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Studies on the cleaning potentialities of high ash non-coking coal of Orissa region

Coal will continue to play a major role in economic development of India with particular reference to energy. The significant resources of coal in comparison with other fossil fuels have enabled this valuable mineral to remain at the centre stage of India's energy scene. This paper presents the detailed laboratory investigations in terms of characterization; size analysis and washability studies carried out on a typical high ash non-coking coal sample and suggest the concept of beneficiation for the improvement in the quality of run-of-mine (ROM) coal.

Introduction

The electrical power has been a vehicle of economic development for modern society so much so that the per capita electricity has become one of the key indicators of the economic progress of the society. The developing economies like India and China are characteristically having high energy elasticity and high energy intensity. This typically happens because of the fact that new capacity and infrastructure addition takes the front seat in such economies letting the efficiency improvement measures to be neglected. Because of these factors the power generation capacity growth and fuel requirement growth will be very much pronounced in the developing world particularly India and China. Looking on the power requirement and fuel availability scenario, coal seems to dominate as the Indian power sector's fuel of choice in foreseeable future. Since our future energy security relies heavily on this fast depleting resource, we have to identify and address holistically the relevant issues like coal production and transportation infrastructure, import tie ups and efficiency of utilization. As our coal reserves are limited, the only way to make it last longer is to be efficient in its utilization. The clean coal technology and advanced power generation cycles have to be perfected for Indian coal conditions. India's total primary energy need is estimated to rise from 3.0 to 4.0 times the 2014-15 level by 2031-32.

The basic assumption here is 8 to 9% GDP growth and projections based on falling elasticities with respect to GDP the projections for electricity requirement in the Integrated Energy Policy of Planning Commission of India indicates that the required installed capacity of power generation is 303 GW as on April 2016 (1), It is expected that it will be increased up to 425GW by the year 2021-22 and 778 GW by the year 2031-32 (at 8% GDP growth assumption at falling elasticity of energy use). Much of the expected growth in electricity in India over the next few decades will likely be based on coal, particularly domestic coal. It is predicted that coal-based capacity of utility power plants is likely to be in the range of 300-400 GW in 2031. In view of utilization of non-coking coal for power generation, huge amount of beneficiated coal will be required. This paper summarizes the washability study conducted. The aim of the study was to investigate and interpret washability characteristics of Indian non-coking coal of Orissa region in order to provide a geological basis of washability and to gain practical information which will be useful in the processing and utilization of these coals for power generation.

Beneficiation of non-coking coal in India was not given due importance till last decade due to its low calorific value and lower cost competitiveness. However, realizing the low useful heat value of non-coking coal and the stringent environmental aspect with respect to ash generation, many coal industries in India are forced to set up more and more non-coking coal washeries. To meet this demand, beneficiation of non-coking coal is essential to meet their stringent specification. As a matter of fact, optimal beneficiation of non-coking coal needs a special approach from that of coking coal because of contrasted nature of constraints involved in their utilization pattern, prevalent practice, existing infrastructure, availability of equipment, etc. Indian coals are difficult to wash because of their close association and intermixing of the coal and inerts (both macerals and mineral matters) resulting from geological phenomena typical to Indian coals of Gondwana origin. The current study investigates the potential use of high ash non-coking coal for power generation after suitable beneficiation.

Sampling, sample preparation/testing

Coal sampling was carried out as per standard practice [2]. The sample collected from Orissa region was mixed

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thoroughly and subjected to screen analysis and screen wise float and sink tests.

Size analysis

Size analysis was carried out at sizes 50, 25, 13, 6, 3 and 0.5 mm. The size fractions were weighed and analyzed for ash and moisture per cent. The data is shown in Table 1. It may be seen from the Table 1 that the percentage of coal fines i.e., below 0.5mm is about 6.5% and the ash content is as high as 44.8%. It may further be observed that ash content is lower 39.4%, in the coarser fraction viz., 50-25mm and it has increased correspondingly in all the next size fractions.

Washability studies

The size fractions 50-25, 25-13, 13-6, 6-3 and 3-0.5 were put for float and sink tests [3] in the gravity range 1.40 to 2.00 at an interval of 0.1. All the gravity fractions were dried, weighed and analyzed for ash and moisture% and the combined washability data were also generated for the size 50-0.5 mm, 50-13mm and 13-0.5mm and shown in Tables 3, 4 and 5 respectively. The combined washability data of all the sizes was used for plotting standard washability curve and the same are depicted in Figs.1, 2 and 3. During size wise float and sink tests, it was found that the weight% of the fraction above 2.0 specific gravity is increased with decrease in size. This may be attributed to the fact that shales/stones concentrated more in finer sizes.

From the washability data and curves, the theoretical yield% for different fraction was found out at 34% ash level to utilize in power generation for the size fraction 50-0.5 mm the theoretical yield% of the clean coal is 82.0% at 34.0% ash level at a specific gravity cut of 1.85, the NGM at this specific gravity of cut is 13.6%, while the corresponding rejects ash being 69.1%. Similarly for the size fraction 50-13 mm the theoretical yield% of clean coal is 82.5% at ash content of 34.0% at a specific gravity cut of 1.80, the NGM at this specific gravity of cut is 17.0%, while the rejects ash content being 67.6% and for the size fraction 13-0.5mm the theoretical yield% of clean coal is 81.3% at 34.0% ash content at a specific gravity cut of 2.02 the NGM at this specific gravity of cut is 14.7, and corresponding rejects ash content is 73.0%.

Development of flow scheme

It may be seen from the size analysis data, that the fraction below 13mm or below 6 mm constitute high ash content.

TABLE 1: SIZE ANALYSIS

Size, mm	Wt%	Ash%	M%
50-25	54.1	39.4	8.7
25-13	7.9	43.3	7.1
13-6	15.8	42.1	6.0
6-3	7.2	41.3	3.6
3-0.5	8.5	39.6	4.2
-0.5	6.5	44.8	8.2
	100.0	40.6	7.4

TABLE 2: WASHABILITY DATA FOR THE COMPOSITE SIZE FRACTION (50-0.5MM)

Sp.Gr	Wt%	Ash%	Cum. float		Cum. sink		Ch. wt%
			Wt.%	Ash%	Wt.%	Ash%	
<1.40	15.0	13.7	15.0	13.7	85.0	45.1	7.5
1.40-1.50	20.1	27.2	35.1	21.4	64.9	50.6	25.0
1.50-1.60	24.0	37.1	59.2	27.8	40.8	58.5	47.1
1.60-1.70	9.0	44.8	68.1	30.1	31.9	62.4	63.6
1.70-1.80	9.6	52.1	77.6	32.7	22.4	66.7	72.8
1.80-1.90	7.1	57.6	84.7	34.8	15.3	71.0	81.2
1.90-2.00	2.6	60.6	87.3	35.6	12.7	73.1	86.0
>2.00	12.6	73.1	100.0	40.4	0.0		93.7

TABLE 3: WASHABILITY DATA FOR THE COMPOSITE SIZE FRACTION (50-13MM)

Sp.Gr	Wt%	Ash%	Cum. float		Cum. sink		Ch. wt%
			Wt.%	Ash%	Wt.%	Ash%	
<1.40	15.4	15.2	15.4	15.2	84.6	44.4	7.7
1.40-1.50	22.3	28.4	37.7	23.0	62.3	50.1	26.5
1.50-1.60	24.9	38.2	62.6	29.1	37.4	58.1	50.2
1.60-1.70	10.1	45.5	72.7	31.3	27.3	62.8	67.7
1.70-1.80	9.9	54.3	82.6	34.1	17.4	67.6	77.7
1.80-1.90	7.1	60.1	89.7	36.2	10.3	72.8	86.2
1.90-2.00	1.3	63.9	91.0	36.6	8.9	74.1	83.3
>2.00	9.0	73.9	100.0	39.9	0.0	0.0	95.6
	100						

TABLE-4: WASHABILITY DATA FOR THE COMPOSITE SIZE FRACTION (13- 0.5MM)

Sp.Gr	Wt%	Ash%	Cum. float		Cum. sink		Ch. wt%
			Wt.%	Ash%	Wt.%	Ash%	
<1.40	14.4	10.6	14.4	10.6	85.6	46.4	7.2
1.40-1.50	15.5	24.0	29.9	17.5	70.1	51.3	22.1
1.50-1.60	22.4	34.8	52.3	24.9	47.7	59.1	41.1
1.60-1.70	6.8	42.6	59.1	27.0	40.9	61.8	55.7
1.70-1.80	8.6	47.0	67.7	29.5	32.3	65.8	63.4
1.80-1.90	7.3	53.0	75.0	31.8	25.1	69.5	71.3
1.90-2.00	5.0	58.9	80.0	33.5	20.1	72.1	70.2
>2.00	20.0	72.3	100.0	41.2	0.0	0.0	89.9
	100						

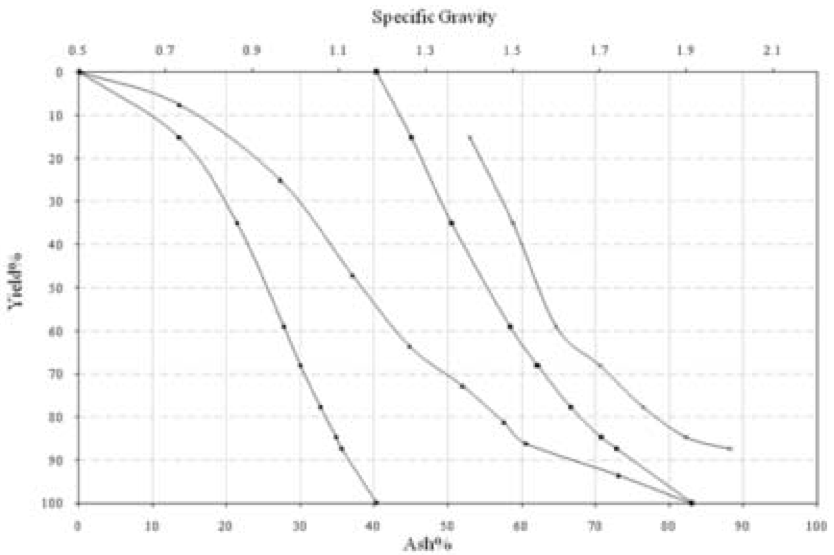

Fig.1 Washability curve size tested 50-0.5 mm

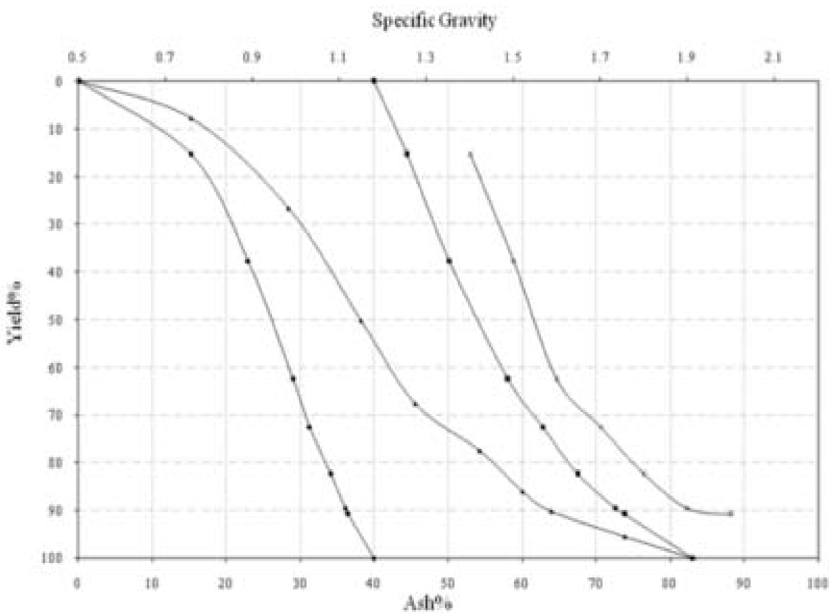

Fig.2 Washability curve size tested 50-13 mm

Hence, for such type of coal partial beneficiation is not advisable.

Based on the washability data the theoretical yield% for different sizes were tabulated, and a flow scheme was developed to achieve clean coal at 34.0% ash level and the same is depicted in Fig.4. It may be seen from Fig.4 that by washing the fraction 50-13 mm and 13-0.5 mm separately a total cleans of 76.8% at 34.0% ash is achievable. The rejects of this both fractions was combined with the below 0.5 mm fraction and the total yield is 23.2% and the ash content is 61.2%.

However, it may be stressed that the practical yield on industrial scale is likely to be less depending on the efficiencies of the washers. The theoretical yield as mentioned above may not be achievable in actual plant practice due to dynamic system of the washers. The practical yield to be obtained from the commercial plants varies in quality and quantity depending on the efficiency of the washing system.

Choice of washer

Jigging is one of the oldest methods adopted for coal beneficiation where separation is needed at higher density of cut. The obvious advantages are their large capacities, cheaper cost, and accessibility to wide size range of coal and simple technique to operate. The Ep values of modern jigs are claimed to be attractive (0.08-0.10). Electronically controlled Batac jigs are more efficient and suitable if the NGM is less than 20%. In the present case, since the NGM is less than 20% for both the sizes viz., 50-13mm and 13-0.5mm, Batac jigs may be an ideal washer.

H. M. bath or cyclone may be other

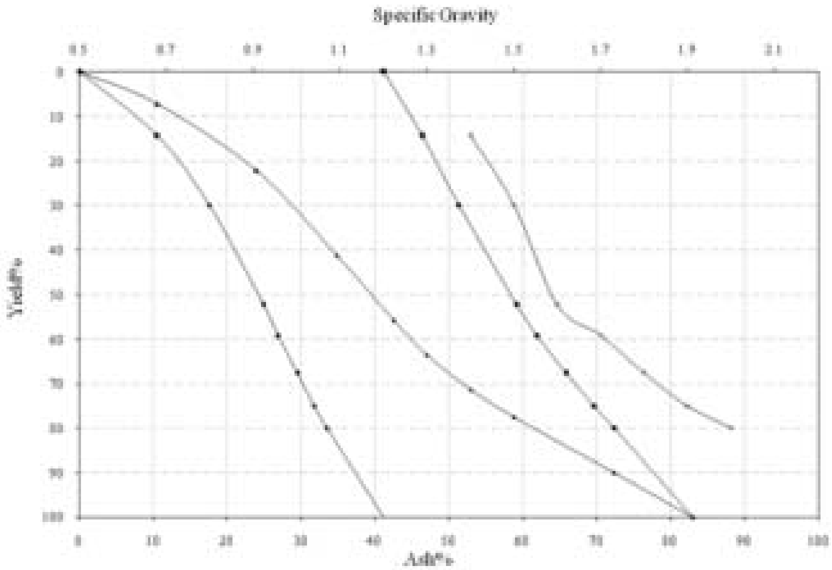

Fig.3 Washability curve size tested 13-0.5 mm

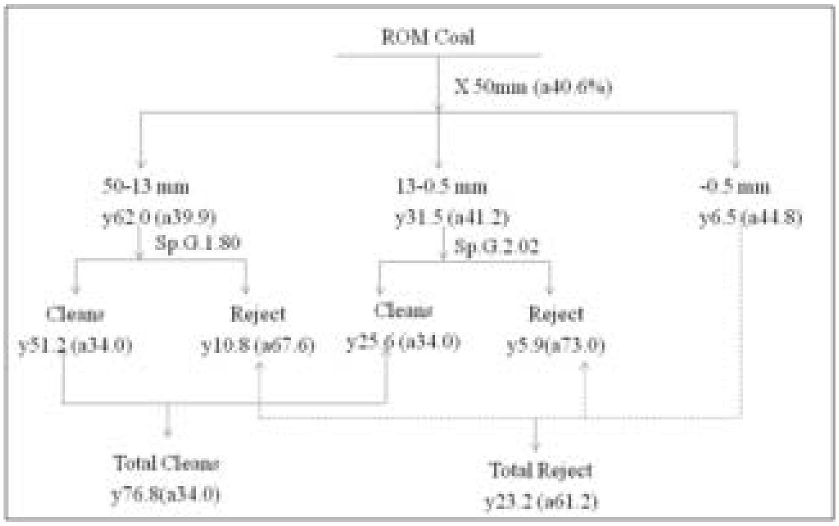

Fig.4 Flow scheme based on theoretical yield% obtained from F&S data

choice, but it should also be remembered that H. M. bath or cyclone may be difficult to operate with media having specific gravity more than 1.8, mainly due to viscosity of the media. Thus, it is not be wise to run the H. M. circuit at very high gravity to produce washed coal with 34% ash.

Conclusions

From the above studies it is clear that for coal sample collected of Orissa region, it was noticed that partial beneficiation may not be recommended. From the detailed float and sink test, it was observed that the NGM at the required specific gravity of cut is less than 20%; hence Batac jigs may be an ideal washer to wash such type of coals.

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