VOLUME I

September 2009

CPSI JOURNAL

A MAGAZINE BY THE COAL PREPARATION SOCIETY OF INDIA

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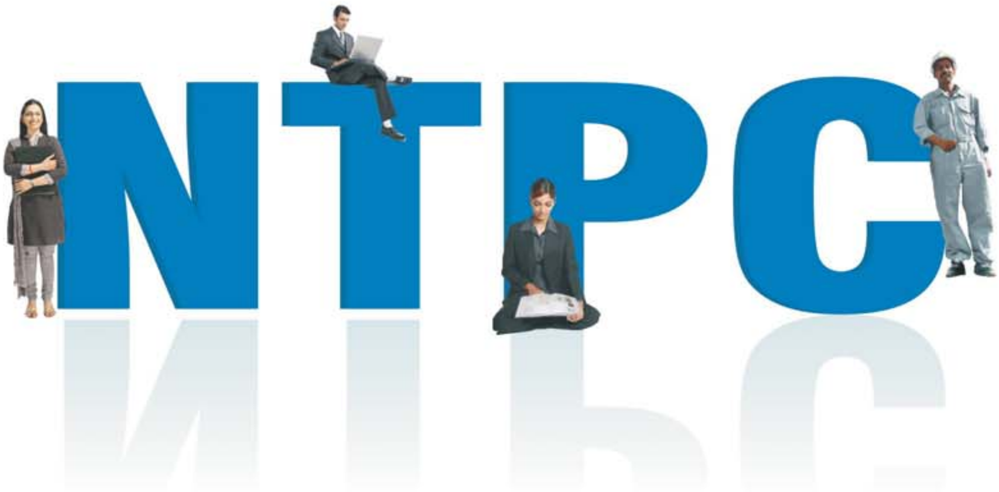

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CPSI JOURNAL
VOLUME - I, Issue - I, SEPTEMBER 2009

Contents

From the President

On behalf of all the members of **Coal Preparation Society of India (CPSI),** *I would like to present our Society Journal to you. In three years from the date of its formation, I have had the privilege to invite many experts from across the coal industry to come and join CPSI. It must be mentioned that the overwhelming response has shown the quickest possible memberships and the desire to such an initiative, that I have seen in my entire career in the coal industry. It only prompts me to thank each one of you who has decided to become a member of CPSI and encourage the founding aims and objectives of this society. It has been and shall remain my sincere objective to reach out to as many people in the coal industry and invite them to join the society, and, in turn add value to the efforts that we have already initiated, and, with your help will provide the right momentum of growth CPSI.*

Another attempt in the popularization of CPSI, in that the society board had decided to issue its in-house journal, keeping in view, all aspects of service CPSI should provide its members and the industry. The Journal shall make all possible attempts to provide all relevant information about coal industry activities as well as make catalytic attempts in bringing about enhancement in the Indian coal Industry and keep you updated with the coal industry.

I would like to thank and congratulate all CPSI members & editorial team of Coal Preparation for bringing out such a unique Journal specially dedicated to Coal Preparation industry of the Country.

Last but not the least your suggestions on how to make CPSI Journal more productive in terms of knowledge sharing, and the role it would play in the enhancement of the coal industry shall always be welcome.

Thanking You

R. K. Sachdev

CPSI Journal also welcomes readers' comments, letters to the editors,and articles on the topical issues. Interesting events, photographs and news are also welcome. Please post your comments at e.mail Id infodesk@cpsi.org.in

For more details about CPSI & regarding membership please log on to www.cpsi.org.in

Published by Coal Preparation Society of India, New Delhi, www.cpsi.org.in

ABOUT CPSI

While the research on washing of coking coal from Jharia coalfield had started around 1911-12, history of establishment of coal washeries in India dates back to early nineteen fifties. Coal washeries at Lodna, Kargali, Nowrozabad, Jamadoba and West Bokaro were among the earliest plants set up in the country. Establishment of four central coal washeries in Jharia coalfield quickly followed it. While all metallurgical coals have been washed as a technological necessity to bring the ash content below 17%, washing of non-coking or thermal coal 'to wash or not to wash' has been debated since 1978. Several committees set up by the government between 1978 and 2003 recommended washing of coal for power plants. Pending a consensus on the issue, government's mandate to the power plants located beyond 1000 km from the coal supply source and also to those located in urban and environmentally sensitive areas to use coal with ash content below 34% was enforced from 1st June 2002.

It is a well-recognized fact that a strong domestic coal production and delivery system is imperative if the country has to achieve the goal of energy self-sufficiency and long-term energy security.

Established in November 2000, Coal Preparation Society of India (CPSI) is a non-governmental and non-profit body of coal washing, coal mining and allied professionals. As a professional body, we are dedicated towards promotion of beneficiation of Indian coal with a view to making it an environmentally acceptable energy source. CPSI is a Member of the International Organizing Committee of the International Coal Preparation Congress (ICPC).

Our membership is very broad-based and we always endeavor to provide an independent platform for deliberating various critical issues relating to coal washing and allied subjects. Our aim is to provide an independent and neutral expert opinion to the industry as well as to the government, as and when called upon to do so.

EDITORIAL NOTE

To excel in any endeavour the main mantra is giving true value to the customer by meeting the demand for any product in terms of quantity, quality and its timely delivery. The same is true for coal whose demand continues to grow because of its abundance and comparative low cost (compared to known hydrocarbon resources) due to which it has acquired a prime position in the country's projected energy mix.

As will be evident from the articles in this inaugural issue of CPSI Journal, all of which have been written by practising specialists and managers, the focus is on innovation, cost reduction, simplification of flow-sheets and finally, value addition through coal preparation, keeping the end-use as the target.

In the heydays of socialistic monopolization making coal a seller's market (which continues to be so despite competition from imports) there was an aphorism ABC (Anything Black is Coal) concept of Quality. With the advent of the LPG (Liberalisation, Privatisation & Globalisation) era where market is to act as the leveler for such aberrations consistency of quality has started finding true meaning.

The alibi of geological basis of high ash low calorie (due to drift origin of coal formation) cannot be used as an eyewash to the consumers since we have the technology, expertise and resources to beneficiate coal to the level where it can meet customer needs. The need of the hour is the will and action by the coal sector to become more customer friendly.

To spur creativity, foster professionalism and encourage R&D and innovation CPSI, under the inspiring leadership of stalwarts like Shri G L Tandon, Padma Bhushan & Shri R K Sachdev, CPSI's President and one of its founding fathers now makes a modest gesture of publishing the maiden issue of its journal.

We are honoured and privileged to put it into your hands and expect with positive hope that you will own it and encourage its growth in true professional spirit.

Ramakant Tiwari

Mukesh Kumar

श्रीप्रकाश जायसवाल
SRIPRAKASH JAISWAL

राज्य मंत्री (स्वतंत्र प्रभार)
कोयला एवं सांख्यिकी और कार्यक्रम कार्यान्वयन मंत्रालय
भारत सरकार
शास्त्री भवन, नई दिल्ली–110001

MINISTER OF STATE (INDEPENDENT CHARGE)
MINISTRY OF COAL AND STATISTICS &
PROGRAMME IMPLEMENTATION
GOVERNMENT OF INDIA
SHASTRI BHAVAN, NEW DELHI - 110001

Message

I am really happy to note that the Coal Preparation Society of India (CPSI) is organizing a one-day Conference on Coal Preparation in India - Issues and Challenges on 12 September 2009 at SCOPE Complex, New Delhi.

According to me, quality is an important link in the process of coal production and delivery in the country. It is commendable that the CPSI is taking the initiative or organizing a conference on an important and topical theme particularly in the backdrop of Coal India's decision to set up a number of coal washeries at their various mines for supply of coal of assured quality to all consumers.

I am sure the deliberations in this conference would result in bringing out important recommendations on the issues and challenges facing the coal industry today for the consideration of the Government.

I wish the Coal Preparation Society of India grand success in its efforts in bringing all stakeholders together on a common independent platform to discuss issues concerning the supply of quality coal to consumers.

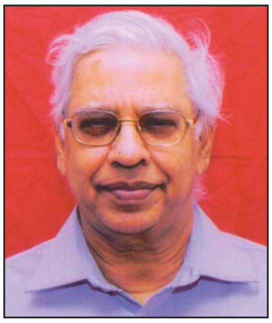
New Delhi
4 August, 2009

(SRIPRAKASH JAISWAL)

बी.के.च तुर्वेदी
B.K. CHATURVEDI

सदस्य
योजनाअ ायोग
योजनाभ ावन
नईदिल्ली–110001
MEMBER
PLANNING COMMISSION
YOJNA BHAWAN
NEW DELHI - 110001

11th August, 2009



Message

I am very happy that the Coal Preparation Society of India (CPSI) is organizing a Conference on 'Coal Preparation in India – Issues and Challenges' on 12th September, 2009 at New Delhi.

Our country's power production is heavily dependent on coal. Therefore, the quality of coal for thermal power plants is an important aspect of the coal supply chain.

I congratulate CPSI for taking the initiative of organizing a conference on an important and topical theme of coal beneficiation.

I wish the Coal Preparation Society of India a success in its efforts in promoting coal washing practices and technologies in the coal industry.

(B.K. Chaturvedi)

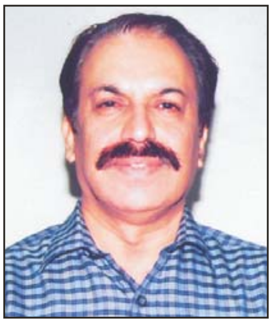
एस.पी.स`ठ
S. P. SETH

सत्यमेव जयते

विशेषस चिव
भारतस रकार
कोयलाम ंत्रालय
शास्त्रीभ ावन,न ईद िल्ली

SPECIAL SECRETARY
GOVERNMENT OF INDIA
MINISTRY OF COAL
SHASTRI BHAWAN, NEW DELHI

31st August, 2009



Message

I am very happy to know about the Conference being organized by the Coal Preparation Society of India on **"Coal Preparation in India – Issues and challenges"** on 12th September'09 at New Delhi.

Ministry of Coal always supports all efforts of the coal industry that lead to supply of coal of standardised specifications to meet the requirements of all customers particularly the power plants.

I am confident that the efforts being made by the Coal Preparation Society of India in promoting coal beneficiation will go a long way in improving the efficiency of coal supply chain in the country.

I wish you a grand success in organising this important conference.

(S.P. Seth)

पार्थए स.भ ट्टाचार्या
Partha S. Bhattacharyya
Chairman

कोलइ ण्डिया लिमिटेड
COAL INDIA LIMITED
(A Govt. of India Undertaking)
Scope Minar, Core 1 & 2,
4th & 5th Floor, Laxmi Nagar,
Delhi - 110092

August 24, 2009

Message

I am very happy to know that the Coal Preparation Society of India is organizing a one-day Conference on **'Coal Preparation in India – issues and challenges'** on 12th September 2009 at New Delhi.

Coal quality and customer satisfaction are among the high priority areas for Coal India and to meet these objectives in a holistic manner, CIL has already initiated action to establish 19 coal washeries for a total throughput capacity of over 100 million tonnes per year, on Build Operate and Maintain (BOM) format in next four years. Therefore, the theme of this conference is most appropriate and also is being organised at a very appropriate time.

I am sure, the deliberations in this conference will bring out the issues that need to be addressed to make CIL's plan of setting up new washeries successful. Indian coal preparation industry would also greatly benefit from this conference.

I am particularly happy to note that the Coal Preparation Society of India is promoting coal beneficiation that would lead to improving the efficiency of coal combustion and lead to reduction in CO_2 emissions per unit of final out put of energy.

I wish the conference a grand success.

(P. S. BHATTACHARYYA)

High Efficiency Coal Preparation Process for Thermal Coal

— Hajime ENDO*, Nobuhiro KOYANAGI**
Yasuo KUBO***

Synopsis

JCOAL (Japan Coal Energy Center) has been carrying out a coal preparation technology transfer program to Asian coal producing countries entrusted by Japanese governmental funds since 1994. This paper will introduce the improved VARI-WAVE jig with a variable wave pattern system and automatic discharging reject control, which has performed excellently in Vietnam and in a Japanese coal preparation plant. The VARI-WAVE jig has also been introduced in India and production will commence in the third quarter of 2010.

1. Coal in Japan

Japan is the world's biggest importer of coal. Coal imports reached 178 million tons including thermal and coking coal in 2006, which is equivalent to roughly one fourth of the coal volume traded worldwide. While coal has major environmental impact, coal is also the energy source offering the greatest stability for price and supply among all fossil fuels. Coal-using economies using coal in a cleaner manner in the future is therefore of paramount importance. In this context, CCT, especially pre-combustion CCT such as coal preparation technology, has the greatest investment effect and is therefore of great importance as CCT. We therefore need a clear strategy to promote the widest possible diffusion of this technology to coal producing developing countries for Sustainable Clean Coal Technology.

2. Japanese coal technology

Before introducing VARI-WAVE jig technology as a Japanese coal preparation technology, the background of Japanese coal technology should be explained to show why coal technology is so active while Japanese domestic coal production only accounts for 1% of the demand now. There were over 600 coal mines, mainly U/G coal mines, and about 50 coal preparation plants in Japan that produced about 55 Mt until approximately 40 years ago. The major features of coal in Japan are the many kinds of coal properties ranging from lignite to anthracite, including thermal coal and coking coal, having coal almost the same as around the world in spite of the limited coal resources in Japan. Japan was a specimen box of coal as well as other minerals. Japan also had experience producing coal with near gravity like typical Indian coal.

The progress of coal preparation technology depends on developing new machines and the progress of materials, but building up experience in processing more the ROM characteristic is important.

3. Vari-Wave jig

The results of the basic study of the jig wave pattern were presented at the 12th International Coal Preparation Congress Cracow, Poland in 1994 and concluded that a trapezoidal wave pattern is the most effective in jig operation. The first VARI-WAVE jig equipped variable wave

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pattern control system was designed by Nagata Seisakusho Co., Ltd., which is the former Nagata Engineering Co., Ltd, and was used in Japan from 1997. All CCP jigs in Japan were remodeled into the VARI-WAVE type jig. By now, the VARI-WAVE jig has been introduced in China, Vietnam, and Indonesia and is under construction now as a model project using NEDO funds to demonstrate proof at the Talcher coal field in India.

The VARI-WAVE type air pulsated jig improved the ordinary jig with two particular features to distinguish it. The first is that the pulsation wave pattern can be varied in accordance with the raw coal properties. The trapezoidal waveform in Fig. 1 has a particular advantage over the Sine curve that is the normal wave pattern: The washing capacity with the same screen area can be increased or the separation accuracy enhanced with same washing capacity. The second is that the automatic reject discharging system is provided with a function that maintains the thickness of the reject bed constant in Fig. 2. Thanks to these features, the imperfection value as a measure of the separation accuracy is shown in Fig. 3. This helps to upgrade the coal yield about 3% as compared with using the existing type jig with the Sine curve, given the same raw coal.

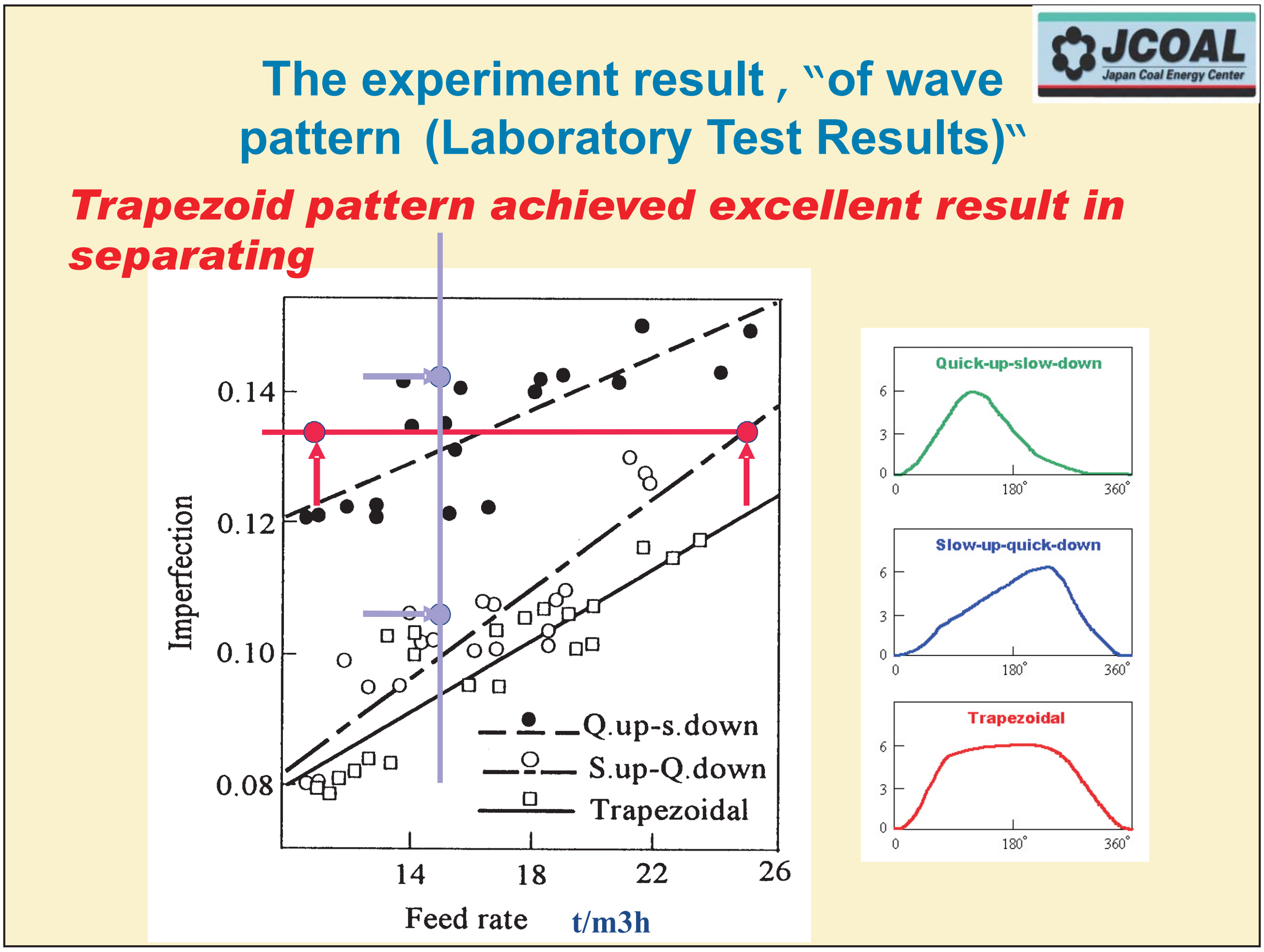

Figure - 1

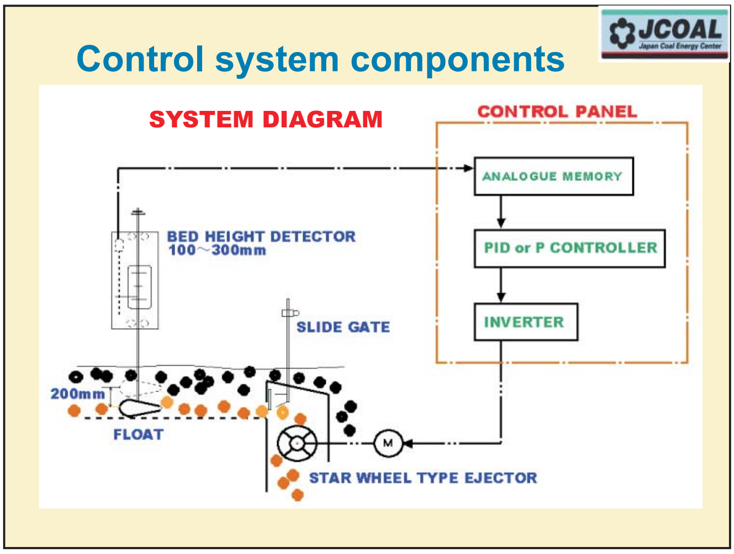

Figure - 2

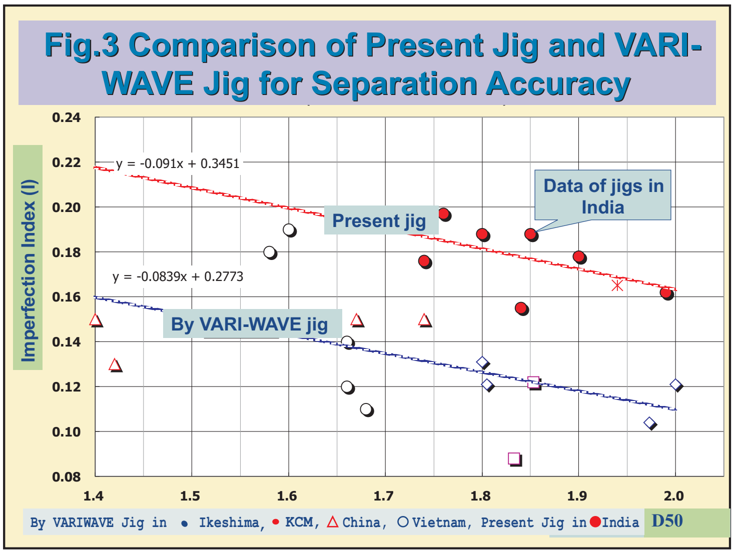

Figure - 3

4. Model project in India

Jig capacity	400 t/h
Max. plant throughput	400 x 6,000 hr = 2.4 Mt/year
Washed coal	Non-coking coal having 34% ash content
Clean coal yield	71.4% at 43% ash content of ROM
Imperfection value	I = - 0.0839 x Dp + 0.2773, Dp: Specific gravity of separation
ROM	Utkal B2 coal block of Monnet Ispat & Energy Ltd.
Washed coal	525 MW TPS of Monnet Ispat & Energy Ltd.

Coal Preparation for Sustaining Generation and Improving Efficiency - Selection of Coals for Blending as a Coal Preparation Option

— B P Singh*

Abstract

Run of Mine (ROM) coal, is a form produced from underground or surface mines, is rarely suitable for use without some kind of processing. Barring India, world over, most of the major coal-producers indulge in Coal Beneficiation/ preparation to meet quality specifications of the consumer. In India, the scenario is just the reverse, where the customer is required to design its plant to use the quality of coal being produced.

Over the last two decades, with increasing thrust on Open Cast mining and use of more-productive but less-selective, mechanized mining methods has led to deterioration in quality of ROM coal, necessitating need for beneficiation of coal to sustain optimal level of performance by the end user.

Besides economic considerations, there are also environmental compulsions to prepare the coal depending on the specific application i.e., stringent norms on SO2, CO2 and particulate emissions; ash disposal requirements etc.

In the absence of adequate Coal preparation facilities at the coal production end, there is an increasing trend for blending of coal as an option to maintain the quality of coal for the very survival of the utility sector.

With the ever widening gap between domestic coal supply & demand, supplementing of supplies through imports is becoming a bare necessity. However, there are technical issues that need to be considered before adopting the blending technology.

In this paper an attempt has been made to address the technical aspects of blending coal for making the end product usable for the power plants, which interallia involves looking into not only the conventional coal properties like ash and calorific value of coal but some of the non additive coal properties like coal reactivity, ash fusion characteristics, HGI, ABI, swelling index etc.

1. Introduction

Coal remains the predominant source of fossil energy in India and this scenario is likely to remain in the foreseeable future. The quality of coal is gradually deteriorating and affecting its efficient utilization for power generation. Large scale non selective mechanical mining is the single largest contributor for the deteriorating coal quality. Over the last two decades, while the Ash content in Indian coal has increased from 30 to 35% range to 40-45%, the calorific value has declined from 3800 - 4500 Kcal/kg level to 2800-3800kcal/kg level.

Efficient utilization of the available domestic resource required its upgradation. While coal beneficiation/washing is the most accepted method for upgradation of coal quality, however, same is coupled with many other associated issues like availability of land & water, disposal of rejects etc.

There are several for & against each of the options i.e., coal washing and blending, however, considering the pressing needs, blending of available coal with low ash, high calorific value imported coal is currently gaining priority for improving coal quality and are likely to increase many fold in near future to actualize our ambitious capacity addition plans.

* Director (Projects), NTPC Ltd.

Blending of dissimilar coals, however, is not a simple proposition and calls for creation of proper blending facilities. It is not possible to lay/adopt a single uniform technology to attain the desired blend. It calls for reviewing the scientific, technological and other issues involved in coal blending for efficient green power generation.

2. Coal blending - The practices in vogue

Successful blending needs proper mixing and homogenization of coal. Each particle of coal enters the boiler furnace as a separate entity. If coal is not mixed properly, it may cause unstable combustion due to stratification and segregation of coal particles, resulting in flame fluctuation and combustible loss etc.

The most commonly used blending practices involve blending in stack and blending in moving conveyer belt. The process is based on stacking of different coals in horizontal layers in a predefined sequence as per required blending ratio with the help of stacker. The stacked coal is reclaimed in perpendicular direction. While more closely spaced layers will result in better blend / mix, however, in actual practice it is difficult to construct such coal stacks.

As an improvised modification over this system, creation of two independent coal stacks of varying quantity and simultaneous reclamation of coal from such stacks in desired proportion is the most widely used method of blending coal. The mixing of coal takes place at a transfer point and finally in mills through feeder during pulverization. This technique results in higher operating cost of CHP

3. Coal quality considerations

All the coal quality parameters are not additive. Therefore weighted average of quality parameters of different coals may not exactly translate into property of the blended coal. While most of the coal quality parameters pertaining to chemical characteristics such as moisture, ash, volatile matter, fixed carbon, calorific value etc., are of additive nature, however, the combustion reactivity, ash fusion behavior, Hardgrove grindability index, Abrasive index, swelling characteristics etc., do not depict additive properties. Quality of component coals to be blended and quality of resulting blends thus needs be studied to ensure success in blended coal firing in power station

4. Laboratory Studies

To see the effect of blending on coal properties laboratory scale study was conducted. For the study purpose, three low ash coals (CL-1 to CL-3) and three high ash coals (CH-1 to CH-3) were collected. Out of the six coals collected CL-3 was imported coal, whereas other five coals were indigenous coals.

For preparing blends, proximate parameters of individual coals were determined. Based on the ash content of individual coal, each high ash coal was mixed in required proportion with each low ash coal to give blends of 34% ash content. Properties of individual coals and blends were characterized.

4.1 Proximate Analysis & GCV

The proximate analysis was carried out as per BIS1350. Gross calorific values determined using Leco's bomb calorimeter as per ASTM D3286. The findings of laboratory scale tests are tabulated as under:

Table 1 : Proximate analysis and GCV (air dried) of individual coals

Coal	Moisture (%)	Ash (%)	VM (%)	FC (%)	GCV (kcal/kg)
CL-1	4.9	19.4	31.0	44.9	5068
CL-2	2.1	24.0	34.0	39.9	5353
CL-3	4.1	4.0	42.9	46.9	6907
CH-1	2.7	39.4	24.5	33.5	4167
CH-2	4.1	42.8	25.5	27.6	3792
CH-3	3.8	44.4	23.5	28.5	3649

Table 2 : Proximate analysis and GCV (air dried) of blends

Coal	Moisture (%)	Ash (%)	VM (%)	FC (%)	GCV (kcal/kg)
CL-1+CH-1	3.6	33.9	28.1	34.4	4421
CL-1+ CH-2	4.9	33.9	27.1	34.1	4272
CL-1 + CH-3	4.5	34.0	26.7	34.8	4232
CL-2+CH-1	3.4	33.9	27.6	35.1	4597
CL-2+ CH-2	3.8	34.0	29.5	32.7	4536
CL-2 + CH-3	3.6	34.4	27.7	34.4	4482
CL-3+CH-1	2.6	33.9	29.1	34.5	4578
CL-3+ CH-2	4.7	33.9	30.2	31.2	4488
CL-3 + CH-3	4.3	33.8	29.3	32.6	4482

Comparison proximate and GCV data of individual and blended coals shows these properties are of additive nature and simply weighted average of such properties of the individual coals can predict the properties of blended coal. Thus proximate ash and GCV of component coals can be used as guide for determination of mixing ratio for obtaining blend of a desired ash or GCV.

4.2 *Ash Fusion Characteristics*

Ash fusion behavior of coal depends on mineral matter composition and content. While mineral matter content & composition of blended coals may be additive in nature, the same may not true for ash fusion behavior of blends.

The results of fusion temperatures of laboratory prepared coal blends and individual coals, measured using Leitz's heating microscope are as under:

Table 3 : Ash fusion temperature (°C) of individual coal

COAL	Temperatures in °C			
	ITD	Softe-ing	Hemis-pherical	Fluid
CL-1	1240	1560	1585	1600
CL-2	1100	1370	1400	1430
CL-3	1160	1400	1430	1450
CH-1	1320	1630	>1650	>1650
CH-2	1240	1570	1590	1615
CH-3	1320	1620	1640	>1650

Table 4 : Ash fusion temperature (°C) of Blended coal

COAL	Temperatures in °C			
	ITD	Softe-ing	Hemis-pherical	Fluid
CL-1+CH-1	1300	1615	1625	1640
CL-1+ CH-2	1240	1560	1585	1600
CL-1 + CH-3	1300	1620	1630	1640
CL-2+CH-1	1270	1590	1600	1620
CL-2+ CH-2	1210	1520	1530	1560
CL-2 + CH-3	1260	1560	1580	1605
CL-3+CH-1	1260	1590	1645	>1650
CL-3+ CH-2	1250	1550	1560	1600
CL-3 + CH-3	1300	1610	1620	1645

Data depicts that CL-2 and CL-3 have lower softening temperature and are prone to slagging. However softening temperatures of all the blends are well above maximum furnace temperature (1400° C -1450° C).

Although the coal blend under laboratory conditions does not depict any slagging problem, however, this situation will only replicate so long the blend is proper and component coals do not segregate before burning in boiler furnace. It is a known fact that slagging generally causes problems like (i) build up on walls that can't be removed by soot blowing, thus insulating the water walls, thereby reducing the ability to raise steam and require super heater spray; (ii) Increased corrosion and (iii) Slag once formed, can fall into the bottom of the furnace, causing damage to tubes and hopper blockage.

Thus, for any blending process, it is necessary to measure Ash fusion temperature of blended coals to determine their slagging propensity.

4.3 Hardness

Hardgrove grindability index (HGI) is a measuring scale of coal hardness. HGI is an important parameter which has major influence on coal blending. Wide difference in coal hardness may result in selective grinding of one coal over the other and segregation of coal particles. This may result in separate burning of component coal particles of blends in furnace and it will be difficult to control operating parameters, thereby resulting in inefficient combustion and causing slagging problem.

Table 5 : Hard grove grindability index of coals

Coal	CL-1	CL-2	CL-3	CH-1	CH-2	CH-3
HGI	77	61	44	66	59	77

Blending of two different coals with variations in HGI, may lead to selective grinding resulting in segregation of individual coal particles and causing combustion problem. This aspect cannot be observed in static laboratory combustion studies. Therefore, before selecting coal for blending, HGI values must be ascertained and given due consideration.

4.4 Swelling Index

Swelling indices determines the swelling propensity of coal at high temperature. It is also a non additive property. Use of low ash coal, having swelling characteristic, if used for blending may result in swelling of coal particles in furnace before burning and even agglomerate with non swelling coal particles. This can result in increase in particle size which in turn may result in delayed combustion - one of the important reasons for unburned carbon loss is bottom ash.

4.5 Combustion Reactivity

Combustion of coal depends on coal reactivity. Different coals have different combustion reactivity depending on the formation period of coal. Generally, low ash high carbon matured coals, are less reactive. Hence for blending coal, it is a prime requirement that the reactivity of individual coal must not differ much. In such an event combustion of coal particles will be affected in boiler furnace leading to flame fluctuation, thermal instability and combustible losses.

In laboratory test, on combustion reactivity of coal blends depicted that burning profiles of some of the blends are not compatible with respect to combustion reactivity.

5. To Sum up

- Any coal in any proportion cannot be blended for use in thermal power station.
- The efficient utilization of blended coal will not only depend upon the efficacy of blending but also the compatibility of coal characteristics.
- Proper selection of coals for blending and optimization of blending ratio will need to be established through scientific studies.
- Therefore, pre-investigation of individual coal properties as well as properties of blends will be necessary to decide upon a proper blend. These properties include HGI, combustion reactivity, ash fusion behavior and swelling characteristics of coal.
- Once the above exercise is completed, blending of low ash imported coal with high ash domestic coal can provide a ready option for efficient utilization of available inferior quality domestic coal and also a ready solution to bridge the demand supply gap.

Coal Washing In India : Challenges Ahead

— A. N. Sahay

1.0 Introduction

All fossil fuels including coal, which have taken three million years to form, have limited availability. Fossil fuels are the main source of energy world-over. Today 85% of primary energy comes from fossil sources (coal, oil, etc.), and their reserves are continually diminishing. India has significant coal reserves and its energy requirement is heavily dependant on coal. Although alternative sources of energy are being thought of on a large scale, coal is expected to remain the dominant fuel for power generation for decades to come. The power history of India reveals its dependence on coal. Around 70% of total domestic electrical energy is generated by coal-fired thermal power plants today.

The Indian power sector has witnessed a strong all round revival in the last five years. When India achieved freedom in 1947, the total installed capacity was just 1.4 Gig-watts. Today it is 148 GW. Propelled by accelerating economic growth, India's demand for power is likely to soar still farther by 2017; projected growth in generation capacity is likely to be more than doubled by then. Most of the capacity building initiatives underway focus on coal based thermal power plants. More than 80% of the capacity addition as commissioned in 2007 is coal-fired. Energy demand is bound to increase further over the years. This has necessitated coal production in the country to enhance accordingly.

The total non-coking coal production in the country has been estimated at about 650 Mty by the terminal year of XI plan, which includes around 104 Mty from captive mining. Target is immense. Most of the augmentation of additional production of coal will be low grade; approx 78% of total non-coking coal production will be either 'E', 'F' or 'G' grade coal. This calls for initiatives for quality upgradation by application of suitable coal preparation technology.

2.0 MoEF Regulation

Ministry of Environment and Forests, Government of India, in an endeavor to protect environment, notified that power houses located in the urban/ sensitive areas and also those located more than 1000 km from the pit heads should use coal, which is having ash below 34%. The 34% ash limit was fixed after studies done by Deutsche Montan Consulting (Germany) and Mott. MacDonald (UK), which indicated that Indian coal when cleaned to 34% ash, would, in general retain 95% or more of energy.

Table - 1 : Distance wise requirement of non-coking coal

DISTANCE	(Million tonnes)			
	1996-97	2001-02	2006-07	2009-10
Pit-head	70	109	128	155
< 500 Km	50	51	55	70
> 500 <1000 Km	30	30	47	60
> 1000 Km	50	95	170	215
TOTAL	**200**	**285**	**400**	**500**

The primary objective of the notification is lowering emission level from coal-fired thermal power plants; all the same, it naturally includes high efficiency and lot of auxiliary savings for power plants. As such, the notification may widen in future to include the power plants located within 1000 km of linked coal source. Coal

*Director (Technical), CMPDI & P.K. Baranwal, SE(E&M), CMPDI

India has decided to wash all low grade non-coking coal except those which are linked to pit-head power plants.

3.0 Plan Projection : Coal Production & Washing Capacity

Table - 2 : Requirement of washing capacity

	XI-Plan Projection
Particulars	Mty
Total Non-Coking Coal Production	650
Less Superior Grade Coal (Grade A to D)	143
Less Low Grade Linked to Pit-head TPPs	160
Less Captive Mining Coal Production	104
Remaining Coal (which is Low Grade)	243
Total Washing Cap at the start of XI Plan	103
Less Total Washing Cap as on date	112
Remaining Low Grade Coal to be Washed	131

The 650 Mty non-coking coal production projects by XI plan terminal year includes production of only 143 Mty coal of superior grades. The present total installed capacity for washing non-coking coal in the country is around 112 Mty, which was around 103 Mty at the start of XI plan. The pit-head linkages (160 Mty) and the captive mining coal production (104 Mty) don't fall under MoEF notification, as such, there will remain around 130 Mty low grade non-coking coal for which planning of Washeries is in progress. Advantage of using beneficiated coal for power generation is well-known and is not an issue any more.

Huge capital investment will be required for setting-up coal washeries of projected capacity. A 10 Mty washery requires around Rupees 180 to 200 Crores depending upon the degree of washing and technology adopted .

Coal washing is an important business, aiming at value addition to the poorly graded solid fossil fuel. Initially there was some indecision regarding who should take the onus of washing coal. Capital investment was probably the biggest constraint. Now, Coal India has come forward and decided to support the good cause of environment protection; it has already taken initiatives to set-up washeries on Build-Operate-Maintain (BOM) concept with capital funding from its own resource. I prefer to repeat that the task is gigantic. The beginning may find certain hurdles but we have to accept all challenges coming in the way for the success of good cause. We have taken certain initial leaps that will go a long way.

4.0 Initiatives for Non-coking Coal Washing & Challenges Ahead

Coal India is heading in a big way for beneficiation of all types of coals to reap the benefits of economics as well as environment. The washery capacity for non-coking coals has to cross over from present 112 Mt per year to 250 Mt per year. The concern of capex is taken care of by CIL to a greater extent. Other issues such as technology selection, reject disposal, reject utilization, availability of water etc. are challenges for the technocrats. All these should be addressed carefully. Under the policy initiative to set-up Washeries, different subsidiary companies of CIL have already taken initiatives to set-up coal washeries for non-coking coal on BOM concept (Refer Table-3). Three washeries, of total 6 Mty capacity in BCCL, four Washeries of total 19.5 Mty capacity in CCL, two Washeries of total 15 Mty capacity in SECL, four Washeries of total 40 Mty capacity in MCL and one washery of 5 Mty in WCL have been planned. They are in various stages of implementation/tendering. Besides two Washeries of 10.5 Mty capacity are being planned in ECL to avoid penalties being levied due to grade slippage.

Table- 3 : Proposed Non-coking Coal Washery Project

Sl. No.	Name of Washery Project	Company	Capacity in Mty
1	Chitra Washery	ECL	2.5
2	Sonepur Bazari *	ECL	8.0
3	Patherdih	BCCL	2.5
4	Bhojudih	BCCL	2.0
5	Dahibari	BCCL	1.6
6	Ashok Washery	CCL	10.0
7	Karo Washery	CCL	2.5
8	Konar Washery	CCL	3.5
9	Purnadih Washery (Piparwar)	CCL	3.5
10	Baroud Washery	SECL	5.0
11	Kusmunda Washery	SECL	10.0
12	Basundhara Washery	MCL	10.0
13	Hingula Washery	MCL	10.0
14	Jagannath Washery	MCL	10.0
15	Ib-valley Washery	MCL	10.0
16	Wardha Coal Washery	WCL	5.0
	Total		96.1

** tentative*

Consistency in quality of coal fed to consumers is their basic demand that can be met by routing the raw coals through Washeries. Coal washing adds value to low grade coals but it is cost intensive. Consumers now-a-days are ready to pay this extra cost. However, technocrats should utilize all their wisdom and knowledge with R&D back-up while selecting technology and washery circuit so that value addition can be achieved at most economical level that still supports consumers' economics.

The practice of coal beneficiation in India is largely based on wet technology for which requirement of water is quite large; approx 0.6 Million gallon fresh water per day may be required for a 10 Mty coal washery plant. Water is not available in plenty in coal bearing areas. It is a scarce resource. It won't be easy to get so much water from already-starved resources. Moreover, drainage from washeries is causing environmental concern to the nearby water bodies and natural streams, besides, loss of valuable fuels. Washery planners are facing difficulties in drawing water from natural resources, including ground water. So this is a big challenge and should be addressed in the beginning itself by suitable selection of technology, making the system closed-water circuit and less dependant on fresh water.

Dry beneficiation may be a suitable technological option. It is fast catching attention of coal preparation experts all over the world. Equipments on different technological options are available abroad but very little work has been done in India so far. Some works have been done jointly with the Institute of Minerals and Materials Technology (IMMT) Bhubaneswar, on air-dense-medium fluidized bed separator, but commercial scale development and implementation will take few more trials and design improvement. Also, under Asia Pacific Partnership (APP) programme, Coal Mining Task Force (CMTF) has identified Dry Beneficiation of coal as a flagship project for India as a beneficiary country. One demonstration project is being taken up under CIL R&D programme to support this Dry Beneficiation project, which is for demonstration of performance of Allair Jig in Coal India. This may open a new era for coal washing.

Dry beneficiation technology has natural advantage for end users. Heat loss due to evaporation of moisture in coal is minimized. There is saving in heat loss resulting in net reduction in consumption of coal. This, ultimately results in reduction of CO2 emission. Adoption of new coal beneficiation technology for reduction in CO2 emission is not a business-as-usual (BAU) scenario for operational boundary of "coal preparation and electricity generation" in India and will definitely affect in improvement of baseline scenario for CO2 emission. This may be a fit case for CDM (Clean Development Mechanism) project that qualifies for earning CERs (Certified Emission Reduction) for Carbon Credits.

5.0 Initiatives for Coking Coal Washing & Challenges Ahead

This is all about non-coking. But, it would be incomplete if we ignore coking coal preparation. Coking coal is consumed by steel industries. Due to technological compulsion, steel sector have been using washed coal almost since its inception. The coal preparation in India was concentrated primarily for coking coal only. The total coking coal production is routed through Washeries. But there are still some un-categorized coking coals in BCCL and CCL and are called low volatile (LVC) coals due to low content of volatile matter, (around 15% to 20%) and is fit for coke making. Total coking coal reserves in the country are 33.4 Bt (Proved 17.5 Bt) out of which about 1.7 Bt (Proved 0.5 Bt) falls under this category (LVC). It has been tested by SAIL and CFRI that these LVC coals may be a potential source of energy for steel industry in India for use in blend with imported prime coking coal, if it is beneficiated to 17.5 + 0.5 percent ash level. The LVC coals of BCCL and CCL are generally characterized by high ash, high inert content and is difficult to wash. The near gravity materials content is generally high (~ 50%) at the desired specific gravity of cut, average raw coal ash is as high as 35 to 38%. Due to intimate mixing of micro-components, these coals have extremely poor liberation characteristics; even progressive crushing to 13 or 6 mm do not produce significant yield of clean coal. Jharia coalfields of BCCL and B&K (Bokaro & Kargali) area of CCL have substantial reserves of low volatile coking coals, which are being sent to thermal power plants.

Table - 4 : Proposed NLW Washery Project

Sl. No.	Name of Washery Project	Capacity
1	Madhuband, BCCL	5.0
2	Patherdih, BCCL	5.0
5	Dugda, BCCL	2.5
	Total	12.5

The existing coking coal washeries in India are designed to treat coals of relatively easier washing characteristics. It may not be techno-economically viable to beneficiate LVC coal in the existing coking coal washeries. Appropriate washing circuit with state-of-the-art technologies to beneficiate such coal, need to be designed in order to maximize the yield of clean coal for metallurgical use. To have a favourable economy, the secondary product from the washery should have around 34% ash (power grade) for use in power plants. Rejects, if at all generated, may be utilized in FBC power generation. This is a big challenge. Three washeries are in pipeline for such LVC non-linked washery (NLW) coals in BCCL (Refer Table-4).

6.0 Fine Coal Beneficiation : Challenge for Coal Preparation

Fine coal washing is a relatively difficult area. Froth flotation has been an established technique for beneficiation of coal fines. All flotation processes including oil-agglomeration technique are based on surface properties of particles and essentially require a chemical reagent that makes the process cost intensive and liable to cause environmental hazards. Surface-based separation processes have been traditionally recognized as the only practical method for cleaning fine coal. These processes are very effective in general but are very selective in rejecting well-liberated mineral matter (i.e. ash) and become much less effective if the feed coal contains a disproportionate amount of composite particles (i.e. middlings). The separation can be further complicated if the surface chemistry of the flotation pulp, such as pH, is not properly controlled. High consumption of costly reagents and its being energy intensive are the two other deterrents for froth flotation. The other techniques of fine coal beneficiation in vogue is water only cyclones, which is economical but less efficient - gives only 2 to 3% reductions in ash content.

Lot of technological improvement has taken place world over in the field of fine coal beneficiation such as enhanced gravity separators. Therefore, challenge lies in identifying suitable technologies and equipments after trial and demonstration of their effectiveness.

7.0 Reject Utilization

Washery rejects contain certain percentage of free carbon, which may be around 10 to 15% or even higher, depending upon the nature of coal and the washing technology adopted. Wasteful disposal of the washery rejects is a loss of non-renewable fossil fuel. Rather, this energy source should be gainfully utilized by application of suitable technology such as Fluidized Bed Combustion. Washery rejects should be utilized at washery end. However, the ash generated from FBC is a big challenge, because quantum of ash-generation is huge. Other suitable technology for utilization of coal washery reject should also be explored.

8.0 Conclusion : 'Now-or-never'

Benefits associated with the use of washed coal in the power plants are generally accepted by all concerned. Awareness to use high grade, low ash coal is increasing amongst consumers. Balls have started rolling in favour of washed coal for power generation. Time is right for setting-up large scale coal preparation plants in the country. Technocrats and Entrepreneurs should come together and avail the opportunity. Issues are there, more will arise during implementation. All parties concerned should sit together and resolve the issues amicably just for the good cause

Economy is always associated with business. Coal washing is no exception. It won't be too much, if consumers ask for just a reasonable rise in energy input price and for that, the technology providers and the plant designers have challenges before them to ensure state-of-the-art technology in all spheres of coal preparation that will finally yield desired quality at least-cost.

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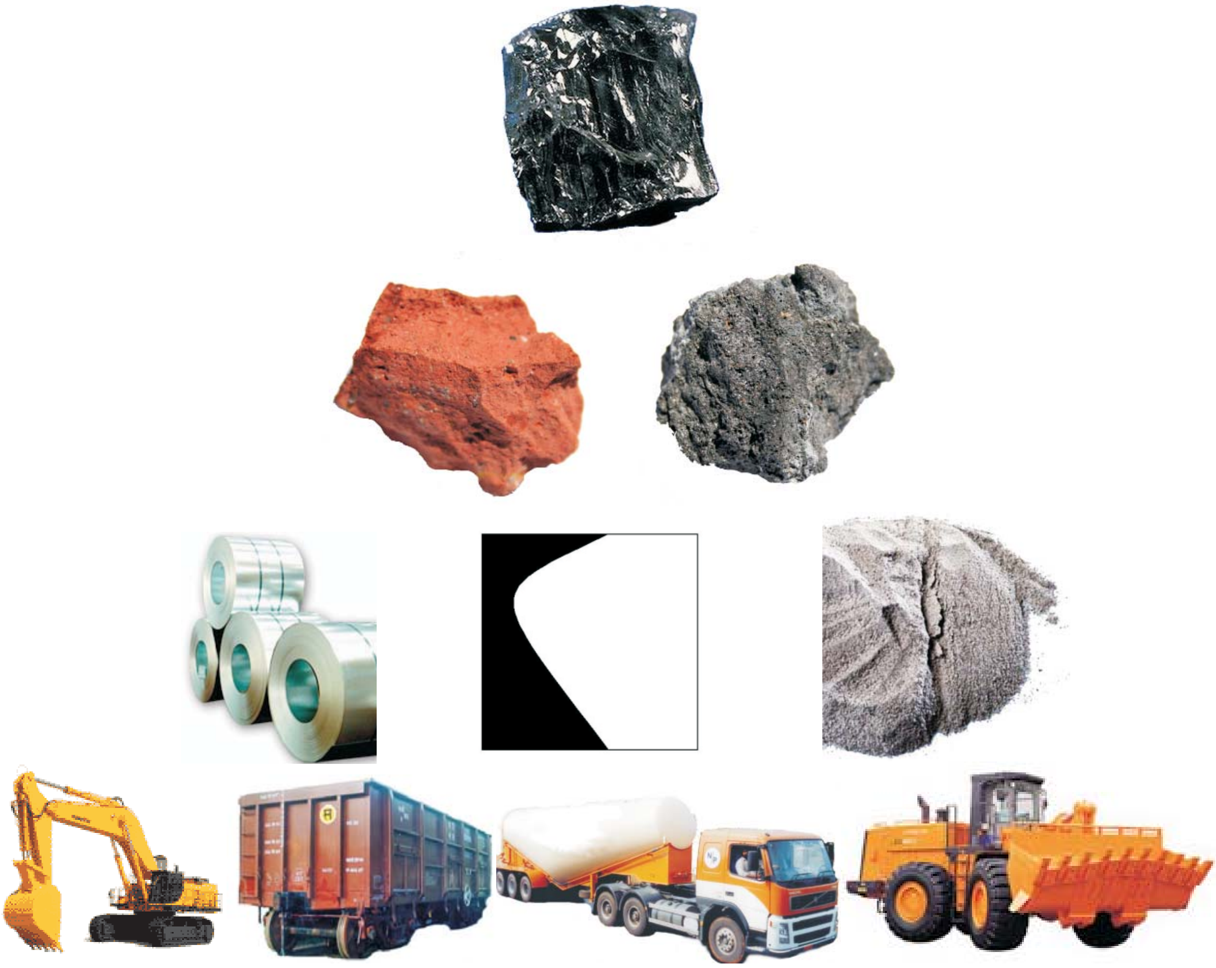

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Beneficiation of Non Coking Coals at Jindal Steel & Power Ltd.

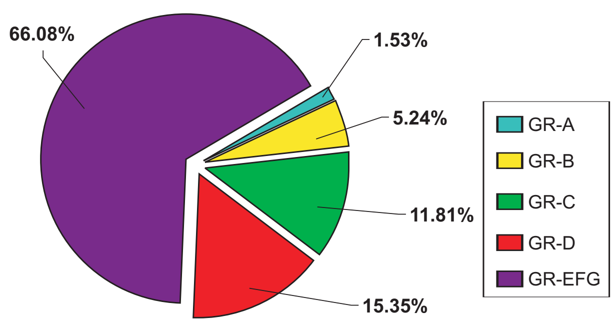
– D.N. Abrol*, P.S. Dhillon**

Jindal Steel & Power Ltd. (JSPL) has an annual turnover of over US$ 2.00 billions. It forms a part of the US$ 12 billion Jindal Group and is a leading player in Steel, Power, Mining, Oil & Gas, Cement and infrastructure. The company has scaled new heights with the combined force of innovation, adaptation of new technologies and the collective skills of its 15000 strong committed workforce. It has won wide acclaim for its efficient operations and commitment to environment & society. As JSPL goes about contributing to India's growth, it also expands globally to become one of the most prestigious and dynamic business groups of the country.

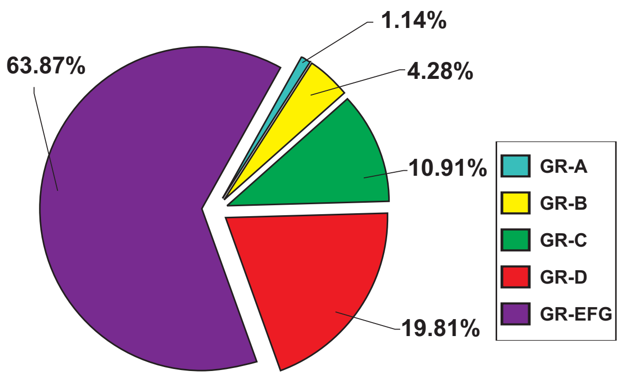
Looking at the grade wise national inventory of non-coking coal reserves, low grade coals of E, F&G are 66% in the proved category where as grades A, B, C & D are 1.5, 5, 12 and 15.5 % respectively.

Scanning through the indicative reserves, the low grade coals of E, F & G contains 64 % where as grade A, B, C & D are 1, 4, 11 & 20 % respectively. So, it is essential to beneficiate low grade coals, whose details are given in the chart below. In addition to these large quantity of un-graded coals can also be put to economic use.

GRADEWISE INVENTORY OF NON-COKING COAL RESERVE (PROVED) Total : 83987 M. Tons

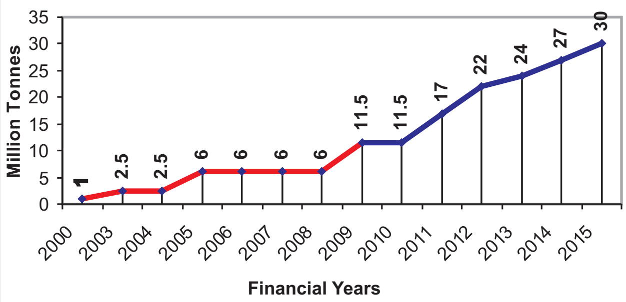


GRADEWISE INVENTORY OF NON-COKING COAL RESERVE (INDICATIVE) Total : 110242 M. Tons



JSPL has made pioneering efforts in the field of mining of low grade non-coking coal & beneficiating the same for metallurgical purpose since 1996 when they put up their first Batac Jig Washery. Later pit head heavy media cyclone in 2002 and subsequently, two stage washing by adding De-shaling plant (6 - 75 mm) as the quality of coal was very poor. Thereafter, enhanced this capacity by adding additional washery of 6 MTY, added another Washery of 5.4 MTY in 2007. The year wise coal beneficiation capacities and projections are given below:

Washeries Production Build UP Plan



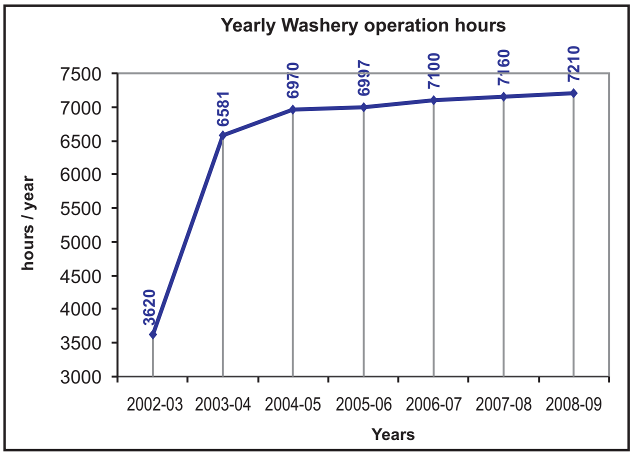
*Executive Director (Raw Materials), Jindal Steel & Power Limited
**Sr. Vice President, Jindal Steel & Power Ltd.

Our Technological Journey of Coal Beneficiation

Particulars	Year
Batac Jig Washery	1996
Pit Head HM Cyclone Washery at Mines	2002
De-shalling Plant (Daniel Make HM Bath to treat 6 - 75 mm coal)	2003
De-shalling plant capacity enhancement (JSPL Make HM Bath)	2003
HM Bath operations from 1 to 25 mm size	2003
Capacity enhancement of pit head Washery to 6 M.T.	2005
Fine coal screening of washed coal as per requirement of customer	2005
Thickener U/F discharge to pond in mines (as a substitute of Belt Press)	2006
HM Cyclones in W-II replaced with High capacity & high efficiency Multotec Cyclones	2006
Classifying Cyclones in W-II replaced with High efficiency Tega Cyclones	2007
Another Washery of 5.5 M.T. commissioned	2007
CCTV introduced for efficient operation	2008

At present the designed capacity is 11.5 MTY, by adding two more Washeries one at Raigarh of 4 MTY & another at Angul of 6 Million Tons it will go to 22 MTY, so within next two years designed capacity will go to 22 MTY & by the year 2015 JSPL will have beneficiation capacity of 30 MTY.

Besides adding the capacities, JSPL has also set the bench mark for its optimization & operations of + 7000 hrs / year. Year wise operating hours are given below:



To set the bench mark of utilization & operating efficiencies some of the major steps taken are detailed below :

- ***Extraction of Full Section of Vii Seam***

Coal is a National asset and its reserves are depleting day by day. As a responsible organization we are contributing to energy conservation by mining even poor grade coal. JSPL took a bold step by mining VII seam full section having ash of + 60% and beneficiating the same.

Previous Practice

Lower portion of VII seam lies just below VII coal with a thin parting of 0.6 to 1.0 mts. Its average stripping ratio is 0.25: 1. This coal seam is of extremely poor grade with 62-63 % ash hence this coal was not planned to be mined.

Innovated Practice

For mining this extremely poor quality of coal, the washeries capacity was to be increased to meet the required quantity of washed coal. This was done by various innovations. Mining of this coal has improved the operational efficiency of the mine.

Advantages

1. Substantially reduced cost of raw coal mining as its stripping ratio is 0.25.
2. Increased the in-pit dumping capacity by 8 % hence reduction in hauling cost.
3. Excess generation of middling coal, which augments our captive power generation.
4. Increase in valuable coal reserve, thus, life of mine.

Tega Cyclone

- ***Use of Improved Classifying Cyclone***

  Initially the diverted slurry to mine pond was containing about 25% of coarse product (+0.10 to 1.00 mm). So we thought, if we can take out this coarse product, the filling period of the pond will increase and the 25% recovery of coarse product will enhance the amount of Middlings. We started searching for high efficiency Classifying Cyclone. We entrusted this activity to M/s TEGA industries (a Cyclone manufacturer) to develop a high efficiency classifying cyclone. They developed a long cone-classifying cyclone to suit our requirement and it reduces the migration of coarse coal to ultra fine coal from 25% to 5%. We introduced these cyclones in our Washeries thus making our fine coal circuit extremely efficient.

- ***Washery Fines Slurry Ponds***

  Coal washing at the pithead, washeries generates ultra fine coal slurry having < 150 micron particles. To recover this coal, the slurry was dried through belt press. This process removes a good amount of water and converted slurry into paste like consistency. Finally belt press product used to be dumped at some designated place for drying. This process was a bottleneck for washery throughput, as continuous disposal and functioning of Belt Press circuit was necessary.

  Innovative Practice

  The Belt press circuit was eliminated from washeries. Ultra fine coal produced in the process was hydraulically transported through pipe upto the designated pond created for its disposal. Here slurry is allowed to settle into the pond by adding small amounts of flocculent. Clear Water separates out and is filtered through porous overburden dump and finally gravitates to the main mine sump. Hence water is recycled.

Advantages

1. Eliminates stoppages in the washeries because of continuous flow process, thus increasing the throughput of washeries. This resulted in an increase in overall utilization by 5%.
2. Lesser consumption of flocculent.
3. Elimination of transportation of belt press products up to dumping site. Hence saving in transportation.

- ***Change of Feed Size of Coal to De-shaler***

  Earlier de-shaler coal feed size was 6 - 75mm as per manufacturer's (M/s Daniell) recommendation. This has resulted in another crushing of deshaled coal prior to feed in the cyclones. So we thought why not we deshale at 1-25mm coal so that after crushing can be eliminated and the system will be streamlined, this will give higher recovery of deshaled coal. We experimented with 1-25mm coal in de-shaler and found the result was very encouraging. Feeding of low sized coal was not a problem in the operation of the de-shaler. On the

De-shaler

contrary we achieved an extra 4-5% increase in deshaled coal due to decrease in coal size. We introduced this system in our Washeries and it is functioning satisfactorily.

- ***Generation of Additional Middlings by Increasing Ash of Rejects:***

Originally it was designed to produce rejects at 65% ash. In the year 2006 it was increased to 72% and subsequently in 2008 it increased to 77%. This reduced the rejects by 20% thus increasing the Middlings by 2.5L.Tons giving benefit of Rs 12 Crores/year by using this natural resource more efficiently.

- ***Standby Circuit Put To Full Operation***

The increase in reject ash from 65% to 77% led to about 60 TPH of coal increase in the washery circuit. This reduced the washery capacity from 600 to 540 TPH so we felt the necessity to augment the capacity of Washery. At the time of Washery-III design we have provided a standby heavy media cyclone circuit. We wanted to convert this standby circuit into a regular one. For this, we put an innovative system to feed coal in the third circuit directly by a 2-way chute in the two circuits. From the trajectory of coal we put a scoop and diverted a part of the total coal approx. 20-25% into the third circuit. Then we put the following circuit by changing the designed parameters of the existing circuits and addition of new circuit. (a) dilute media circuit (b) desliming circuit (c) fine coal circuit and (d) clarified water circuit. We only introduced a new dilute media circuit and the other equipments capacities were augmented to suit the new capacity. By the introduction of the third circuit washery capacity enhanced from 540 TPH to 660 TPH. This not only helped to produce required amount of washed coal for DRI-II but also allowed 26% more low-grade coal beneficiation and resultant saving of prime coal (VIII & IX).

Scooping of Coal for Feed to Innovated Third Circuit W - III

- ***Customer Satisfaction***

The DRI-II needs washed coal whose max. size is 30 mm, moisture 14 to 15 % and -3mm coal max. up to 12%. We modified the Washery III systems &

Washery-II for DRI-I

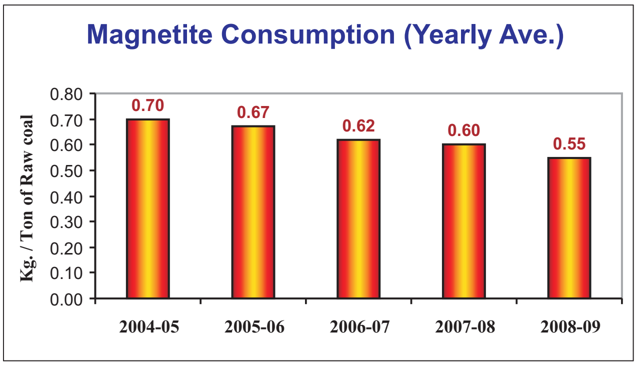
Coal Drier

Washery-III for DRI-II

equipments to produce exactly as per requirements. To reduce moisture we incorporated exclusive drying system-rotary kiln with hot air blowing, to reduce moisture. As the-3mm size in washed coal is higher than the requirement of customer, we started screening the same. DRI-I needs a max. Coal size of 25 mm moisture 16.5 to 17% and -3mm coal max. 14%. We modified the Washery-II process also and crushing equipments to produce washed coal as per the requirement of DRI-I.

- *Magnetite Consumption*

  Adequate steps are taken to minimise magnetite consumption despite two stage washing.



- *Use of Sodium Silicate at Coal Washery*

  ROM coal always contains some mud and other impurities on its surface. Some of these impurities adhere to coal. During beneficiation, in cyclone circuits these impurities contaminate the media and thereby hamper yield. We were thinking of a process to eliminate these impurities. It is observed that sodium silicate has got this property. We started adding sodium silicate at 1:1000 dilution in the system and we observed that it removed adhered impurities during desliming and improved the yield and stability of the medium. This process improved the yield of washed coal by 0.5-0.6%.

- *Use of Discarded Cyclones Cast Basalt Pipes*

  Discarded Traverse Pipe : Traverse pipes are parts of vibrating screen which is made from high quality seamless pipe with thickness of 13 mm.

Discarded Traverse Pipe

After about 8-9 months of operation, cracks develop in these pipes due to vibration but there is no wear and tear, so we re-use these pipes; in the process pipelines give almost the same life as that of a new one.

Discarded Conveyor Belt : Use of discarded conveyor belt as dust shield. In place of coloured galvanized sheets. These discarded conveyors do not get eroded due to rain and

Discarded Conveyor Belt

dust. This not only gives higher life but also reduces cost.

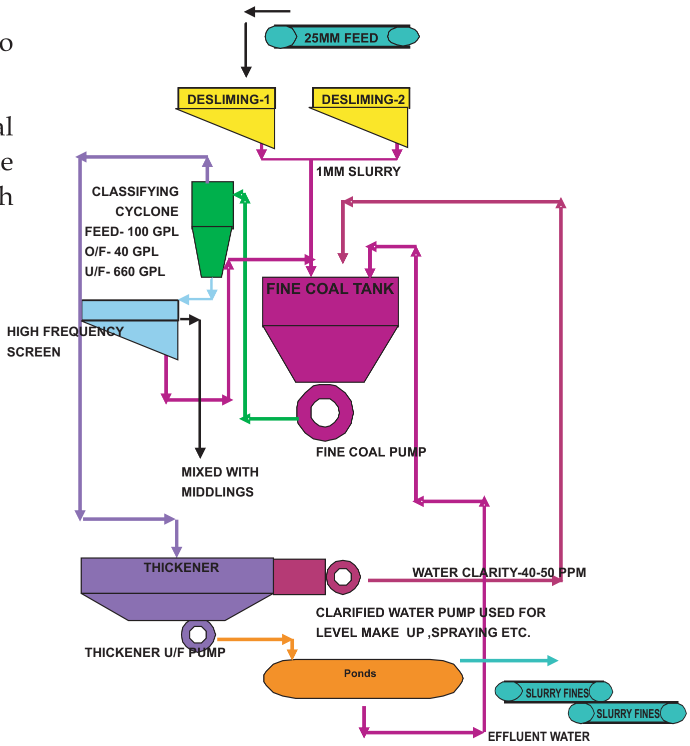
Discarded Cyclones : After ten lakhs Tons of coal washing the cyclone needs to be changed, the inner surface of the cyclone is tiled with high

Discarded Cyclones

alumina ceramic tiles of 15 mm thickness. After completion of its life period there is a wear of about 3 mm of tiles. We reuse these discarded cyclone as chutes, transfer boxes in different places of Washeries. The life of these are about 2-3 years. They not only reduce cost but also reduce breakdown.

- ***Rain Water Harvesting & Zero Discharge***

  The Real Green Revolution is about rainwater harvesting. We plan large catchments every year before the rains & store rainwater which caters to



our requirement of 5000 Cu. M./day for the washery operations, as there is no other source of water availability.

Orchards at Dump Yard

Besides coal mining & beneficiation we grow orchards on dump yards & on waste lands.

Coal Preparation in India - A Historical Perspective

— Kalyan Sen*

The earliest record of systematic coal washing study in India was an attempt by Prof. William Galloway using a pre-Baum type Jig washer before World War I to test Assam coals. Sometime later Prof. Henry Louis of Newcastle-upon-Tyne conducted similar experiments on Jharia coals. However, Rev. E. H. Roberton, Prof. of Mining at the Bengal Engineering College, Shibpur during World War I made systematic washability study, for the first time

Again, in 1920 E. C. Evans, a chemist from London conducted experiments for washing of Jharia coals in a Draper Washer. All of them concluded that Indian coal couldn't be economically washed, to the level of British coals.

It is interesting to note that K. Reinhardt (Germany) invented the present day Float and Sink method in 1926. Before that, the washability characteristics used to be determined by pulsating crushed coal on a perforated pan, dipped in water, simulating jigging.

A. Farquhar of the Tatas carried out washability studies on Jharia coals from 1918 to 1924 and confirmed in 1938 that Jamadoba, Malkera and Bhowra Coals can be washed economically. After further studies during 1938 to 1940, Tatas decided for two washeries in 1946 and established West Bokaro Washery in 1951 and Jamadoba Washery in 1952. Dr C Forrester of the Indian School of Mines, Dhanbad along with J. N. Majumdar conducted systematic washability studies of Indian coals, under the aegis of the Fuel Research Committee, which was the fore-bearer of CFRI (now CIMFR after it got merged with CMRI), commissioned in 1946 as the first Central laboratory at Digwadih, under CSIR.

After the Coal Board was created in 1952, the erstwhile Coal Washing Committee suggested installation of 4 Central Washeries at the Railway Marshalling Yards (viz Dugda, Patherdih, Bhojudih and Kargali) to meet the coking coal requirement of the steel plants being planned in the public sector. Lodna washery was installed for washing crushed - 13 mm coal in a Feldspar Jig. Subsequently, the four central washeries were established at the above mentioned railway yards during 3rd and 4th Five Year Plans, followed by Durgapur washery near the steel plant in West Bengal.

Dudga-I washery (1962) was the first Central Washery in Jharia Coalfield, located on its western fringe near the railway marshalling yard, serving as the junction point between the Eastern and the South Eastern Railways. More than 150 washability studies were conducted at CFRI. Dugda II central washery was installed in 1968. This was an "All Cyclone Washery", quite novel at that period of time.

Over the years the upper seams in Jharia Coalfield were exhausted and the raw coals from the middle seams contained higher ash and were found to have poorer washability characteristics. The fines contained ash more than acceptable as cleans and Flotation Plants were incorporated in mid 80's. Jigs were also installed to sweeten the middlings. At the same time, another Jig was installed in the same dovetailed building to rewash the dry screened smalls (-13mm) of Dugda I washery. When Dugda I outlived its life, then for utilizing the receiving and loading out sections and the above mentioned Jigs, it was converted to a non-coking coal washery by 1998.

The Patherdih Central Washery was installed in 1964. A 10 tph Oil Agglomeration Demonstration Plant was installed, having Ball Mill grinding facilities, to study the liberation and the recovery potential from the slurry.

* Secretary (General), CPSI

By far the Bhojudih central washery (1962), located at the southeastern fringe of JCF, by the side of the Damodar / Goai river, has proved to be most successful. Firstly, the coal sourcing mines produced best coals, with highest yield and easy washability characteristics, and secondly the design and construction made by the Belgium Company incorporated HM Bath for 75-25mm coarse coal and Jigs for smalls, a standard European circuit for good coals. Over the years, due to deterioration of raw coal characteristics, the popular circuit of Batac Jigs and Flotation plants was installed in late 80's to early 90's.

Sudamdih (1981) and Moonidih (1983) washeries were installed after the Nationalisation of Coal Mines and formation of BCCL in 1972. Both, the linked underground mines that were to supply coal to these Washeries did not come up to the expected level of production of 2 mtpy. As a result these two Washeries did not perform as expected. Two more Washeries namely Barora (1985) and Mahuda (1986) with a capacity of 100 to 150 tph were installed as pithead washeries. Since Barora did not perform well, it was dismantled in 1990. Mahuda was successful, possibly due to easy washable coals of Ranigang series. In 1998, BCCL established Madhuban Washery, where raw coal from Block II OCP. Later, when coal production from Block II OCP declined, it was temporarily converted into a non-coking coal washery, dealing mainly with lower seams coals available nearby. Recently it has again been reverted back to washing of coking coal.

The Kargali washery (1959) was installed with Japanese collaboration. It is interesting to note that a 20- tph Pilot Plant was set up at CFRI, so as to fine-tune the proposed circuit and study possible alternatives. The circuit was originally simple, feed size 80mm, screening at 12mm, HM Drum (two stages) for coarse coal and Jig for the smalls. The sinks of the first Jig was rewashed in a smaller capacity second Jig for reducing the overall costs. Kargali washery was renovated in 1984, by adding a Batac Jig circuit.

Kathara washery was installed with Russian collaboration and commissioned in the year 1970. As expected it was equipped with one large Gyratory Crusher, having opening mouth radius sufficient to let go a medium size dumper. However, it has so much of power and excess capacity that with minimum maintenance and hardly utilizing the original spares that came along with the first supply, it worked dauntingly since commissioning. Raw coal from neighbouring Kathara OCP (containing large boulders up to 1200 mm size) was crushed to 200mm and further crushed to 75mm before storage in ground bunkers.

The washing circuit of Kathara is having an international flavour. The deshaling of the coarse coal (75 - 13mm) is done by a French Drewboy bath, the crushed deshaled coal of size 13-0.5mm is washed in Polish supplied H.M.Cyclones and the slurry is beneficiated in Russian made Flotation Cells. While it had virtually best available systems, but the synchronization seemed to be poor.

Set up in 1966, the washery at Sawang was another pit head plant where the feed is primarily crushed to 80mm, prewashed in Jigs and floats crushed to 20mm for deslimming and feeding to HM Cyclones. The slurry (-0.5mm) was treated by Hydro-cyclones, thickened and filtered by vacuum filters. The underflow of the hydro-cyclones was dewatered by Dirty Slurry Screens and centrifuged along with the sinks of the HM Cyclones for production of middlings.

Gidi washery was also set up around 1966 with the objective of washing non-coking (thermal) coal for supply to the Indian railways that were still using the age-old steam locomotives. But the plant remained idle as the railways did not pick up washed coal due to cost reasons and also the dieselisation of railways had also been launched in a big way, almost at the same time. Subsequently, Gidi was modified to process coking coal from Rajrappa mines. With the commissioning of coking coal washery at Rajrappa mine in 1987, Gidi washery again started washing thermal coals. Kedla washery was the latest coking coal wash plant in CCL.

The non-coking coal washery at Piparwar (1997) is the most modern designed plant to wash 6.5 mtpy thermal coal for supply to NTPC's thermal power plant at Dadri, near New Delhi The washery was constructed with in about two years, with the help of total digital drawings, prefabricated tubular structure and strict disciplines in checks and measurements. The sides are open and non-cladded; computerized control room is if a separate RC column building (to make it free from vibration, with an isolation gap of some 50mm from the main plant). From the control room the whole material handling sections are visible, unlike most of the earlier designed windows, less control room and with wall-to-wall mimic panels.

In 1999, Humboldt Wedag set up a non-coking coal washery in Singrauli coalfield at Bina open cast mine based on ROM jig supplied by the same company. The plant processes run of mine coal of the size - 200 mm by a rocking pan Jig, which separates, cleans and rejects into two streams while the coal is winnowed on an inclined screen, dipped in water. The consumption of water is low around 8m3/hr and almost no slurry is thrown out of the plant.

The only coking coal washery in the western part of India is at Nandan. This plant was set up in 1984, washing of medium coking coal from Pench area. The washery has simple circuit: crushing raw coal to 75mm, screening at 10mm, washing both the coarse and small coals in 3-P Batac Jig, with usual deslimming at 0.5mm.The slurry is thickened in thickeners, floated and vacuum filtered. The tailings pass through high-speed screens.

There are two more washeries in the captive coking coal sectors - Chasnalla at IISCO and DSP washery at Durgapur. Chasnalla was constructed in 1969 and Durgapur washery was set up in 1968.

With a view to promoting the use of washed coal in thermal power plants, Indo-US Coal Prep Programme was launched in 1996. Under this programme, extensive testing of thermal coals from Korba and Talcher coalfields were carried out at CFRI Dhanbad followed by flow-sheet optimization and techno-economic studies carried out at the US DOE's Pittsburgh Energy Technology Centre (now called NET Lab). This programme culminated in successful establishment of Korba washery, that supplied washed coal to Dhahanu plant in Maharashtra. Being the first modern private sector coal washery, it helped in giving a fillip to the washing of thermal coals in India. Of course, major driver was the government mandate of using coal of below 34% ash content by power plants located at 1000 KM and more from the supply source and those located in urban and environmentally sensitive areas. This washery led the consumers to accept the benefits of using cleaner coal in thermal power plants and paved the way for installation of Cyclone Washers for washing of non-coking coal in India.

After more than 50 years of practicing washing of Indian coals, which hitherto considered as 'un-washable', it was observed that the challenge of utilizing indigenous coking coals for the steel plants, as a self-sufficiency measure, was successful till 1984. Since then, when the global perspective changed to self-reliance, coking coal started to be imported.

The real breakthrough in utilizing high ash difficult-to-wash but sufficiently matured (Ro = 1.15 to 1.25 or even 1.3 and low sulphur) Gondwana coals was the concept of limiting 'characteristic ash' at the point of cut to about 25%, beyond which the individual coal particles lose their intrinsic coking property. This is a universally proven fact, even in Europe or America, the limiting Characteristic Ash content at the point of cut for steel plant use is at the same level. That means that all the particles having Ch. Ash <25%, included in the cleans, contribute to the coking propensity, even if the overall ash content is 17% in India or 8 to 9% in Europe or USA.

Thus, there should be no laxity at producing washed coking coal from matured seams of JCF and CCL areas, for the sake of energy security and cost control. The remaining requirement for Steel Plants, for further sweetening to 15% ash or so, may be imported, considering matching carbonization properties.

Due to various historical reasons three 'schools' of coal washing practices got developed in India, primarily focusing on washing coking coals. Each of these 'schools' had its own approach, namely:

- **Dhanbad School (BCCL/CCWO/CFRI ISM, etc.) :** HM washing, either all Cyclone or Bath/followed by small coal Jig or Cyclone and flotation of fines (which is also internationally practiced, by Australia and South Africa are the other two countries dealing with Gondwana coals), other than India.
- **Ranchi School (NCDC/CCL/CMPDIL, etc.) :** Modern Jigs for both coarse and small coals with Deduster where ever possible, and flotation (Generally practiced in Germany)
- **Tata School :** Crushing coal to 20mm, HM Cyclone and flotation.

In line with the old adage 'necessity is the mother of invention', several mini flotation plants are also working successfully, in and around Jharia coalfield which are processing the slurry recovered as effluent from various washeries. The first plant (5 tph) was installed in 1994. Since then plants of 10 and 15 tph have also come up. The plants are low profile, all equipment are positioned / supported from the ground floor, flotation cells are individual sub-aeration type, vacuum pumps are used in place of vacuum legs for taking out the filtrate, etc. The water circuit is "closed", as these are located by the side of G T Road, near the coke ovens. These plants (about 20 in number) have a cumulative capacity build up of 150 tph =0.6 Mtpy. The flotation concentrate (ash 14 to 15%) is dried by Belt Discharge Vacuum Filters with belt washing facilities. M/s IISCO made a trial of using the 1000 tpm of this flotation concentrate to substitute imported coals by the same quantity.

Washing of Thermal Coal

Several committees constituted by the government between 1978 and 2003 have debated whether 'to wash or not to wash' thermal coal. In 1988, real time tests were carried out at Sarni power plant by burning washed coal from Nadan washery, just to establish the benefits of using coal with lower ash and uniform quality in the power plant boilers. Though the results of the study, which was carried out by an independent agency were considered positive and clearly in favour of using beneficiated coal in power plant boilers. However, due to various reasons both coal producers and coal consumers went on debating the issue. Pending a consensus on the issue, government mandated for some power stations the use of coal of 34% ash (or below) from June 2002. Despite this mandate the pace at which the washing capacity got established had been very slow, due to factors like power plants not willing to pay extra washing charges and Coal India not willing to invest in washeries as many power utilities owed huge areas on account of coal supplied etc. A few private entrepreneurs seized the opportunity and established a fairly large number of small and medium sized washeries. This more for compliance the government mandate of use of 34% ash coal by some power stations.

It was only recently that Coal India finally decided to supply washed coal to all power plants except the pithead ones. This policy decision has virtually rejuvenated the coal preparation industry in India. Hoping that the progress on Coal India's plan of setting up of 19 washeries on 'build-operate-maintain' format will yield positive benefits, it is definitely going to change the old approach of 'take it or leave' it.

Going by the growth in production of thermal coal from most of the coalfields it can be safely anticipated that coal preparation industry encompassing all aspects of coal preparation and blending will see a very encouraging growth cycle during the 11th and 12th five year plan periods.

Technical Problems Envisaged in Washing of Thermal Coals

Non-coking coal available in India are of high ash (40 to 50% or more), less matured (Ro = 0.8% or less). Thus, they are less hydrophobic in particulate surface character than that of coking coals. Though, it is generally preferred to wash only the coarse size of coals and mix up the smalls (less than 20/15/10 mm) along with the washed coals, with a view to keep the moisture content of the supply within acceptable limits (less than 10 to 12%), the production of effluent due to degradation of coal particles by attrition with others and mechanical impacts in channels and launders, is apprehended to be significant.

It has been found that 1 to 1.5% of the feed to the washery may be produced as ultra fine particles as effluent (size less than 5 micron) whose quantity may be as large as 30 tph for a 10 Mtpy washery. Over the year it can produce as much as 1.5 lakh tonne. As the water loving functional group on the surface of these ultrafine particles is high, they are likely to remain in Brownian movement in the effluent, and as the surface charge of these particles (Zeta potential) is negative (-), it will be difficult to coagulate or floc them without high dose of costly flocculants.

It is estimated that the existing washeries (120 Mtpy capacity build up) might have already impounded at least 1.8 Mt effluent in different lagoons and low lying areas in and around coalfields, if they have not been manually recovered. With the envisaged washing capacity of about 200 Mtpy by next 5 years or so, the effluent production may cross 3 Mtpy. If not tackled at the washery sites, they can spoil the surface water bodies like the Damodar, Mahanadi, Son and other tributaries of Ganges and Yamuna rivers.

This calls for serious efforts on development of washing technologies that are either dry or consume least amount of water. Some efforts in this direction are already making progress. We can expect good results from dry beneficiation techniques that are under development in the country. Some push is however, needed from the coal producing companies so that such efforts are encouraged to scale up their efforts on commercial scale.

Disposal of Washery Wastes

The main objective of the washeries is to separate the stones and high ash shales from raw coals. The stones are generally coarse grained sandstones and shales, degrading to argillaceous clay. As some of the stone layers form partings of variable thickness in between coal seams, it is always possible to lose some coaly matters along with the wastes. The carbon content of these rejects can be as high as 10 to 15%, which imparts them a blackish color not favorable as building materials.

The generation of rejects from washeries in CIL in 2004-05 was 2.44 Mt. and accumulated stock of washery rejects up to March' 05 was 18.15 Mt. Presently, with the washing capacity of more than 80 non-coking coal washeries, having a total input capacity of more than 120 Mtpy, expected production of washery rejects can be as high as 24 Mtpy. Disposal of this huge quantity of rejects in an environment friendly manner poses a real problem.

R & D efforts in development flow sheets that can recover maximum clean coal leaving very little carbon in the rejects, must be undertaken so that after washing, the rejects have very little value and can be disposed in the de-coaled voids in open cast and underground mines, and/or can be used in construction of roads etc.

Manufacturing Capacity

It is an ambitious task for CIL to install 19 washeries in next 5 or 6 years. The choice of circuit will depend upon the washability of coals. As most of the coals from major sources are difficult-to-wash, as revealed by CFRI studies, and selection criteria like highly efficient performance, set by CIL are stringent, it is most likely that either efficient modern jigs or Large Diameter Cyclones or HM Baths may get initial preferences, though there could have been several other choices like Barrel washer, Hydro separator, Larcodem, etc.

As an example, it is highlighted that every 10 Mtpy washing capacity build up requires either : -

- Jigs of around 650 tph capacity (area 35 to 40 m2, Im=0.10) = 3 to 4 nos, efficient and well proven, with associated blowers, bucket elevators, screens, etc.
- HMC of around 1000 to 1200 mm dia = 3 to 4, with associated pumps of more than 1000 to 1500 kW or so, associated Deslimming and Dewatering screens, etc.
- Primary double roll crushers for feed size 250mm / product size 50mm of 1000tph capacity = 2 to 3 nos.
- Washed coal loading Silo or bunker of 15,000 to 20,000 t live capacity
- Conveyors of 1000 to 1200mm width = 4 to 5 km
- Ground storage for crushed raw coal = 15,000 to 25,000 t capacity
- Reclaiming plough for feeding washery at a consistent rate, 1000 to 1700 tph capacity

Thus, it is stressed that manufacturing / import of so many robust and efficient washers within such a short time is an involved task.

From the historical perspective it is observed that the Coal Preparation Engineering Institute was created at Ranchi in 1980s with a view to handle this task. However, no organization can single handedly tackle such a behemoth task. CIMFR in Dhanbad is equipped with the world's biggest and best Pilot plant (funded by CCDA/MOC) to conduct crushing/liberation matrix and washability studies required for tackling most-difficult-to-wash coals. It is particularly required because green field washeries are to be installed in many places and the process data required for designing the large washeries are not readily available. ISM, IITs (KGP and Kanpur), BESUS and other engineering colleges are good in Mathematical modeling and theoretical guidance required for practical optimum designs and conducting laboratory physico-chemical studies to solve "new" pollution problems (could be funded by SSRC/ CIL R&D fund).

CIL has also envisioned resurrecting MAMC, Durgapur that was the storehouse of design and production of coal preparation equipment. Already turned around HEC, Ranchi can help in manufacturing large crushers including gyratory crushers of capacity 1500 to 2000 tph (mouth 1500 mm), and private large corporate houses like McNally Bharat/Wedag/Sayaji, TRF etc have reputation in construction of CP equipment and accessories.

What is most required is a synchronized and synergistic plan of action.

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Dry Beneficiation of Coal - Relevance for Indian Coals

— Dr. G.V. Ramana*

Basic principle of coal beneficiation has remained unchanged over 150 years. The essence of it consists in utilizing density differential between good and bad coal for stratified separation in a liquid medium. With changed environment scenarios, there is now a need for a paradigm shift in the use of liquid medium since water has become a scarce commodity.

Major developments on the energy and environment front have taken place. The current ongoing international negotiations on reducing carbon emissions by 50% by 2050 from levels prevalent in 1995, are examples of how the world is looking at the need to protect the environment. Coal being the most polluting energy source, there is a need to address environment-related issues in coal mining, beneficiation and use. As responsible global corporate citizens, we need to realize this fundamental truth and see the responsibility thrust on the industry as an opportunity, rather than a burden. The heartening news is that this realization has already come about and is being acted upon with a sense of urgency never felt before in India.

The Changing Scenario

The present leadership - political and executive - has shown a capacity to make a clean break from the past and display dynamic, out-of-the-box thinking. Several examples can be drawn but perhaps the prime example is the commitment to deliver quality coal to the consumer. Coal India, has initiated the process of delivering clean coal to consumers by setting up washeries. This is in consonance with international practices and a complete break from its past policy stance. Incidentally, this also helps perk up the bottom line with value-added activities.

Further, instead of taking up construction and operations of these washeries on its own, Coal India has evolved a public-private partnership model through the build-transfer-operate route. Objective is to minimise capital and operational costs and ensure maximum capacity utilization through improved plant availability. This would have been unheard of a couple of years ago.

What is now required is to expand the technology frontiers of coal beneficiation so that the right tool is used for the right job. The industry is now stuck in the mire of choosing a limited set of technology alternatives - mostly micro variations of each other. There is a definite need to seek more optimal solutions, especially in the realm of dry beneficiation.

Dry Beneficiation of Coal - some recent developments

Three known forms of coal dry beneficiation are the Bradford Breaker, air jig and the air dense media. Bradford breaker is suitable for softer coals and lignite and not for Indian coals which have no appreciable differential in friability as compared to stones/shale.

The air jig's limitation is that separation efficiency is low, target ash in clean coal is difficult to obtain and cross-migration is on the higher side apart from high power consumption and dust

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pollution caused. The latter can be addressed with some change in the design related to enclosure of the equipment, but other limitations persist. On the plus side, air jigs do not need water and cost of beneficiation is a fraction of wet technologies. Given the levels of efficiency, air jigs can at best be a transient phase, till better dry beneficiation technologies replace them.

In the air dense media jig, limitations are the difficulty in maintaining specific gravity of media which can be affected by a whole host of variables- particle size and specific gravity variation in magnetite, nozzle clogging, drop in air pressure and moisture content in raw coal. Other grey areas are : capacity limitations of modules, power consumption and recovery of magnetite.

It is in this background that radiometric technologies have emerged as a viable option. Radiometric techniques are of two kinds - gamma ray plus laser height profiling technology (RAMDARS) and multi-energy x-ray differential attenuation technology (ArdeeSort). What differentiates radiometric from earlier dry beneficiation techniques is that separation is based not on physical form, colour or friability of the particle but on its inherent properties.

RAMDARS (RAdioMetric Detection and Automatic Removal of Shale/Stone) is the new generation technology where a combination of gamma rays and laser height profile measurement helps detect high ash particles. Screened coal in a size range, for example 50 - 100 mm, is fed as a monolayer on the belt which enables particle by particle analysis. Ejection is done by nozzle bank at transfer point which in turn is actuated after time delay by the evaluation unit (see Figure 1).

ArdeeSort is the nextgen technology which has been developed as an answer to the need for beneficiating smaller size fractions using similar principles as RAMDARS. While RAMDARS is for coarser size particles, viz. 50 - 200 mm, ArdeeSort is for - 50 + 6 mm size fraction. Thus, along with RAMDARS, it provides the comprehensive technology for improving coal quality with required accuracy for obtaining target ash in clean coal.

ArdeeSort uses multi-energy x-ray technology where differential attenuation aided by appropriate high speed image processing software yields a density profile of particles being analysed. A reflex value is, thereby, obtained which has a direct correlation with ash content in coal. Ejection is achieved by tiny high speed air nozzle jets specifically designed for the sizes these modules are supposed to handle. (see Figure 2). It is possible to plan for target ash in clean coal by fixing threshold reflex value in the control software, very similar to what is done in a conventional dense media beneficiation system. The added advantage is no moisture is added, no magnetite is to be recovered and no tailings generated. Sequential beneficiation in RAMDARS and ArdeeSort after appropriate resizing of products will help maximize yield and minimize ash in the cleans.

Why Dry Beneficiation?

Ash content in raw coal is increasing. We have huge deposits of inferior grade coals and to exploit these resources and transport them across distances for final use involves wasting energy and costs in logistics. If one were to consider transportation costs, end cost of raw coal more than doubles per unit of energy vis-à-vis cost at pithead. This situation is going to further aggravate once more and more inferior coals are exploited.

In many new coal blocks, raw coal being mined has ash content of + 45%. If conventional wet technology is to be adopted, to derive one unit of

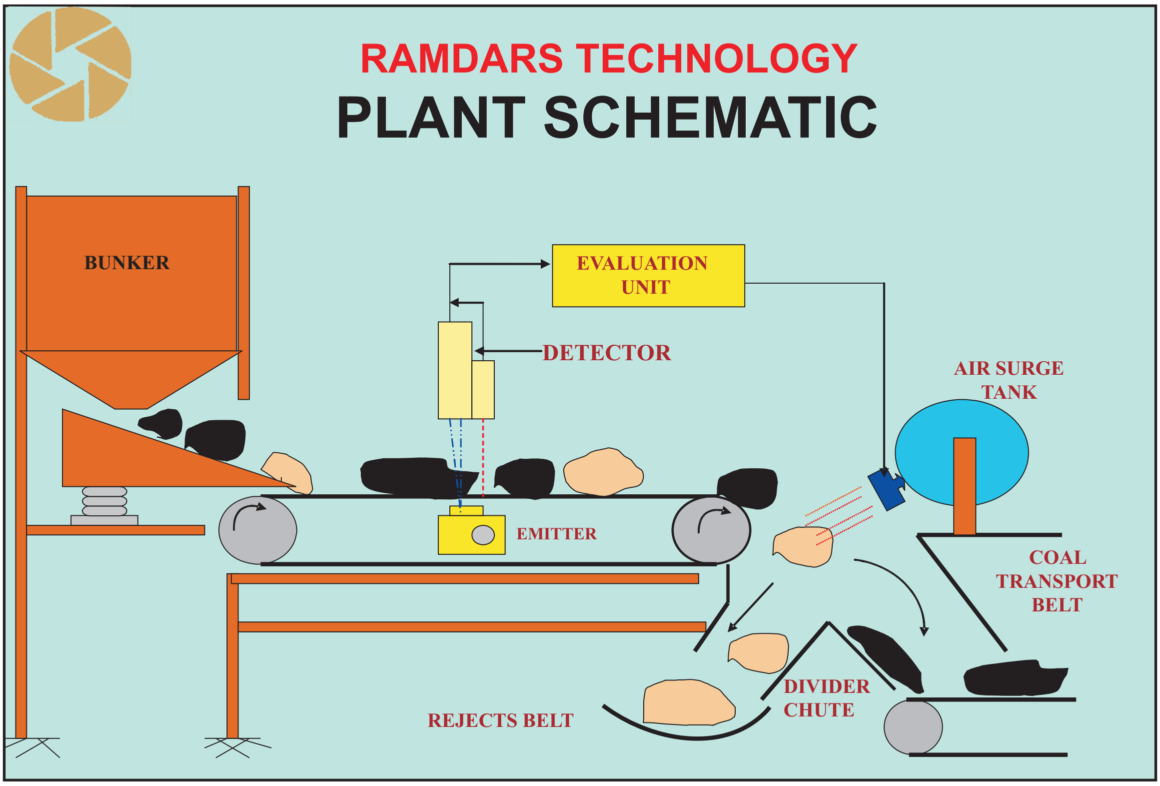

Figure 1

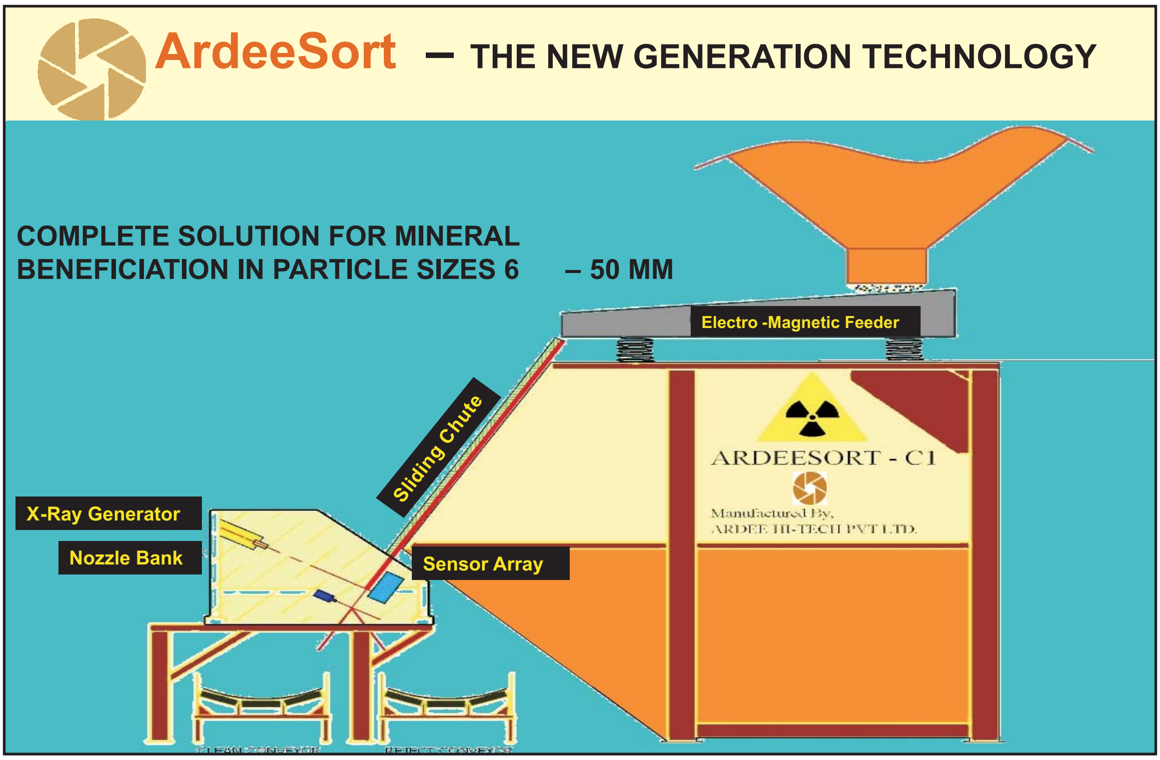

Figure 2

usable energy, water requirement will be far higher than present. The widespread fear of drought in 2009 is perhaps a wake-up call to the coal industry to relook at the use of water. A few factors need to be highlighted:

1. 48 billion litres of water are required, at a conservative estimate, to wash an additional 300 million tonnes of raw coal in the near future. Where is so much water going to come from is given the opposition from agriculture and other users?

2. There is increasing resistance to washery effluents finding their way into drains, streams, rivers and aquifers. Handling these problems requires far higher level of investments for effluent control and recycling than is being envisaged in present washery proposals.

3. In thermal grade coals, addition of moisture has the same deleterious effect on heat value as ash. Therefore, while ash is lowered, this gets negated by moisture addition. Drying of clean coal in most cases is not commercially feasible due to its huge costs as well as further loss of coal fines when moisture is expelled.

Sceptics may argue that dry beneficiation may not be suitable since target ash in cleans required for their processes are lower than what is feasible with dry beneficiation. This was true in the era of rotary breakers, air jigs, manual sorting etc. Emergence of technologies such as RAMDARS - ArdeeSort has to a large extent overcome these objections. Further, most washeries for non-coking coal in the private and public sector, have limited their beneficiation operations to the + 13 mm size fractions and mix the unwashed - 13 mm raw coal with clean coal. On this issue alone, the ArdeeSort technology scores over conventional wet systems since even + 6 mm particles are also beneficiated in ArdeeSort.

Most thermal grade coals **DO** not require wet washing. It is only the very difficult to wash coals, which require treatment at the - 6 mm size fractions which may necessitate conventional washing at these sizes. Let us assume that this is indeed the case. What is the solution then?

A hybrid solution! It is feasible to eliminate extraneous ash matter in sizes + 6 mm using dry beneficiation techniques. Thereafter, deshaled coal can be crushed to - 6 mm size to achieve better liberation and subjected to conventional washing. A number of other options may also be explored, such as bypassing those deshaled coals that do not need washing and directly added to cleans with appropriate on-line quality monitoring and blending systems.

By adoption of such innovative practices, quantum of coal that needs to be conventionally washed can be reduced by more than half with all attendant benefits such as reduction of moisture in the cleans, reduced water and magnetite consumption, lesser amount of effluents to be handled, reduction in both capital and operating costs and so forth.

This will hold true for coking coal where ash percentage in cleans is a critical factor and dry beneficiation may not be the only solution. Given below is a typical process flow (Figure 3) incorporating a dry beneficiation technology where the end product can either be directly used (thermal grade coal) or can serve as an input to conventional washing systems (coking coal).

Dry beneficiation technology is relevant even on other counts. Capital requirement and availability is also a major issue. For example, to set up 300 million tonnes of beneficiation capacity in thermal coal segment, a conservative capital requirement estimate is Rs. 6000 crores. Non-capital related operating costs will cause another serious dent on techno-economics. Add to this project delays due to clearances on account of

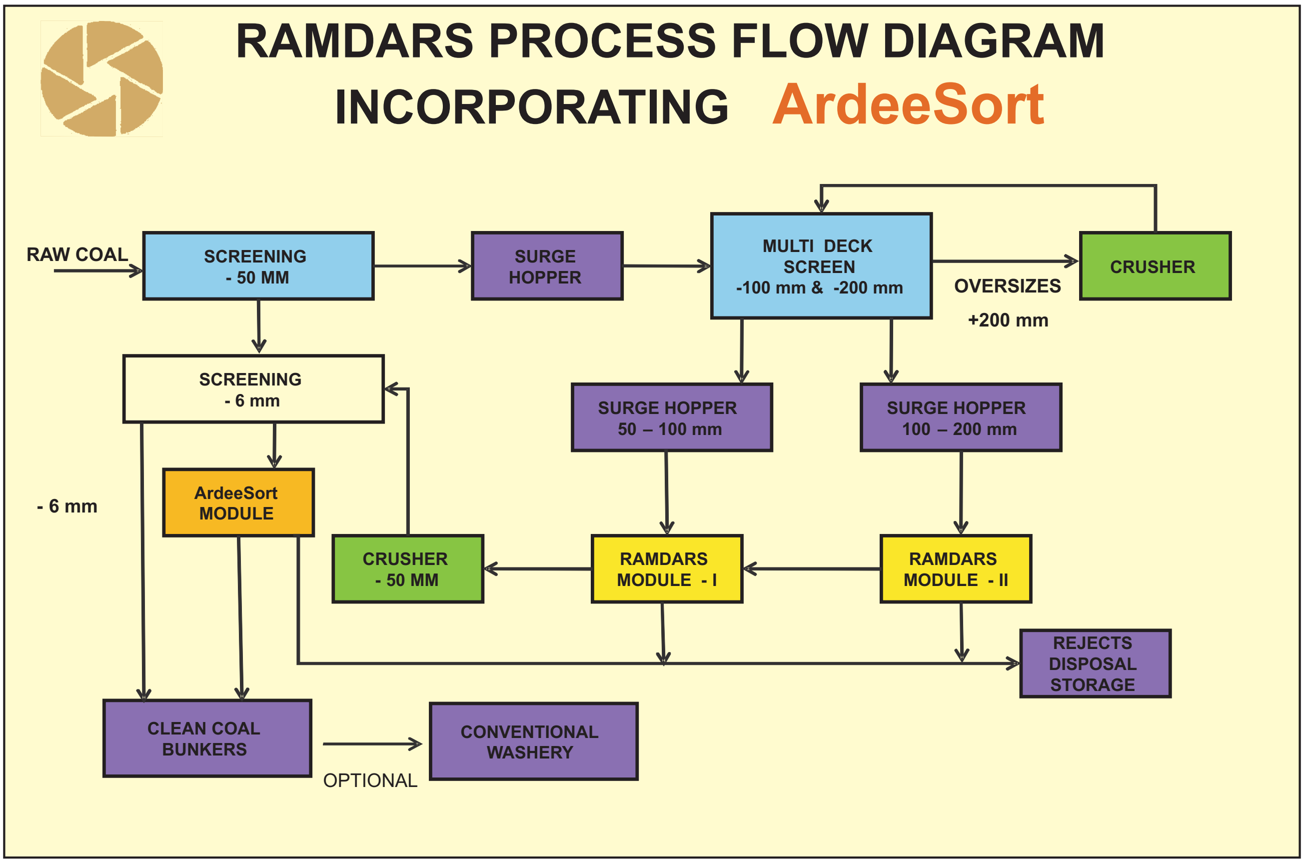

Figure 3

Prevention of Pollution (Water) Act, ground or surface water permissions, etc. - the writing on the wall is clear.

While Indian businesses, public and private, have a decent track record in taking commercial risks, the picture is quite dismal with technological risks. Indians are more prone to copy or borrow from others, and not create their own solutions - few exceptions notwithstanding. Dynamic times require dynamic solutions - ossified thinking and status quoist managements can only lead institutions to stagnation. It is the radical and bold thinkers and doers through history who have changed the way we live. The present coal sector leadership is in the unique position of determining the way we mine, process and use coal in the future. We are sure they will deliver.

Delkor Horizontal Belt Filter (HBF) Replaces Dewatering Centrifuges in Indian Coal Preparation…….

Delkor India has recently commissioned India's first largest Horizontal vacuum belt filter for Coal filtration at West Bokaro Coal washery III of Tata Steel. The Horizontal belt filter is also the world's largest HBF with effective filtration area of 145 m^2 for coal slurry. Washery II at West Bokaro was the first to implement Delkor HBF with effective filtration area of 64m^2. The success of the project is the result of Tata Steel's vision for adopting advanced technologies and Delkor's exhaustive filtration tests and rich coal filtration experience from more than 60 installations by Delkor in Australia and other parts of the world.

The complete Horizontal belt filter was erected at site. The filter was commissioned in month of August 2009. This filter has replaced existing dewatering centrifuges.

145m2 Delkor Horizontal Belt filter installation at Washery III West Bokaro, Tata Steel

Tata Steel would benefit on power saving and eliminate the loses of solids through centrate, by changing from dewatering centrifuges to Delkor Horizontal Belt filter.

Cake discharge and thickness

The particle size range of clean coal is -0.5mm. The froth from flotation cells is thickened in Delkor High Rate Thickener to the consistency of 30% solids w/w and fed to the filter. The filter is designed to handle 45 tph of solids (dry basis) and moisture in the discharge cake is varying between 22% to 28% depending on the coal seam.

Problems Associated With Setting of New Washeries

— H. L. Sapru*

Abstract

India has about seven percent of the world's proven coal reserves. More than 50% of the total energy requirements in India are met from coal. It is estimated that the reserves are enough to meet India's needs for more than 50 years. A study conducted in the recent times states that the total coal requirement in 2011-12 will be about 680 Million Tonnes and it may go up to 1055 Million Tonnes in 2016-17.

Although India has huge coal reserves, the quality of coal is not up to the mark. Due to emphasis on mechanized mining, the quality has been deteriorating consistently. The percentage of coking coal (prime, medium & semi coking) is only about 13% and non-coking coal is about 87%. Due to inconsistent quality of coal, the productivity and efficiency of the end user plants (metallurgical, cement, thermal power plants etc) is declining and it necessitates to beneficiate the coal to match their quality parameters.

To improve the quality of coal, coal-producing companies are coming up in a big way to establish coal beneficiation plants through Indian/global competition. But, there are certain constraints in the process which are being over looked in establishing these washeries since inception. The author's endeavor is to highlight the difficulties faced by the washery construction agencies for establishing new coal washeries. Some suggestions have been offered to address these issues.

Introduction

The Indian coal is having high ash and difficult washing characteristics. With emphasis on surface mechanised mining, quality of coal has further deteriorated which has necessitated its washing to meet the requirements of the end users. Coal is bound to play a major role in power generation for at least for 50 years by now, thus demands greater attention from planners as well as coal & power industry.

Coal reserves of India : Out of coal inventory of 264.53 Bt, only 101.83 Bt are proved as on 1st April 2008. 60% of these coal are deposited up to 0-300 meters depth and the rest is more than 300 meters, which is difficult to mine, and beneficiate. 87% of total reserve is non-coking coal.

Table - 1

Depth (M)	Proved (Bt)	Indicated	Inferred	Total	
	(Bt)	(Bt)	(Bt)	(Bt)	%
0-300	79.34	66.84	14.34	160.52	60.68
300-600	7.11	45.22	18.10	70.33	26.63
0-600 (Jharia)	13.71	0.50	0.00	14.21	5.37
600-1200	1.67	11.65	6.05	19.37	7.32
Grand Total (0 - 1200)	**101.83**	**124.21**	**38.49**	**264.53**	**100.00**

* Vice President (Coal), Monnet Daniels Coal Washeries Pvt. Ltd., New Delhi

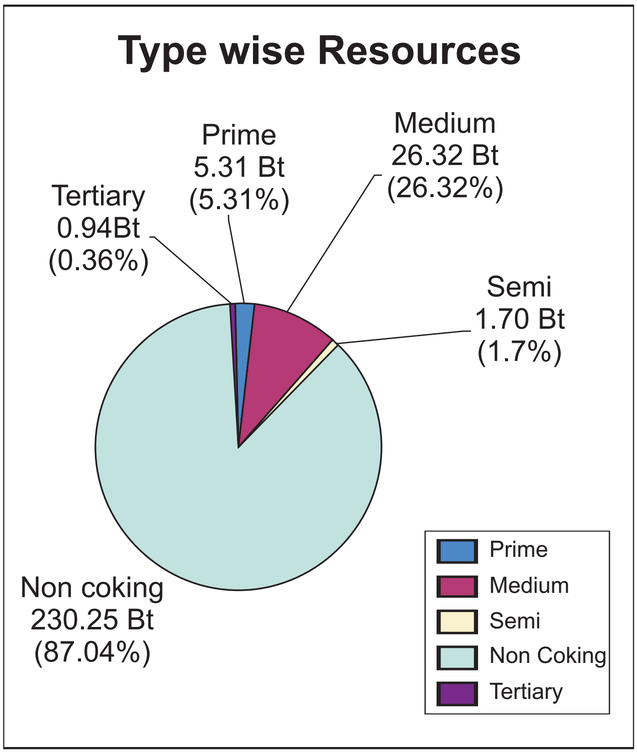

Figure - 1

It may be seen that 87% of total reserves are non-coking coals.

Indian Coal Characteristics

Favourable:

- More environment friendly due to low Sulphur content (less than 0.5%) in general.
- Contains less trace elements in general.

Unfavourable:

- Most of the Indian coals contain high percentage of inorganic impurities (due to Drift Origin). 65% of non-coking coal belongs to high ash category (grade 'E' and below). This is contrary to western coal.
- Contain a high percentage of Near Gravity Materials (NGM) thus making it difficult to wash.

Major Coalfields having potential for thermal coals with different quality parameters.

Table - 2

Quality Parameters	Name of the coal fields			
	North Karanpura (CCL)	Ib-Valley (MCL)	Talcher (MCL)	Korba (SECL)
Ash%	39-45	39-44	38-44	36-39
Moisture	5-8	6-8	6-8	4-4.8
GCV (Kcal/Kg)	3721-3447	3721-3541	3815-3541	4469-4303

Quality Parameters required by different Consumers

Table - 3

Sl. No.	Name of the Consumer	Required Ash % range
1.	Steel Sector	17 +/ - 0.50
2.	Sponge Iron Technology (DRI)	24-26%
3.	Cement Sector	20-25%
4.	Power Sector	Below 34%
5.	Coal Dust Injection (CDI)	About 15
6.	Heat Intense Industries	About 25%
7	Corex Technology for Steel	20-25%

Most of the consumers require coal with ash% below 34. Thus beneficiation of Indian coals becomes a necessity, which in addition to decrease in ash content contribute to overall economy of power plant and other process plant operations.

Some major benefits of coal beneficiation:

1. Less transportation cost per unit of heat value.
2. Increase in boiler efficiency and other auxiliary units of power plants and to other utility, for instance, increase in capacity of kilns used in DRI process etc.
3. Increase in GCV (heat value) / per unit of coal fixed carbon.

4. Reduction of Co2 emission.
5. Reduction in operation & maintenance as well as capital cost of power plants, sponge iron & other utilities using coal either as heat source or a reducing agent.

However, disposal of rejects generated in coal beneficiation needs proper attention in view of environment concerns. Indian coal has high ash & which has further increased by emphasis on, mechanized opencast mining to meet huge demand of coal. It is well acknowledged now that Indian coals need to be beneficiated before end use. Most of the washeries installed in India before 1998 barring one or two have out lived their lives and have lost relevance to the quality and type of coal being fed at present. Most of the coal for which these washeries were designed earlier, are not available now as they have exhausted and thrust on surface mining has further deteriorated the quality of raw coal which they are confronted to at present.

There is mismatch with washing capacity and production of raw coal in India. It is projected that requirement of thermal washed coal in 2024 will be 361 Mt out of total projected quantity of 810 Mt. At present total washing capacity including that of coking coal is only 120.75 Mt

Coal Washeries in operation in the country

Table - 4

Washery	Coking Coal		Non-coking coal		Total	
Operators	Nos.	Capacity (MTPA)	Nos.	Capacity (MTPA)	Nos.	Capacity (MTPA)
CIL	11	19.68	7	20.2	18	39.88
Non-CIL	7	11.27	27	69.6	34	80.87
TOTAL	18	30.95	34	89.8	51	120.75

CIL has come up with plans for construction of 19 new washeries on BOM basis which include three NLW coal washeries to supplement the production of coking coal, others are in non-coking coal sector. These washeries will enhance capacity by 100 MTPA.

Apart from the allotees of new coal blocks, major State Electricity Boards and other utilities like sponge iron/cement manufactures etc are coming up with plans to have pithead washeries. Thus, there is a large demand for coal beneficiation plants in the country. Use of washery rejects in generation of power has inspired private players to go for the coal beneficiation business which is a welcome step, and, capital has started to flow into coal washing industry in a big way.

Major constraints in setting up of washeries in India

1. Land

a. In the vicinity of coal mines there is scarcity of suitable non-coal bearing land for setting up of washeries.

b. Large distances between washeries and coal mines results into huge transport cost, which also strains the transport and road infrastructure of coal producing companies.

c. Most of the land in coalfields area have been procured by coal companies. Thus a private utility cannot get access to a suitable land easily.

d. Coal companies are hesitant to make land available for setting up of washeries even where mining is not planned in near foreseeable future due to non availability of suitable technology or whatsoever be the reason as the coal seams are much below 500 meters or so.

e. Part of the unused land in coalfield though procured by coal companies, which could be used for setting up of washery, is illegally occupied by villagers. Removal of such encroachments creates a law & order problem.

f. Leasing of land by coal companies to other utilities willing to set up washery even having linkage with coal companies in coalfield area becomes a problem and is time consuming.

g. Obtaining forest land for setting up washeries in coal fields is very difficult and time consuming.

2. ***Location:***

Land procured from private land owners suffers from insufficient infrastructure like roads, housing and others. Huge expenditure is to be incurred for developing these infrastructure.

Washeries cannot be installed in designated places of State Government i.e. Industrial Estates etc, which are relatively developed.

3. **Non- availability of power/water & other infrastructure** from the public sector infrastructure. To get new power lines and water pipeline drawn from other sources are problematic and time consuming as procurement of land comes in between either from forest department or from other public sector coal companies.

In coalfield area generally there are only two major landlords - one Forest Department and the other Public Sector coal companies. It is very difficult to proceed without their help.

4. **Environmental clearance** from MOEF/ State Pollution Control Boards is a very lengthy process and time consuming task, which delays the whole process. Public Hearing for procurement of land has been made mandatory by MOEF.

5. ***Railway siding***

Reluctance of Public Sector Coal Companies to lease out railway siding to washery operators is a big constraint although washery operators are dispatching only the coal provided by these public sector coal companies, which otherwise coal companies had to dispatch themselves.

In fact, washery operators increase utilisation of railway sidings as the number of rakes required for transportation of same heat value (GCV) of coal incase of washed coal is less than that of raw coal. Otherwise also, the number of rakes handled by a siding leased to operators increases thus increasing utilization of sidings.

Land is a problem for washery operator for construction of new railway siding particularly in the vicinity of washery/ mines as the coal companies do not lease out the land for this purpose easily.

6. ***Manpower***

Sudden increase or rush for construction of washeries of late has posed a challenge for transforming available manpower into useful manpower for the upcoming washeries. A serious thought needs to be given to this issue. Perhaps CIL could take lead in training manpower in both managerial/supervisory/skilled work-force levels to man the future washeries which are bound to be more sophisticated for better process control and productivity.

7. ***Equipment manufacturing***

Sudden increase in number of washery projects has also put washery equipment manufacturing infrastructure under strain. Delayed supply of equipment is going to be a big constraint to new washeries.

8. *Finalization of tenders*

The time taken for finalization of tenders by public sector is also a constraint, more so recent tenders of a large public sector company have officially communicated that the expected date of commencement of work from the last date of the receipt of bids is 18 months. Washery construction is also going to take at least 18 months making it minimum 36 months. Thus price quoted by tenders may go wayward and at the same time it involves higher risk.

This, long time for finalization of tenders have virtually restricted the foreign players to venture in setting up new washeries in India or even modernization of old washeries.

In this way we may be deprived of getting access to most modern world-class technology, which could have been offered by these foreign players.

Serious thought needs to be given to this issue and remedial measures may be taken.

Some suggestions for overcoming the hurdles during the setting up of washeries:

1. Coal companies should come forward to help to set up washeries by providing land in the vicinity of coal mines and provide railway siding on lease if available. If operating sidings are not available for the purpose, old abandoned /non-operating sidings may be leased to washery operators on mutually agreed terms.

   For construction of new railway lines, land may also be leased wherever feasible.

2. If Power/Water cannot be made available from existing network of coal companies, Company's unused land may be leased to enable washery operators to draw their own power and water lines. If coal companies can take up this job and provide water & power near the washery site, it would be of great help to washery operators.

3. Integrated washery and mine projects must be planned so that Environmental Clearance can be taken together at a time to save time and avoid repetition of all the formalities. In fact project reports for washeries and mines should be made together as an integrated project and processed together to get approval of competent authority to save time.

4. If the washeries are to be constructed inside the boundary of existing mine, it should be taken as a part of coal mine as in the case of CHP etc. for the purpose of environment clearance by MOEF and other agencies as it is going to wash the coal from the of same mine. This will also save valuable time in setting up of washery.

5. Coal companies should revive coal preparation training institutes already constructed for the purpose of training skilled manpower for new washeries.

   CFRI, ISM & IITS should be approached to plan executive development programme in Coal Preparation for upgrading skills/ knowledge of young & middle level executives of Coal India.

6. Companies dealing with material handling equipments & washery process plant equipments should be involved actively in the planning process of construction of new washeries so that they can gear up their resources to meet the huge demand.

7. CIL may issue fresh guidelines to subsidiary coal companies for setting up new washeries by private operators after getting the matter studied by a core committee and after gaining the experience by tendering new washeries.

Status of Coal Beneficiation in BCCL Washeries - Present Practices and Future Trends

– K N Singh*

Introduction

Energy is the keystone for Economic growth of our country. Economic development and increase in population has led to an ever-increasing demand of energy. Though, the global financial crisis and credit crunch have slowed India's economic growth, but India's energy demand continues to increase.

Coal is the mainstay of India's Energy sector. Currently about 55% of our primary energy needs and about 70% of power generated is coal based. It will continue to play a significant role in supporting our Energy needs and meet our energy security concerns.

Why Beneficiation and Demand of Beneficiated coal

India is endowed with huge coal resources. However, the reserves of Prime Coking Coal are limited to Jharia and Raniganj coalfields whereas Non-Coking coal is fairly widespread throughout the country. Because of the drift origin and nature of deposits; majority of Indian Coal is of high ash content and Low in calorific Value. High ash in coal is caused by high quantity of mineral matter and causes various technological difficulties, high specific coal consumption in power generation and other pollution hazards.

The need for beneficiation can be broadly categorized in three broad areas

A. *Quality deterioration of ROM Coal:*

ROM coal as mined today is of inferior and variable quality. The upper seams and high quality coal reserves have exhausted. Coal of Lower seams have difficult Washability characteristics, besides high ash content. All the Washeries in coking coal were based on design considerations keeping the quality of raw coal of the then days and the sources as envisaged at that time. With gradual change in time, from few sources to multiple sources, and coal being fed largely from mechanized Open cast mines rather than underground mines, quality deterioration in form of the intermixing with shale, clay and other extraneous material creates serious imbalances in the washing circuits. Further, generation of additional fines poses greater difficulties for the fine coal circuit and in the recovery of fines.

B. *Quality-need of the Customers:*

The quality of coal being dispatched to various customers have assumed great proportions in view of the competition being faced from the imported coal and customers stress on consistency of quality both in respect of size and ash%. The benefits accrued from meeting quality parameters are beneficial to both the producer and the customer and the society at large.

C. *Environmental Aspects - the Need of the Hour:*

High ash in coal is caused due to presence of high quantities of mineral matters, which causes various technological difficulties and hazards, high specific coal consumption in power generation. On application of appropriate beneficiation technology most of the extraneous inorganic impurities can be removed from the coal, which in turn helps in reducing release of particulates including toxic trace elements during the combustion process. Beneficiation of coal helps to improve the power plant performance and economy of power generation.

As per the stipulations of MOEF, thermal power plants located in specified locales should not use raw coal feed having ash percentage greater than 34.

Hence, to achieve sustainable development with present quality of coal, increasing mine mechanization, environmental threat, varying customers need, coal beneficiation in India is no more a matter of choice but a necessity.

Washing options in India- technologies in vogue

- Raw coal crushed to 100/75/50 mm size
- Coarse coal washing (100/75/50-25/15 mm)
  - ROM jigs (Moving screen jig)
  - Coarse coal jigs
  - Dense medium separators
  - Barrel washers

*Chief General Manager (Washeries), Bharat Coking Coal Ltd.

- Small coal washing (15 - 0.5 mm)
  - Small coal jig
  - Dense medium cyclones (Dia. 600-1000 mm)
- Fine coal washing (-0.5 mm)
  - Froth Flotation
  - Spiral concentrators
  - Water only cyclones
- Dewatering
  - Vacuum filters
  - High frequency screen
  - Centrifuge
  - Belt press filter

An Overview of BCCL Washeries

- Total number and their capacity :

  Coking Coal : 7 - 11.63 mtpa.

  Non-coking : 1 - 1.00 mtpa.
- Washery design based on Coal from Upper Seams, which are no longer available.
- Present feed from Lower Seam Coal which have difficult Washability Characteristics and high ash content creates imbalance in the washing circuits.
- Most of the Washeries are 20-40 years old and have outlived their life.
- Modification/Revamping of Washeries is need of the hour.
- System of Washing at BCCL Washeries:

Washery	System of Washing
Dugda-II	HM Cyclone (13-0.5mm), Flotation (-0.5mm)
Bhojudih	Deshaling Jig (75-0mm), HM Bath (75-25mm), Batac Jig (25-0.5mm), Flotation (-0.5mm)
Patherdih	Deshaling Jig (75-0mm), HM Bath (75-13mm), HM Cyclone (13-0.5mm)
Sudamdih	2 Stage HM Cyclone (37-0.5mm), Flotation (-0.5mm)
Moonidih	2 Stage HM Cyclone (30-0.5mm), W/O Cyclone (- 0.5mm)
Mohuda	HM Cyclone (25-0.5mm), Hydro Cyclone (-0.5mm)
Madhuban	Batac Jig (13-0.5mm), Flotation (-0.5mm)

- *Proposed new washeries at BCCL :*

Name of Washery	Capacity (MTY)
NLW (Non linked Washery coal)	
Madhuban	5.0
Patherdih	2.5
Dugda	2.5
Sub-Total	**10.0**
Non-Coking:	
Patherdih	5.0
Bhojudih	2.0
Dahibari	1.6
Sub-Total	8.6
Grand Total	**18.6**

Issues to be addressed:

Short term:

- Improvement in Raw Coal Quality
  - Face management in mines
  - Pre-washing Plants/Feeder Breaker/ In pit Crusher
- Increase in Capacity utilization of Washeries
- Enhancement in Yield of Cleans
- Effort to improve Quality of Clean/Middlings

Long term:

- Fine Coal washing / up gradation
- Disposal of Washery products lying around Washeries.
- Washing of Non Linked Washery Coals and Low Volatile coal (LVC)

Challenges ahead:

- Exhaustion of upper seam coals and Open Cast Mining has led to deterioration in Raw Coal quality.
- Most of the Washeries are 20-40 years old and have outlived their life.
- Increase in generation of Fines with rapid mechanization & Open cast mining

- Disposal of Fines -Lack of buyers
- Environmental hazards both for water and air pollution

Suggestion to meet the challenges :

- Optimization of Process Flow sheets & Circuits for handling difficult washing characteristics of Indian Coal.
- Efficient process for washing LVC and NLW coal. These Coals have high Ash (35-40%), Low V.M. (15-20%), difficult washability potential (NGM 50-60%). Presently these coals are not being washed due to anticipated low yield (about 22%).
- Modernization/updating of technology and automation.
- Large-scale use of Dry Beneficiation methods like, Feeder breakers, In Pit crushers, Rotary Breakers and Dry beneficiation using Radiometric techniques.
- Replacement / renovation of old equipments and technological structures etc.
- Installation of high capacity, high-pressure cyclone for High NGM coal.
- Cost effective & efficient process technologies for recovery of Fine Coal, suitable for Indian Coal.
- Slurry Management and Disposal of Fines
- Cost effective technologies for Utilization of Rejects.
- Long term agreement for interaction, transfer of technology and supply of equipment needed.

Conclusions

With the expected growth of the economy in the foreseeable future, the energy requirement shall be multifold. Coal being the dominant source of Energy and hence, its role in the coming years shall assume even greater proportions.

The importance and significance of coal beneficiation from the point of view of technical, economic and environmental considerations is now well established. It is in this perspective, that beneficiation of coal today has assumed great significance with immediate measures to be taken in the light of the challenges ahead to keep pace with the industrial growth in terms of both quality and quantity needs.

Measures to adopt suitable technology will have to be adopted with necessary changes in the washing circuit for our existing coking coal plants in view of the new challenges posed in terms of deterioration in the quality of coal to be washed. For greater control over quality, the operational need of the hour is complete automation and computerization wherever required.

Manpower appropriate to the technology and skill required will have to be generated for meeting the day to day operational challenges and it has to be complemented by training and knowledge up-gradation at various level.

Issues & Challenges of CCL Washeries

— V.K. Sahay*

Introduction

In spite of the fourth largest in terms of coal reserves and third largest in terms of coal production in the world, till date we have not been able to minimize our coal deficit. As per the Annual Plan 2008-09s the demand supply gap in country was 70 MT. The total coal imports during 2008-09 was 24 MT of coking coal and 35 MT of non-coking coal.

Table - I : All India Coal Production Plan - XI (2011-12)

Type of Coal	X Plan 2006-07	XI Plan 2011-12
Coking Coal		
Metallurgical Grade	17.90	27.65
Non-Metallurgical	9.31	13.00
Non- Coking	405.29	639.35
Total	432.50	680.00

Table - II Sector wise demand of Coal

Year	2006-07	2011-12
Coking Coal	37.2	40.0
Non-Coking Coal (Power)	317.1	469.0
Captive Power	28.3	32.0
Cement	24.6	24.0
Fertilizer	4.2	5.0
Others	49.1	50.0
Total Demand	460.5	620.0

Status of Coal Washing in CCL

Existing Coking & Non Coking Coal Washeries:

As per Coal India's policy to wash 100% coal, the performance of existing Coal Washeries of Coal India Limited has come in question for studies and reorientation of existing Coal Washing strategy. The Central Coalfields Limited has four Coking and three Non-Coking Coal Washeries. Details given in Table III & IV. Table V & VI shows the capacity utilization of last 10 years of existing Coking and Non-Coking Coal Washeries with respect to their installed capacities.

Coking Coal Washeries

Table : III

	Kathara	Sawang	Rajrappa	Kedla
Year of Commissioning	1969	1970	1987	1997
Raw Coal Input Capacity (Lakh Tonne)	3.0	0.75	3.0	2.6
Designed Raw Coal Feed Ash%	24 - 28	24	25	34
Clean Coal Yield%	50	50	70	46
Clean Coal Ash%	15$\pm$0.5	18.5	17	17
Method of Separation	HM Cyclone & Froth Floatation with Primary & Secondary Crushing	Deshaler &HM Cyclone Washing with Primary & Secondary Crushing	Coarse Coal Jig & Small Coal Jig Floatation Circuit For Fine Coal Separation with Primary & Secondary	Coarse Coal Jig & Small Coal Jig Floatation Circuit For Fine Coal Separation with Secondary Crushing

*General Manager (W/S & W/C), Central Coalfield Limited, RANCHI

Non-Coking Coal Washeries

Table : IV

Year of Commissioning	1970	1997	1958
Raw Coal Input Capacity (Lakh Tonne)	2.5	6.5	2.7
Raw Coal Feed Ash%	42	40	43
Washed Coal Yield%	78	85	70
Washed Coal Ash%	34	34	34
Method of Separation	HM SHALLOW DISA BATH & Baum Jigwith Primary & Secondary Crusher	Jig & Cyclone with Primary & Secondary Crusher	Initially this Washery was meant for washing Coking Coal with Heavy Medium WEMCO DRUM WASHER and Batac Jig besides ROM JIG for deshaling of Dhori Command Area Coal. But at present it is being operated as Non-Coking Coal Washery only with ROM JIG.

Coking Coal Washeries

Table : V

	Kathara	Sawang	Rajrappa	Kedla	Total
Capacity (in MTY) Year-wise Capacity Utilisation (%)	3.00	0.75	3.0	2.6	9.35
1999-2000	38.50	94.30	68.80	33.30	50.40
2000-2001	45.50	104.70	68.80	35.00	54.80
2001-2002	44.80	88.10	53.00	28.50	46.40
2002-2003	40.30	84.30	65.80	32.00	50.00
2003-2004	41.80	90.40	67.10	33.80	51.60
2004-2005	42.10	87.90	71.20	44.20	55.70
2005-2006	39.50	78.00	68.17	48.23	51.01
2006-2007	30.80	75.61	44.16	63.12	44.02
2007-2008	39.05	80.00	38.60	46.46	44.25
2008-2009	28.10	72.50	34.80	41.50	37.60

Non-Coking Coal Washeries

Table: VI

	Gidi	Piparwar	Kargali	Total
Capacity(in MTY)	2.5	6.5	2.72	11.72
Year-wise Capacity Utilisation (%)				
1999-2000	42.40	97.60	31.20	70.40
2000-2001	41.20	86.50	34.90	64.80
2001-2002	32.40	88.00	28.30	52.30
2002-2003	42.80	85.40	34.00	54.07
2003-2004	41.60	81.70	31.70	51.67
2004-2005	36.20	84.80	29.10	61.50
2005-2006	30.84	99.09	33.01	69.20
2006-2007	29.46	103.41	28.20	70.18
2007-2008	28.39	100.31	27.90	68.16
2008-2009	22.95	104.99	21.25	68.02

It is observed from the Table - III above that both Kathara and Sawang Washeries have already outlived their lives and Rajrappa has completed 25 years, which is also more than the predicted life of a Washery.

Issues of Coking & Non-Coking Coal Washeries of CCL

1. The design parameters of Washery equipments have changed in all the Washeries.
2. The feed ash of Raw Coal has increased from 24%-28% to 28%- 34% in Kathara, Sawang, Rajrappa and >34% in Kedla Washery. The above changes adversely affected the performance of Washeries.
3. Due to deterioration in Raw Coal Characteristics from UG to OC, the need to change the mode of size reduction is being a pertinent issue to improve the separation performance of equipment and throughput.
4. Conventional Crushers need to be replaced by sizers to control the fine coal generation during crushing and better liberation of impurities due to changed raw coal characteristics by shifting from U/G to O/C.
5. The earlier design of Cyclone is not able to give better separation results due to change in Raw Coal Quality and high NGM resulting in inconsistency in clean coal quality.
6. The Fine Coal Beneficiation system is also not giving the desired result due to change in Fine Coal Characteristics as well as non performing classical dewatering disc filters of concentrate.
7. The old model existing Jigs need to be changed by improved technology Jig.
8. Recovery and regeneration of dense medium magnetite play a vital role in a performance of any washery. Three out of four Coking Coal Washeries and one out of three Non-Coking Coal Washery in CCL and one in three Non-Coking Coal Washery, separation of coal is being carried out in magnetite suspension.

   The magnetite recovery circuit of all the above four washeries are four decade old and not performing efficiently. Moreover, the present cost of magnetite is very high which needs to be addressed. The erratic supply of magnetite with less quality assurance, consistency of magnetite recovery system is compelled to fail, affecting the performance of washery.
9. Water balancing and treatment of effluent becomes a great challenge to all washeries to prevent pollution now a days. All the old Washeries are not having efficient and effective full proof effluent treatment system. Water balancing and harvesting becomes need of the time for statutory compliance of Environment and Pollution Control Board.
10. Frequent strike call by Trade Union and MCC, due to diluted law and order situation in the surrounding area of washery, is also affecting badly, the performance of washery and its continuity of operation.
11. Kargali and Gidi Washery are not meant for Non-Coking Coal Washing. Lot of modification jobs are required to accommodate maximum input.
12. Disposal of huge rejects of all the washeries needs to be addressed in line with the guidelines of Ministry of Environment by installing FBCC for power generation as well as utilizing of waste carbon where GCV varying from 1300 - 2000 Kcal.

Action to overcome issues and challenges of CCL Washeries.

1. Actions have already been initiated to change all outlived equipments of Kathara Washery.
2. a) Action Plan already under preparation for Sawang Washery for changing of outlived equipments.

   b) Incorporation of fine coal beneficiation in the existing system.

   c) Enhancement of bunkerage capacity of clean and middlings with the help of CMPDIL.
3. Installation of primary and secondary sizers at Kedla Washery to increase its capacity utilization with the help of CMPDIL.
4. Modification work has already been initiated to conform technological requirement of non-coking coal washing with the help of CMPDIL.

5. Re-washing of old coking coal (30 lakh tonne) rejects of Kargali Washery started treating in ROM jig for power coal.

6. Studies are being done at CMPDI for improving the performance of coarse and fine coal jigs at Rajrappa Washery for enhanced input and better quality of clean coal.

7. Besides the above, one coking (NLW) and four non-coking coal washeries' installation schemes are under process of tendering and clearance of MOEF. (Table III A & III B).

8. Modalities for installation of FBCC (Power Plant) at CCL are under studies.

Coking Coal Washeries

1. Existing installed capacity of Coking Coal Washeries :

(a)	Kathara	3.0 MTY
(b)	Sawang	0.75 MTY
(c)	Rajrappa	3.0 MTY
(d)	Kedla	2.6 MTY
	TOTAL	**9.35 MTY**

2. (+) Present programme for new coking coal washeries in XI plan ending 2011-12

(a)	Dhori (NLW) (Replacement of Kargali Washery)	2.5 MTY
(b)	Parej	3.0 MTY
	Total	**5.5 MTY**
	Total capacity of Coking Coal Washery	14.85 MTY

Incoming Non-Coking Coal Washeries

Non-Coking Coal Washing Plan for XIth Plan

(in Million Tonnes)

a.	Existing washery capacity	:	11.75
b.	New Capacity planned	:	20.25
	Total Capacity	:	32.00
c.	Project Coal Production	:	62.32
	• Superior grade coal	:	6.37
	• Linked to pithead plants	:	22.66
	• **Balance to be washed**	**:**	**33.29**

Conclusion:

- Replacement of old equipments are now the need of time.
- Old designed dense media cyclone must be changed to accommodate changed raw coal characteristics.
- Automation of washeries in general and in fine coal beneficiation, media recovery system is in particular are needed
- Better state of the art technology to be accepted for optimum recovery of fines from the system to prevent pollution etc.
- Continued system of training to update modern achievement of coal preparation.
- All the washeries should be equipped with update art of technology.
- An elaborate research is required on dewatering characteristic of coking coal fines as well as utilization / treatment of huge stock fine coal at different washeries' heads of CIL.

R & D in Coal Preparation : Issues & Challenges

— D.D. Haldar*, T. Gouricharan*

Introduction

Amongst other natural resources, coal occupies the key position as a major resource of commercial energy. As on today, the total reserves of coal in India is 265 billion tonnes. Out of which about 83% constitute non-coking coal, 14% coking coal and the rest is others. The total reserves are shown in Table-1.

The demand of coal and so its production in the country is increasing at a fast rate particularly with the growth of steel and power sectors. By virtue of formation of coal (drift theory), Indian coals are inherently of inferior nature with high ash content. With globalization of industrial sector and promulgation of stringent environmental legislation, beneficiation of coal has become mandatory for the survival of low-grade coal producers.

The coking coal reserves are meagre and at the same time, the coking coal washeries in India are incapable to produce the desired quality cleans in sufficient quantity to keep up with the high growth of its steel industry. Inevitably, India depends on imports, purchasing substantial quantities of coke and coking coal, particularly from Australia.

Table - 1 : Reserves of Coal (As on 01.04.09) in million tonnes

Type of Coal	Proved	Indicated	Inferred	Total
(A) Coking: -				
- Prime Coking	4614	699	0	5313
- Medium Coking	12449	12064	1880	26393
- Semi-Coking	482	1003	222	1707
Sub-Total Coking	17545	13766	2102	33413
(B) Non-Coking	87798	109614	35312	232724
(C) Tertiary Coal	477	90	506	1073
Grand Total	105820	123470	37920	267210

(Source GSI)

To meet the increased demand of coking coal, concerted efforts have to be made to correct the imbalance between need and availability by increasing the production of coal of desired quality through better management of available resources of inferior grade. The problems of existing washeries must be looked into, so that they may produce cleans of desired quality from the present feed.

Low volatile coking coal (LVCC), though inferior in quality, but abundantly available in eastern part of the country may be an immediate choice. These coals, being of lower seams are likely to be more matured (Ro ~1.30%) than the upper seams and consequently exhibit lower values of volatile matter. The country has a moderate reserve of such coal, amounting to about 50% of the total coking coal reserve. Unfortunately, the washability potential of this coal is so poor that the existing washeries having conventional washing technologies may not able to supply coals of ash 17-18% as desired by indigenous metallurgical industries and cannot stand in competition with foreign coals because of poor yield of clean coal. As such, these coals are being treated as NLW (Non-linked washery grade) and are supplied to the thermal power plants, against augmenting the demand of metallurgical coal for coke making, thus, wasting the scarce coking coal resources.

India is having huge quantity of non-coking coal reserves but these coals contain high ash. These coals are used for power generation, sponge iron and cement industries etc. The power sector being poised of higher growth rate, will have increased dependence on the non-coking coals. A newer dimension in the area of coal washing has come up, with the MoEF restrictions on the utilization of non-coking coals for power generation, use of

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low ash non-coking coal for sponge iron and cement industries. To meet the stipulations laid by different end users a large quantity of high ash non-coking coals need to be upgraded to the required ash limits.

The paper discusses the issues and problems of the existing washeries treating the NLW coals and the R & D to be carried out for improvement and/or to be adopted to meet the requirements. It also highlights some of the recent R&D studies carried out on LVC coals.

Beneficiation of Coking Coal : Issues and Problems

Owing to the gradual depletion of good quality coals from higher seams, judicious beneficiation of 'difficult to wash', high ash, lower seam coals becomes the major concern from the standpoint of conserving coking coals in the country.

The existing washeries were designed to beneficiate relatively easy or moderately difficult washing coals. The original raw coal feed linkage to the washeries has undergone a major change in the characteristics of coal in terms of ash percentage and washability characteristics. The deteriorations are mainly due to:

a. Increased production from Lower Seams.

b. Enhanced supplies from mechanical opencast mine consisting of considerable proportions of free dirt, boulders and other lumpy extraneous materials.

c. Increased proportions of fines below 0.5 mm in the feed and

d. 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.

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

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

Further, due to depleting reserves of good quality coking coal in the existing mines, the production of good quality coking coal are declining year after year. Due to non-availability of sufficient quantity of good quality coking coal, there is a steep decline in washery efficiency. Washery Yield, which is a ratio of total clean coal produced to total raw coal feed into the washery, is very low as compared to International standard and utilization of existing coking coal washeries is deteriorating day by day due to less supply of good quality coking coal. Most of the washeries are old and needs complete retrofitting.

R & D on Coking Coals : A Challenge

About 85% of the coking coals produced in India are from mechanized opencast mines with obvious stones, which are typically harder than coal. These result in an increased power cost as well as increased maintenance and wear cost on all the downstream equipments. The option of dry deshaling, employing techniques like rotary breaker, sorting etc., may be tried for improving the quality of the ROM Coal.

The feed characteristics play a vital role in choosing a washing unit for beneficiation of coking coal. Since the characteristics of the coking coal varies from seam to seam, source to source detailed characteristics of the feed to the washeries need to be studied for the operating conditions of the washers for better performance. The efficiency of the washer to beneficiate high ash coking coals is of paramount importance. Extensive R & D studies needs to be carried out to improve the efficiency of the washers.

The ultimate problem of cleaning of coking coal in India is the problem of fine coal washing. A concomitant problem in fine coal washing is the up gradation and dewatering of clean concentrates.

The need for beneficiation of coal fines may be attributed to the following reasons :

- v One of the reasons is that most of the washeries originally designed to treat easy to wash upper seam coking coals did not initially include flotation circuit as the quality of fines produced were enriched in requisite macerals necessary for metallurgical coke. The raw coal fines were simply blended with the washed coarser coals to give steel grade clean coals.
- v With fast depletion of the good quality coals the quality of coal fines has deteriorated to a great extent and it has become practically impossible to maintain the quality of washed coal at desired level, while mixing the coal fines directly with the clean coal.

The treatment of coal fines by various beneficiation routes is justified to the fact that they are having better coking propensity and it is a valuable prerequisite in preparing cleans for metallurgical coke. Though enriched in vitrinite content, the fines cannot be mixed directly with clean coal due to their high ash content (more than 25%) and of high percentage of silica content. The slurry needs to be washed through suitable coal-cleaning technology for enrichment of coking propensity and for utilization of total cleans as high valued component for coke making.

Beneficiation of LVC coals - issues & Problems

The coking coals in the Jharia coalfields may be segregated into two major sectors i.e., Eastern and Western. The characteristics of the coals in the Eastern sector are generally superior in quality than the Western sector. The country has a moderate reserve of such coal, amounting to about 50% of the total coking coal reserve.

The LVC coals are difficult-to-wash as these coals have high percentage of near gravity materials, generally over 50 at the primary separation gravity and in most cases yield considerable proportion of co products like middlings, sinks etc. The liberation characteristics of this type of coal are very poor due to highly inter grown nature of the coal. Generally, there is no commensurate increase in yield of cleans at equivalent ash level by crushing the coal gradually down to below 13 or 6mm. As the fines - 0.5 mm generated from these coals possess poor surface characteristics, conventional flotation agents fail to retrieve the coaly matter fully and as a result there is loss of substantial amount of coal along with the tailings.

For effective beneficiation of high ash, difficult-to-wash LVC coals and to understand the washing characteristics and development of beneficiation circuits of a detailed and systematic R&D Studies shall be carried out at source/Colliery wise.

R & D on LVC Coals - challenges

The low volatile coking coals when fed to the existing washery circuits (2 or 3 product) does not yield requisite quality demanded by the steel sector of the country and thus entire production is supplied to the thermal power stations. The challenge at this juncture is to explore the various possibilities of beneficiating the difficult-to-wash lower seam coals keeping in view the following points :

- Substantial increase in recovery of clean coal.

- Desired level of ash around 17% or even less.
- Coking properties of clean coal/blend sufficient to give standard metallurgical coke.
- Possible use of substandard coking coal in the blends.
- Recovery of coking coal component from middlings.
- Improved petrographic make up
- Conservation of coking coal.

The following are the important areas where R & D studies need to be carried out:

- Selection of Beneficiation Circuit.
- Attention on finer crushing
- Importance to up gradation of coal fines.
- Capacity of Washing Plant.
- All washed coal particles should have coking propensities.
- Characteristics ash in cleans should be < 26-27%

Recent R&D Studies carried out at CIMFR

Case - 1 : Western Sector BCCL (2006-07)

Characterization of Raw Coal

Characterization tests of raw coal revealed that ash percentage of coal is 49.1% and Moisture percentage (on as received) of the coal is 0.9%. The sample tested is low volatile in nature, the VM% being 14.4. The Gross calorific value is 3810 kcal/kg. The results of the carbonization tests on the head sample shows that the coal tested is not having coking properties. The petrographic analysis of the head sample revealed that the vitrinite% is 22.7, inertinite% is 42.4 and the Mean Ro% is 1.24.

Liberation Studies

A study was undertaken to investigate the liberation behaviour of coal particles through size reduction and density separation. For this purpose, the ROM Coal was crushed to different sizes viz., 75 mm, 25 mm, 13 mm, 6 mm and 3 mm. Table -2 shows the yield of cleans at 17.5% at different crushing sizes.

Table - 2 : Yield of Cleans at different crushing sizes

ROM crushed to	Yield at 17.5% ash
75 mm	17.5
25 mm	19.2
13 mm	19.4
6 mm	18.7
3 mm	17.0

It was found that even when the coal is crushed to finer sizes there is no liberation of coal particles:

Detailed laboratory flotation tests were carried out on the coal fines generated by crushing the raw coal to different sizes. It was found that the coal fines (-0.5mm) generated by crushing the ROM coal to 75 mm responded to flotation whereas the coal fines generated by crushing the ROM to still finer sizes did not respond to flotation.

The studies lead to the conclusion that finer crushing does not help to increase the yield of the clean coal at the desired ash level.

Case - 2 : Eastern Sector (BCCL) (2007-08)

Characterization of raw coal

Characterization tests of raw coal revealed that ash percentage of coal is 29.1% and Moisture percentage (on as received) of the coal is 1.0%. The sample tested is low volatile in nature, the VM% being 18.0. The results of the carbonization tests on the head sample shows that the coal tested is not having coking properties with CSN being 1 and LTGK coke type being F. The petrographic analysis of the head sample revealed that the vitrinite% is 21.6, ineretinite% is 61.0 and the Mean Ro% is 1.27.

Generation of Clean Coal at 19% and 15% ash levels through pilot plant studies

The coal was crushed to below 75 mm, Laboratory washability investigations on ROM Coal crushed to < 75 mm reveals that the theoretical yields at 15% and 19% ash levels are 35.0% and 55% respectively.

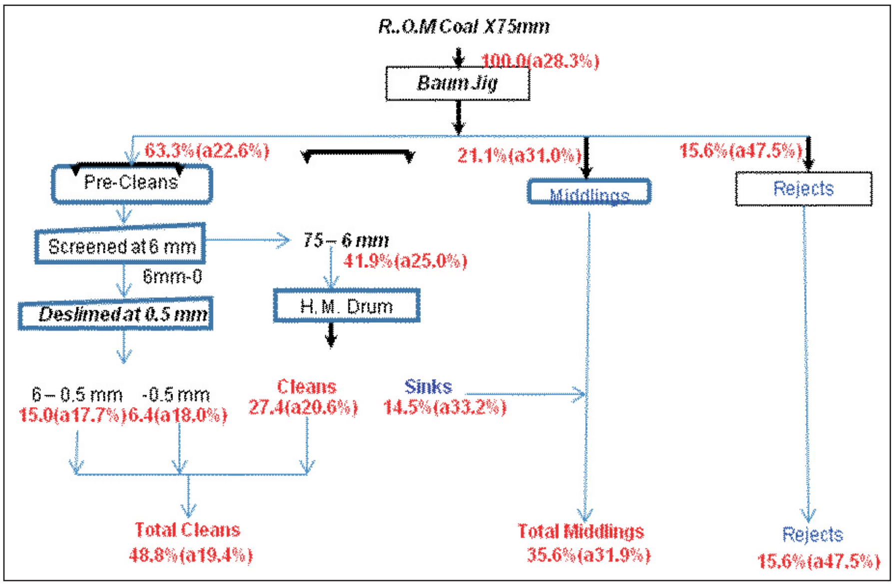


Fig.-1 : Beneficiation Circuit for Generation of Clean Coal of 19% Ash Level

The computer simulation on the washability data suggests that < 75 mm fraction may not be beneficiated efficiently due to high percentage of near gravity material and jig is the only washer where this fraction of coal may be fed for up-gradation. The simulation studies indicated that the coal may be pre-cleaned in a three product jig washer to achieve cleans at about 22% ash content, middlings at around 30% ash content and rejects at above 45% ash content.

The pre-cleans to be obtained from the jig washer may be further processed for achieving cleans at desired ash levels. The pre-cleans may be studied in terms of particle size distribution and washability investigations and the results may guide for further studies to be carried out to produce cleans in bulk quantities at desired qualities by pilot plant operation.

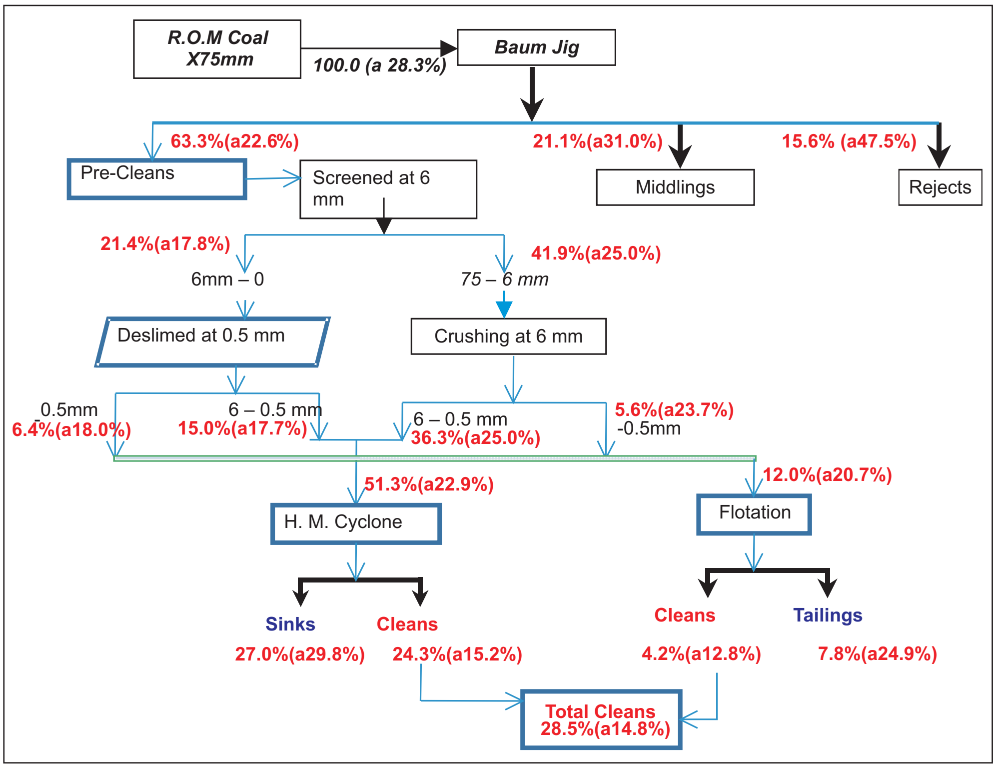


Fig.-2 : Beneficiation Circuit for Generation of Clean Coal of 15% Ash Level

The basic concept as detailed above is the concept of Erstwhile Central Fuel Research Institute as two-stage beneficiation of low volatile coals of Jharia coalfields for producing bulk cleans at desired qualities by pilot plant operation. Fig 1 and Fig 2 shows the flow scheme for generation of cleans at 19% and 15% ash levels.

The properties of raw coal and clean coal samples at about 19% & 15% ash contents are presented in Table - 3.

Table-3 : Properties of Raw and Clean Coal Samples

Parameters	Raw Coal	Clean-I	Cleans - II
Proximate			
Moisture%	1.0	1.3	0.9
VM%	18.0	19.6	20.3
Ash%	29.1	19.4	14.8
Fixed Carbon	51.9	59.7	64.0
Carbonization			
CSN	1	2½	4
LTGK Coke type	F	G	G5
Petrographic Analysis			
Maceral Composition (% v/v)			
Vitrinite	21.6	39.1	59.3
Semi-Vitrinite	0.7	2.2	2.7
Exinite	0.0	1.4	0.2
Inertinite	61.0	46.9	29.7
Mineral Matter	16.7	10.4	8.1
Reflectance of Vitrinite (%)			
MMR	1.35	1.32	1.37

The findings of the above R & D studies suggest that the low volatile coals may also be upgraded to the desired quality if the coals are judiciously beneficiated.

Case - 3 : Eastern Sector (bccl) (2008-09)

Characterization of Raw Coal

Characterization tests of raw coal revealed that ash percentage of coal is 37.0% and Moisture percentage (on as received) of the coal is 1.0%. The sample tested is low volatile in nature, the VM% being 16.2. The coking propensities of the coal seems to be very inferior in quality. The swelling index is hardly 1.0, which may not be termed as good coking coal. The LTGK is D, which gives an indication that the coal may be used as a blendable coal to a certain extent. The petrographic analysis shows the vitrinite content is hardly 22.3% and the active reactives are hardly 24%. The coal as such may, not be used for coke making. But the reflectance is very high having the value of 1.46%, which shows the high maturity of coal.

Raw Coal Crushed to 50 mm

The raw coal was crushed to below 50 mm and detailed washability investigations were carried out to evaluate the theoretical yields of clean coal, middling and rejects (Table-4) for the size fraction 50 - 0.5mm.

Table - 4 : Yield and Ash percent of Cleans, Middling & Rejects on coal crushed to 50 mm

	Wt%	Ash%
Cleans	13.5	18.1
Middlings	65.2	32.0
Rejects	21.3	65.2
	100.0	37.0

The percentage of coal fines is about 7.1 and ash being 31.6%. Coal fines did not yield desired results by normal flotation.

Raw coal crushed to 50mm, deshaling of coarser fraction and crushing to 13 mm (Washability of 13-0.5mm)

The raw coal was crushed to 50 mm and the coarser fraction 50-13 mm was deshaled. The deshaled coal was crushed to 13mm and detailed washability investigations were carried out on 13-0.5 mm fraction. The theoretical yields of clean coal, middling and rejects are shown in Table - 5.

Table - 5 : Yield and Ash percent of Cleans, Middling & Rejects on deshaled coal crushed to 13 mm

	Wt%	Ash%
Cleans	15.9	17.8
Middlings	59.4	37.6
Rejects	12.7	66.4
	100.0	37.0

The percentage of coal fines is about 12% and as being 28.6%. Coal fines did not yield desired results by normal flotation.

The properties of raw coal crushed to 50 mm and deshaled coal crushed to 13 mm are presented in Table- 6.

Table - 6 : Properties of Raw coal crushed to 50 mm and deshaled coal crushed to 13 mm

Parameters	Cleans from Raw Coal crushed to 50 mm	Cleans from Deshaled coal crushed to 13 mm
Proximate		
Moisture%	0.9	0.9
VM%	19.6	17.8
Ash%	18.1	17.8
Fixed Carbon	61.4	63.5
Carbonization		
CSN	5 ½	4
LTGK Coke type	G	E/F
Petrographic		
Maceral Analysis (% v/v)		
Vitrinite	37.2	35.3
Semi-Vitrinite	1.4	1.7
Liptinite	0.1	0.3
Inertinite	51.6	54.2
Mineral Matter	9.7	8.5
MMR	1.45	1.46

The studies indicate that generation of cleans at finer crushing (deshaled coal) deteriorates the coking propensity, though, the yield increases marginally.

Beneficiation of Non Coking Coal : Issues and Problems

The vast reserves of the non-coking coal have high moisture, high ash, high volatile and sub-bituminous types (Ro% ranging from 0.4 to 0.65). The characteristics of the coals are :

- Thick coal seams,
- Highly inter-banded
- Inferior in quality
- High ash content
- High inertinite (45-55% or even up to 70%)
- Less vitrinite content (25-45%);
- Low Sulphur content
- Refractory nature
- Low Chlorine content
- Low Iron and Phosphorous content
- Low toxic elements

Table - 7 : Shows the percentage share of different grades of non coking coal presently being mined in India.

Grade	Share, %	Ash, %	CV, kcal/kg
A+B+C	10.2	< 27.7	>4940
D	12.5	27.7-34.0	4940-4200
E+F+G	77.3	34.0-55.0	4200-1300

It is indicative from the above table that the major issues and challenges lies in beneficiation of the coals above 34% ash level whose share is more than 77%. The major challenge lies in optimal utilization of high ash non-coking coal resources mainly, because of the different nature of the constraints involved in their utilization pattern, prevalent practice, existing infrastructure, etc.

R & D on Non-Coking Coals : A Challenge

In spite of the appreciation of technological benefits accrued from the use of clean coal, the present trend is to beneficiate the coal to the extent of removing only the obvious dirt and stones, notwithstanding the fact that the product still preserves sufficient quantity of non-combustibles detrimental to the boilers and other downstream equipments. The objective of washing should be the optimum rejection of these non-combustibles and not merely to achieve a prefixed ash limit.

Some of the R & D studies where non-coking coal beneficiation should be looked into are:

a. Partial or whole coal beneficiation

b. Dry coal beneficiation

c. Crushing size/Type of crushers to be used

d. Characteristics of the clean coal for different end uses

e. Utilization of rejects

f. Characteristics ash

R&D Studies carried out at CIMFR

The Coal Preparation Division of CIMFR carried out detailed washability studies on coal samples collected from all the major Coalfields. The details of the studies are as follows:

- Detailed raw coal characterization with respect to proximate, ultimate, GCV, HGI, Ash fusion, ash analysis and petrographic studies.
- Washability characteristics and computer simulation followed by pilot scale run of selected samples.
- Washing at different characteristic ash levels (not overall ash) and evaluation of their burning characteristics by Thermo Gravimetric Analysis (TGA) and Drop Tube Furnace (DTF).
- Identification of the beneficiation strategy and development of flow sheet by linking the level of cleaning with the burning behavior.
- Development of suitable washing scheme to produce low ash coals for the sponge iron and cement industries.

Conclusions

- The inferior quality low volatile coking coals from lower seams of Jharia Coalfields may be upgraded to the desired quality if the coals are judiciously beneficiated.
- In order to deal efficiently with the changed feed characteristics, the existing washeries are required to be suitably modified/ modernized to optimize plant performance in terms of capacity utilization and yield of clean coal of better quality.
- Future coking coal washeries should focus attention on source, capacity, new technology and meeting the quality demands of different metallurgical industries.
- Emphasis for Non-coking coal beneficiation should be on dry beneficiation, partial or whole coal washing, Choice of crusher/ crushing size, use of appropriate beneficiation technology.

N E W S

CIL to Set-Up 19 Nos. of new Coal Washeries

CIL is going to set up 19 nos. of coal washeries on Build, Operate & Maintain basis in the first phase. These washeries are expected to be commissioned by 2011-12. CMPDI has prepared a Model Bid Document for this purpose. These washeries will be set up in different subsidiaries except NCL. These 19 washeries will have cumulative capacity of about 100 MTPY.

(Source: www.coal.nic.in)

Swastik Sponge plans power plant, coal washery unit at Korba

Swastik Sponge & Power will set up a 50 MW power plant and a 0.9 million tpa capacity coal washery at Kanberi in Korba district of Chhattisgarh, at an estimated cost of Rs.257.08 crore.

The proposed power plant will utilise run-of-mine (ROM) and reject coal. The project will acquire coal from SECL and water from RBC of the Darri division of Hasdeo Bango project.

(Source: Projectstoday.com news, 7th July 09)

SAIL to Invite fresh tenders for Tasra Coal Mine, Washery

SAIL is to invite tenders for development and operation of the 4 million tonne capacity Tasra open cast coking coal mine and a pithead coal beneficiation plant (washery) in Jharia coalfield area in Jharkhand.

Initially, SAIL planned to develop one million tonne capacity mine at Tasra. Later on it decided on developing the entire 100 million tonne reserve to produce four million tonne of coking coal a year for 25 years.

(Source : Projectstoday.com news)

BHP Billiton to sell Indonesia coal project

BHP Billiton Ltd plans to sell its Indonesian coal project after deciding not to proceed with the project on Borneo Island.

In June, BHP Billiton said it would not go ahead with the Haju trial coal mine in Central Kalimantan because it did not fit with its long-term investment strategy.

"We are continuing to review our commercial options in relation to the project, including potential sale of our interests," said Indra Diannanjaya, president director of PT Lahai Coal, which is part of BHP's Maruwai coal project.

(Source: Reuters, 7th Aug 09)

CIL eyeing tie-ups with global mining firms

Coal India Ltd (CIL) is looking to tie up with global mining firms to jointly mine for coal abroad.

The country's largest coal firm is looking to secure assets in four countries, namely Indonesia, Australia, South Africa, and the US, and the proposed tie-up would focus on these locations.

“We have floated global expression of interest for a strategic partnership with global mining firms such as BHP Billiton, Rio Tinto, Anglo American… We will seek equity partnership in their companies,” the CIL Chairman, Mr Partha S. Bhattacharyya, told reporters here at an industry event. However, he added that the Indian firm is also open to other forms of partnership in the proposed ventures.

He added CIL plans to directly import 4 million tonnes of coal in the current fiscal.

(Source: Business Line,10th Aug 09)

N E W S

Disinvestment plan for CIL to be firmed up soon

The proposal to divest up to 10 per cent Government stake in the Navratna PSU CIL is likely to be finalised in a couple of months.

"The disinvestment proposal (in CIL) is expected to be firmed up in a couple of months," the CIL Chairman Mr P. S. Bhattacharyya, said on the sidelines of the India Leadership Summit 2009 here. The board of Coal India Ltd has recommended that around "5-10 percent" Government equity be disinvested.

The Hon'ble Coal Minister Sriprakash Jaiswal, had earlier said the first right for purchase of shares would be given to the company employees to make them partners in the company and then offered to those whose land had been acquired by CIL.

CIL has estimated coal reserves of up to 100 billion tonnes and over 80 per cent market share in the country. The company produced about 403 million tonnes of coal last fiscal.

(Source: Business Line, 7th Aug 09)

Overall Coal Demand and Supply

Planning Commission of India had assessed the demand of Raw Coal for 2008-09 at 550.00 Mill Tonnes (Mt), (including colliery consumption and export). Against this demand indigenous supply was expected at 497.29 Mt and materialization through import was to be at 53.17 Mt (coking -17.80 Mt, non coking - 35.36 Mt.).

Actual Supply of Raw coal was at 489.85 million tones from indigenous sources, whereas import estimated to have taken place is 59.0 Mill Tonnes, comprising of 24 Mt of coking and 35 Mt of non coking coal, during the year 2008-09.

(Source: PTI)

CESC Subsidiary invests in Coal Washery

RPG group company Integrated Coal Mining Ltd (ICML), a subsidiary of CESC, is investing Rs 40 crore in a coal washery to improve the quality of coal for use by power plants of the parent.

"We are installing coal washery close to our mine. It will cost us Rs 40 crore and is now under trial run. We hope commercial production will begin from early next fiscal," ICML President P Neogi said here today on the sidelines of a CII organised Energy Conclave.

ICML has coal mine near Asansol and has received consent for another mine at Jharkhand for a pithead power plant.

(Source: PTI, Feb 09)

Rio to sell mine stakes to India September 04, 2009

RIO Tinto and Gina Rinehart's Hancock Prospecting are looking to sell state-owned giant Coal India stakes in thermal coal mines as the big Asian nation scrambles to cover an expected shortfall in domestic supply.

Coal India, the world's biggest coalminer, wants to import 50million tonnes of thermal coal a year from Australia, Indonesia and Mozambique from 2016-17 to cover a forecast increase in demand for power, Chairman Partha Bhattacharya told The Australian yesterday. India imports Australian coking coal for its steel mills, but it takes only a fraction of Australia's 130 million tonnes a year of thermal coal exports.

Hancock, which is in the early stages of studies to build two large-scale Queensland thermal coalmines, and Rio, are understood to be among a number of Australian miners that have submitted expressions of interest to sell stakes in mines and projects to Coal India.

Source : The Australian News

STATISTICS

Coal

Performance of Coal Companies :

PRODUCTION (2008-09)			
Company	Production		Achvmnt %
	Target	Achievement	
CIL	405.00	403.73	99.7
SCCL	41.50	44.54	107.3
Others	50.79	44.68	88.0
Total	497.29	492.95	99.1

OFF-TAKE IN MT (2008-09)			
Company	Dispatches		Achvmnt %
	Target	Achievement	
CIL	405.00	401.41	99.11
SCCL	41.50	44.53	107.30
Others	50.79	43.92	86.47
Total	497.29	489.86	98.57

SECTOR-WISE DISPATCHES/ OFF-TAKE IN MT (2008-09)			
Sector	Target	Achievement	Achvmnt %
CSteel	18.74	16.84	88.8
Power (U)	336.69	344.57	102.30
Power-Captive	44.16	29.92	67.7
Sponge Iron	25.19	19.33	76.7
Cement	13.76	15.28	111.1

(Source: Coal Statistics 08-09, MoC)

During the year 2008-09, for power generation (utilities), CIL dispatched 295.54 Mt against MOC target of 292.93 Mt and SCCL dispatched 30.12 Mt against target of 28.88 Mt. Thus, CIL and SCCL achieved 100.9% and 104.3% of their targets in case of power (u). It may be mentioned that CIL and SCCL dispatched 73.63% and 67.64% of its total raw coal for power (U).

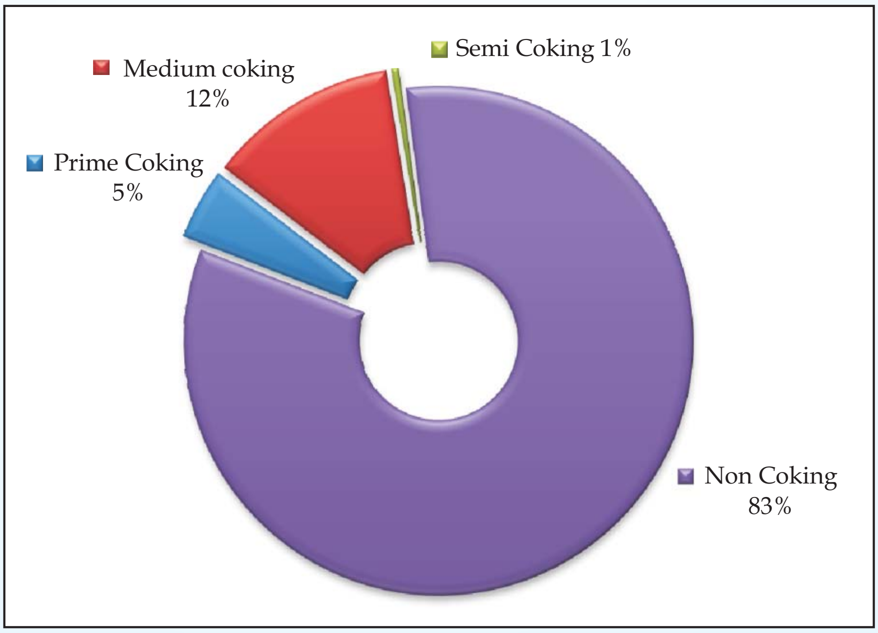
STATISTICS

INVENTORY OF GEOLOGICAL RESOURECES OF COAL BY TYPE AS ON 1st APRIL 2009

Reserve in Million Tons

Type of Coal	As On	Proved	Indicated	Inferred	Total
(1)	(2)	(3)	(4)	(5)	(6)
Prime Coking	01/04/2008	4,614	699	-	5,313
	01/04/2009	4,614	699	-	5,313
Medium Coking	01/04/2008	12,308	12,136	1,880	26,324
	01/04/2009	12,448	12,064	1,880	26,393
Blendable/Semi Coking	01/04/2008	482	1,003	222	1,707
	01/04/2009	482	1,003	222	1,707
Non Coking (Including High Sulphur)	01/04/2008	84,425	110,378	36,388	231,191
	01/04/2009	88,275	109,704	35,819	233,798
Total	01/04/2008	101,829	124,216	38,490	264,535
	01/04/2009	105,820	123,470	37,921	267,211

Distribution of Proved Resources of Coal in India as on 01/04/2009



Source : Geological Survey of India

GALLERY

Historical Perspective of ICPC :

First International Coal Preparation Congress (ICPC) was held in France in 1950. Since then the sequence of international congresses has been as follows :

- 1954 - Essen, Germany
- 1958 - Liege, Belgium
- 1962 - Harrogate, UK
- 1966 - Pittsburgh, USA
- 1972 - Paris, France
- 1976 - Sydney, Australia
- 1979 - Donetsk, USSR
- **1982 - New Delhi, India**
- 1986 - Edmonton, Canada
- 1990 - Toyko, Japan
- 1994 - Krakow, Poland
- 1996 - Brisbane, Australia
- 2002 - Sandton, South Africa
- 2006 - Beijing, China
- **2010 - Lexington, USA**
- **2013 - Turkey**

International Organizing Committee (IOC) comprises of the following country representatives :

1. G. William Kalb, US Chairman, IOC
2. Andrew Swanson, Australia
3. Ahmed Salama, Canada
4. Zhou Shaolei, China
5. Dieter Ziaja, Germany
6. Raj K Sachdev, India
7. Wieslaw Blaschke, Poland
8. Boris Linev, Russia
9. Kevin McMillan, South Africa
10. Gulhan Ozbayoglu, Turkey
11. Doug Jenkinson, UK
12. Alexandr Yegurnov, Ukraine

Corresponding members are :

1. Ljudmilla Bokanyi, Hungary
2. Peter Fecko, Czech Republic
3. Slavomir Hredzak, Slovak Republic
4. Georgios Anastassakis, Greece

Organization of XVI ICPC 2010

A meeting of the International Organizing Committee (IOC) was held on April 23-27, 2009 in Kentucky, Lexington, USA, when the ICPC had reviewed inter alia the abstracts and selected the presentations to be given at ICPC 2010, organizational aspects of the technical sessions and other related details. Shri R K Sachdev President CPSI and Shri G Mustafi Member CPSI had attended the IOC meeting. Some of the glimpse of the trip are shown in this issue.

XVI ICPC 2010

The Coal Preparation Society of America & the International Organizing Committee (IOC) of the ICPC invite you to participate in the

XVI International Coal Preparation Congress

April 25-30, 2010 • Lexington, Kentucky, USA

The **XVI International Coal Preparation Congress (ICPC 2010)** will be held in Lexington, Kentucky on April 25 -29, 2010. Lexington is central to the US bituminous coal fields and is internationally recognized for its beautiful horse farms and distilleries. This is the first time that this Congress has been held in the United States since the early 1960's. The Congress will be held in conjunction with Coal Prep 2010 which will have the largest international exhibition of coal preparation equipment and services in the history of coal preparation. The industrial exhibition will have in excess of 250 booths including every major coal preparation equipment and service provider in the world (exhibitors from the United States, Australia, South Africa, Germany, Russia, Canada, and England). The Chinese will have a pavilion introducing their coal preparation equipment manufacturers to the world

The host hotel for the Congress will be the Marriott Griffin Gate. The Sunday evening reception and various hospitality rooms on Monday and Tuesday nights will be held at the Marriott Griffin Gate. The Griffin Gate is a resort hotel set on a large estate with a multitude of recreational facilities including swimming, golf, tennis, etc. The Griffin Gate is central to the Kentucky Horse Park and the Lexington Convention Center with the Congress providing continuous bus service between the various sites.

The technical program will consist of two parallel sessions presenting 132 papers on coal preparation from around the world. The program will consist of 110 presentations and 22 poster sessions. English is the official language. Each presentation will be instantaneously translated into Chinese and Russian. A limited number of authors uncomfortable with English can present in Russian or Chinese with instantaneous translations into English. All presentations will be incorporated into a hard bound copy of the Proceedings which will be provided to each registrant. Lunch will be provided to the registrants each day.

The social program will consist of a reception with entertainment Sunday evening, a buffet during the opening of the Exhibition Monday evening, and the ICPC Banquet Wednesday evening at the Kentucky Horse Park. Tuesday evening is open with the Congress providing some optional choices for dinner. A parallel spouse program has been developed that will consist of a blend of visiting various sites of interest and experiencing shopping in the Lexington area. The spouse program will include lunch on Monday, Tuesday, and Wednesday. The spouses are encouraged to attend the Opening Ceremony and the Thursday lunch / Closing Ceremony.

Post Congress tours are planned starting Thursday afternoon visiting a combination of coal preparation facilities (mines and manufacturers) and other sites of interest ending in Chicago, Pittsburgh, Niagara Falls, and Washington, DC.

On line registration will start in September 2009. All authors will need to pre-register by December 2009 to insure that their papers are included in the Proceedings. Visit the ICPC 2010 WebSite at www.icpc2010.com.

ICPC 2010 Program

Sunday, April 25, 2010

3:00 to 8:00pm	Registration, Marriott Griffin Gate
5:00 to 8:00 pm	Reception / Entertainment, Marriott Griffin Gate

Monday, April 26, 2010

Opening Ceremony - Lexington Convention Center

Afternoon	
Room A	Preparation Plant Design
Room B	Marketing & Utilization
	Waste Processing & Utilization
5:00 to 7:00 pm	Exhibition Hall Opens
	Buffet

Tuesday, April 27, 2010

Morning	
Room A	Preparation Plant Design
	Preparation Plant Operations
Room B	On-Line Monitoring & Control
	Research
Afternoon	
Room A	Dense Medium Separations
Room B	Dry Coal Cleaning
	Low Rank Coal Upgrading
Evening	Open

Wednesday, April 28, 2010

Morning	
Room A	Water Based Separations
	Froth Flotation
Room B	Research
	Thermal Drying
Afternoon	
Room A	Froth Flotation
Room B	Modeling & Simulation
Banquet	Kentucky Horse Park

Thursday. April 29, 2010

Morning	
Room A	Dewatering
	Screening & Classification
Room B	General
	Environmental Management
Noon	Closing Ceremony
Afternoon	Start of Post Congress Tours

Authors' Profile

Hajime ENDO

General Manager of Japan Coal Energy Center (JCOAL), Tokyo, Japan

B.P. Singh

B.P. Singh (55 yrs), Director (Projects), is a Graduate in Mining Engineering. He is also the Chairman of NTPC-SCCL Global Ventures Private Ltd. He joined the Board of the Company as Director (Projects) in Aug, 2009. Besides representing NTPC in various committees set up by Govt. of India on Integrated Coal Policy, fuels for Power Generation, Pricing of Coal, Techno-economics of using washed coal, etc. He is also a 'Senate Member' of Dr. BR Ambedkar National Institute of Technology, Jalandhar, Expert Member' on Research Council of "Central Institute of Mining & Fuel Research (CIMFR)" and represents NTPC as 'Member' in MGMI.

A.N. Sahay

A N Sahay holds a degree in Mining Engineering from IIT Kharagpur and has to his credit over 33 years of experience in Coal Industry covering Operations, Planning and Project implementation. He has successfully handled project execution in Tanzania for "Exploration of Mchuchuma coalfield and preparation of feasibility report for the mine and pit head thermal power plant". He has also worked as the Coal Controller with Govt. of India. He is at present working as Director (Technical) in CMPDI and is looking after R&D activities in coal sector as well as new technology initiatives like CBM/CMM, UCG etc. in Coal India Ltd. Sri Sahay is actively associated in introduction of washery construction on Build-Operate-Maintain (BOM) basis.

D. N. Abrol

D.N. Abrol is working as Executive Director (Raw Materials) in Jindal Steel & Power Limited, a Company engaged in the production of Sponge Iron, Steel and Generation of Power for the last 12 years. He graduated in Mining Engineering from the prestigious Indian Institute of Technology, Kharagpur in the year 1962. He possesses over 46 years of experience in the field of Mining, predominantly Coal and Iron Ore. He has to his credit the setting up of biggest Coal washery of 7-mtpy capacity at Raigarh, Chhattisgarh.

P. S. Dhillon

P.S. Dhillon is a graduate in Mining Engineering from Indian School of Mines Dhanbad, with a 1st Class in the Managers Certificate Course. He started his career with Tata steel, and was there for the next 32 years, where he rose to the Head of Mining in 2002. This growth phenomenon can be mainly attributed to his ability to plan and execute successfully. He specializes in the planning of large scale Opencast Mines, Coal Beneficiation plants and the execution of various mines & coal beneficiation plants beyond the designed capacities. At the moment Mr. Dhillon is working as Sr. Vice President with Jindal Steel & Power Ltd. since 2003. He is looking after their interests in Coal Mining & beneficiation.

Dr. Kalyan Sen

Dr. Kalyan Sen had his specialised training in coal beneficiation in Poland. He retired as Director, Central Fuel Research Institute & now he is working as a consultant. He is also Secretary General, CPSI.

Dr. G.V. Ramana

Dr. G.V. Ramana (born 1960) completed schooling at Rourkela and college at Madras Christian College. At JNU, New Delhi, he completed Masters and obtained doctorate degree in Economics in 1993.

Dr. Ramana was Economic Consultant at Bureau of Industrial Costs and Prices, and was involved in study on coal pricing and policy, specially in the proposal to de-regulate coal pricing (Volume II) under the leadership of Dr. Vijay Kelkar.

He worked at IGNOU and at Economic Times. He is now based at Visakhapatnam involved in coal-related R&D for past 16 years.

H. L. Sapru

H. L. Sapru had graduated from National Institute of Technology, Srinagar (Kashmir) in Mechanical Engineering and later he had is PG Diploma and M. Tech (Mineral Engineering) from India School of Mines, Dhanbad. He was awarded gold medal for having passed M.Tech in first class and first position. He has worked in most of the coal washeries in Coal India Ltd as a Project Officer/General Manager and later he worked as General Manager (Washery Construction) in CCL. He has a vast experience in design, erection, commissioning and operation of coal washeries. Presently, he is working with Monnet Daniels Coal Washeries (P) Ltd., New Delhi as the Vice President (Coal). He has been responsible for construction of 3.5 MTPA coal washery at KDH, near Ranchi.

Kamal Nath Singh

Born in 1951, Kamal Nath Singh has a degree in Chemical Engineering and is an MBA. He has to his credit a total experience of more than 25 years in various managerial positions in Bharat Coking Coal Ltd. He has been responsible for managing coke oven plants and coal washeries. Presently he is working as Chief General Manager (Washeries) in BCCL.

Vinay Kumar Sahay

Vinay Kumar Sahay hold an M Tech Degree in Mineral Engineering from Indian School of Mines and B Sc (Engg) from B I T, Mesra, Ranchi. He has over 32 years of experience in design, construction and operation of coal washeries in India.

Dr D D Haldar

Born in 1951, Dr D D Haldar holds Bachelor's and Master's degree in Chemical Engineering from BIT Sindri. He joined Coal Preparation Division of Central Fuel Research Institute in 1978 & was responsible for the development of Oil agglomeration process to 10 tph demonstration module. He got his Ph D in Mineral Engineering from Indian School of Mines, Dhanbad in 1988. He has been carrying out R & D studies on the various aspects of Coal Preparation including washability investigations, development of beneficiation circuits, performance evaluation of washeries, process design of equipment etc.

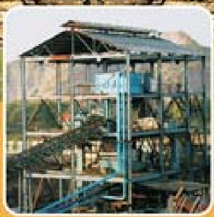
T Gouri Charan

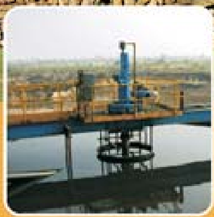
Born in 1961 T Gouri Charan holds a masters degree in Mineral Processing from Gulbarga University and M Tech in Mineral Engineering from Indian School of Mines, Dhanbad.

After working as Mineral Engineer in a Chromite Beneficiation Plant and as a Scientific Pool Officer at Regional Research Laboratory, Bhubneswar he had joined Central Institute of Mining & Fuel Research, Dhanbad in 1989. He is engaged in R & D work primarily in the area of Coal Preparation.

COAL BENEFICATION : ENESTEE OFFERS ENE-TO-END SOLUTIONS


HM Cyclones


Ramagundam Washery before Commissioning


Thickener at Wani

400 TPH Coal Washery at Gondegaon, Near Nagpur.
for Gupta Coalfields & Washeries Ltd.
EPCC By Enestee Engineering Pvt. Ltd.

- ENESTEE born in 2005 and since its inception we have successfully installed a combined capacity upwards of 2000 TPH (Tonnes Per Hour) in Coal Washeries all over India.
- ENESTEE promoted and operated by professionals having more than 50 man years of experience in designing, installing and operating Coal Washeries.
- ENESTEE range of washery equipments with expertise overseas designer help economizing project cost.
- Manufacturing capacity spread over a covered/open space of more than 200000 Sq. ft. in the close vicinity of Nagpur City which also happens to be the geographical centre of the country.
- A group of dedicated and experienced engineers blended with sophisticated in-house equipments facilitates quality products / completion of projects on committed timelines.
- INDIGENOUSLY developed equipments provides for better service, timely spares and least down time of the plant.

ENESTEE have wherewithal to design, supply, install and commission coal handling plants for utilities other than coal washeries also.

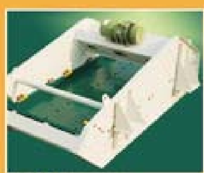
ENESTEE RANGE OF WASHERY EQUIPMENTS


Classifying Cyclones


Radial Sieve Bend


Sizing Screen Double Deck


Banana Screen


High Frequency Dewatering Screen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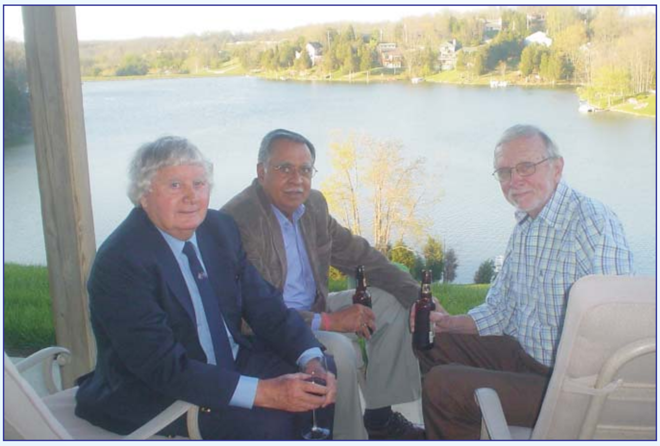
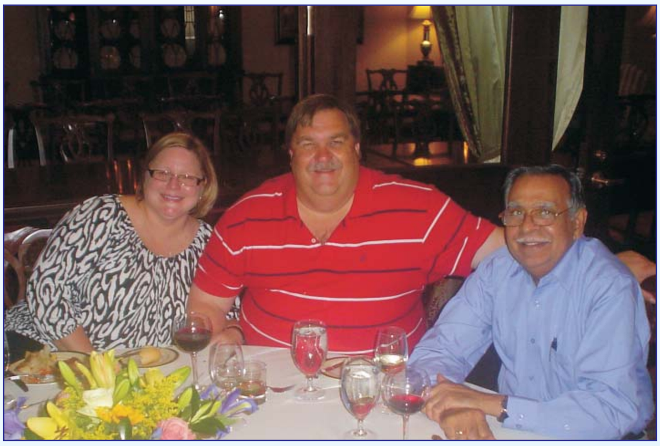
| E - mail - info@enestee.com Website - www.enestee.com

Glimpses of the Meeting of International Organising Committee (IOC) for XVI International Coal Preparation Congress held in April, 2009 at Lexington, Ky. USA





COAL PREPARATION SOCIETY OF INDIA

(Registered under Societies Registration Act XXI of 1860)

Membership Application Form

I am desirous of becoming Life Member of CPSI. My personal details are as follows:

1. Name (with title) : ....

2. Date of Birth : ....

3. Organisation & Designation : ....

4. Mailing Address : ....

   ....

PHOTO

5. Phone : .... Fax : ....

6. E-mail : ....

7. Brief Professional background : ....

   ....

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   ....

8. Payment Cheque/Demand Draft details : ....

   Amount : .... Date : ....

   Bank details : ....

9. Signature ....

Note : 1. Please attach a copy of your photograph.
2. You can also log on to www.cpsi.org.in