



TECHNOLOGIES FOR FINE COAL BENEFICIATION IN INDIA

Dr. D.D.HALDAR

Deputy Director & Head, Coal Preparation Division

Central Institute of Mining & Fuel Research (Digwadih Campus)

Erstwhile Central Fuel Research Institute

DHANBAD - JHARKHAND



INTRODUCTION

- ✓ **Indian coals, in general are inferior in quality and difficult in cleaning characteristics.**
- ✓ **Due to 'Drift Origin', the coals contain inherent mineral matter or contaminates.**
- ✓ **The Erstwhile CFRI ever since its inception in 1946 has been campaigning for establishment of large Coal Preparation plants to upgrade inferior coking coals for steel making.**
- ✓ **Upgradation of coal fines and dewatering of clean concentrates is the real problem of coal preparation in India.**
- ✓ **The Beneficiation circuit of the washing plants installed in 1960's did not include coal fines upgradation due to their acceptable quality.**
- ✓ **The depletion of good quality reserves and deterioration of quality due to open cast mines called for coal fines upgradation containing high ash.**
- ✓ **The coal fines are normally enriched with vitrinite, a component to increase the coking propensity and hence their presence in total cleans is essential.**



INDIAN SCENARIO OF COKING COAL PLANTS

- ✓ Prior to 1950, there were no Beneficiation plants, since selective mining was in practice.
- ✓ The first Indian coal washery was set up at West Bokaro in 1951, followed by the second one installed at Jamadoba in 1952 – both by M/s Tata Iron and Steel Limited. The third washery came up at Lodna colliery by M/s Turner Morrison in 1955. A large washery in the public sector was commissioned at Kargali by NCDC in 1958.
- ✓ Five Central washeries were set up by Hindustan Steel Limited on the recommendation of coal washeries committee during the period from 1960 to 1968.
- ✓ The Durgapur Washery of DPL and Chasnalla Washery of Indian Iron and Steel Co. was installed in the year 1968.
- ✓ In 70's NCDC (now CCL) installed three more pithead washereis at Kathara, Swang and Gidi for the upgrading of medium coking coal.

Contd.....



- ✓ After Nationalization of coal mines in 1972, Pithead washeries in the Jharia coalfield have been installed at Sudamdih and Moonidih, each with a throughput capacity of 700 tph.
- ✓ The Rajrappa washery (CCL) has been commissioned in 1988 to beneficiate medium coking coals with the latest equipment and instruments.
- ✓ A demonstration plant of 100-tph throughput capacity was set up in 1984 at Barora (BCCL) to beneficiate difficult-to-wash Prime Coking coal.
- ✓ Two more washeries came into existence at Nandan (WCL) and Mahuda (BCCL) in mid eighties. Bhelatand washery of TISCO was commissioned in 1994.
- ✓ Two more washeries Madhuban (BCCL) and Kedla (CCL) were installed in mid-nineties for treating coking coals.



PROBLEMS IN EXISTING COAL BENEFICIATION PLANTS

- **Increased production from Lower Seams.**
- **Enhanced supplies from mechanical opencast mine consisting considerable proportions of free dirt, boulders and other lumpy extraneous materials.**
- **Increased proportions of fines below 0.5 mm in the feed**
- **Change in the seam wise composition in feed with the inclusion of lower horizons, the generation of sinks material has increased considerably leading to operational problems in the circuit and lowering washery availability. This also poses handling and disposal problems.**



NEED & JUSTIFICATION OF TREATING COAL FINES

- ❖ **The Coal Beneficiation Plants installed in 1960's did not include coal fines circuit.**
- ❖ **The quality of fines were acceptable for blending with coarse coal cleans for producing metallurgical coke.**
- ❖ **The depletion of good quality coking coal reserves and inclusion of feed/fines from open cast mines, deteriorated the quality of fines.**
- ❖ **The ash content of the coal fines increased to 25% or even more, which had adverse effects if blended with coarse cleans.**
- ❖ **The coal fines are normally enriched with vitrinite, which is the important component responsible for increasing the coking propensity of the total cleans.**
- ❖ **Hence, the coal fines need to be up graded to the acceptable quality.**



INCORPORATION OF COAL FINES CIRCUITS IN WASHERIES

Sl. No.	Washery	Year of Installation	Washing system	Capacity (tph)	Manufacture	Remarks
<u>TATA</u>						
1	West Bokaro W-II	1981	Flotation	80	Dorr_Oliver	In Operation
2	West Bokaro W - III	1994	Flotation	100	OTOKUMPU	In Operation
3	Jamadoba	1982	Flotation	30	Dorr_Oliver	In Operation
4	Bhelatand	1994	Flotation	60	OTOKUMPU	In Operation
<u>BCCL</u>						
5	Dugda -I	1986	Flotation	100	Denver	Non Coking coal washing
6	Bhojudih	2001	Flotation	100	Denver	In Operation
7	Dugda – II	1986	Flotation	150	Denver	In Operation
8	Sudamadih	1981	Flotation	100	OTOKUMPU	Not in operation
9	Moonidih	1983	W.O.C.	100	MAMC	In operation

Contd.....



Sl. No.	Washery	Year of Installation	Washing system	Capacity (tph)	Manufacture	Remarks
10	Barora	1981	Flotation	250	OTOKUMPU	Not in operation
11	Mohuda	1990	Flotation	32	OTOKUMPU	Not in operation
12	Madhuban	2000	Flotation	100	Dorr-Olivir	Non Coking coal washing
	<u>CCL</u>					
13	Kargali	1978	W.O.C.	75	West Germany	Non Coking coal washing
14	Kathara	1969	Flotation	100	USSR	In operation
15	Swang	1970	W.O.C.	40	West Germany	In operation
16	Gidi	1970	Flotation	120	Poland	Non coking coal washing
17	Rajrappa	1988	Flotation	120	Denver	In operation
	<u>IISCO</u>					
18	Chasnalla	1990	Flotation	60	Dorr_Oliver	Not in operation



PROBLEMS IN COAL FINES CIRCUITS

It was observed that the general instability and overall poor performance of the flotation plant are due to: -

- ❖ Variation in pulp density of feed slurry
- ❖ Variation in quantity of slurry (cum/min) from thickener underflow
- ❖ Improper conditioning
- ❖ Inconsistency and poor quality of frother
- ❖ No provision for multiple dosing
- ❖ Less solids content and higher proportion of ultra fine particles (- 0.053 mm) in concentrate
- ❖ Poor recovery of cakes from vacuum filter.



CFRI CONTRIBUTION ON BENEFICIATION OF COAL FINES

CFRI has been working on the treatment of coal fines/finely ground high ash coals/Middlings for a long time.

The Institute has developed the following processes to meet the requirement of the coal based industries mainly the Steel Industries

- ◆ **Improved Froth flotation Process**
- ◆ **Oleo flotation Process**
- ◆ **Oil Agglomeration Process**



Improved Froth flotation Process

1. **CFRI has developed an Improved Flotation Process for the beneficiation of high ash coal slurry.**
2. **The process can recover finest cleans (less than 15% ash) from Indian coal slurry.**
3. **This is a cost effective process for beneficiating high ash coking coal fines**
4. **Three Flotation Plants having 10-15 tph capacity plants have been installed by Private firms on CFRI Process**



Novelty of the Process

- ❖ Flotation cell with self suction of input slurry from conditioner.
- ❖ Provision of secondary feeding for re-treatment of froth/tailings.
- ❖ Pulp level control in each flotation cell.
- ❖ Low powered emulsifier fabricated at CFRI.
- ❖ Belt discharge type vacuum filter
- ❖ Gravity filtration/settling tank for dewatering of tailings for use in briquette making, brick burning, etc.
- ❖ Completely closed water circuit process.
- ❖ No air or water pollution.



Oleo Flotation Process

- ❖ **Oleo Flotation Process has been developed at CFRI for the beneficiation of Natural slurry and dewatering of concentrate with cyclone cleans in centrifuge.**
- ❖ **The thick slurry is conditioned with two reagents comprising diesel oil and fraction of tar oil.**
- ❖ **The conditioned pulp after dilution is treated in flotation cells with controlled aeration to separate concentrate as oil flocs.**
- ❖ **After partial removal of water, the concentrate is mixed with over size cyclone cleans.**



- ❖ **The combined clean coals are dewatered in centrifuge.**
- ❖ **The final product is having moisture content of 6-8%.**
- ❖ **The process provides for cleaning and dewatering of coal fines to the acceptable limit in terms of ash and moisture content.**
- ❖ **Oleo flotation pilot plant of 20 tph capacity with around 40 tph dewatering arrangements of combined cleans has been set up in the Sudamdih washery of BCCL.**



Oil Agglomeration Process

- ★ CFRI developed an emerging process called “Oil-Agglomeration” for the effective beneficiation of coal fines, finely ground high ash coals and washery middlings. The process has three distinct merits
- ★ High yield of cleans with very low loss of carbonaceous matter through tailings.
- ★ Easy dewatering characteristics of cleans and
- ★ Improvements in the coking propensities of the cleans.
- ★ Coal fines or finely ground high ash coal / middlings in thicken slurry under controlled pH are agitated in a suitable designed conditioning vessel with mineral oil



- ★ The coal particles get preferentially coated with thin layer of oil.
- ★ These selectively coal particles along with non-combustibles and water are agitated in an agglomeration cell in presence of agglomerating oil.
- ★ Clean coal particles form dense, compact and spherical agglomerates and mineral matter remain dispersed in water;
- ★ These materials (agglomerates and tailings) are passed over a bent sieve followed by a vibrating screen.



The agglomerates being bigger in size are separated and collected and the water carrying the mineral matter passes through the aperture of the screen.

- ★ The process provides an attractive method of beneficiation and dewatering.**
- ★ The process has been successfully demonstrated in a 2 tph plant at Lodna, BCCL.**
- ★ A 10 tph demonstration module was installed and commissioned at Patherdih washery, BCCL.**



FINE COAL TREATMENT PILOT PLANT (FCTPP)

Installed and Commissioned in the year 2004

Modern Fine Coal Treatment Pilot Plant with on line instruments and PL control comprise the following facilities/circuits :

- Experimental Batch Rotary Breaker, 3.5 m dia
- **Primary Crushers (in closed circuit)**
- Closed circuit Secondary Crushing House
- **Size classification equipment (Screens and Hydro Cyclone Classifier)**
- 200mm HM Cyclone Unit
- **Spiral 1 m dia.**
- A battery of Flotation Cells with dewatering devices
- **Oil agglomeration unit**
- Grinding Mills



OTHER TECHNOLOGIES FOR FINE COAL BENEFICIATION

Some of the other technologies, which are emerging for fine coal beneficiation are as follows:

- Column Flotation
- **Spiral**
- Jameson Cell
- **Kelsy Jig**
- Multi-Gravity Separator
- **Knelson Separator**
- Falcon Separator
- **Water Only Cyclone**



CONCLUSIONS

- ✓ The beneficiation circuits incorporated in the existing Coal preparation plants in India for the upgradation of coal fines have been discussed.
- ✓ It reveals that the circuits are not producing clean concentrates of desired quality and quantity.
- ✓ **Beneficiation of coal fines containing enriched vitrinite is essential to maintain the quality of metallurgical coke.**
- ✓ Attention needs to be paid to revamp/renovate the fine coal circuits for producing the desired quality products.

THANK YOU