

Beneficiation of Thermal Coal

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INTRODUCTION :

About 110 million tonnes of non-coking coal is being mined every year out of which 32% is being used in thermal power plants. The quality of thermal coal is deteriorating day by day due to mechanised bulk mining, poor quality control and depletion of high quality coal seams. The properties and quality of impurities in coal are of major importance in the design and operation of steam generation equipment. The efficiency and longevity of thermal plants and equipment can be improved by using high quality coal. Increased demand for quality coal and environmental requirements necessitate beneficiation of thermal coal. Beneficiation will reduce the burden on transportation especially when power plants are far off from the pit heads. An attempt is made in this paper to beneficiate Talcher thermal coal in order to reduce ash.

Talcher coal field in Orissa covers an area of about 1800 sq. km. and has a total insitu reserves of about 3243 million tonnes and represents one of the biggest reserves of non-coking coal in the country (1). Out of 1060 million tonnes of total proved and indicated reserves, 37 per cent is of superior grade quality and 63 per cent is of inferior grade quality. The Talcher coal of upper seam contains about 15 to 25% ash whereas coal from lower seams (seam II to seam VIII) contains 27.0 to 42.0% ash (2).

At present the coal containing on an average of 40% ash and up to 15% moisture is pulverised to 80% passing 75 microns to feed

the steam boilers of Talcher Thermal Power Plant. Because of the high ash and abrasive nature of the coal, the wear on the grinding media and I.D. fans is excessive and about five times more than similar installations in the country. As a result of high wear rate, frequent replacement of ring and grinding media are needed which involves a lot of expenditure (3). In addition high ash coal results in low usable calorific value.

In view of these facts it was considered necessary to investigate the possibility of reducing ash from 40 per cent to around 20% by flotation, since ultimate product required is 80% passing 75 microns and grinding media replacement cost in wet grinding would be less compared to the present practice. The beneficiated product is proposed to be transported to the power plant in slurry form, through pipe line and burnt there as coal-water slurry with minor modifications to the existing plant.

Regional Research Laboratory, Bhubaneswar has developed a flotation column, a better alternative to conventional cells to achieve higher grade and recovery at lower cost (4). The possibility of utilising such an equipment was studied for the beneficiation of the above coal.

EXPERIMENTAL :

Sample :

About 100.0 kg. crushed coal forming feed to the existing thermal plant was obtained from Talcher. The coal was further crushed in stages to reduce entire amount to 1.00 mm size using

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jaw and roll crushers. The sample was further ground in 1'×1' ball mill to get the required size samples for the flotation studies. The size and ash distribution of different samples prepared for the investigations are given in Table 1.

PROCEDURE :

Sink-float studies :

A representative sample was prepared and ground to different sizes (100 per cent passing). The ground samples were further classified into closed size fractions in each case. The fractions so obtained were subjected to sink and float test by using organic liquid having 1.5 specific gravity (mixture of Bromoform and Benzene). Both the light and heavy fractions were collected, washed, dried and weighed. All the light and heavy fractions were analysed for ash.

Batch flotation tests :

Some batch flotation tests were carried out to establish the extent to which ash can be reduced and to optimise collector dosage in a standard D-12 sub-aeration flotation machine with 10 litres capacity cell. 800 gms of sample is taken and conditioned at 40% solids for 5 minutes at 1500 RPM. Then the solids concentration was brought down to 10% by adding additional water and then the flotation was carried out. Diesel oil was used as collector and 1 : 1 volumetric mixture of pine oil and MIBC was used as frother. The effect of collector was studied on different size materials (-500, -250 and -125 microns).

Continuous flotation tests :

Continuous flotation tests were carried out employing 100 mm diameter glass column at the nominal capacity of 20 kg/hr. The experimental set up was shown schematically in fig.2. Ground sample was conditioned at 40% for five minutes with required amount of diesel oil as collector. Then the slurry was diluted to 10% solids and then fed to the column. Required amount of frother 50 : 50 MIBC and pine oil (by volume) was introduced with the feed slurry

before feeding to the column. Measured quantity of wash water was sprayed from the top of the column. Constant slurry level in the column was maintained by siphon arrangement. Air was introduced through air diffuser from the bottom of the column. Samples of froth and tailings were collected after the steady state was attained. Samples were dried and analysed for ash.

RESULTS AND DISCUSSIONS :

Results of sink-float test on 1000, 500, 250 and 125 microns size ground materials are reported in Table 1. It is clear from the results that even after grinding to -124 microns, the sinks of different size fractions contained about 60% carbon which indicate the gangue is not liberated at that size. Fine grinding may be required to liberate gangue completely.

The results of batch flotation experiments were presented in Table 3. Results of tests on flotation column are reported in Table 4. It is possible to reduce ash from 40% to 24.6% with carbon recovery of 60% in conventional cell by two stage flotation. Whereas a product with 18% ash can be obtained with 60% recovery in two stages in flotation column and a product with 21.0% ash with 76% carbon recovery can be obtained by regrinding the tailings and floating in the column.

Conclusions :

The mineral matter in the coal is fine grained and the limited response to flotation indicates highly oxidised state of coal. However, it was shown possible to get a product with 21 % ash with 58 % yield by regrinding the tailings and using proper dispersant. Following such a beneficiation at pit head, the slurry containing concentrated coal could be conveyed to plant side through pipe line and can be burnt as coal-water mixture in special burners without dewatering or filtration. The cost of flotation can be off-set by the savings with the improved calorific value of the coal, less consumption of grinding media and less wear rate.

Table—1 : Size and ash distribution of different samples

Size, Microns	- 1 mm size		- 0.5 mm size		- 0.25 mm size		- 0.125 mm size		
	Wt, %	Ash, %	Wt, %	Ash, %	Wt, %	Ash, %	Size	Wt, %	Ash, %
+710	2.7	35.8							
-710 +420	12.3	36.7	12.3	35.8			+125	4.5	36.1
-420 +250	31.1	36.6	16.6	36.8	3.7	33.5	-125 + 75	10.8	37.1
-250 +105	8.6	37.9	19.5	37.6	19.5	35.1	- 75 + 45	12.5	31.4
-105 + 45	10.3	34.3	12.9	38.5	16.2	34.5	- 45	72.2	41.7
- 45	34.9	44.5	38.7	45.4	60.6	43.9			
Head	100.0	39.2	100.0	40.4	100.0	40.3		100.0	39.7

Table—2 : Results of sink and float tests on different size fractions

Size, microns	Feed		Float		Sink	
	Wt %	Ash %	Wt %	Ash %	Wt %	Ash %
— 1000 micron sample :						
-1000 +710	2.7	35.8	1.8	20.2	0.9	36.8
- 710 +500	12.3	36.7	8.7	19.5	3.6	37.5
- 500 +250	31.1	36.6	21.9	20.4	9.2	41.0
- 250 +105	8.7	37.9	5.1	18.6	3.6	44.7
- 105 + 45	10.3	39.0	4.1	18.7	6.2	53.5
- 45	34.9	44.5	—	—	—	—
— 500 micron sample :						
- 500 +420	12.3	35.8	4.8	21.8	7.5	43.3
- 420 +250	16.6	36.8	5.8	21.3	10.8	43.2
- 250 +105	19.5	37.6	7.8	20.7	11.7	45.2
- 105 + 45	12.9	34.3	6.8	16.8	6.1	47.9
- 45	38.7	45.7	—	—	—	—
— 250 micron sample :						
+250	3.7	33.5	0.6	19.5	3.1	41.9
- 250 +105	19.5	35.1	12.2	18.0	7.3	39.6
- 105 + 75	16.2	34.5	6.3	17.5	3.8	42.9
- 75 + 45	—	34.5	3.4	15.9	2.8	39.6
- 45	60.6	43.9	—	—	—	—
— 125 micron sample :						
+125	4.5	36.1	1.8	20.0	2.7	44.3
- 125 + 75	10.0	37.1	2.3	15.7	8.5	39.7
- 45 + 45	12.5	31.4	6.0	20.0	6.5	39.8
- 45	73.0	41.7	—	—	—	—

Table—3 : Results of batch flotation tests**Frother : 0.6 gm/kg.**

Sl. No.	Feed, size, microns	Collector gm./kg.	Product Ash, %	Recovery, %	
				Weight	Carbon
1.	500	2.0	21.6	17.5	22.2
2.	500	3.0	13.0	12.8	17.9
3.	500	5.0	17.3	26.3	35.3
4.	500	7.5	22.9	41.0	49.0
5.	500	8.0	24.6	46.6	59.3
6.	250	5.0	19.4	22.0	30.0
7.	250	8.0	16.8	18.7	24.7
8.	125	8.0	17.1	30.4	41.5

Test No. 5 : Tailings reground and floated.

Table—4 : Results of continuous flotation tests on column





Feed : 20 kg./hr. Frother : 0.6 ml./kg. coal,

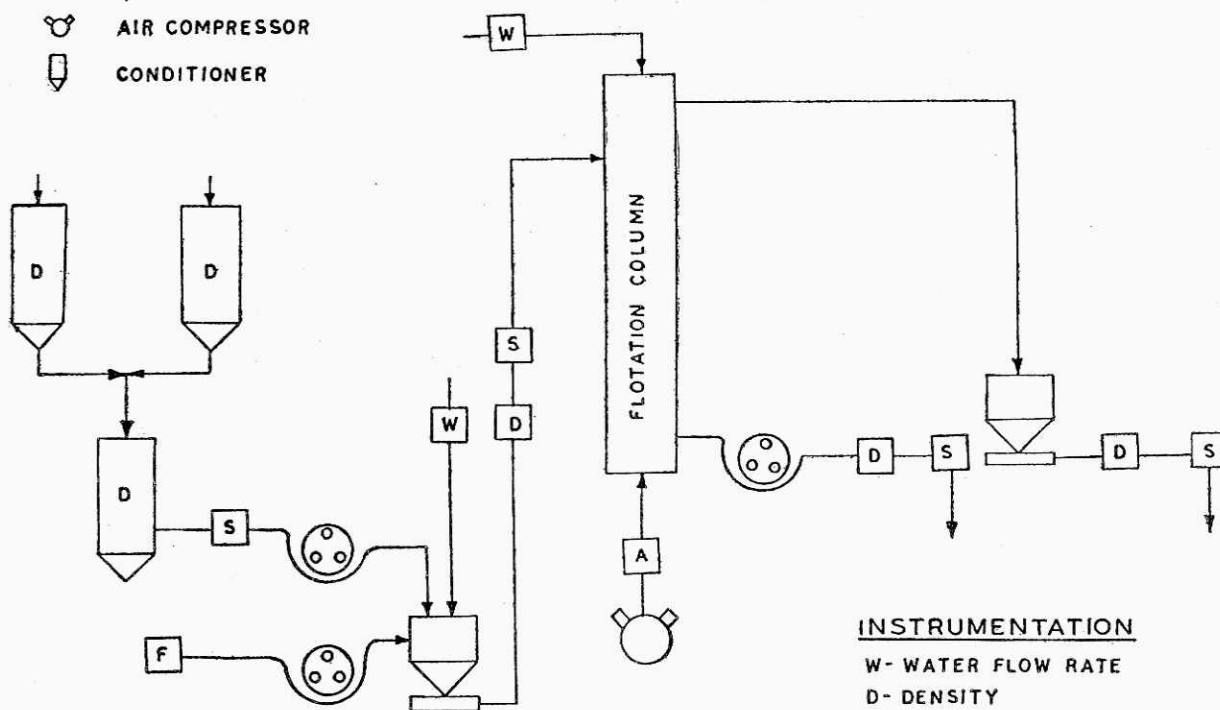
Wash water : 60 l/hr, Solids conc. : 10%

Sl.No.	Feed, size, microns	Collector gm./kg.	Air l/m	Product Ash %	Recovery, %	
					Weight	Carbon
1.	1000	1.5	6.5	25.5	33.4	41.5
2.	500	1.5	5.0	28.0	33.5	40.2
3.	500	1.5	6.5	31.3	52.2	59.7
4.	500	4.0	4.5	27.7	77.5	93.0
5.	500	4.0	4.5	17.8	44.0	60.3
6.	500	4.0	4.5	21.0	58.1	76.5
7.	125	2.5	4.5	17.5	24.0	31.4
8.	125	4.0	4.5	25.9	51.2	63.2

Test No. 5 : Concentrate was cleaned.

Test No. 6 : Concentrate was cleaned and middlings reground and floated.

-  METERING PUMP
-  SLURRY PUMP
-  AIR COMPRESSOR
-  CONDITIONER



SCHEMATIC DIAGRAM OF FLOTATION PLANT
(FOR INSTRUMENTATION & DATA LOGGING)

INSTRUMENTATION

W- WATER FLOW RATE
D- DENSITY
S- SLURRY FLOW RATE
A- AIR FLOW RATE
F- FROTHER RATE

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DISCUSSION :

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Question 1 : Do you think we will ever go for column flotation in the next few decades ?

Author : Column flotation was already commercialised in Canada for the flotation of molybdenite from Cu-Mo bulk concentrate. It is also commercialised in USA and USSR for the beneficiation of coal fines and rock phosphate. It is also used commercially for zinc concentrate cleaning and in beneficiation of copper ore.

Bench scale studies indicated several advantages over conventional cells. In view of encouraging results and in the interest of country for the conservation of coking coal resources, semi-commercial plant is proposed to be set up at Sudamdih Coal Washery for the beneficiation

of coking coal fines to prove the results on larger scale.

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Question 2 : What are the advantages of column flotation over the Froth flotation ?

Author : Advantages of Column Flotation over Conventional Cells are :

- i) Better grade product without sacrifice in the recovery,
- ii) Reduction in number of cleaning operations because of the high selectivity of process.
- iii) Ability to handle a finer feed,
- iv) 2 to 3 times lower flotation time
- v) Simplicity in design for construction without any moving parts,
- vi) Savings in depressant requirement and
- vii) Occupies less floor space.

Question 3. : Up to what extent we can reduce ash percentage by column flotation ?

Author : Ash reduction in Column flotation depends upon the nature of the coal sample. From our studies it is indicated that ash reduction in column is more compared to conventional cells. Typical results are :

- i) reduction of ash from 40% to 21% in case of Talcher Thermal Coal,
- ii) reduction of ash from 37% to 12% in case of Sudamdih Coking Coal fines.

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Question 4. : Let us know the maximum capacity of column flotation developed so far and its capital cost.

Author : The largest commercial operating column is in USSR for the beneficiation of coal sludge. Maximum operating capacity is 9.0 t/hr./m². However its capital cost is not known.