate, the film of flowing water becomes thicker and the upper layers of water film having more velocity exert more force on upper part of larger particles which increases their rolling action and results into their movement to concentrate launder, thus increasing the yield.

Similar trend was found for table tilt of 5 mm/m for clean coal yield but clean coal ash of -3.327+1.168 mm was also increased at higher water flow rate. Tilting of table increases the movement of particles along the flowing water due to gravity effect which results in higher yield. At larger table tilt e.g. 10 mm/m, the effect of water flow rate was found very significant on clean coal yield and ash for the coal size of -3.327+1.168 mm but coal particles of size -1.168+0.295 mm were found to be little affected because the yield of these particles had already been reached at peak value e.g. more than 90%. At low water flow rate, the larger particles did not experience sufficient forces due to flowing film of water which resulted in their lower yield while larger flow rate with larger table tilt increased forces along the transverse direction which resulted in higher yield.

Maximum yield of 41.00 and 43.67% with 14.3 and 13.1% clean coal ash were achieved for the particle size range of -1.168+0.295 and -3.327+1.168 mm, respectively at 36 l/min water flowrate for 0 mm/m tilt. Although the yields were higher for both size ranges at table tilts of 5 and 10 mm/m with water flow rate of 36 l/min but the clean coal ash were not reduced enough to be considered for utilization of clean coal in cement industry. The cement industries in Pakistan usually require coal with less than 15% ash content. Therefore, the best cleaning practice would be to clean -3.327+1.68 and -1.168+0.295 mm size fractions at 36 l/min water flow rate with no table tilt. This would result in cumulative product yield of 42.34% and clean coal ash of 13.7%. The cumulative yield and ash contents of tailings at these conditions would be 57.66 % and 41.4%, respectively.

In Punjab coal mines, coals with more than 40% ash content are normally sold to brick kiln industry with reasonable price ranging from 5000 to 7000 rupees per ton while coals containing ash contents between 20 to 30% are normally sold at prices from 7000 to 9000 rupees per ton. Cement industries of Punjab are using more than 70% imported coal which costs more than 13000 rupees per ton at arrival to the factory. Dalwal coal mines are situated within the distance of 20 km from three major Cement industries of Punjab namely Pakistan Cement Industry, DG Cement Industry and Bestway Cement Industry. Since the costs for coal processing normally varies from 300 to 450 rupees per ton

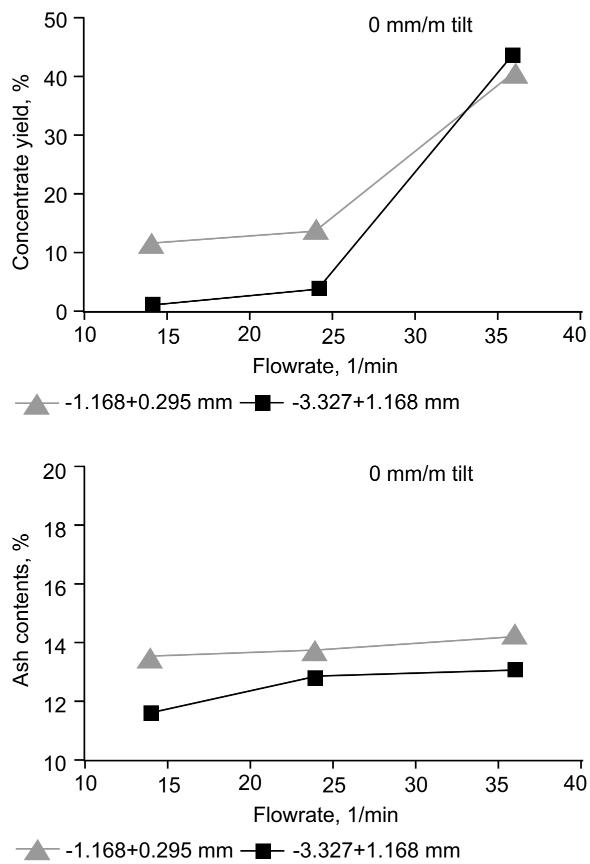

Fig. 1. Effect of water flowrate on concentrate yield and ash contents with 0 mm/m table tilt.

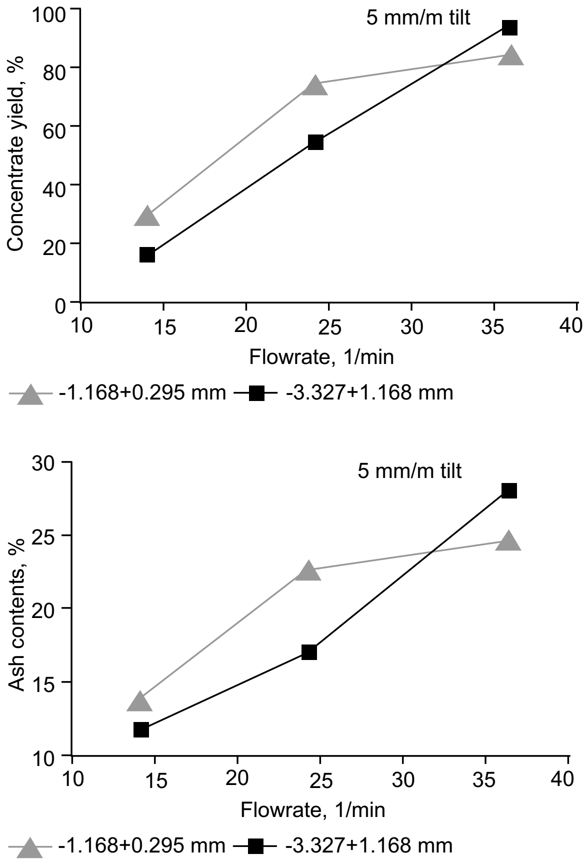

Fig. 2. Effect of water flowrate on concentrate yield and ash contents with 5 mm/m table tilt.

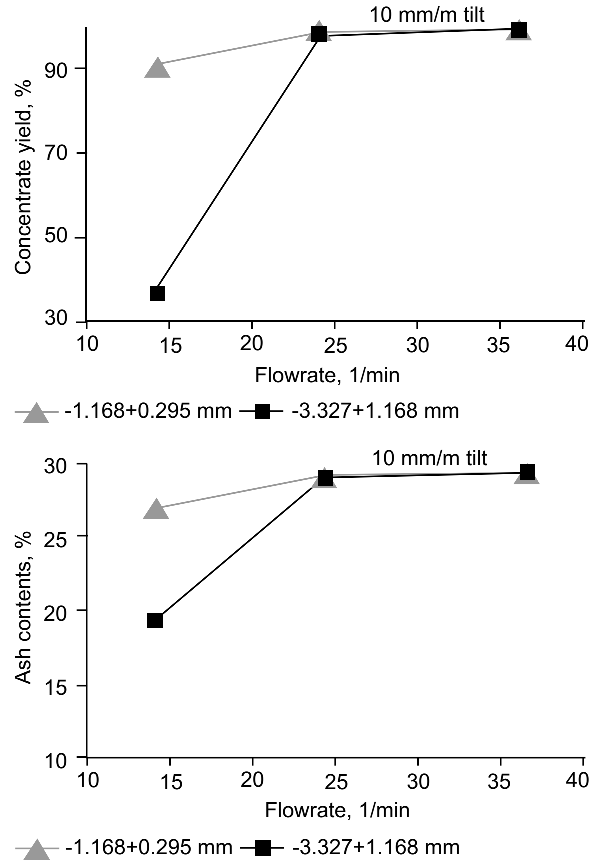

Fig. 3. Effect of water flowrate on concentrate yield and ash contents with 10 mm/m table tilt.

and transportation cost per ton would be minimal therefore, it is concluded that the selling of clean coal to the cement industry and tailings to the brick kiln industry could result in higher revenue for the coal mine owners.

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