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Recycling and treatment of settling pond fines — A challenge to industry and Environment

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ABSTRACT

About 3.0 million tonnes of coking coal fines (-0.5mm) generated from various coal preparation plants are lying in the lagoons/settling ponds in the vicinity of these plants for quite some time. In addition, 60,000t of slurries are being bled every month to these waste basins. These discarded coal fines which contain significant amount of vitrinite enriched coking materials, are not being properly utilised due to the following reasons.

(i) Inability of existing coal washing circuit to beneficiate these coal fines from the slurry economically; (ii) Environmental restrictions regarding waste disposal were not stringent; (iii) Non-availability of suitable technology to recover the coal fines at desired quality.

To use these coal slurry fines, CFRI through decades long R&D efforts have developed an improved process technology, which can recover finest cleans (ash < 15%) from the said high ash (30-35%) coal slurry. Based on CFRI technology, three mini flotation plants have been commissioned of throughput capacity 5 to 10 tph in small scale sector, which are successfully producing cleans (Yield 50-60%, and Moisture < 20%) from high ash coal slurry and dispatching the low ash cleans to M/s IISCO, Burnpur as one of their coking blend constituents for metallurgical coke making. Many new mini flotation plants are coming into picture based upon this technology. This paper sunmmarises data, concerning slurry pond quality estimate, floatability, material recovery, etc.

Key words *: Waste, Coal, Flotation, Recycling.*

INTRODUCTION

The disposal of tailings and coal fines in the form of slurry is a worldwide problem. It not only occupies a vast land, but also creates environmental problems. Particularly in rainy season, it pollutes adjacent water and soil. In India, as per a broad estimate, the total stock of slurry /tailing accumulated at different

washeries of CIL, is to the tune of 3.0 million tonne. Added to this are the regular slurry discharges of about 60,000 t/month[1]. The factors affecting the quality of slurry pond fines may be mentioned as under. :

i) Parent coal characteristics : The quality of the parent coal is typically reflected in the coal fines. If the parent coal is high in coking properties, it is likely that the fines will also be high in coking properties.

ii) Mining technique : Different mining methods produce run of mine coal with varying characteristics. Open cast mining generates higher quantities of fines than under ground mining.

iii) Preparation procedures : The crushing technique employed, the type of cleaning equipment used, the presence or absence of fines cleaning circuit, the method of dewatering and the application of reagents are all factors that can influence the final quality of coal fines. A plant with denser medium vessels and cyclones, for example, will produce fines of different quality than a plant with jigs and flotation cells.

iv) Efficiency of the preparation plant : Plants that do not practice quality control, have not instituted preventive maintenance programs and do not seek continuous process improvement are destined to operate inefficiently and discharge good quality slurry (coal fines) to ponds.

v) Degree of oxidation : Depending on the method of deposition, geological conditions and climate, coal fines may become oxidised in slurry ponds.

Quality Trend in Slurry Ponds

Spatial distribution often exists in slurry pond fines. Quality tends to deteriorate (higher ash) with increasing depth in slurry pond. This is because, during formation of slurry pond at the discharge point, larger denser mineral matter particles will often be found near the discharge location, having quickly settled out upon deposition. The lightest particle on the other hand, is usually carried far away from the discharge point and concentrate in certain portions of the pond.

In advanced countries[2], quality tends to increase (lower ash) with increasing depth in the slurry pond. This is because, years ago, preparation plants did not operate efficiently, resulting in the disposal of good quality coal. Today, in an effort to optimise coking recovery from coal, plant efficiency is much higher, so slurry pond materials are of much lower quality. These discarded coal fines which contain significant amount of vitrinite enriched coking materials, are not being properly utilised due to the following reasons.

(i) Inability of existing coal washing circuit to beneficiate these coal fines from the slurry economically.

(ii) Environmental restrictions regarding waste disposal were not stringent.

(iii) Non-availability of suitable technology to recover the coal fines at desired quality.

Now, due to environmental restriction parameters and availability of improved coal fines treatment techniques, these solids have found new economic importance. The slurry so produced is yet to be fully recovered by large-scale flotation units, which are still to be made properly operational. This results in the accumulation of slurry/fines and creates both management and technical problems for the existing washeries, due to loss of solids and, more significantly the recirculating water. Moreover, due to its high ash content (30-35%), such fines may not be mixed with clean coal and are sold for domestic coke making, brick burning and other non-metallurgical uses. Thus, huge quantity of potentially rich coking coal fines are virtually wasted, which, if properly beneficiated, could have augmented the supply of scarce coking coal to steel industries.

CFRI through decades long R&D efforts have developed an improved process technology, which can recover finest cleans (ash < 15%) from the said high ash (30-35%) coal slurry. Based on CFRI technology, three mini flotation plants have been commissioned of throughput capacity 5 to 10 tph in small scale sector, which are successfully producing cleans (Yield 50-60%, and Moisture < 20%) from high ash coal slurry and dispatching the low ash cleans to M/s IISCO, Burnpur as one of their coking blend constituents for metallurgical coke making.

PROCESS

The process involves a physico-chemical technique called froth flotation. The fine coal particles (below 0.5 mm) are conditioned in a stirred tank using a reagent called "collector". The conditioned coal slurry is fed into a series of specially designed flotation cells where air bubbles are generated by self-contained diffuser-impeller system, using a "frother". Thus, the coaly particles adhered to the air bubbles float onto the surface as froth. The ash forming mineral matter remains in the pulp and is discharged from the cell as tailings. The froth containing low ash clean is dewatered in the vacuum filter and separated as cake. The product is excellent in quality and produce superior grade coke on carbonisation. This is very cost-effective process for beneficiating high ash coking coal fines and using the cleans for coke making. The capacity of these mini flotation plants varies between 5 to 10 tph.

Laboratory Studies

The ultimate objective of a flotation circuit is to achieve high yield while producing low ash clean coal with good filtration characteristics. In order to

achieve these qualities, optimal operating condition is essential. Hence, optimisation of process variables is must, which affect the performance of individual cells. Slurry from coking coal preparation plants (about 15% by weight of total feed) was collected and subsampled for the test. For optimisation of reagent dosages, diesel oil and kabakol were varied as 1.25, 1.50, 1.75 kg/t and 0.25, 0.30, 0.35 kg/t of dry coal respectively. Laboratory experiments were carried out under pre-determined conditions, using Box-Hunter Method 3, 4, so as to cover both the process variables simultaneously. A laboratory flotation test at 13 levels of collector and frother combination was carried out with the sample under following conditions:

Diesel oil (collector) dosage, kg/t of dry coal	1.25, 1.50, 1.75
Kabakol(frother)dosage, kg/t	0.25, 0.30, 0.35
Solid content during conditioning	33%
Solid content during flotation	10%
Feed ash	35%
Time of flotation(second)	120
Cell (sub aeration type)	2.50 litre
Aeration rate, $m^3/m^2/min.$	2.07
Speed of impeller,rpm	1500

RESULTS AND DISCUSSION

It may be observed from the results in Table 1 that the best result is obtained when the dosage of collector and frother are maintained at 1.75 kg/t, 0.35 kg/t respectively. It is further noted that under this condition of operation, the EI (efficiency index) and RNA (recovery of non-ash materials) have been found as 356.8,79.1 respectively, which are the maximum values under this series of investigations. This reveals that for the treatment of such coal fines, the dosages of collector and frother should be maintained at the above noted levels. The slurry sample was again treated under the same condition of collector and frother dosages, cleans were collected at the time interval of 15, 30, 60, 120 & 240 seconds. Results are shown in Table 2 it may be noted that about 59% of the feed was recovered in the form of concentrate as the first 60 second with 14.5% ash content. It is further observed that the recovery of cleans in the subsequent 60 seconds is negligible. It reveals that the maximum floatable coal particles having low ash content are reporting to the cleans within the first 60 seconds. These kinetic studies may be of much use while operating a pilot plant.

Table 1 : Flotation results under varying dosage of collector and frother

Sl.	Diesel kg/t	Kaba- kg/t	Conc. wt %	Conc'n Ash %	Tailing wt. %	Tailing Ash %	RNA	E1
1.0	1.75	0.35	60.2	14.6	39.8	65.9	79.1	356.8
2.0	1.25	0.35	56.4	14.2	43.6	61.9	74.4	324.6
3.0	1.75	0.25	55.2	14.0	44.8	60.9	73.0	317.6
4.0	1.25	0.25	59.6	15.5	40.4	63.8	77.5	318.8
5.0	1.15	0.30	60.1	16.5	39.9	62.9	77.2	294.2
6.0	1.85	0.30	57.2	14.1	42.8	62.9	75.6	337.4
7.0	1.50	0.23	57.2	13.2	42.8	64.1	76.4	371.1
8.0	1.50	0.35	57.4	13.9	42.6	63.4	76.0	347.0
9.0	1.50	0.30	59.0	14.7	41.0	64.2	77.4	338.2
10.0	1.50	0.30	58.4	14.5	41.6	63.8	76.8	337.9
11.0	1.50	0.30	59.2	14.5	40.8	64.7	77.9	347.7
12.0	1.50	0.30	58.3	14.6	41.7	63.5	76.6	333.3
13.0	1.50	0.30	57.1	14.2	42.9	62.7	75.4	332.7

Table 2 : Flotation results with timed collection of froth product

Concentrate	Wt %	Ash %
Time, sec		
0-15	35.0	14.3
15-30	15.1	14.5
30-60	9.2	15.5
60-120	1.3	33.0
120-240	0.7	39.0
Tailing	38.7	65.4
Re-calculated feed	100.0	34.6

The results obtained, from the laboratory were used to operate and scale up flotation circuit at CFRI Pilot Plant (earlier cap. 40kg/hr.) and subsequently to 400 kg/hr. Now this flotation technique established commercially at M/s Tetulia Coke Plant (P) Ltd, Dhanbad, M/s Jai Maa Kali Udyog LTD, Dhanbad, and

M/s Arun Coke (P) LTD, Chirkunda, Dhanbad, where the input capacity is 5 to 10tph. The flowsheet of the plant is shown in Fig. 1.The salient features of the mini flotation plant are as follows.

Novelty

The novelty of the process are listed below :

- Superior design of flotation cell with self suction of input slurry from conditioner
- Provision of secondary feeding for retreatment of froth/tailings.
- Pulp level control in each flotation cell.
- Use of synthetic frother (KABAKOL) and diesel oil as collector.
- Special emulsifier (low powered) designed and fabricated at CFRI.
- Belt discharge type vacuum filter.
- Gravity filtration tank for drying of tailings for use in briquette making, brick burning, etc.
- Complete closed water circuit process.
- Air, dust, sound and water pollution within permissible limit.

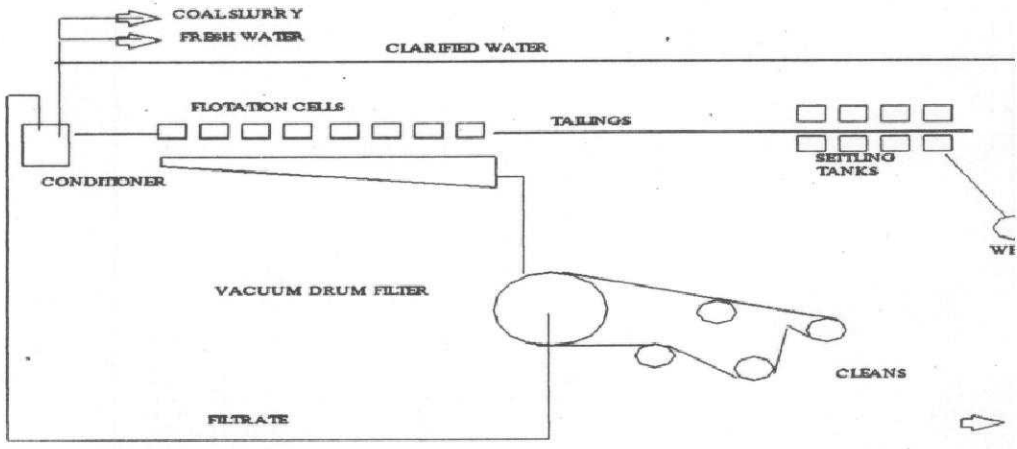

Fig. 1 : Coal slurry flotation plant

CONCLUSION

1. Slurry pond fines can be beneficiated to use in steel plant as one of the constitutes of the coke-blend.
2. Being an environmental-friendly system, the concept of mini flotation plant is useful and attractive.

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