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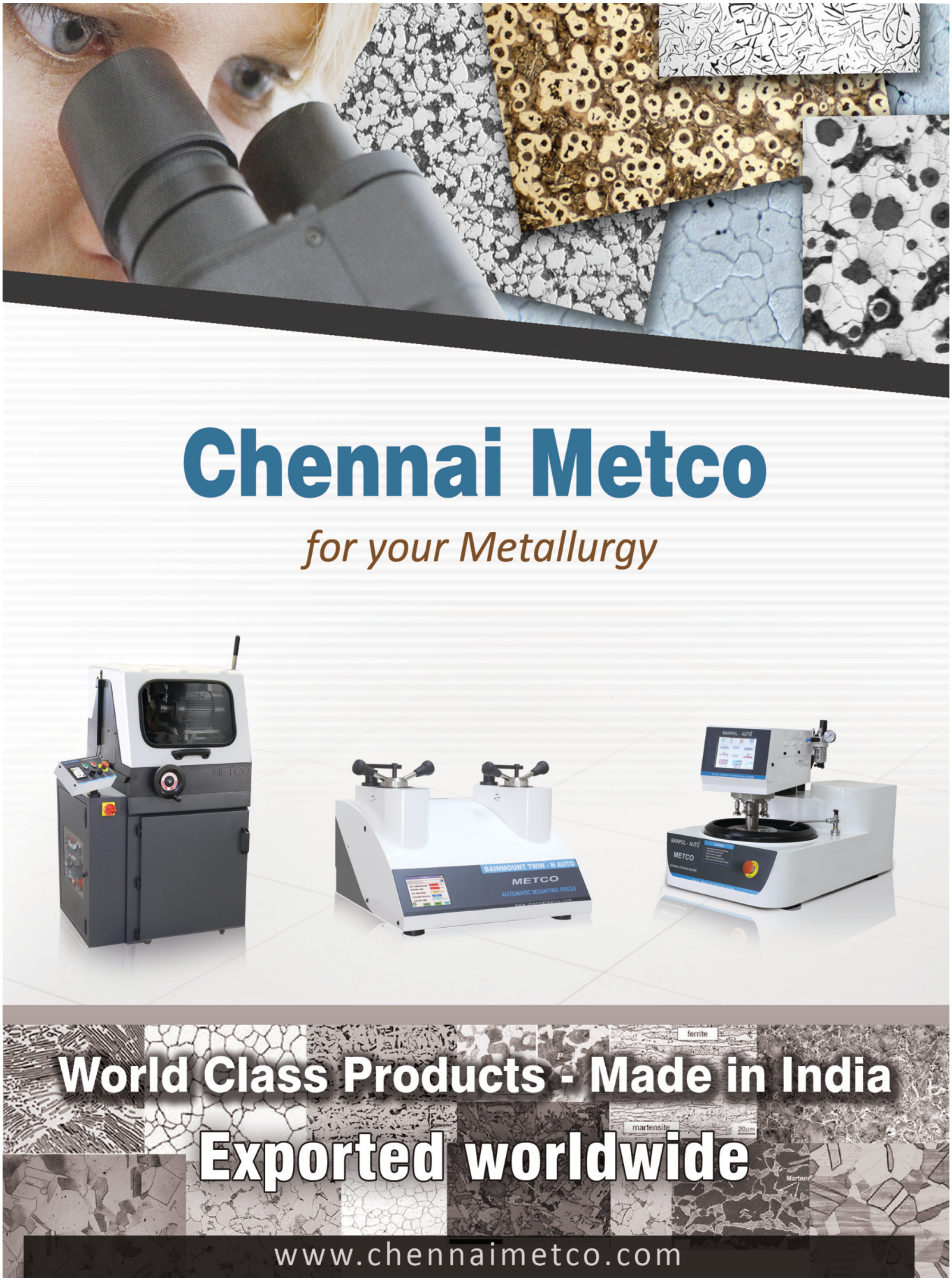
shall be indebted forever...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EDITORIAL

Coal Production & Supplies in perspective of Steel Industry

Through sustained programme of investment and greater thrust on application of modern technologies, it has been possible to raise the production of coal from a level of about 70 million tonnes at the time of nationalization of coal mines in early 1970's to 676.48 (Provisional) million tonnes (All India) in 2017-18.

Coal India limited (CIL) and its subsidiaries accounted for 567.36 million tonnes during 2017-18 as against a production of 554.14 million tonnes in 2016-17 showing a growth of 2.4%.

Singareni Collieries Company Limited (SCCL) is the main source for supply of coal to the southern region. The company produced 62.01 million tonnes of coal during 2017-18 as against 61.34 million tonnes during the corresponding period last year. Small quantities of coal are also produced by Tata Steel, IISCO, DVC and others.

Coal Distribution and Marketing

The Marketing Division of CIL coordinates marketing activities for all its subsidiaries. CIL has set up Regional Sales Offices and Sub-Sales Offices at selected places in the country to cater to the needs of the consuming sectors in various regions.

Import of Coal

As per the present Import policy, coal can be freely imported (under Open General Licence) by the consumers themselves considering their needs based on their commercial prudence.

Coking Coal is being imported by Steel Authority of India Limited (SAIL) and other Steel manufacturing units mainly to bridge the gap between the requirement and indigenous availability and to improve the quality. Coal based power plants, cement plants, captive power plants, sponge iron plants, industrial consumers and coal traders are importing non-coking coal. Coke is imported mainly by Pig-Iron manufacturers and Iron & Steel sector consumers using mini-blast furnace.

Details of import of coal and products i.e. coke during the last six years is as under:

(Million tonnes)

*Import upto Feb, 2018

Coal	2012-13	2013-14	2014-15	2015-16	2016-17(Prov.)	2017-18*
Coking Coal	35.56	36.87	43.72	44.56	41.64	42.36
Non-Coking Coal	110.23	129.99	174.07	159.39	149.31	146.15
Total Coal Import	145.79	166.86	217.78	203.95	190.95	188.51
Coke	3.08	4.17	3.29	3.07	4.35	4.12

Policy Initiatives and Reform Measures

CIL has taken the following steps to increase production of coal:

- High capacity mines are being planned with State-of-the Art mechanization.
- Mines are being modernized for increasing productivity both in underground & opencast mines depending upon geo-mining conditions.
- Improving capacity utilization through efficiency improvement and modernization.
- Ensuring implementation of on-going projects in time bound manner to achieve targeted production as per schedule.
- Capacity augmentation of running projects through special dispensation under the EP act 2006
- Effective monitoring & persuasion of issues related to projects with related Ministries & State Government.
- Projects being formulated for mining under MDO mode
- In order to maintain the planned growth in production and evacuation in future, CIL has undertaken three major Railway Infrastructure Projects to be executed by Indian Railways Authority in growing coalfields of SECL, MCL & CCL.
- Effective & persistent support from the Ministry of Coal etc.

Source: https://coal.nic.in/content/production-supplies

TECHNICAL ARTICLE

Iron Ore-Coal Composite Pellets as New Feed Material for Ironmaking

Sujay Kumar Dutta*

Introduction

India became third largest producer of steel in the world after China and Japan. Iron and steel industry's growth in India has been exceptional since last 10 years. India's crude steel production was 53.5 million tonne (Mt) in year of 2007, that increase to 101.4 Mt on 2017. Correspondingly, the per capita steel consumption in the country was 43 kg in the year of 2007 which increased to 65 kg[1] in the year of 2017 which is much lower than the world average 215 kg. Per capita steel consumption in Indian rural area is still much lower value (around 10-12 kg). As per National steel policy[2], Indian steel production was estimated to 300 Mt which would be achieved by 2030-31. The policy seeks to increase consumption of steel and major segments are infrastructure, automobiles and housing. There is significant potential for growth in rural area. New Steel Policy seeks to increase per capita steel consumption to the level of 160 kg by 2030 from existing level of 65 kg.

Still the recent past, domestic steel industry was mainly using higher grades of iron ore and a higher proportion of lumps due to their easy accessibility and availability. High grade ores are depleting fast in all parts of the world. However, there is a pressing need to utilize low grade iron ores including slimes and dump fines (ore) which are stockpiled at different mine heads[2]. Hence, optimal use of existing low grade iron ore resources with special emphasis on conservation of high grade ores will be encouraged.

The following amount of materials are required for 300 Mt per year steel production (calculated by author):

- Processed iron ore requirement → 486 Mt per year,
- Iron ore (geological) requirement → 757 Mt per year,
- Coking coal requirement → 195 Mt per year.

Indian iron ore deposits are partly soft and friable in nature. Hence, they contain a good amount of superfine (-100 mesh) rich in iron content (65% and above). These are known as blue dust. Ore and iron oxide fines are generated during processing as well[3]. During mechanized mining, 60 to 70% output is generated as fines below 10 mm size. Fines are also generated during transportation and handling[2]. The low grade ore fines are lying at mine sites of captive iron ore miners. These fines create pollution to the environment, which are not desirable. Utilization of these fines for extracting metal is of vital concern for resource conservation and pollution control. In several iron and steel making processes about 500 kg/t of solid wastes[4] of different nature are generated.

There is shortage of coking coal all over the world in general and in India in particular. About 85% of the coking coal requirement of the Indian steel industry is presently being met through imports[2]. Integrated steel plants will also be pursued to reduce their coking coal consumption at par with global best practices by resorting to auxiliary fuel injection technologies like pulverized coal injections (PCI)/ cold dust injection (CDI) or natural gas/synthesis gas injection along with PCI/ CDI.

India also has a large deposit of non-coking coal (148, 284 Mt, 81.3%). Again, significant quantities of coal fines and coke breeze are produced during coal mining and coking of coal respectively[3]. By incorporating non-coking coal fines in cold bonded iron ore-coal composite pellets, the metallurgical coke requirement in the blast furnaces can be reduced. Utilization of iron ore and coal fines takes place by producing the iron ore-coal composite pellets. Also, utilization of low grade ore as well as waste of the plants can be taken place by producing the ore-coal composite pellets that will reduce the pollution.

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Composite Pellet

The term composite pellet describes a pellet consisting of a mixture of fines of iron-bearing oxide and carbonaceous material (coal, coke, char), to which cold bonding techniques have imparted sufficient green strength for subsequent handling[3]. The pellets should have sufficient strength to withstand high temperature and stresses during reduction in a furnace.

Interest in iron ore-coal composite pellets technology had been there for many years without any significant successful application in ironmaking. The principal technological problem was to produce such composite pellets at low cost. Advances in cold bonding technology have brightened the prospects. Interest in composite pellets has grown from the decade of 1980s, because of the following advantages[5]:

(i) Rate of reduction is very fast (as established in laboratories and pilot plants), since the carbonaceous reducer is in intimate contact with ore fines.

(ii) Iron ore fines, generated at mine sides, mill scale etc. are cheaper than lumps. Traditional pellet making is costly due to need of heat hardening in furnace. On the other hand, cold bonded composites do not require costlier heat hardening process.

(iii) Composite pellets can also utilize cheap and readily available reductants such as coal fine, coke breeze, coal char fines, and wood char fines.

(iv) Resource utilization and lower environmental pollution.

Preparation

Pelletization is more popular than any other processes for agglomeration of fines. Pelletization process has the following conditions[6]:

- The ore must have a sufficiently fine size,
- Sufficient moisture is needed to make the ore sticky enough to pelletize but not so much moisture that the ore becomes muddy,
- A binder is necessary to hold the particle grains together after the pellet is dried.

Binders must satisfy the following requirements[7]:

i. Mechanical properties: A good binder should maintain good mechanical properties of pellets, including green, dry and fired pellets, e.g., deformation under load, resistance to disintegration/fracture by compression and impact, resistance to abrasion, superior compressive strength etc.
ii. Chemical composition: A good binder should bring no environmentally and metallurgically harmful elements such as P, S, As etc. into product pellets. It should not increase impurities such as silica.
iii. Metallurgical performance: A good binder should maintain pellet's excellent metallurgical properties, such as high reducibility, little swelling, and little pressure drop during reduction.
iv. Processing behaviour: Adding, mixing, dispersion of binder, green ball preparation, pellet drying, etc., should not be complicated or essentially change conventional pellet production circuit. It should possess good thermal stability.
v. Cost factor: Price of binder should be acceptable for iron pellets production. It should be cheap and easily available in the market.

The purpose of a binder is to impart enough green and dry strength to the pellets. Various binder combinations[7-9] were tried for cold bonded iron ore-coal composite pellets. The fines of iron bearing oxides and carbonaceous materials are mixed with a suitable binder and optimum quantity of moisture. The mixture is then pelletized into balls of appropriate size (8-20 mm diameter). In cold

bonding process, the composite pellets are hardened due to the physico-chemical changes of the binder in ambient conditions or at slightly elevated temperature (125 to 225°C). Figure 1 shows the flow diagram for composite pellet making.
Cold bonding pelletization process offers the following advantages over the conventional pelletization process[10]:

i. The cold bonding process is quite flexible and allows usage of metallurgical wastes like blue dust, coal/coke fines, steel plant dust, mill scale, sludge etc.,
ii. The cold bonding processes use coarser material for pelletizing and consequently the grinding costs and power requirements are considerably reduced,
iii. The cold bonding eliminates indurations at high temperature in an oxidizing atmosphere,
iv. The usage of furnace oil is either fully eliminated or reduced considerably,
v. Chemical composition of the raw material does not change (unlike in conventional pelletization) and magnetite will not be oxidized to hematite,
vi. Cold bonded pellets can be self-fluxing,
vii. High temperature properties of cold bonded pellets have been found superior to indurated pellets in certain cases, and
viii. Capital and operating costs of cold bonded pellets are estimated to be only two-third of indurated pellets.

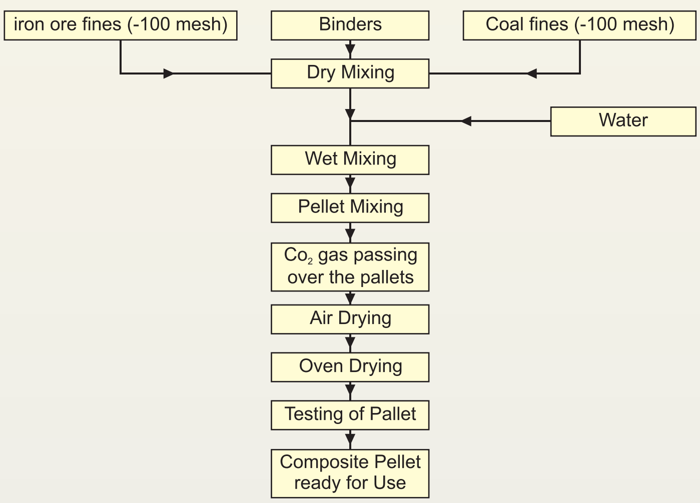

Fig. 1: Flow diagram for composite pellet making[7]

Compressive Strength

Dutta and Ghosh[8] prepared composite pellets using inorganic binders with and without autoclaving. The dry compressive strength of composite pellets was 202 N per pellet by using cement and lime (both -100 mesh size). By using -325 mesh size cement and lime, the strength of pellet was increased to 357 N per pellet. The cement bonded was not desirable due to increase of gangue contents, so increased in slag volume during smelting. The strength of 240 and 1030 N per pellet were obtained for ore-coal and ore-char composite pellets by using an autoclave with lime and silica mix as binder. They also prepared composite pellets using organic binders, the strengths obtained were 329 N per pellet for thermo setting resin (TSR) and 339 N per pellet for TSR and dextrin.
Sah and Dutta[7] used lime and dextrose as binder. The maximum strength was 357 N per briquette. Dutta and Chokshi[9] observed that the average strength of briquette increased with increasing of molasses for fixed amount of fly ash and lime after CO_2 treatment. They observed that CO_2 treatment was helpful to increase the strength of the briquette, due to the formation of carbonate bond. The strength of 404 N per briquette was obtained with the binder combination of fly ash, slaked lime and molasses with CO_2 treatment. The maximum strength of 722 N per briquette was obtained with the binder of polyvinyl alcohol (PVA).

Solid State Reduction

During reduction of iron ore-coal composite pellet, evolution of volatile matter takes place due to pyrolysis of coal. The volatile matter comprises mainly of large amount of hydrocarbons, and small amounts of H_2 and CO. Above 700°C, the hydrocarbons are quickly dissociated into hydrogen and carbons. Hence, pyrolysis of coal generates reducing gases such as hydrogen and carbon monoxide. So, the reduction of iron oxide, in composite pellets, is due to reactions with these reducing gases as follows[3]:

$$3Fe_2O_3 (s) + CO / H_2 (g) = 2Fe_3O_4 (s) + CO_2 / H_2O (g) \quad (1)$$

$$Fe_3O_4 (s) + CO / H_2 (g) = 3FeO (s) + CO_2 / H_2O (g) \quad (2)$$

$$FeO (s) + CO / H_2 (g) = Fe (s) + CO_2 / H_2O (g) \quad (3)$$

Again, gasification of carbon by carbon dioxide and steam takes place as follows:

$$C (s) + CO_2 (g) = 2CO (g) \quad (4)$$

$$C (s) + H_2O (g) = CO (g) + H_2 (g) \quad (5)$$

Volatile matter in the coal evolves during heating and decomposition of hydrocarbons also occurs at high temperature, according to the reaction:

$$\text{Higher hydrocarbons(g)} \rightarrow \text{Lower hydrocarbons(g)} + H_2(g) + C(s) \quad (6)$$

During reduction of composite pellets, it was found that the temperature was not remain constant; so, reduction of composite pellets were non-isothermal in nature. During non-isothermal reduction of composite pellets, it is found that degree of reduction varies from 46 to 99%, depending upon pellets composition and heating rate. A significant quantity (approximately 10 to 20% weight of pellet) of extraneous H_2O and CO_2 are retained by oven-dried pellets as chemically combined or strongly adsorbed species[11]. These gases, liberate during heating to high temperature, react with carbon and hydrocarbon to generate additional quantities of CO and H_2.
Overall reduction of iron ore-coal composite pellets are very fast and more complex due to side reactions and processes, such as evolution of volatile matter from coal, cracking of hydrocarbon, evolution of chemically held / strongly adsorbed moisture, generating H_2 and CO gases.

Smelting Reduction

The smelting reduction (SR) of iron ore–coal composite is very complex with respect to simultaneous reaction steps due to a system consisting of many phases, that is, solids, liquids, and gases. The movements of reactants and products at the interface are affected by several factors and control the rate of reduction. However, Sah and Dutta[12] investigated the reduction kinetics and dissolution behavior of iron ore–coal composite pellets in liquid metal bath in an induction furnace.
It was observed that the fraction of reduction increases with decrease of Fe_{tot}/C_{fix} ratio. It is obvious that a decrease in the Fe_{tot}/C_{fix} ratio means the carbon present in composite pellet increases, that is, more reductant material is present in the pellet and hence more reduction takes place. For pellets of Fe_{tot}/C_{fix} ratio of 4.0, that is, where the carbon content is less in the composite pellets, at the final stage reduction, the carbon from the melt (molten cast iron, and melt is carbon saturated) diffuses toward the pellet–melt interface and takes part in the reaction:

$$FeO + C = Fe + CO (g) \quad (7)$$

Figure 2 and Figure 3 show the fraction of reduction and rate of reduction with respect to time in liquid metal bath. The rate of reduction is higher for pellets contain higher volatile coal than that of pellets contain low volatile coal. This is attributed to the high volatile content in coal which cause more porosity and leads to increase the rate of reduction. For 16-17 mm diameter composite pellets, the time required for complete dissolution in fully immersed condition in liquid metal bath was observed to be 83-90 seconds.

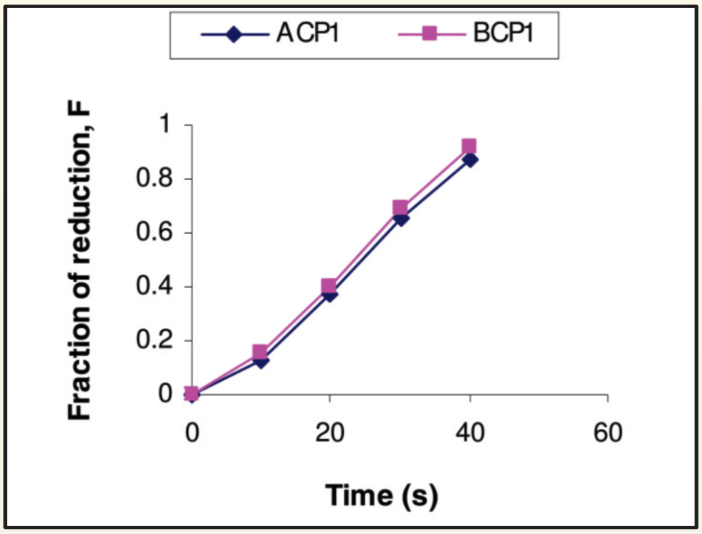

Fig. 2: Fraction of reduction vs time[12].

(ACP refers to the composite pellet made with coal (low VM and high ash) from Jharia mines, Dhanbad and BCP refers to the composite pellet made with coal (high VM and low ash) from Bhilai Steel Plant, Bhilai.)

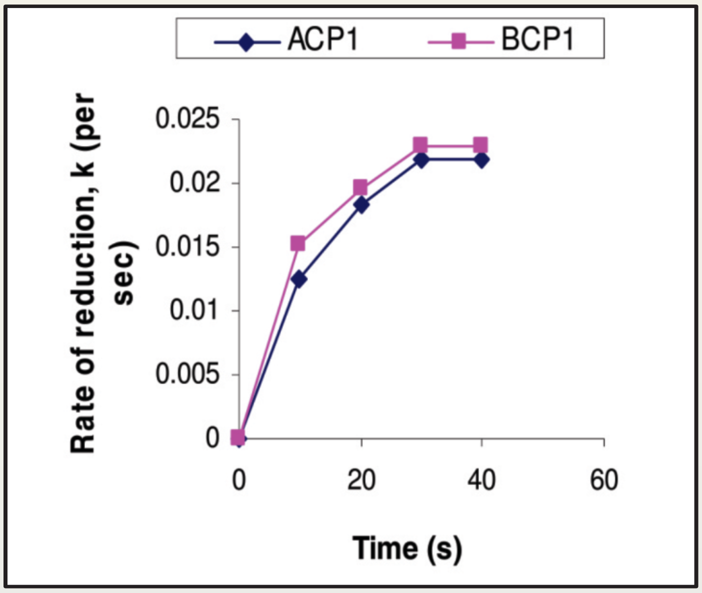

Fig. 3: Rate of reduction vs time[12].

Uses of Composite Pellets

Owing to very fast rate of reduction for Iron ore-coal/char composite pellets, the composite pellets can be used as feed materials in Rotary Kiln for sponge iron production, ITmk3 for production of pig iron nuggets; Cupola for cast iron and Blast Furnace for ironmaking.

I. Rotary Kiln: The retention time of feed materials for Rotary Kiln is very high, so productivity is low. Only solution of drastic increase in productivity is by using iron ore-coal composite pellets. The retention time for feed materials can be reduced sufficiently by using composite pellets. Hence productivity of Rotary Kiln is increased drastically (3 to 4 times). The residence time in the reduction zone is 40 to 60 minutes for iron ore-coal composite pellet is much less compared to ordinary case (6 to 8 hours) due to higher rate of reduction of iron ore-coal composite pellets.

ii. ITmk3: The ITmk3 (Ironmaking Technology Mark 3) process is the 3rd generation of iron making technology, the first two generations comprising blast furnace and direct reduction processes. In ITmk3, green iron ore-coal composite pellets are used as feed material[13]. The composite pellets are fed to a rotary hearth furnace (RHF) and heated to 1300 to 1450°C, at this temperature range, the pellets are reduced to form iron nuggets. The temperature of RHF is raised and thereby melting the reduced iron and enabling it to easily separate from the gangue. This iron making process takes only 10-20 minutes against 10 hours in Blast Furnace process and 8 hours in Rotary Kiln process. Iron and slag get separated and product is called nuggets. Iron nuggets can be fed directly into LD/BOF or EAF as pure iron source and substitute of scrap.

iii. Cupola: Partially replacement of pig iron/scrap with iron ore-coal composite pellets is possible in cupola. Price of the composite pellets is more stable than that of pig iron or scrap, which depends on demand and supply. Composite pellets are uniform in size, it can be continuously charged into the furnace aiming at higher productivity. By using composite pellets as feed material in cupola a reduction in energy consumption and consistency in product quality are envisaged. Trials were taken by author[14] by using composite pellets, partial replacement of pig iron, as feed material in cupola.

iv. Blast Furnace: The iron ore-carbon composite pellets are promising feed stock for reducing the consumption of coke used in blast furnaces, due to fast reduction caused by direct contact between carbon and oxide iron particles. Using this idea, Yokoyama et. al[15] experimented in a commercially operated blast furnace (BF) in Japan and verified its positive effect. They used cement (10-11%) bonded iron ore-coke composite pellets for trials in blast furnace. They charged composite pellets in between sinter layers in BF. Where it concerns carbon in composite pellets, if its carbon content is high, it not only reduces quickly the iron oxide inherent within, but it also prompts the reduction of surrounding sinter in BF. Such positive effects are attributable to the high carbon content (20%) in the composite pellets. They conducted tests where iron ore-coke composite pellets were used in an amount as high as 10% (160 kg/thm), to evaluate the drop of temperature at the reduction equilibrium point, along with the changes in carbon consumption.

Increasing coke gasification rate can lower the temperature of the thermal reserve zone, resulting in a decrease of carbon consumption as well as the reducing agent rate of blast furnaces. They[15] found that the iron ore-coke composite pellets in sinter layers had two functions: one having high reducibility itself and the other enhancing the reduction of the surrounding sinter. Because of the two functions, a significant decrease of the temperature of the thermal reserve zone and an increase of gas utilization in BF result. Long-term plant trials have been conducted at the Oita Works No. 2 Blast Furnace with a maximum use of 54 kg/thm. It was found that composite pellets could lower the temperature of the thermal reserve zone and carbon consumption in a commercial blast furnace. Carbon consumption was decreased along the relationship of 0.36 kg C/thm per 1 kg C/thm of input carbon from iron ore-coke composite pellets.

Conclusion

1. India is poised for a leadership role in steel production of the world; that will be important to consider optimum use of raw materials.
2. Utilization of iron ore fines for extracting metal is of vital concern for resource conservation and pollution control.
3. By producing cold bonded iron ore - coal composite briquettes

/ pellets from iron ore and coal fines, utilization of these fines takes place for resource conservation as well as to control the pollution. Utilization of iron ore and coal fines by producing composite briquettes / pellets, which are the value added products and turn the waste into wealth; that will be future feed materials.

4. The retention time of Rotary Kiln for feed materials can be reduced sufficiently by using composite pellets, hence productivity is increased drastically.
5. Replacement of pig iron / scrap / lump ore with iron ore-coal composite pellets in cupola / blast furnace is viable.
6. By incorporating non-coking coal fines in cold bonded iron ore-coal composite pellets, the metallurgical coke requirement in the blast furnaces can be reduced.
7. Reaching 300 Mt by 2030, utilization of raw materials will be done properly and precisely; otherwise there will be shortage of raw materials in near future.
8. The exercise shows promising prospect for small-scale ironmaking / steelmaking with higher production rate.

References

1. World steel in figures 2018, World Steel Association.
2. National Steel Policy 2017: Ministry of Steel (Establishment Division), Notification, New Delhi, India. 2017 May 8, pp 1-36.
3. Dutta S. K.: Kinetics and Mechanism of Iron Ore-Coal Composite Pellets Reduction, Trans Ind Inst Met, 58(5), Oct 2005, pp 801-808.
4. Bagatini M. C. et al.: Characterization and Reduction Behavior of Mill Scale. ISIJ International, 51(7), 2011, pp 1072-1079.
5. Ghosh A.: Kinetics and Mechanism of Reduction in Composite Iron Ore-Reductant Pellets , Proc. Inter. Conf. on Alternative Routes of Iron and Steelmaking, Perth, Australia, Sep 1999, pp 71-78.
6. Dutta S. K., Sah R. and Chokshi Y.: Iron Ore-Coal/Coke Composite Pellets, Lap Lambert Academic Publishing, Germany, 2013.
7. Sah R. and Dutta S. K.: Effects of Binder on the Properties of Iron Ore - Coal Composite Pellets, Min. Processing & Ext. Met. Review, 31(2), Jan 2010, pp 73-85.
8. Dutta S. K., and Ghosh A.: Evaluation of Various Cold Bonding Techniques for Iron Ore-Coal/Char Composite Pellets, Trans. Ind. Inst. Met., 48(l), Feb 1995, pp 1-13.
9. Dutta S. K. and Chokshi Y.: Utilization of Iron Ore and Coal Fines by Producing Composite Briquette/Pellets, Proc. of Inter. Mineral Processing Congress 2012 (IMPC 2012), Sep 2012, New Delhi, pp 1269-1278.
10. Patil J. B., Kakkar N. K., Srinivasan T.M., Dharanipalan S., Patel B. B. and Nayak N.M.: Production of Cold Bonded Pellets, Trans. Ind. Inst. Met., 33 (5), Oct 1980, pp 382-90.
11. Dutta S. K., and Ghosh A.: Study of Non-isothermal Reduction of Iron Ore-Coal/Char Composite Pellets, Met. and Mat. Trans, 25B, Feb 1994, pp 15-26.
12. Sah, R. and Dutta, S.K.: Smelting Reduction of Iron Ore-Coal Composite Pellets, Steel Res. Int., 81(6), 2010, pp 426–433.
13. Dutta, S.K. and Sah, R.: Alternate Methods of Ironmaking, S. Chand & Co. Ltd, New Delhi, 2012.
14. Dutta, S.K: Use of Iron Ore-Coal Composite Pellets in Cupola, Unpublished work.
15. Yokoyama H., et al: Decrease in Carbon Consumption of a Commercial Blast Furnace by Using Carbon Composite Iron Ore, ISIJ International, 52 (11), 2012, pp 2000–2006.

TECHNICAL ARTICLE

Coking Coal Availability for Indian Steel Industry – Issues and Challenges

N C Jha

India has become the third largest steel producer in the world with a production of 91 MT and a capacity of 125 MT in FY 2015-16. The low per capita steel consumption of being low at 61 kg in India compared to world average of 208 kg, there is significant potential for growth. As per the National Steel Policy, 2017, the crude Steel demand will grow threeforld in next 15 years to reach a demand of 255 MT by 2030-31. It is anticipated that a crude steel capacity of 300 MTPA will be required by 2030-31, based on the demand projections. Even with this demand of crude steel by 2030-31, India's per capita finished steel consumption would reach only to 158 kg. However, achieving crude Steel capacity up to 300 MT will require extensive mobilization of natural resources, finances, manpower and infrastructure including land.

Requirement of cooking course

As per the aforesaid Policy, the demand for cooking coal is expected to be 161 MTPA; that of non-coking coal for PCI about 31 MTPA and the non-coking coal requirement for DRI route is estimated at 105 MTPA by the FY 2030-31.

The current dependence on imported coal is about 85%, which as per the National Steel Policy is supposed to be brought down to 65% by 2030-31. This indicates that 35% of the total requirement of 161 MTPA by 2030-31, i.e., 56.35 MTPA needs to be met from the domestic sources by the year 2030-31. This is a great challenge for both the Steel Producers and the Coal Producers in the country.

The National Steel Policy aims at increasing the availability of coking coal through overseas asset acquisition, establishing sufficient number of modern coking coal Washeries, facilitating allocation of indigenous coking coal reserves in the country exclusively to steel sector with no diversion of such coal to any other sector, facilitating exploration and optimal utilization of deep seated coking coal reserves, expeditious implementation of Jharia Action Plan to improve the domestic availability of coking coal and taking suitable fiscal measures to support the rising requirement in the steel sector.

Coking Coal availability in India

Though, India is fortunate to have third largest share of coal reserves in the world, the quantity of coking coal is very limited. Further, due to the "Drift Theory" origin of coal in India, where the woody material was transported to longer distances, carrying along external impurities, made such coals contain very high amount of inert material or mineral material, commonly known as ash content. These mineral matters are finely disseminated within the coal matrix, which have made the coal more difficult to be washed or beneficiated for reducing the ash content.

Coking coals in India are categorised in three categories, namely Prime Coking Coal, that can form coke for metallurgical purposes without blending with other coals: Medium Coking Coals, that require blending with Prime coking coals for coke making: and Semi-coking Coals that are weak in coking properties but can be blended in small proportions with Prime coking coals for coke making.

Prime coking coals are available in India only in the upper seams (Seams IX and above) of the Jharia Coalfield, which have mostly been exploited in the past and the remnant resources are now available in the surface constrained areas like, Surface Fires, Rivers, Townships, Human Settlements and Road & Rail infrastructure.

Medium coking coals are available in various coalfields in Jharkhand (lower seams of Jharia coalfield, Raniganj, East Bokaro, West Bokaro, Ramgarh, North Karanpura and South Karanpura), West Bengal (Raniganj coalfield) and, Madhya Pradesh (Pench Kanhan & Sohagpur), which have substantial resources with high ash content.

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Semi-coking coals are available in very limited areas of West Bengal (Raniganj coalfield), Jharkhand (Ramgarh coalfield) and Chhattisgarh (Sonhat coalfield).

As per the GSI estimates of 2017, the total coking coal resource in India is 34.533 billion tonnes (Bt) with Prime, medium and Semi-coking being 5.313Bt, 27.512Bt and 1.707Bt respectively. Based on the status of exploration the break-up of these resources is as follows[1]:

Coal Type	Measured Resource (billion tonnes)	Indicated Resource (billion tonnes)	Inferred Resource (billion tonnes)	Total Resource (billion tonnes)
Prime Coking	4.614	0.698	0.000	5.313
Medium Coking	13.500	12.132	1.879	27.513
Semi-coking	0.519	0.995	0.193	1.707
Total Coking	**18.634**	**13.826**	**2.072**	**34.533**

1. Source GSI publication

General characteristics of coking coal

Coking coals are such coals that can form quality coke during carbonisation. Coke quality in terms of cold and hot strength plays an important role in the smooth running of Blast Furnaces. The four most important characteristics of coke that dictate the right quality parameters of coking coals required to make such coke are, Micum-10, Micum-40, CSR and CRI values. These are basically the strength parameters of the coke at different conditions.

Amongst all ranks of coal, depending on their age (Peat, Lignite, Bituminous and Anthracite), only a few bituminous coals possess the required properties for production of right quality coke for the use in a Blast Furnace. As such, the quality parameters of the coking coals are very important for deciding the blend ratio of different coking coals from different sources for making a good coke. The required characteristics of coke are achieved by making coke after blending coking coals from different sources to satisfy the pre-defined proximate characteristics, ultimate analysis characteristics rheological properties, petrographic properties and the ash chemistry.

Important parameters of the proximate analysis are the moisture content, volatile matter and the ash (inorganic residue), each expressed as percentage of total. The ultimate analysis results show the percentages of different elements like C, H, N, S and P.

In the rheological properties, Free Swelling Index (FSI) or Crucible Swelling Number (CSN), Maximum Fluidity (ddpm) and Plastic Range are very important to decide the suitability of any coal for coke making. For high strength coke, various coals used in the blend should have a broad range of common plastic temperature; otherwise coals will not be compatible.

During the process of formation of coal, that is, conversion of wood or plant material to bituminous coal stage, different types of macerals, like Vitrinite, Semi-Vitrinite, Liptinite, Exinite and Inertinite are formed that behave differently upon heating. Only the first four macerals are characterised as reactives. Petrographic properties are determined through microscopic studies of coal samples for determination of their type, rank and mineral matter. General characteristics of coking coals show that the reflectance of Vitrinite (Ro) varies from 0.6% to 1.8%, however, the acceptable range of reflectance (Ro) for good coke making varies from 1.1% to 1.4%. Mean maximum reflectance (MMR), which is denoted as Rmax or MMR is normally 1.066 times of Ro value.

The ash chemistry of coal in terms of its composition as CaO, SiO_2, Al_2O_3, Na_2O, K_2O etc. are also important to decide whether the slag of the Blast Furnace will have acidic nature or basic nature.

Thus, it can be seen from the above that selecting a particular coal for coke making requires rigorous testing of the same in terms of the different required properties and making coke after blending the same with other suitable coals to meet the required coke parameters.

Quality Comparison of Indian Coking Coals with Australian coking coal

Australia is major supplier of coking coal to India and also to the world trade. Indian Steel producers meet their requirement of coking coal largely from Australia and partly from USA, New Zealand, Mozambique, Russia and China. Quality-wise Australian coals are superior and as such are more favoured by the Indian Steel industry. However, the international price of coking coal is very volatile and becomes unaffordable for the steel producers at times.

A comparison of some typical parameters of imported Australian coking coal with typical Indian coking coals is shown below[2]:

Sl. No.	Coal/coke parameters	Australian coking coal	Indian washed coking coal	Remarks
A.	Proximate Analysis			
	Moisture (%)	1 - 2	2 – 2.5	
	Ash (%)	7.5 - 9.8	15.24 – 18.03	Higher in Indian coals.
	Volatile Matter (%)	19.3 - 24.3	18.58 – 24.84	
B.	Ultimate Analysis			
	Carbon (%)	88.3 - 90	70.9 – 75.1	
	Hydrogen (%)	4.67 - 5.0	4.03 – 4.23	
	Nitrogen (%)	1.8 - 2.06	1.08 – 1.57	
	Sulphur (%)	0.55 - 0.7	0.57 – 0.83	
	Phosphorus (%)	0.007 - 0.07	0.026 – 0.18	
C.	Petrographic Analysis			
	Vitrinite (%)	55 - 70	46.5 – 55.0	Lower in Indian coals.
	Liptinite (%)	0 - 1	0 – 4.4	
	Exinite (%)	0	0	
	Inertinite (%)	27 – 42	38.1 – 45.6	Higher in Indian coal.
	Mineral Matter (%)	2 – 4	5.9 – 9.9	Higher in Indian coal
	Vitrinite Reflectance (Rmax)	1.17 – 1.55	0.98 – 1.3	Lower in Indian coal.
D.	Ash Analysis			
	SiO_2	50.3 – 66.5	8.22 – 11.25	
	Al_2O_3	28 – 33.1	4.92 – 5.29	
	Fe_2O_3	2.4 – 7.6	0.01 – 1.05	
	CaO	0.2 – 3.9	0.095 – 0.63	
	Na_2O	0.3 – 0.9	0.001 – 0.052	
	K_2O	0.85 – 1.5	0.2 – 0.33	
E.	Caking Property			
	CSN	7.5 – 9.0	5 – 6	Lower swelling index due to higher ash in Indian coal.
	Gray King Coke Type	$G_5 – G_{10}$	C – E/F	Relatively inferior coke type
F.	Giesler Plastometer Value			
	Maximum Fluidity (ddpm)	75 – 1100	772 - 2400	Superior fluidity in Indian coal.
G.	Coke Properties			
	Micum M_{40}	80 – 84	NA	
	Micum M_{10}	7 – 8	NA	
	Coke reactivity index (CRI)	21 – 35	NA	
	Coke Strength after reaction (CSR)	65 – 72	NA	

[2.] Source: Compiled from various available sources.

Coking coal price concern

Historically, price of imported coking coal had a downward trend since 2012 (US$ 252.1) till 2015 (US$ 90). From the second half of 2016, there has been steep rises in the prices, sometimes touching the figure of US$ 260 per tonne. Coking coal prices in the international market continue to trend higher since December 2017 on the back so supply tightness in Queensland, Australia. Difficulties in securing loading slots in Queensland for contract cargoes continued to tighten global supply of coking coal in late 2017. In March 2018 the prices are in the range of US$ 220-225 per tonne.

Soaring price of internally traded coking coal is a cause of great concern for the Indian steel producers due to their competitiveness in the world market for the steel products.

Need for demand side management

With the limited availability of domestic coking coal for the required quality and its spiralling high prices in the international market, it is necessary to look at the demand management side. It is more so important when we look at the current consumption rate of coke in Indian Steel Plants vis-à-vis global best practices. The National Steel Policy endeavours to pursue with the Integrated Steel Plants to reduce their coking coal consumption at par with global best practices by resorting to auxiliary fuel injection technologies like Pulverized Coal Injections (PCI)/ Coal Dust Injection (CDI) or natural gas/ syngas injection along with PCI/ CDI.

Targets for the techno-economic performance, as set forth in the National Steel Policy are as shown below:

Parameters	Units	International Best Practice	Current	Target for 2030-31
Coke Rate	kg/thm	275 - 350	400 - 600	300 – 350
CDI Rate	kg/thm	200 – 225	50 – 200	180 - 200
BF Productivity	tonnes/m^3 /day	2.5 – 3.5	1.3 – 2.2	2.5 – 3.0
Specific Energy Consumption	Gcal/tcs	4.5 – 5.0	6.2 – 6.7	5.0 - 5.5

Coking coal production plan of Coal India Ltd for FY 2019-20

CIL has planned to enhance its coal production to the tune of 908MT by 2019-20. A breakup of the planned production vis-à-vis individual subsidiary is as follows[3]:

Subsidiary Name	Total (MTPA)	Coking coal	Non-Coking Coal (MTPA)	
			G-10 & superior	G-11 & inferior
ECL	62.0	0.25	44.75	17.0
BCCL	53.0	45.78	7.22	-
CCL	133.5	24.4	45.57	63.5
NCL	110.0	-	96.00	14.0
WCL	60.0	0.52	59.48	-
SECL	239.6	0.14	20.42	219.0
MCL	250.0	-	1.5	248.5
Total	**908.10**	**71.12**	**274.94**	**562.04**

[3] Source: Published paper in the 5th International Conference on Coal Washing.

As can be seen from the above, around 71 MT of coking coal is planned to be produced, but due to non-availability of adequate washing capacity in CIL, most of these are being supplied to the power plants. This is the current practice and is likely to continue until the washery construction programme of CIL gains ground.

Coking coal washing – Present capacity and future plans

Most of the coking coals, being produced currently and also projected to be produced in future, are of inferior grade with ash content generally exceeding 35%. The current washing capacity of Coal India for coking coals is around 23.3 MTPA and it has a plan to set up new coking coal washeries to meet the requirement of coking coal for the steel producers. However, as Indian Coking coals have very poor washability characteristics these washeries are planned to wash at 18-19% ash content.

At present the total installed capacity of the coking coal washeries in India is about 31 MTPA which operate at around 20-30% capacity utilisation. Such low capacity utilisation is owing to the fact that most of them were set up 4 to 5 decades ago and not much required improvements were made in them with the changing quality of feed over the years. These washeries were planned with feed from superior grade coals, which have since exhausted.

CIL has identified to set up 18 new coking coal washeries with total throughput capacity of 48.2 MTPA (Source: Corporate presentation of CIL, April 2017) in its various subsidiaries under BOM/BOO concept. Three of these washeries at BCCL with a combined capacity 11.6 MTPA are likely to be commissioned shortly. Other three coking coal washeries with total capacity of 7.0 MTPA are in different stages of construction and are likely to be commissioned by the year 2019-20. Additional one new coking coal washery with throughput capacity of 3.5 MTPA is planned to be set up at Tasra project of SAIL.

In view of the above, the total installed capacity of the new washeries and the existing washeries of Tata Steel would be about 59.4 MTPA, which at an average yield of about 45% - 50% can provide clean coals at 18% ash to the extent of 27 to 30 MTPA. As most of the existing washeries would be replaced with the new ones, there still remains much gap between the estimated demand of coking coal from indigenous sources and its likely availability. Further, it is also important to examine whether, all the domestic coal with 18-19% ash can be blended with imported coal at the steel plants from the point of view of Blast Furnace productivity and the related costs.

Prospect of washing Indian Coking coal at lower ash level

A Committee was constituted by the Ministry of Coal, Government of India in March 2017 under the Chairmanship of CMD, CMPDI with members from Steel and coking coal producing companies, CIMFR and IIT(ISM), Dhanbad for assessing the technical feasibility of washing coking coals (W-IV/LVMC) to 13% ash content and the cost economics thereof.

Comprehensive studies were made by collecting samples of coking coal from the mines/seam currently under production, conducting washability tests and evaluating the cost of clean coal at 18% ash, 15% ash and 13% ash. The Committee's major findings were as follows:

i. In general, the desired selling price of clean coal produced on washing W-IV coal is less than the desired selling price of clean coal produced on washing ungraded coal.

ii. In the case of washing coal to obtain cleans coal at 13% ash, there is huge generation of middlings as compared to that at 18% ash clean coal. Marketability of such huge quantity of middlings needs to be looked into.

iii. In the case of clean coal at 13% ash, it is obvious that significant quantity of coal having coking properties is reporting to the middlings which could otherwise be used for metallurgical purpose.

iv. Depending on the quality of raw coal feed (W-IV & ungraded) and its washability characteristics, the theoretical yield of clean coal at 13% ash varies from 13% to 28% and the corresponding middlings at 34% ash varies from 62% to 51%, which is more than double the quantity of middlings generated at 18% ash clean coal. This indicates that huge quantity of coal having metallurgical properties migrates to middlings which can otherwise be used for metallurgical purpose if washed to obtain clean coal at 18% ash level.

v. For washing W-II/ W-III grade coking coal at 13% ash clean coal, new washeries may be set up in the areas where there is potential of better yield leading to favourable techno-economics and the consumer is willing to accept clean coal at that price on long-term basis.

vi. The technology for Washing may be selected on the basis of percentage of Near Gravity Material (NGM) at the cut-off ash, which could be Jig for <20% NGM and Heavy Media for >20% NGM.

vii. Washing of coking coal to produce clean coal at 13%, 15% and 18% may be considered based on the overall economics of the project which is greatly dependent on yield%. To have a balance between cost of production yield and ash%, project specific study needs to be carried out in a holistic manner.

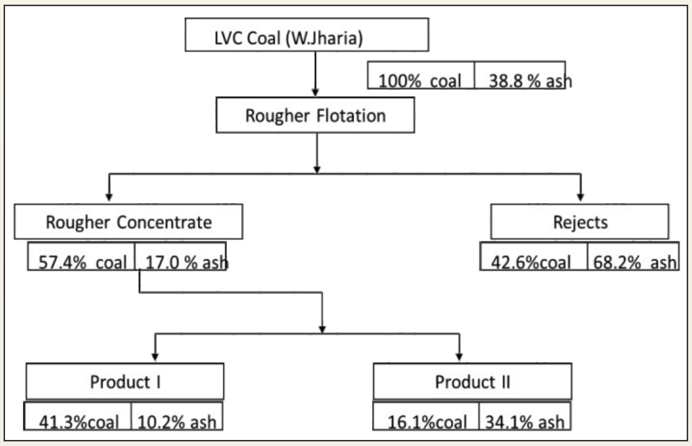
In view of the above, it was recommended that washing of coking coal (WIV & LVMC) at 18% ash level will give viable techno-economics for both Steel Sector and CIL.

Emerging Technologies for extracting less than 10%-12% ash coal from high ash Indian coking coals.

A. Studies done by CIMFR

CIMFR had conducted some studies on grinding of Low Volatile Coking coal to 100 micron size and then beneficiating it by floatation. To achieve the low ash (below 12% ash content), two-stage floatation studies were carried out. The typical results of the rougher and cleaning stage floatation by floatation column is shown in the flow sheet.

This coal has potential to give the product at around 10%-12% ash content with 41%-42% yield and second product can be produced at around 34%-35% ash having 16%-17% yield. The overall yield in two stage processes is around 57%-58%. The rejected tailings are having 68% ash content. The second product can be used directly for power generation. There is also the possibility by blending the tailings with product II to use in fluidized bed power generation plant to utilize the full combustible values.



Material balance of two stage floatation process

The above study indicates that there is ample potential to get up to 10% ash coking coal from Indian ROM coking coals. However, its cost economics and the technology for binding the 100 micron size product, to make them transportable, needs to be developed.

It is suggested that Indian Steel Producers should commission Research Organisations to develop this technology to recover maximum carbon from the domestic coking coal. It may be worth mentioning that the technology for drying and conditioning micron size coals to form a product in pellet size has already been developed in USA, which would require to be adopted in this technology.

B. Recent developments in coal refining (reducing ash in clean coal to around 5%)

A remarkable new coal technology has been developed recently in the USA where coal refuse from the coal washeries are processed efficiently to separate it into hydrocarbon, mineral matter and water factions. The process takes place at a very small particle size (averaging around 100 microns) enabling the particles to respond to nano agents – the coal becomes very hydrophobic, facilitating very effective ash-mineral separation. The hydrocarbon fuel separated from this process is an extremely high quality coal and is produced as a robust, stable pellet with approximately 2% moisture and 5% ash. As a fuel, such low ash-low moisture hydrocarbon fuel delivers substantial value in use for power stations (for thermal coal) and steel production (for coking coal).

Pilot scale demonstration of such separation at a capacity of 3 tph module has been made with the result of substantial reduction in the ash and improvement in the FSI of coking coal rejects. It is also gathered that a number of small modules of 3 tph could be clubbed together to create an integrated capacity of 2 MTPA throughput for such processes.

Though, the above mentioned development is quite new and requires to be evaluated on commercial scale, the development itself appears to be innovative and requires a closer scrutiny for its use on a commercial scale for treating Indian coking coals which have inherently high ash content.

Conclusions

Indian Steel Producers are facing a lot of challenges in meeting the competitiveness of marketing steel in the world market due to highly volatile prices of coking coal. This is further compounded by the mammoth plan of increasing steel production in India in the coming 15 years. Domestic coking coal, having high ash content and difficult to wash characteristics, restrict their washability at lower ash levels and become extremely costly compared to the internally traded coking coals. However, in order to control overall costs of production of steel, it is necessary to blend domestic coking coals to the maximum extent, without compromising on the overall cost of production of steel. A lot of R&D work has to be undertaken to harness maximum quantity of coal at lower ash from the domestic coal. The conventional system of gravity based coal washing is not a solution to the increasing demand of coking coal. The emerging technologies need to be developed as discussed in the previous paragraph need to be tried and established to make them commercially viable to increase the availability of domestic coking coal for metallurgical purposes. The best way to maximise utilisation of Indian coking coal would be to conventionally wash it at 18% ash and treat the rest of coal (middlings and rejects) in the new technologies to reduce the ash to below 8-10% and blend it with 18% ash clean coal to reduce the overall ash content of the blend.

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Shear Blade Manufacturing from Induction Furnace Steel

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Abstract

AISI-D2 / AISI-D3, as most popular grades of high carbon- high chromium steel for making shear blades are melted in induction furnace and ingots are subsequently forged or rolled and heat treated as shear blade blank for final shaping in modern CNC machines in machine shops. The end products as final shear blade in heat treated conditions in accurate dimensions with uniform hardness throughout the blade meet the specific requirements in the metallurgical process plants for shearing products during hot or cold rolling or forging operations and perform shearing of metals in efficient ways with their uniformity of metallurgical structure providing keen cutting and satisfactory services life.

Introduction

In the metallurgical process plant, mainly in steel plants, shearing of products at high and low temperature rolling or forging is done for production of flats or long products, forgings into specified pieces and lengths. During shearing, two knives or blades are positioned at an angle relative to each other where the lower blade or knife is firmly attached in the stationery table whereas the upper knife or blade is fixed to the moving ram assembly and blades are separated by a gap termed as clearance between the blades measuring in millimeter.

Blades for shearing are mainly grouped as high quality machine knives, shear blades and guillotine shear blades produced from high quality steel grade groups of types work-hardening, cold work, shock resisting, high speed, hot work and special purposes for different industries. These are manufactured both economically and technologically from the inputs produced mainly from steel by induction furnace, hot working followed by subsequent treatment, machining/ shaping focusing on product quality, upgrading & developing products reducing cost.

Most shear blades used for shearing metal products in hot, warm or cold conditions are made from tool steel grades like high carbon, high chromium or high carbon-high chromium steels. Scrap shearing, of course, is done by shear blades made from low alloy steel grades. The sharpening aspect of shear blades depend on cutting load and material removed from blade as dull blade may tend to tear the material opposed to cutting resulting in roll over, heavy burring work hardening of the products sheared. Shear blade steel is chosen based on the properties like product strength, toughness, surface hardness, shock resistance, working temperature and cost. In early 80s, ASP, Durgapur, as value added products, developed different types of shear blades from degassed tool steel establishing vendors providing them technical guidance for final shaping of quality blades for use in steel plants in the country.

Steel Grades for Shear Blades

Standard Steel Grades Shear blades in this grade groups are characterized for their hardness, ability to resist deformations, and long-term service. Finer edge of the blades should be perfect for precise cutting and slitting operation for which the blades are regularly sharpened on routine basis based on shearing loads and blade condition. Therefore, these grades of steel are generally used for infrequent cutting of paper or miscellaneous jobs with less quality issues.

Alloy Tool Steel contains additional alloying elements compared to Standard Steel Grades where blades made out of Alloy Tool Steels which offer improved hardness, strength, toughness, and wear resistance as briefed below:

High Carbon High Chromium Shear blades provide excellent hardness and wear and corrosion resistance. These blades perform in a better ways than standard steel grades maintaining sharp edge for longer and better. However, blades made out of HC-HCr steel are more difficult to sharpen. Most popular grade in this group is D2, nominal composition (%) being C 1.7, Cr 12, V 0.10, W 0.50 - delivery condition usually Annealing. The other popular grade is D3, nominal composition (%) being C 2.0, Cr 12.0 - delivery condition usually Annealing.

High Speed Steel Shear blades withstand generated heat from the friction of continuous use as fast moving cutting tools. As such, these shear blades are of choice to user industries widely for cutting various materials in different applications in the hardness range of RC 62-63 which is significantly increases blade life compare with any standard quality.

Tungsten Carbide Tipped blades are known for being sharp and durable sustaining significant loads as highly wear-resistant cutting tools in a variety of industrial applications where extremely sharp cutting instruments are required.

Hardened and Tempered Stainless Steel shear blades types 420 (nominal composition C 0.40, Cr 13.50, hardening & tempering temperature as 1000-1050° C & 100-250° C /440 B(nominal composition C 0.90, Cr 17.50, Mo 1.20, V 0.10, hardening & tempering temperature as 1020-1070°C & 100-200°C). Stainless steel blades have high carbon content which increase hardness, improving strength, wear and corrosion resistance. Because of the steel hardening process these blades are resistance to any food or water with mild alkalosis or acids. As a result these blades are the best choice for applications within the packaging and chemical processing industries.

Shear blade manufacturers should be conversant about the specific shear model for use of good quality hardened shim material, mild steels can compress or distort in operation causing frequent blade damage from chipping. Manufacturers, while making shear blades from the inputs as forged or rolled and heat treated condition, must ensure the surface hardness and also through hardness, toughness of the shear blades as required by customers. Tool steel grades are used for manufacturing shear blades in the categories.

- Oil hardening O & L series tool steels,
- Air hardening A & D series tool steels,
- Shock resisting S series tool steels,
- Heat resisting tool steels H series,
- High speed tool steels with Molybdenum M series,
- High speed tool steels with Tungsten T series.

Steel Making

Shear blade steel is produced by mini steel plants mostly by induction furnace melting route under carefully controlled conditions to produce the required quality and composition. Tool steel for shear blades has a carbon content between 0.5% and 2.0% and often made from around 75% scrap as mixture of return/ home / mill scrap, purchased scrap and sponge iron/ HBI along-with required quantity of ferro-alloys as per grade composition. The manufacturing process introduces alloying elements that form carbides, commonly by tungsten, chromium, vanadium and molybdenum. It is important at melting stage for avoiding contamination of the scrap especially from metals which cannot be oxidized by Nickel, Cobalt and Copper.

The three stages of activities in melting shops are:

1. The scrap and scrap substitute is melted quickly in the furnace maintaining composition of the melt.
2. Then tapped liquid steel in heated ladle is transferred to the secondary reefing station as quick as possible for reefing and

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trimming alloy addition in need.

3. The refined liquid steel is then brought into the casting station and poured into ingots by up-hill teaming. The resulting ingots are usually annealed (heated and cooled slowly) to prevent cracking by eliminating thermal stresses developed in the ingot.

In absence of secondary reefing unit in the melt shop, argon purging is done to bring uniformity in temperature and float the impurities from liquid steel at the top surface.

Hot Working

Ingots are forged or rolled following standard heating cycles without any deviations as grades are very sensitive. After forging or rolling, grade-wise suitable disposition cycle has to be given. The products are to be annealed preferably in controlled atmosphere properly documenting the test results and properties and passed on to the shear blade manufacturers. Modern tool steels depend strongly on alloying elements and heat treatment for their mechanical property requirements.

Most rolling mills run with an over speed on the shears, this is normally done to ensure the nose and tail crops are thrown into the disposal chute and not left in the path for the next bar, and on the divide shear that the nose end is straight. The amount of over speed will be determined by the size of the crop end disposal problem for each shear. Factors determine the over speed are size of bar/ rod to be cut, temperature of material, steel grade and condition of blade.

Crop shear blades are used in the hot strip mill line in rolling mills where slab stock temperatures are from 1000-1150°C and rolled one after another in the roughing mill line.

Thus, their front and back ends change in shape which are sheared by flying shear. Then they are rolled for well-formed materials in the finish rolling mill line and rolled up like a coil.

Heat Treatment

The parameters depend upon understanding of the inter-relationships among carbon content, alloy composition, and mechanical properties of the stock. Usually annealed stocks are preferred by shear blade fabrication industries for machining and final shaping.

D3 tool steel requires hardening and tempering to achieve maximum properties. For maximum accuracy, the parts of D3 tool steel should be stress relieved after roughing operations. Stress should be relieved at 648°C one hour and cooled slowly.

Annealing of D3 tool steel needs to be done in a controlled atmosphere furnace, should be heated thoroughly to 871°C and cooled slowly at a rate of not more than 6°C per hour, until the furnace is black. Then the material should be removed and air cooled.

For Hardening, D3 tool steel should be heated properly since it is very sensitive to overheating and if not heated maximum hardness cannot be achieved. The work should be directly placed in a furnace preheated to 954°C and soaked for 20-25 minutes, plus 5 minutes per inch of thickness, and then oil-quenched to harden it.

For Tempering, D3 tool steel should be cooled to room temperature and should be tempered immediately. The parts should be placed in the tempering furnace and increased slowly to the desired tempering temperature. Tempering for 1 hour per inch of thickness is required.

Annealing of D2 tool steel, heat uniformly to 843/871°C, then slow furnace cool at a rate of not more than 10°C per hour. After annealing D2 a maximum hardness of 240 Brinell may be achieved

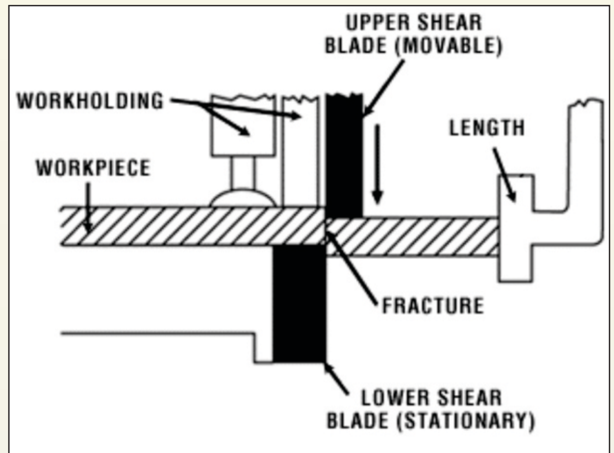
For Hardening D2 tool steel, this grade is extremely sensitive and not to be over heated. Pre heat slowly to 750/780°C and soak. Continue heating to the final hardening temperature of 1000/1030°C and allow the component to equalise. Quench in oil or cool in air.

For Tempering, Heat uniformly and thoroughly to the desired temperature and hold for 25 minutes per cm of thickness. D2 can be double tempering at approximately 15°C below the first tempering, after intermediate cooling to room temperature.

Shearing operation is considered as a metal fabricating process which used to cut straight lines on flat metal stock. During the shearing process, an upper blade and a lower blade are forced past each other with the space between them determined by a required offset. Normally, one of the blades remains stationary.

The shearing process characteristics include:

- Its ability to make straight-line cuts on flat sheet stock
- Metal placement between an upper and lower shear blades
- Its trademark production of burred and slightly deformed metal edges
- Its ability to cut relatively small lengths of material at any time since the shearing blades can be mounted at an angle to reduce the necessary shearing force required.

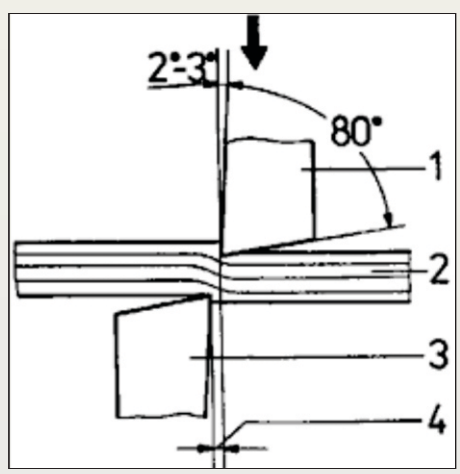


SHEARING PROCESS

The illustration provides a two-dimensional look at a typical metal shearing process where the upper shear blade fractures the metal work piece held in place by the work holding devices. The sheared piece drops away.

Typically, the upper shear blade is mounted at an angle to the lower blade that is normally mounted horizontally. The shearing process performs only fundamental straight-line cutting but any geometrical shape with a straight line cut can usually be produced on a shear.

Metal shearing can be performed on sheet, strip, bar, plate, and even angle stock. Bar and angle materials can only be cut to length. However, many shapes can be produced by shearing sheet and plate.



Materials that are commonly sheared by different types of shear blades are:

1. Sheet metal and plate using a squaring or bow tie shear
2. Angle materials using an angle shear, and
3. Bar stock using a bar shear, high speed bar/rod by using flying shear.

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continuation after pg. 16

Manufacturing Process of Shear Blade

Common types of shear blades are shears with parallel blades, Guillotine shears, Flying shears, Disc shears. In the first stage of manufacturing process, from a precursor material present in the form of a flat material, a blade blank whose geometric dimensions approximately correspond to those of the ultimate finished blade form is produced by punching. The machining of the precursor material can be accomplished by the processes of punching technology, pressure forming, bending or shearing. Thus the cutting of the blank to size is also known from the prior art.

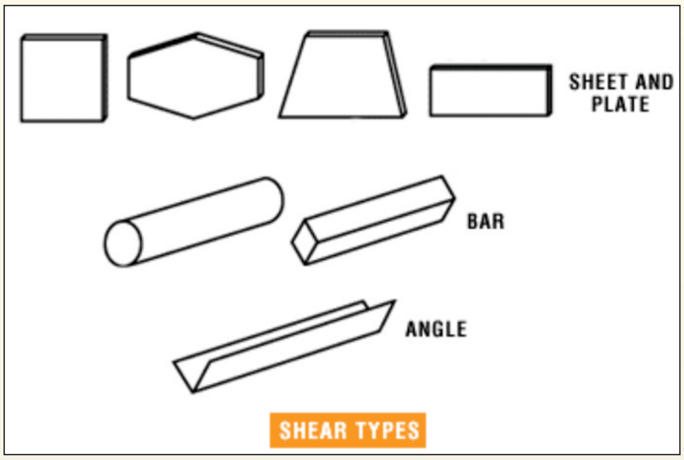
In the second stage, the fine machining of the blade blank takes place forming the appropriate blade contour on the one hand and the edge area on the other where the appropriate grinding agents being used for this.

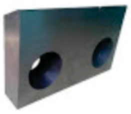
In the third stage, finally, the boundary layer of the blade material in the edge area is hardened by heat treatment process and the boundary layer, for specific material, can be enriched with an additive material such as tungsten, chromium or titanium. In particular, nitriding, wherein the chemical composition of the boundary layer is modified in that nitrogen in atomic form is diffused into the material surface, is employed as the thermo-mechanical diffusion treatment process. Most of the manufactures of shear blades have up-graded their machine shops with modern equipment and processing units like CNC Presses/ Press Brake, NC Guillotine, CNC Profile Cutting, CNC Turning, CNC Milling machines. (Common Tools used during machining of Shear Blades in CNC machines are shown in the picture below.)

In order to form hard, chemically and thermally very resistant nitrides, alloying elements having an affinity for nitrogen can be added in melting shop. Finally, following the boundary layer hardening, the extra machining of the blades and particularly edge area , for instance, grinding, is necessary in a fourth stage. There is generally a through-hardening or a boundary layer hardening with a hardening depth of <0.2 mm, which, in conjunction with an embrittlement, results in chipping of the hard boundary layer when edge area of the blade may be destroyed and as a result the shear blade becomes unsuitable for the intended use. However the processing technology has been developed as

1. In the first stage, shear blade base material is laser treated along a curve contour determined by cutting edge of said finished blade to form a laser treated area.
2. In the second stage, blade material is formed to a desired shape with cutting edge inside the laser treated area or machining the blade in the first stage by punching or trimming base material to the desired shape having said cutting edge subsequently laser treating the cutting edge of finished blade in the second stage and then shaping the laser treated cutting edge in third stage.

Shear blade performance, therefore, depends on steel composition and quality, standard process in hot working and heat treatment and finally processing stages at shear blade manufacturing end which, together, will ensure blade life avoiding chipping or blade damage as well as enable an economical production thereof shearing different shaped products. Indian shear blade manufacturers with their engineering expertise and skilled personnel adopting developed manufacturing technology, modern heat treatment technology and latest CNC machining equipment are manufacturing shear blades of the highest quality giving best possible performance , Products sheared by blades are shown below:



 Shear Blade for Plate cutting	 Flying Shear Blade	 Parallel Blade	 Parallel Blade

 Circular Shear Blade	 Circular Shear Blade
 Circular Shear Blade	 Circular Shear Blade

Shears with parallel blades are used in slabbing mill, blooming & billet and bar mills. They are used for cold and hot rolling cutting to length and profile cut as rectangular, square, round. Cut surface during cutting with these shears during hot rolling or forging remains constant. The temperature of the metal delivered to the shear metal is 750-1100°C.

Guillotine shears are divided into two types in accordance with their design features: opened type and closed type. Opened type shears have got short blades, they are used for flat steel work pieces and cold rolled section steel. Closed type shears are used for wide sheets and strips cutting to length, both in cold and hot conditions. Closed type shears are manufactured with upper and lower moving blade.

Flying shears blades, basic types being drum type, lever - crank type, pendulum type, materials for cold cutting should have hardness 52-59 HRC and for metal hot cutting is of 40-50 HRC. Flying shears are used for rolled products travelling cut-off. Generally, flying shears working capacity means rolling mill working capacity. Disk shears are used for strip trimming.

General rule for setting shear blade clearance at 7% of the material thickness of the material being sheared. The amount of clearance between the upper and lower shear blades will have a definite impact on the quality of the cut. Setting the shear blade clearances too tight will increase the tonnage required and also cause the piece to have a burnished appearance of the edge. Shear blades set with a too wide a clearance may reduce the tonnage required but will also incur some bending at the edges of the cut.

Reasons for Shear Blade Failure

In absence of proper attention in terms of design, correct grade selection, improper cutting edge, use and maintenance may affect blade life. As with any type of cutting blade the clearance between the shear blades needs to be controlled. Effective lubrication of shear blade is to be ensured in routine ways, lubrication of the rear face of the blade encourages flow of the butt across the blade, and helps butt detachment. Replacement action has to be taken at regular interval after inspection. Clearance between the blades shall be checked under hot operating conditions. Shear blade clearance can be controlled with shear blade design incorporating guidance fingers to ensure the die face and shear blade face maintain the same separation.

Conclusion

Shear blades in the process of industrial fabrication plays a crucial role in the industrial sector by shearing products in running conditions as both hot and cold conditions. However, these vital items in the production process must be of consistent high quality. It is extremely important that industrial fabrication units/ shops manufacturing shear blades should fully understand the importance of quality control in fabrication and have strong quality control systems with processing standard as is being done in melting shop, hot working and heat treatment units. A sample has to go through specified testing to make sure that it fits the right specifications. Shear blade manufacturers should consider themselves in the total activity that they partner with for equipment, materials, and supplies which will yield benefits to all.

References:

1. Mini Steel Plants with IF, Rolling & Forging Units, Treatment Shop,
2. Observation in Shear Blade manufacturing Units,
3. Metals Hand Book.

RECENT DEVELOPMENTS

How water vapour changes metal at the atomic level

Corrosion is difficult to prevent, as the exact mechanism that accelerates its growth on metals and alloys has remained elusive to engineers.

Now an international team of scientists has peered into the atomic-level workings of water vapour corrosion, using an environmental transmission electron microscope (TEM). Their work, published in Nature Materials, reveals how the involvement of protons speeds the corrosion process.

Knowing how water vapour such as mist or steam corrodes metals and alloys can help engineers keep industrial systems working at peak performance longer. Armed with that knowledge, engineers can also improve catalytic conversion process.

Scientists studied the effect of water vapour and elevated temperatures on a nickel-chromium alloy. They directly observed oxide growth on the alloy during corrosion at the atomic level. What they discovered was a complex dance of protons, cations, and anions that led to increased corrosion and a more porous structure of the oxide.

Then they modelled the process through computer simulations that revealed the role of hydrogen in stabilizing the observed structures. Their work provides insights into how water vapour might change other materials, particularly at elevated temperatures.

The research team was from Pacific Northwest National Laboratory, Chinese Academy of Sciences, and State University of New York at Binghamton. They used an environmental transmission electron microscope, located at the Environmental Molecular Sciences Laboratory (EMSL), a DOE Office of Science user facility.

Source: ASM International

Melting Gold without Heat

The surface of a gold object has, for the first time, been melted at room temperature by researchers at Chalmers University of Technology, Sweden. This occurred following periodic increases in the electric field observed via an electron microscope, and researchers say that the results give a new fundamental knowledge of gold. Although the study is in the interest of pure science, researchers envision that with further work it could have a number of applications, including use in catalysts, sensors or field-effect transistor technology and new concepts for contactless components.

It has been previously known that the application of an intense electric field to a gold surface can cause atoms to evaporate. However, it had never before been observed in real time at atomic resolution. During an experiment to observe this, researchers saw that, at an electric field lower than needed to evaporate atoms, the outmost atomic gold layers melted.

Ludvig de Knoop, Master of Science in Engineering Physics at Chalmers' Department of Physics, told Materials World about his interest in the phenomena in gold. 'We were interested in working with metals because they are conductive, and we chose gold because it does not oxidise. If we had been working with a metal that oxidises the surface would have been covered in an oxide layer, hindering any observation of the gold surface.'

The discovery showed a novel behavior for gold under a strong electric field. The surface-melted outmost layer can also be reverted back to a solid when the electric field is decreased. 'In other words, the discovery shows us that we can controllably switch a few atomic layers of gold between surface melted and solid using an electric field,' said Knoop.

Crank up the field

Researchers used a transmission electron microscope to zoom in on a gold cone two million times in order to see individual gold atoms. The gold cone was mounted in a specialised sample holder used to apply a voltage of 100V. 'Since the size of the cone and the distance to the grounded electrode are extremely small, the [resulting] electric ield is large – around 25,000,000,000V/m,' Knoops explained. 'Being able to apply this large electric field while simultaneously observing the movement of the atoms with the microscope allowed us to see live how the outmost atomic layers of gold melted. The technique is called in situ transmission electron microscopy.'

To understand the mechanism behind the observed melting, ab initio molecular dynamics simulations, led by shared first author Mikael Juhani Kuisma, were made. These concluded that the reason for the surface melting was that the energy cost of form surface defects vanishes when the intense electric field is applied. 'In other words, we have a high density of surface defects in our surface melted layer,' said Knoop.

When the electric field is applied, it excites the gold's atoms causing them to break all structure and connections to each other. Knoop explained that although a few atomic surface layers of gold have been seen to melt at close to room temperature, the team learnt that the surface melted not from an increase in temperature, but from an increased density of surface defects.

As it stands, the study shows only a way to melt very small amounts of gold surface. But, researchers have plans to apply this technique to other materials. 'At the moment we are writing an article where we observe the effects of electron bombardment on gold cones,' said Knoop. 'Following this, we want to see if we can surface-melt other metals and materials by applying an intense electric field.

'To reach such a high electric field, we have to be working on the nanoscale. This could be done using existing techniques from the semiconductor industry. We also want to stress that it is only a few atomic layers that are melted. Therefore, the technique will surely not be used to melt any larger sized objects.'

Materials World

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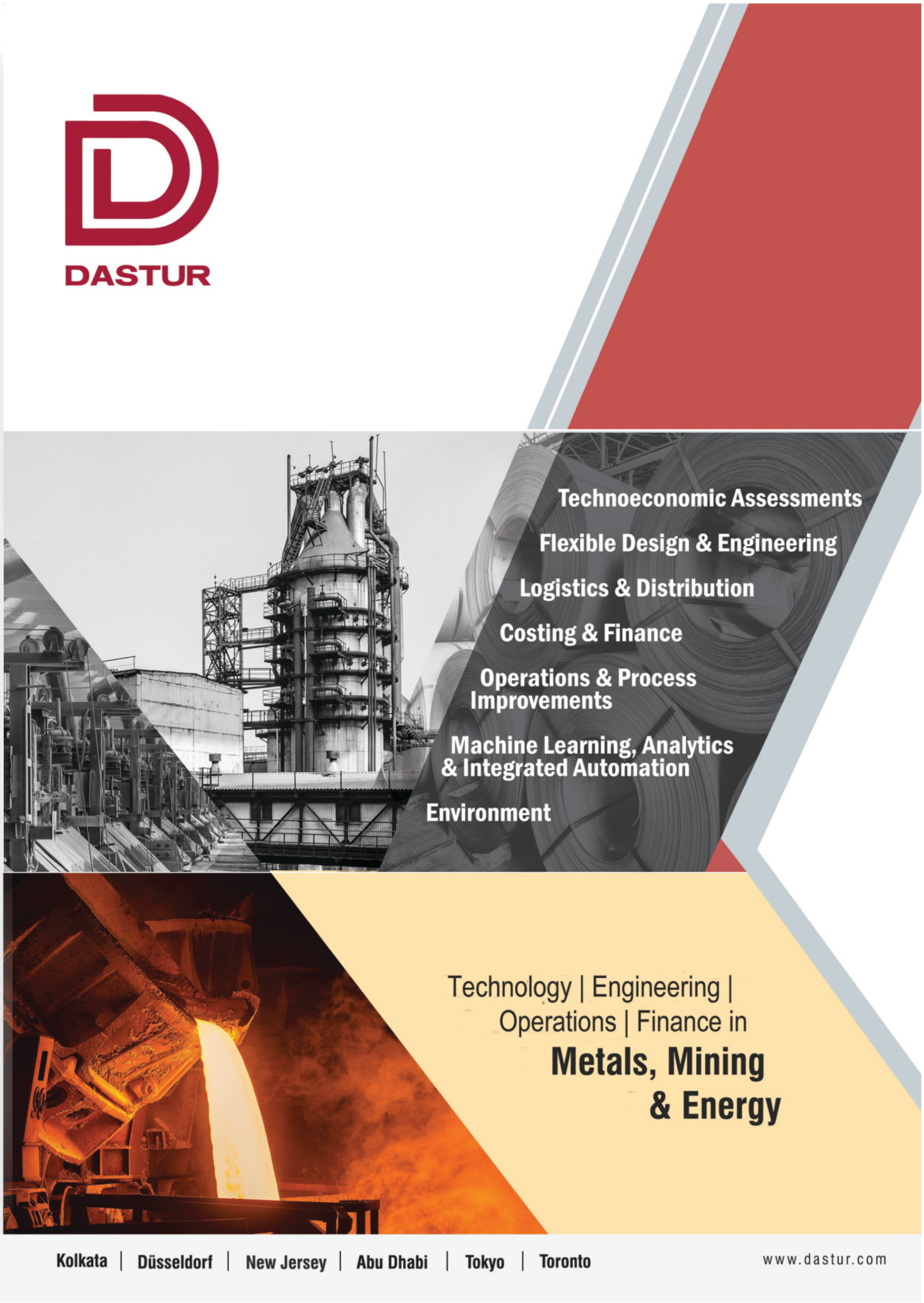

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India's aluminium scrap import rises over 22% in April-October (2018-19) : AAI

India's aluminium scrap import jumped 22 per cent to 7,73,000 tonne during April-October this fiscal, according to industry body AAI which has demanded higher import duty on the metal to protect domestic players. The import of aluminium scrap was 6,32,000 tonne during the same period of 2017-18, the Aluminium Association of India (AAI) said in its latest report. They had already requested the government to increase the duty on imports of aluminium scrap and apprised the government that Indian aluminium sector may become a victim of escalating trade war between the US and China. On March 8, 2018, US President Donald Trump imposed a 25 per cent tariff on steel imports and 10 per cent on aluminium. Later, China also announced 25 per cent import duty on various US goods and commodities, including aluminium scrap. The report further said the local aluminium industry is facing immense threat in the wake of ongoing trade tiff between the two major economies -- the US and China. It said that India is a natural market and the affected countries are dumping aluminium into India and the US is diverting large volume of scrap to India since EU and other countries have stringent standards for scrap. In July, the AAI had apprised the Department of Industrial Policy and Promotion (DIPP) of the situation which could arise in future. An AAI delegation had urged the government to increase the duty on imports of aluminium scrap, saying the domestic players may become a victim of escalating trade war between the US and China. Besides the AAI, various industry bodies and agencies like Assocham and S&P Global Ratings had also raised concerns that India may become the victim of escalating trade war between the two economies as the countries exporting to these nations may start dumping their products into India. The association said it request the government to safeguard the interest of the local aluminium players, the duty on both primary aluminium and aluminium increased to 10 per cent, in line with other nonferrous metals like copper, zinc, lead, nickel, tin etc. Union Minister Suresh Prabhu has said that the commerce ministry is in favour of hiking import duty on aluminium with a view to support domestic manufacturers. "That is a proposal to protect our domestic industry. The proposal is under examination and we support the proposal," Prabhu told PTI. The minister said there has been a complaint by aluminium industry about dumping of the commodity. Earlier, Union Steel Minister Chaudhary Birender Singh had also said that the tariff imposed by the US can indirectly affect the domestic steel sector.

The Economic Times

Hindustan Copper chalks out strategy to ramp up output to 20 MT by 2024

State-owned Hindustan Copper (HCL) has chalked out a strategy, which includes reopening of closed mines, to augment production capacity up to 20 million tonne per annum by 2024. The company's current capacity of copper ore is 3.8 million tonne per annum (MTPA). "My target is to go to 20 MT by 2024...This ramp-up will be done by particular strategy which includes expansion of existing mines like Malanjkhand...Number two strategy will be to reopen the closed mines...construction of new mines," HCL Chairman and Managing Director (CMD) Santosh Sharma told reporters.

"All these three activities will enable (the company) to reach 20 MT," he said. The company, which plans to pump in Rs 5,500 crore over the next six years to scale up its output by six times, is looking to reopen its Rakha copper mine soon. It is planning to raise the capacity of the company to 4.1 MTPA by the end of the current financial year. Then 2020-21 it is 6.1 MT," he said. Hindustan Copper, which is currently catering to around five per cent of the domestic copper demand, expects to take it to 30 per cent. "HCL will be able to cater to 30 per cent domestic requirement of refined copper after this expansion (after 2023-24)," Sharma said. The company is also hopeful that its Malanjkhand underground mine would come into operation in September. The mine is almost ready for production, he said. More than 60 per cent of the company's revenue comes from Malanjkhand open-cast copper mine, whose production capacity is 2.5 MTPA currently. "We are going to increase our production capacity of Malanjkhand to 5 million tonne and thereafter 8 million tonne," Sharma added. "Railways has already given acceptance certificate. My secondary resources are of fit quality for Railways. That communication we have received. To supply it to Railways, we need some permissions from state authorities. Trial run is already in progress," the CMD said. The company is also likely to commission its waste-to-wealth project soon at its Malanjkhand project, which will enable it to extract precious metals such as gold and silver, as well as minerals such as silica through a copper ore tails project.

"We are company which has non-LME (London Metal Exchange) verticals like copper ore tailing beneficiation....These non-LME verticals will be waste rocks, copper ore tailing...these will support us in case of lower LME. Even if LME goes down, we are able to maintain our profitability and sustainability. This will provide me hedge," he said.

The Economic Times

Talking to WTO on US tariff exemption move: Steel Minister

Amidst rising concerns over the US moves on exemptions on steel tariffs, Union steel minister Chaudhary Birender Singh said the government is not "jittery" about it and that government is taking appropriate steps, including talking to the World Trade Organisation to arrive at some solutions.

The minister said our steel exports to the US is barely 0.31 percent of our production, "yet we have approached the WTO regarding this and we hope something will happen through dialogue."

"We are not jittery about it, nor we are in a hurry to take any step. We are aware of the developments coming in from the US," Singh told reporters on the sidelines of the India Steel Expo 2019 here.

On March 8, 2018, US President Donald Trump had imposed a 25 percent tariff on steel and 10 percent on aluminium imports from countries like India, China, Japan, Korea, the EU and Mexico.

Earlier, addressing the gathering, steel secretary Binoy Kumar said the measures taken by the US, Canada and the EU were "unfair".

"One of our teams is already in Canada requesting them to reconsider their decision. At the same time we are in talks with the WTO as well," he said.

Singh further said despite the global scenario, the domestic industry has shown a robust performance, growing at 8.4 percent in steel consumption and 4.5 percent in production in the first nine months of FY19. This has ensured that that country overtook Japan to become the second largest alloy producer in the world.

"We took several measures such as imposing minimum import price and later the anti-dumping duty. Due to these steps, we have seen a turnaround in the steel industry. As per the National Steel Policy 2017, we've set a 300 million tonne production target by FY31 and we are on the track to achieve the same," he said.

The minister further said the initiatives like giving preference to domestic iron and steel products by the states and Centre as well as government agencies has given good results and the country has managed to save nearly Rs 8,000 crore on imports in less than two years.

He said the Rs 5.95-trillion budgetary allocation for infrastructure projects will drive the steel industry.

"Another decision is of applicability of BIS standards on steel products. Currently, 86 percent of the products are covered and our endeavour is to achieve 100 percent. This has given a level-playing field to both the integrated and secondary steel industries," Singh said.

Financial Express

India likely to leave behind US in steel consumption this year: Steel Minister

India is expected to edge past the US with regard to steel consumption this year, Steel Minister Chaudhary Birender Singh said.

Addressing the fourth edition of India Steel 2019, the minister said, "Growth trend in steel consumption in India will continue, due to strong manufacturing sector, diversified demand demographics, accelerated expenditure on infrastructure, anticipated increase in GDP and strong focus on 'Make in India'."

"We are likely to leave behind US in terms of steel consumption this year," Singh said.

A budget of around Rs 6 lakh crore was allocated for infrastructure development in the current financial year, he noted.

"So, based on these enabling factors and with huge potential yet to be tapped, the per capita consumption can easily be increased from the current levels," he added.

Steel Secretary Binoy Kumar said that the National Steel Policy 2017 along with the Policy for Preference to Domestically Manufactured Iron & Steel Products have resulted in savings of more than Rs 8,000 crore till date.

Underlining the importance of not showing any disadvantage to the sector, he added that the government was also reviewing the DMI&SP policy and trying to find convergence between DMI&SP policy and Public Procurement Order 2017 of DIPP.

"Under the ambit of the policy, 16 more steel products were brought under Quality Control Order, which now covers a total of 53 products. The endeavour is to bring more products under the Quality Control Order in an effort towards prohibiting production, import and distribution of substandard products," he added.

Times of India

NMDC may tie up with Stamico for mineral exploration in Tanzania

State-owned NMDC Limited which is currently developing a gold mine and is in the process of setting up a pilot gold refining facility in Tanzania is likely to enter into a MoU with that country's State Mining Corporation (Stamico), for mineral exploration there, sources said.

NMDC is holding four mining licences covering over 38. 8 square kilometres in Tanzania.

NMDC has carried out some portion of exploration work and completed it.

The Indian miner is also putting up a four-tonne per hour capacity processing plant in the African country.

"A high-level delegation from NMDC and the Ministry of Steel met the directors of Tanzania State Mining Development Corporation in the recent visit to Tanzania. Both the parties have shared their knowledge with each other," sources told PTI.

Tanzania is ready to make a JV or some sort of understanding with NMDC for developing new mines there. As NMDC has vast knowledge of mineral development, they want to collaborate with us. Stamico is also holding some licence over there in that country, the sources added.

Two tender processes are on- one is for carrying out the detailed exploration work in the remaining area which was not explored earlier and the second for setting up four ton per hour processing pilot plant as part of the forward integration, sources said.

Tanzania's Ministry of Energy and Minerals had granted NMDC four mining leases at the Bulyang'Ombe gold prospect in 2012 having a total area of 38.83 sq km for 10 years.

A top official of NMDC had earlier said the miner was planning to invest about USD 50 million in the Tanzanian mining project.

According to a communication from the Indian Steel Ministry, there may be opportunities for both NMDC and Stamico in the long run.

The communication also advised the top brass of the PSU to look for "possible collaboration opportunities" in Tanzania, with Stamico.

Business Standard

HZL Q3 net profit declines 3.7%

VEDANTA GROUP FIRM Hindustan Zinc posted a 3.7% decline in its net profit to Rs. 2,211 crore for the quarter ended December 31, 2018. The company had posted a net profit of Rs. 2,298 crore in the year-ago period. The total income declined 1.8% to Rs. 6,090 crore, compared with Rs. 6,203 crore in the corresponding quarter previous fiscal.

Financial Express

JSW in cash-for-steel deal

JSW Steel and global trading firm Duferco are in advanced talks on a five-year cash-for-steel prepayment deal, four sources familiar with the matter said, in a rare move for the industry.

JSW, India's biggest private steel maker, and Duferco had a prepayment deal in 2006 for $150 million in upfront cash that would be repaid over seven years with steel cargoes, but the scale of the proposed new deal is much larger.

Two sources said the deal, expected this quarter, would be worth about $600 million. Backed by banks, the Switzerland-based Duferco will provide the cash to be repaid with physical steel.

Duferco, one of the world's largest steel trading firms, declined to comment. JSW did not confirm the value of the deal, but said it had a long-standing relationship with Duferco that involved financing arrangements. One of the sources said JSW was looking for alternative sources of funding while, for Duferco, the deal would lock in future sales of steel with its clients.

Jeff Kabel, chairman of the International Steel Trade Association (ISTA), said the deal would represent "a great move forward" for an industry that had seen few such arrangements.

Steel derivatives, which allow buyers and sellers to lock in future prices, are still in their infancy, making trade houses wary of pre-paying for large tonnages and risk prices moving against them in the future.

Such deals are frequent in commodities such as oil with the liquid derivatives markets that allow for hedging future sales. A $600-million dollar deal would be equal to about 1 million tonnes of steel supply.

"It's rather innovative. The only thing steel companies usually do is pre-export finance and not that big a number," said Kabel, referring to financing options that do not involve repayments in physical cargoes.

In 2013, as banks increasingly withdrew from Europe's steel sector, Duferco moved to offer its clients trade financing, though these deals typically involved it acting as a bank, not taking delivery of steel.

JSW plans to expand its steelmaking capacity by 2030 to 44-45 million tonnes from 19 million tonnes at present.

The Telegraph

Tata Steel restarts blast furnace at UK steelworks

Tata Steel marked a new start at one of the largest steelworks at Port Talbot in Wales, United Kingdom (UK), with the relaunch of a blast furnace at a cost of "tens of millions of pounds".

The life extension project of Blast Furnace 5, described by the Indian steel giant as the "biggest single investment" in its European operations in over five years, is seen as a critical part of its long-term strategy to strengthen its operations in the UK.

"This project demonstrates our commitment to building a stronger and more sustainable steelmaking business in the UK, now and in the future," said Hans Fischer, Chief Executive (CEO) of Tata Steel's European operations.

In reference to the impact of Brexit on the company's operations, he said that Tata Steel would hope for a last-minute deal that does not result in a hard Brexit.

Fischer noted, "When you look to our production, more than 70 per cent stays in the UK. So directly the impact of Brexit is maybe not that big. But if our customers are impacted very heavily then that immediately leads to a disturbance in the supply chain and that immediately leads to disturbances in our productions as well. In the short term that's what I'm really worried about".

Tata Steel said engineers drained the giant furnace last year in order to carry out vital engineering work, extending its life by five to seven years. Following the relighting of the furnace, the first iron has now been produced and turned into a finished steel product before being delivered to a manufacturing business in the UK.

Once the heart of the furnace, which is normally more than 1200°C cooled in 2018, skilled engineers replaced part of the heat resistant interior and vital structural parts.

"The waste gas and dust extraction system was also replaced. The final part of the process involved the hot blast main being opened, injecting air at 1,100 degrees Celsius, bringing the furnace roaring back to life," said Tata Steel in a statement.

This project had been announced in June 2018, alongside the announcement of definitive agreements being signed by Germany's Thyssenkrupp and Tata Steel to form a joint venture of their European steel businesses.

The Hindu

JSHL posts Rs 55-cr PAT in Dec Quarter

Jindal Stainless (Hisar) said its stand alone profit after tax (PAT) fell by 59 per cent to Rs 55 crore during the third quarter ended December 31. The company had clocked Rs 134 crore PAT in the same quarter a year ago, JSHL said in a statement. During the said quarter, the company said, its revenue dropped by 8 per cent to Rs 2,233 crore compared to Rs 2,439 crore in the corresponding period last year.

Financial Express

Indian steel firms seek higher duties on steel imports as prices drop

Indian steel firms are putting pressure on the government to impose higher duties on imports as trade disputes and a global economic slowdown divert surplus Asian steel stocks to India, industry executives and government sources said. Local producers are suffering from the double whammy of a rise in cheap imports and low domestic steel prices, which threatens to wipeout the healthy profits made in the past couple of years. The steel companies have approached the ministry multiple times over the past few months, alleging China, Japan, South Korea and Vietnam are dumping various grades of low-cost steel into the Indian market and stealing market share as a result, three government sources said. India's top four steelmakers - JSW Steel Ltd, Tata Steel Ltd, state-owned Steel Authority of India Ltd and Jindal Steel and Power Ltd - who together control over 45 percent of India's total steel production, are the key companies who have complained, the sources said. The ministry has given various indications that some measures might be taken, the sources added. However, they are more likely to be non-tariff measures as India has already suffered defeat in a dispute with Japan at the World Trade Organisation (WTO) on charges that New Delhi unfairly imposed import duties in 2016 to safeguard its steel industry. The WTO upheld Japan's complaint in November but India is planning to appeal. The steel ministry did not respond to a Reuters email seeking comment.

Rising Imports

Imports of various grades of steel into India rose by around 8 percent in the April-December 2018 period, compared with a year earlier, government data showed. During the same period, exports from India fell by more than 17 percent, making the country a net importer of steel, mainly because the U.S., one of India's biggest markets, imposed additional duties last year on steel coming from some Asian countries, including India. As a result, the nation's steel imports from countries such as Japan, South Korea and Indonesia surged. Chinese imports also climbed in the final quarter of 2018, Indian companies say. According to government figures, for the April-September 2018 period imports from South Korea rose 29 percent from the year-earlier period, Japanese imports increased 35 percent, and Indonesian imports by 106 percent. "The worry is imports," said Seshagiri Rao, joint managing director at JSW Steel, India's biggest steel company based on local production. He said the government had to "ensure that our borders are protected and goods will not come into India and hurt the domestic steel industry." The price of steel in India dropped by an average of more than 10 percent between October and December, according to government data. Domestic brokerage firm Edelweiss Securities said that they see earnings at metals companies "going downhill" after the third quarter. Anil Kumar Chaudhary, chairman of SAIL, and Rao from JSW Steel, told Reuters they have both told the government of their concerns about imports. Tata Steel and JSPL did not reply to an email seeking comment.

Existing Measures

India has been monitoring the impact of imported cheaper steel from China on domestic industry, the government said last month. In a bid to support use of locally made steel, the ministry has urged automakers to cut imports from Japan and Korea. That has led to a dispute between the government and automakers who claim local producers are unable to make the high-quality steel they need. India has already imposed stricter quality controls on more than 85 percent of steel products and it is expanding the list of locally made steel that must be used in government infrastructure projects, two government sources said. It is unclear if any low quality shipments have been turned back. India's steel minister Chaudhary Birender Singh told Reuters earlier this month that the government wants to expand the quality control regime to all steel products very soon. The government is also considering imposing higher duties on the import of iron ore, a key raw material, to help state-owned miner NMDC Ltd, the sources said. While this could hurt JSW Steel, other steel majors have their own captive iron ore mines which shields them from price volatility. Abhyuday Jindal, managing director of Jindal Stainless, the country's largest stainless steel producer, said the company had asked the government review import duty on raw materials, as well as the impact of free trade agreements with the likes of Japan, South Korea and southeast Asian countries.

Source: Money Control

EVENTS CALENDAR 2019

April

11-12

IIM Mumbai Chapter in association of Indian Institute of Technology, Bombay, organizing a Symposium on "Critical Non-Ferrous Metals: Establishing the value chain". Convener: Dr Vilas Tathavadkar, Aditya Birla Science & Technology Co Pvt Ltd.

IIM CHAPTER ACTIVITIES

Kalpakkam Chapter

The Kalpakkam chapter of Indian Institute of Metals conducted two theme meetings during Oct-Nov 2018 on topics namely (i) Fatigue deformation & damage and (ii) Materials development to performance - Key issues faced & lessons learnt. The first meeting (Oct. 29) consisted of lectures delivered on topics such as low cycle fatigue, creep-fatigue interaction, thermo-mechanical fatigue and fatigue crack growth behavior of fast reactor structural materials. The topics presented in the second theme meeting (Nov. 30) ranged from microstructural aspects of Ti-5Ta-1.8Nb alloy and INRAFM steel, interface of dissimilar welds, fracture behaviour in ferritic-martensitic steels, precipitation behaviour using non-destructive evaluation techniques and low-dose irradiation effects on SS304L(N) and SS316L(N). The speakers comprised of senior members from IIM Kalpakkam and the meetings were well attended by over 80 members with useful discussions and interactions resulting in dissemination of knowledge.

- Report from IIM Kalpakkam Chapter

Visit of IIM-HO to Varanasi chapter

A joint meeting of IIM Varanasi chapter with the staff of IIM HQ was held on 12 January, 2019 at the Conference Hall of the Department of Metallurgical Engineering, IIT (BHU) Varanasi. The three staff members from IIM HQ, Ms. Atashi Saha, DGM of IIM, Ms. Indrani Ghosh, Senior Manager of IIM and Mr. Dhruv Agrawal, Tax and Finance Consultant of IIM visited IIM Varanasi Chapter. The meeting started with welcome and introduction of faculty members by Prof. N.K. Mukhopadhyay, Head of the Department & IIM Varanasi Chapter Executive committee member & Council Member of IIM. Dr. R. Manna, Chairman, IIM Varanasi chapter started meeting with brief introduction of chapter and its activities. Ms. Atashi Saha made presentation on recent happenings and organizational updates. Ms. Indrani Ghosh gave an overview of the current membership scenario of the Varanasi Chapter, Membership categories and other details. Mr. Dhruv Agarwal provided information about GST & its implications in a nutshell. They also provided clarification about various questions asked by faculty and student members. Suggestion received from Dr. R. Manna regarding membership subscription hike and related difficulties to enhance the student membership. Dr. Vikas Jindal, Honorary Treasurer, IIM Varanasi Chapter presented upcoming activities and information about IIM Varanasi Chapter Website. The meeting ended with a vote of thanks from the Chairman of IIM Varanasi Chapter.

Around 8 Executive Committee Members & 32 Student Members also attended the meeting.

- Report from IIM Varanasi Chapter

IIM Mathura Chapter Inauguration

The Indian Institute of Metals (IIM) launched its 'Mathura Chapter' on 11th January, 2019 at GLA University to accelerate industry sponsored 'R&D' work in the University. The Mechanical Engineering Department of the University is the custodian of the Mathura Branch of IIM to promote R&D on materials processing and material behaviour.

Dr. Vinod Kumar, DGM, R&D (SAIL) graced the occasion as Chief Guest and inaugurated the chapter by lighting of the lamp. He interacted with the students by his deliberation on structural strength of steel rebar as material. He also emphasised on the damage experienced by the structural materials owing to corrosion. The Secretary General of IIM, Mr. Kushal Saha, Former President of IIM, Mr. L Pugazhenthy, and Head-Finance of IIM, Mr. Chiradeep Majumdar graced the occasion as Guests of honour.

The Secretary General addressed the gathering and appraised about the role of IIM in Nation building as well as in international scenario about interactions and sharing of metallurgical and materials knowledge to promote Research and Development work. Professor Piyush Singhal, HOD and Chairman of Mathura Chapter highlighted about the use of metallic materials in everyday life. The detail of on-going research work also has been narrated by him. The vice Chairman of the Chapter, Prof. Kamal Sharma welcomed all guests and the secretary, Dr. Kuldeep Saxena, Secretary of Mathura Chapter proposed a vote of thanks.

Inauguration of Sambalpur Chapter

The inaugural ceremony of the Indian Institute of Metals, Sambalpur Chapter was held on 19 January, 2019 at Gyan Dharaa, Learning Centre, Lapanga, Sambalpur. The chief guest of the day was Mr. K N Pandey, Unit Head, Aditya Aluminium. The other dignitaries present were Mr. Kushal Saha, Secretary General-IIM, Mr. Chiradeep Majumdar, Head Finance-IIM, Mr. Tamal Goswami, Manager-Membership IIM, Mr. Khalil Khaji, Life Member, IIM Calcutta, Mr. Barun Roy, Chairman-IIM Sambalpur Chapter and Mr. Debasish Mallik, Vice Chairman-IIM Sambalpur Chapter.

The Program started with the arrival of chief guest and other dignitaries at the venue at 3 pm. The ceremony commenced with the lighting of lamp by the dignitaries. Mr. Bijaya Kumura introduced all the dignitaries to the dais. Mr. Suryakant Nayak, Secretary, IIM Sambalpur Chapter welcomed all the dignitaries with flower bouquets. He also welcomed all the members of IIM Sambalpur Chapter and the students from the Burla Engineering College who were invited for student membership. The IIM Sambalpur Chapter was officially inaugurated digitally by Chief Guest, Mr. K N Pandey.
The Chief Guest, in his address briefly introduced about the history of Indian Institute of Metals. He also told about the importance of IIM in providing a platform for collaboration and technological discussions among various organizations. He wished for the success of IIM Sambalpur Chapter.

Chief Guest, Mr. K N Pandey

In his address, Mr. Kushal Saha briefed about the various activities being organized by IIM and the benefits of becoming a member of IIM. He motivated everyone to join the IIM Sambalpur Chapter. After that the other IIM dignitaries explained about the membership and financial part in details. Guest of Honour, Mr. Khalil Khaji was also very hopeful for the success of the new chapter of IIM at Sambalpur.

Mr. Kushal Saha delivering his speech

The Chairman of IIM Sambalpur Chapter, Mr. Barun Roy congratulated all the members on the occasion of formation of the new Chapter of IIM in Sambalpur. He explained about the back ground story behind the formation of IIM Sambalpur Chapter. Mr. Deepak Dash, Joint Secretary, IIM Sambalpur Chapter discussed about the way forward of IIM Sambalpur Chapter for the next financial year.

At the end, Mr. Jay Prakash Soni, Treasurer, IIM Sambalpur Chapter offered a vote of thanks to all including Chief Guest. He thanked all the invited guests and members for gracing the occasion by their solemn presence. He also thanked the HR and Admin. Department of Aditya Aluminum for providing all kind of facilities to conduct the inaugural ceremony.

- Report from IIM Sambalpur Chapter

Mumbai Chapter

The Indian Institute of Metals, Mumbai Chapter organized the Y M Mehta memorial talk on January 23, 2019. Prof. NB Ballal, Emeritus Fellow, Centre of Excellence in Steel Technology, Department of Metallurgical and Materials Science, IIT Bombay, Powai delivered the Memorial Lecture for 2019. Contributions of Late Y M Mehta towards IIM; and especially Mumbai and Baroda chapters of IIM were recalled by Dr. Vivekanand Kain, Chairman, IIM Mumbai Chapter.
The title of the talk was 'Agariyas: the Iron People and the Art of Ancient Iron Making' and was delivered at Multipurpose Hall, Training School Hostel & Guest House, BARC, Mumbai. Prof. Ballal described marvellous iron pillars and other artifacts in different parts of India. He showed photographs of iron making furnaces used 3000 years ago; as well as furnaces that are still used in rural areas of India. The iron making practices used by Agariyas was described in detail. Prof. Ballal offered technical explanations for the iron making practices of Agariyas and also results from studies done by his group at IIT Bombay on these practices. Prof. Ballal also described the daily routine and culture of Agariyas and the need to document these iron making practices in detail. The talk was attended by over a 150 members.

Prof. NB Ballal delivering YM Mehta Lecture

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• बेहतर संक्षारण रोधन क्षमता
• सालों साल चलने की शाक्ति
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COAL STATISTICS

Coal Reserve in India

315.149 billion tonne of Coal reserves have been estimated by the Geological Survey of India (01.04.2017). The reserves have been found mainly in Jharkhand, Odisha, Chhattisgarh, West Bengal, Madhya Pradesh, Telangana and Maharashtra.

Coal Production

The overall production of Coal for 2017-18 was projected at 730.10 MT. During the period April to December 2017 the actual production was 461.42 MT compared to 452.97 MT during corresponding period of 2016-17 and showing a growth of 1.9 per cent. The Company-wise details for coal production from CIL, SCCL and Others are given below:-

Name of Company	2016-17 Actual (Provi-sional)	Production (2017-18) in MT					
		Target (BE)	Target (RE)	Actual (Apr -Dec. 2017)	Achievement (%)	Growth (%) (Apr-Dec.16)	Anticipated during Jan 18-March 18
CIL	559.46*	600.00	600.00	383.93	64	1.6	216.07
SCCL	59.53	62.00	62.00	41.99	68	-1.0	20.01
Captive	32.54	46.10	46.10	27.34	59	11.09	18.76
Others	11.25	22.00	22.00	8.15	37	-0.18	13.85
Total	662.79	730.10	730.10	461.42	63	1.9	268.68

* * Including production of Gare Palma (GP) IV/2&3 and GP IV/1.

Sector wise Raw coal Dispatch (Jan-Mar'18 projection on BE basis)

(In Million tonnes)

Sector	Jan'18-Mar'18	Jan'17-Mar'17	% growth in Jan'18-Mar'18 over Jan'17-Mar'17
Steel *	2.00	1.92	4.2
Power (Utility)**	128.95	118.05	9.2
Power(Captive)#	14.09	8.38	68.1
Cement	1.98	1.04	90.7
Others	31.52	22.09	42.7
CIL	178.54	151.47	17.9

* includes coking coal feed to washeries, direct feed and blendable to steel plants,

** includes non-coking coal feed to washery and Bina Deshaling Plant for beneficiation and special forward e-auction to power

\# Captive Power includes dispatches to fertilizer sector

Sector wise Raw Coal Dispatch (Provisional)

(In Million tonnes)

Sector	Apr'17-Dec'17	Apr'16-Dec'16	% growth in Apr'17-Dec'17 over Apr'16-Dec'16
Steel *	4.11	4.84	-15.0%
Power (Utility)**	331.44	308.24	7.5%
Power(Captive) ***	29.02	22.47	29.2%
Cement	2.95	2.64	11.9%
Others	53.69	53.39	0.6%
CIL #	421.22	391.58	7.6%

* includes coking coal feed to washeries, direct feed and blendable to steel plants

** includes non-coking coal feed to washery and Bina Deshaling Plant for beneficiation and special forward e-auction to power

*** Captive Power includes despatches to fertilizer sector

\# excludes colliery consumption

Coal Distribution and Marketing

Allocation of coal to power, cement and steel plants.

The allocation of coking coal to Steel plants was earlier made by the Coal Controller. However, after deregulation of coking coal, the supplies of coking coal are being made by the coal companies themselves on the basis of linkages established by the SLC (LT) or on the basis of their existing MOU commitments. During the time Apr'17-Dec'17, CIL supplied the following quantities of coal to various sectors:

Coal India Limited

(Prov.) (Fig in MT)

Sector	AAP Targeted off take	Actual Off take	Supply % against Target
Steel*	5.96	4.11	69%
Power (Utilities) **	325.35	331.44	102%
Captive Power ***	36.32	29.02	80%
Cement	5.11	2.95	58%
Sponge Iron	7.12	5.52	78%
Others	52.07	48.17	93%
TOTAL DESPATCH	431.93	421.22	98%
Colliery Consumption	0.17	0.19	109%
Total	432.11	421.41	98%

* includes coking coal feed to washeries, direct feed and blendable to steel plants.

** includes non-coking coal feed to washery and Bina Deshaling Plant for beneficiation and special forward e-auction to power

*** Captive Power includes dispatches to fertilizer sector

Enhanced exploration efforts

CMPDI is the nodal agency for implementing the Plan scheme of Detailed Drilling in Non-CIL blocks. CMPDI executes the job through MECL and also through outsourcing. The actual drilling vis-à-vis targets in non-CIL/Captive mining blocks during last five financial years, anticipated drilling during 2017-18 and the target for the financial year 2018-19 are as under:

Non-CIL Blocks (Drilling in Lakh Metre)

Year	Target	Actual	Growth % w.r.t. Previous year
2012-13	1.75	2.28	2.70
2013-14	3.62	2.38	4.39
2014-15	4.16	2.82	18.48
2015-16	4.82	2.87	1.77
2016-17	3.48	3.08	7.32
2017-18	4.99	3.92 (Anticipated)	27.27 (Anticipated)
2018-19	6.20		

CIL Blocks (Drilling in Lakh Metre)

Year	Target	Actual	Growth % w.r.t. Previous year
2012-13	4.07	3.35	23.20
2013-14	5.38	4.59	37.01
2014-15	7.84	5.46	18.95
2015-16	10.18	7.02	28.57
2016-17	7.52	8.18	16.52
2017-18	7.50	8.58 (Anticipated)	4.89 (Anticipated)
2018-19	6.80		

Source: https://coal.nic.in/content/annual-report-2017-18

Restricted Circulation RNI Regn No. 69992/98