Cluster Profile
Dhanbad coke oven industries

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Promoting Energy Efficiency in SMEs
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Dhanbad coke oven industries

Overview of cluster

Dhanbad is the district town, which is located between 230 25' to 240 04' (North) Latitude and 860 to 860 50' (East) Longitude. Dhanbad is famous as 'Coal Capital' and one of the leading industrial regions of Jharkhand state. Apart from coal, the area is also rich in mineral resources such as lime stone, fireclay, china clay, granite, stone and sand. The town is surrounded by Giridih and Jamtara in the north, Burdwan (West Bengal) in the east, Purulia (West Bengal) in the south and Bokaro in the west. The two important rivers Damodar and Barakar are passing North and South side of the district. Hydel power plants of DVC on Damodar and Barakar river supplies power to Dhanbad town. Dhanbad has more than 3000 registered small scale industries and around 14 large industries. Some of the important industries in Dhanbad area are given below.

Dhanbad coke oven cluster in Jharkhand
Source: Google maps

- Bharat Coking Coal Limited (BCCL), Dhanbad
- Eastern Coalfield Limited (ECL), Mugma
- Damodar Valley Corporation, Maithan
- Damodar Valley Corporation, Panchet
- Tata Iron and Steel Co. (TISCO), Digwadih
- Indian Iron and Steel Co. (IISCO), Jamadoba
- Coal based industries like hard coke and coal briquette
- Refractory cluster, Chirkunda
- Food processing (flour mill) cluster, Dhanbad

The industries in the cluster under micro, small and artisan categories include engineering & fabrication, refractories, mineral based, leather based, paper products, rubber goods, etc. Dhanbad coke oven cluster is the one of the important industrial clusters in Jharkhand. The coke making industries are more than 100 years old. Dhanbad cluster produces various grade of coke, which are used within the country among various metal casting industries. The primary domestic market for coke includes large steel manufacturing industries within 200 kilometre area like TISCO (Digwadih), TELCO (Jamshedpur), IISCO (Jamadoba), Bokaro Steel, SAIL (Durgapur), Alloy steel plant – Durgapur, etc. A small quantity is also exported to neighbouring countries.

Product types and production capacities

There are about 100 coke making units in the cluster. The coke industries are located in about 10 kilometre radius. Some of the primary areas are Baliapur, Govindpur, Chirkunda, Nirsa, Tetuliamari, Katrasgarh, Rajganj and both sides of National high way (G T Road), etc. The type of coke products produced in the cluster include hard coke, soft coke and metallurgy coke etc. The coke categories differ between each other by their constituents like fixed carbon, moisture, ash, sulphur, etc.

The average coal processing capacity of individual oven varies in the range of 6–8 tonne per batch depending on internal chamber dimensions. With an average batch cycle time of about 48 hours, coke oven can process a maximum 15 batches per month. The total production of coke in the cluster is estimated to be 945,000 tonne per year (tpy), considering an average yield of about 75%.

Freshly cooked coke lump

Energy scenario in the cluster

The coke oven units in Dhanbad cluster use batteries of horizontal ovens. Except a few industries, use of central chimney is very common in the cluster. The thermal energy for coke production is derived from burning of volatiles in the coal. Electricity from grid is used in different various process equipment and utilities like pulverisers, motors, belt conveyors, overhead bins, water pumps, etc. The details of major energy sources and existing tariffs are shown in the table.

Prices of major energy sources

Energy source	Price
Electricity	Rs 5.80 per kWh

Production process

Manufacturing of coke uses different grade coal as raw materials which are blended appropriately to produce desired coke quality. Coke making process primarily consists of coal crushing, blending, mixing, loading and cooking. The different process steps in manufacturing of coke are described below.

(i) Coal crushing

The coke making units procure different grade of coal from authorised collieries as lumps. These coals are tested in the laboratories to estimate the required ratio of different grade of coal to be mixed during blending to produce desired quality of coke. Jaw crushers are used to reduce the size of lumps before sent for blending.

Manual blending of coal

(ii) Blending of coals

Mixing of different grades of coal is carried out manually. It is done in batches of fixed quantity of heterogeneous mass of two or more types of coal of varying aggregate size to prepare uniformly blended batch for cooking.

(iii) Cooking of blended coal batch

A special fixture is placed on the floor surface of empty oven before charging blended coal batch, which will be an integral part of the coke lump on completion of cooking cycle. One end of this fixture is kept outside the oven wall to enable removal of coke lump produced and open quenching with water.

View of coke horizontal coke oven

The blended batch in the floor normally takes the shape of cone on completion charging, which is flattened to even the surface. Levelling is carried out manually with the help of a lever from unloading door side. The door of the coke oven battery is kept closed during entire phase of cooking. The status of cooking is regularly monitored through inspection window/ opening provided for air ingression, which helps in the cooking process.

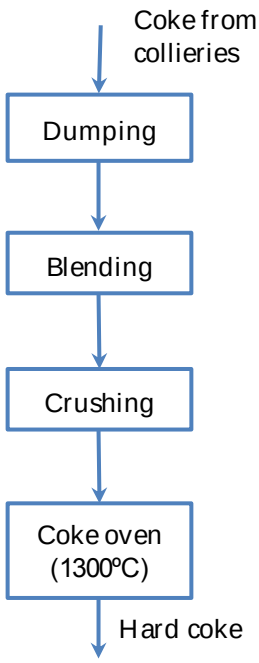
During cold start, initial heating is done with biomass and diesel. Subsequently, the residual heat will be sufficient enough to reignite and initiate the cooking process. Generally, the ovens are loaded with fresh batch immediately after final coke is removed so as to utilize the residual heat. The cooking temperature of coke ovens is 1200–1300 °C and the total batch cycle is about 48 hours.

(iv) Quenching

The final yield of coke is pulled out as a single lump from the oven floor once the cooking cycle is completed. This is done with the help of steel cable connected to one end of fixture and other end with a winding drum (figure). Winding drum is connected with electrical motor to provide motive power. Water is poured to cool the hot coke with shortest delay to avoid any burning of coke and reduce the yield. Later, cooled coke is cut to size manually and transferred to store yard for dispatch.

A typical manufacturing process followed in the cluster for production of coke products is shown in the figure.

Water quenching coke



Coke manufacturing process

Technologies employed

(i) Coke oven / bhatti

Cooking ovens can be classified into two types - recovery type and non-recovery type. The coke ovens in Dhanbad cluster are of non-recovery type. In this, the slag and other by-products formed during coking process are combusted within the oven and are not recovered. This provides the heat required for the coke making process. The oven is of horizontal design and operates under negative pressure. The primary combustion air is introduced though ports in the oven doors which partially combusts the volatiles in coal.

Coke oven in operation

Traditionally, the coke oven industries in Dhanbad cluster use non-recovery, horizontal type ovens for cooking blended coal batch and produce desired quality of coke products. Coke ovens are batch type systems, wherein loading of coal and unloading of coke are carried out manually. The major energy source in coke production is the volatile material present in coal, which is combusted.

Coke oven battery

Special purpose fixture

The horizontal coke ovens consist of a series of batteries or coking chambers. In a regular operation of a coke oven unit, alternate chamber will be on cooking phase in case of a single series of horizontal coke oven. A complete row of oven will be in cooking phase in the ovens consisting of two rows in parallel. Blended coals are transferred to mechanised overhead bin using belt conveyor. Loaded bins are moved on rail tracks using motorized overhead cable to unloading point of each chamber. Ovens having high coal processing capacities or larger chambers are provided with two loading points (figure).

Double track charging

The traditional coke oven batteries in the cluster have the followings common features:

- Coal processing capacity varies in the range of 5-8 tonne per batch
- Average batch cycle is 48 hours
- Internal temperature of ovens when coal cooking in progress is within 1200 - 1300 °C
- Smaller ovens have single track charging whereas high capacity coke ovens use double track charging
- Low grade refractories are used for lining of chambers
- Chimneys are either placed in the middle of batteries of oven or placed away from ovens.
- Each oven is connected with a central flue path, which is further connected to a common chimney for dispersal of flue gases
- Opening of unloading doors are mechanized but are not insulated properly

- The coke ovens do not have any temperature monitoring facilities and only visual inspection is done

(ii) Kilns used in Dhanbad coke oven cluster

Most of the coke making units has horizontal single row of coke ovens and connected with a common chimney placed away oven series. There are also units with two rows of batteries of coke oven connected with a chimney placed in the middle of the rows.

Central chimney

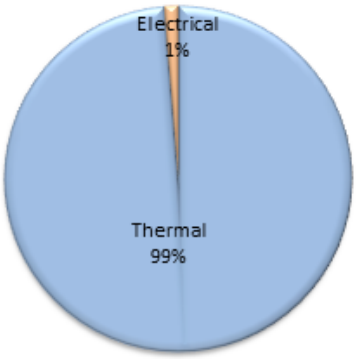
Off-site chimney

Energy consumption

Coal is the main energy form used as feedstock as well as to provide energy in coke forming process. The energy consumption details at unit level and cluster level are provided below.

(i) Unit level consumption

Coal is processed to obtain coke in the kilns. The volatile matter present in the coal is burnt to produce coke. Electricity is used in in pulverisers, motors, belt conveyors, overhead bins, water pumps, etc. Thermal energy accounts for almost 99% of energy consumption in a typical coke oven unit in the cluster, whereas electricity consumption is only 1%. The total energy consumption of a typical coke oven in the cluster is estimated to be 2083 toe per year. The SEC of hard coke production is calculated to be 0.220 toe per tonne of hard coke.



Share of energy consumption

(ii) Cluster level consumption

The total annual energy consumption at cluster level is estimated to be 208,254 toe. The corresponding GHG emissions at cluster are 858,894 tonne of CO_2. The break-up energy consumption and GHG emissions based on different energy sources is shown in table.

Energy consumption of Dhanbad coke oven cluster (2016)

Energy type	Annual consumption	Equivalent energy (toe/yr)	GHG emissions (t CO_2/yr)	Annual energy bill (million INR)
Coal	315,000 tonne	204,750	826,875	2,835
Electricity	30.24 million kWh	2,601	29,635	175
Diesel	903 kilo litre	903	23,84	63
	Total	**208,254**	**858,894**	**3,073**

Energy saving opportunities and potential

Dhanbad coke oven cluster offers significant scope for energy savings. Some of the major energy saving opportunities in the cluster are discussed below.

(i) Use of insulating refractory in lining

Traditionally, the linings of the coke oven are made mainly with low grade refractory bricks, which lead to higher surface temperatures and heat losses along with poor workplace environment. The existing lining may be modified using insulating refractories and the internal surface of the furnace veneered, which would help in reducing heat losses through oven surfaces substantially. Further, ceramic fibre blankets can be added between layers of bricks in bottom layer, side wall and the crown which would further help in reducing heat losses.

(ii) Installing temperature indicators for monitoring oven temperature

The coke industries in the cluster do not use temperature indicators for monitoring and controlling furnace temperatures. At present, furnace temperature and coal cooking is done through human judgement and skill level of operators. This can lead to substantial variations in oven temperatures vis-à-vis actual requirements for different coke products. This can lead to either over-firing (causing damage to final product quality and the yield), and under-firing (resulting in sub-standard product quality). On-line temperature probes must be installed in at least in two locations at crown level of each oven. The use of temperature indicators would help in close monitoring of internal temperatures and controlling air flow through ports as per requirements.

(iii) Installing dual track arrangement for coal loading

There is a significant potential for coke oven units to switch over to larger chamber with two locations for feeding blended coal batch. This can be done by installing a double track arrangement at oven roof for coal feeding. The use of a two-point feeding would ensure even distribution during coal loading which otherwise would lead to localized hump formation of the batch material. By ensuring even distribution, the quality as well as yield of coke formed are expected to improve to a large extent.

(iv) Optimum furnace loading

The present level of furnace loading and number of ovens in operation were observed to be lower which may be attributed mainly to existing market conditions. It may be noted that various associated heat losses in oven such as surface heat losses would remain the same irrespective of the level of loading. Hence reduced loading would lead to higher energy consumption hence higher production costs. Thus, the coke oven units must ensure optimum loading of ovens to minimise energy consumption.

(v) Other energy saving measures

The flue gas losses are observed to be quite high as they leave at very high temperatures of more than 1000 ^{o}C, leading to substantial energy wastage. It is possible to tap the unused waste heat, which can be utilized effectively for a variety of "waste heat recovery" (WHR) systems. However, the use of any WHR systems is quite limited with the existing type of coke ovens in the cluster. Other energy saving measures relevant for the cluster include the following:

- Power factor improvement with automatic power factor controller

- Installing energy efficient motors in different drives
- Use of clogged V-belts in place of flat belts
- Energy efficient lighting

Major stakeholders

The major stakeholders in Dhanbad coke oven industry cluster include Industries and Commerce Association and MSME Development Institute (Dhanbad).

Cluster development activities

There are no specific on-going activities in the coke oven units in the cluster.

About TERI

A dynamic and flexible not-for-profit organization with a global vision and a local focus, TERI (The Energy and Resources Institute) is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to tackling issues of global climate change across many continents and advancing solutions to growing urban transport and air pollution problems, TERI's activities range from formulating local and national level strategies to suggesting global solutions to critical energy and environmental issues. The Industrial Energy Efficiency Division of TERI works closely with both large industries and energy intensive Micro Small and Medium Enterprises (MSMEs) to improve their energy and environmental performance.

About SDC

SDC (Swiss Agency for Development and Cooperation) has been working in India since 1961. In 1991, SDC established a Global Environment Programme to support developing countries in implementing measures aimed at protecting the global environment. In pursuance of this goal, SDC India, in collaboration with Indian institutions such as TERI, conducted a study of the small-scale industry sector in India to identify areas in which to introduce technologies that would yield greater energy savings and reduce greenhouse gas emissions. SDC strives to find ways by which the MSME sector can meet the challenges of the new era by means of improved technology, increased productivity and competitiveness, and measures aimed at improving the socio-economic conditions of the workforce.

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About SAMEEEKSHA

SAMEEEKSHA (Small and Medium Enterprises: Energy Efficiency Knowledge Sharing) is a collaborative platform set up with the aim of pooling knowledge and synergizing the efforts of various organizations and institutions - Indian and international, public and private - that are working towards the development of the MSME sector in India through the promotion and adoption of clean, energy-efficient technologies and practices. The key partners are of SAMEEEKSHA platform are (1) SDC (2) Bureau of Energy Efficiency (BEE) (3) Ministry of MSME, Government of India and (4) TERI.

As part of its activities, SAMEEEKSHA collates energy consumption and related information from various energy intensive MSME sub-sectors in India. For further details about SAMEEEKSHA, visit http:/ / www.sameeeksha.org