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Effect of some operating variables on the performance of a 76 mm heavy medium cyclone

M VANANGAMUDI, J P BARNWAL and T C RAO
Department of Fuel and Mineral Engineering, Indian School of Mines, Dhanbad 826 004, India

Abstract. Tests were carried out on a 76 mm heavy medium cyclone-treating coal. The results show that the specific gravity of separation of coal is influenced not only by the specific gravity of the feed medium but also by the magnetite to coal ratio in the feed slurry.

Keywords. Heavy medium cyclone; coal preparation; magnetite-to-coal ratio.

1. Introduction

Heavy medium (HM) cyclone uses centrifugal force for separation of coal from impurities in a heavy medium. Because of the use of high centrifugal force, HM cyclone can efficiently treat large tonnage of feed containing considerable proportion of near gravity material (Deurbrouck and Hudi 1972). The performance of a HM cyclone is influenced by (Dreissen and Absil 1980): (i) operating variables such as feed medium specific gravity, feed slurry pressure, magnetite to coal (MC) ratio; (ii) design variables such as spigot and vortex finder diameters, cone angle, feed inlet area and (iii) magnetite and coal characteristics such as their size distribution and specific gravity.

For optimum results, the effects of the variables on the performance of HM cyclone have to be determined. In the present investigation, an attempt has been made to study the effects of (i) specific gravity of the feed medium (SG_f) and (ii) MC ratio in the feed slurry on the performance of a laboratory HM cyclone.

2. Experimental

Tests were carried out on a 76 mm HM cyclone using coal in the size range $-2{\cdot}0+0{\cdot}5$ mm. The size and size-wise ash analyses of the feed coal sample are given in table 1. Heavy medium was prepared by using finely ground magnetite with a specific gravity of 4·63 and a magnetic content of 98%. The size analysis of the magnetite used in the tests is given in table 2.

The details of the experimental set-up and experimental procedure were described

Table 1. Size and size-wise ash analyses of feed coal.

Size range (mm)	Wt %	Ash %
$-2{\cdot}0+1{\cdot}4$	19·0	32·54
$-1{\cdot}4+1{\cdot}0$	32·2	31·77
$-1{\cdot}0+0{\cdot}5$	48·8	30·08

Average feed coal ash: 31·09%.

Table 2. Size analysis of magnetite (by wet sieving).

Size range (μ)	Wt %
+71	3·5
−71+50	9·0
−50+36	13·4
−36	74·1

Table 3. Test conditions and the results obtained.

Test No.	SG_f	MC	SG_{50}	E_p	R
1	1·31	11·08	1·455	0·0400	0·0262
2	1·27	6·26	1·345	0·0425	0·0419
3	1·24	2·85	1·390	0·0575	0·0793
4	1·43	11·36	1·675	0·0375	0·0358
5	1·40	8·03	1·635	0·0475	0·0437
6	1·42	3·58	1·755	0·1175	0·0959
7	1·49	12·30	1·770	0·0875	0·0328
8	1·52	8·61	1·985	0·1700	0·0485
9	1·53	4·32	2·065	—	0·0925

elsewhere (Vanangamudi *et al* 1985). The feed inlet pressure was maintained constant at 1 kg/cm^2. The MC ratio was varied by changing the feed rate of coal to the cyclone. Table 3 presents the results obtained under different conditions of operation.

3. Results and discussion

3.1 *Effect of specific gravity of the feed medium*

The specific gravity of the feed medium has been varied at three levels, viz 1·3, 1·4 and 1·5. The results in table 3 show that the specific gravity of separation (SG_{50}) increases with increase in SG_f while the magnetite-to-coal ratio is kept constant. The probable error values (table 3) reveal that the sharpness of separation generally decreases with increase in SG_f.

3.2 *Effect of magnetite-to-coal ratio*

The results in table 3 lead to the conclusion that a drop in the coal rate to the cyclone i.e. an increase in the MC ratio results in a decrease in SG_{50} even when SG_f is maintained constant.

The above observation has a direct bearing on the operation of industrial HM cyclone in coal washeries. In an operating plant, the control of the SG_f is achieved by monitoring with γ-ray density gauge. Since the feed slurry is fed through an overhead tank, the feed rate of the medium to the cyclone is maintained constant. However, the feed rate of coal to the cyclone frequently fluctuates depending upon

the supply of raw coal to the washery. The present investigation indicates that even if SG_f is maintained constant, the fluctuations in the feed rate of coal to the HM cyclone will result in fluctuations in the MC ratio being maintained in the feed slurry to the cyclone. This would result in fluctuations in SG_{50}. Hence, even with constant SG_f, the yield and ash content of the clean coal would drop with decrease in the feed rate of coal to the cyclone and vice versa.

The results also show that a decrease in the MC ratio results in a decrease in the sharpness of separation (E_p) while SG_f is maintained fairly constant. This indicates that the feed rate of coal to the HM cyclone has a direct influence on the sharpness with which it separates.

3.3 *Relationship for the specific gravity of separation*

It was reported earlier that a linear relationship exists between SG_{50} and SG_f while the design and operating variables are kept constant (Vanangamudi *et al* 1986, 1988). The following relation has been obtained for SG_{50} in a HM cyclone treating $-2{\cdot}0+0{\cdot}5$ mm coal.

$$SG_{50} = -1{\cdot}519 + 2{\cdot}198\, SG_f + 2{\cdot}092\, R, \tag{1}$$

where R is the ratio of the rate of coal in the feed to the rate of feed slurry (by weight). The actual and the calculated SG_{50} values are compared in figure 1. The above equation relates SG_{50} with the two operating variables fairly accurately. The factor R is dimensionless and hence this relationship can be used for estimating the SG_{50} for any cyclone since the relationship is independent of cyclone diameter. However, if the feed size of coal to the unit or any of the design or operating variable changes, then the constants in the relationship have to be evaluated for its application. In any operating plant it is easy to measure R by collecting a representative sample of the feed slurry to the HM cyclone and estimating the fraction of coal in the slurry by weight. An expression of this form would help in day-to-day operation of the plant. The extent of influence of change in the feed rate of coal can be estimated accurately and corrective measures can be taken accordingly.

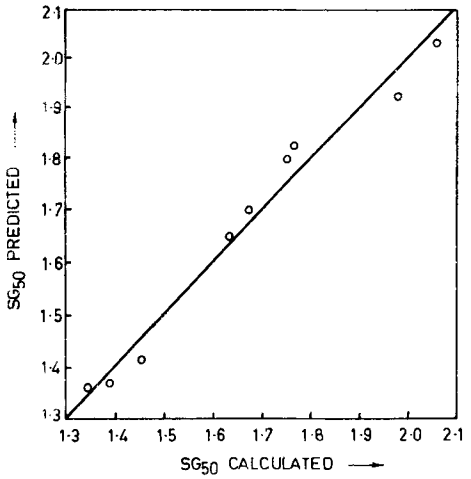

Figure 1. Comparison of calculated and experimental specific gravity of separation.

4. Conclusions

The specific gravity of separation increases with increase in the specific gravity of feed medium while the MC ratio is kept constant. However, the sharpness of separation decreases with increase in the specific gravity of the feed medium. Even when the specific gravity of the feed medium and its flowrate are constant, an increase or decrease in the feed rate of coal to the cyclone has a direct influence on the performance of the cyclone. The former would result in an increase in the specific gravity of separation with a corresponding decrease in the sharpness of separation. This results in an increase in both the yield and ash content of the clean coal. The latter would result in an opposite effect. SG_{50} has been related linearly with SG_f as well as the ratio of feed coal rate to feed slurry rate.

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