Cluster Profile
Ranchi refractory industries

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Contents

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Ranchi refractory industries

Overview of cluster

Ranchi is the capital of the Jharkhand. Ranchi district is rich in mineral resources such as coal, lime stone, fireclay, china clay, granite, stone and sand. Some important industrial areas in Ranchi include Tupudana, Kokar, Getalsud, Namkum, and Tatisilwai. Some of the large industries in the district are Heavy Engineering Corporation, Marine Diesel Engine Project (Garden Reach Ship Builders Ltd), Central Coalfields Limited, Metallurgical Consultant Limited, Doranda, Steel Authority of India Limited, Central Mining & Planning Design Limited, Indal, etc. The total number[1] of micro, small and artisan industries in the district is close to 10,500. The type of industries in these category include engineering & fabrication, refractories, mineral based, leather based, paper products, rubber goods, etc. The refractory cluster is close to 50 year old. The refractory material produced are used within the country, with more than 95% of products are sold outside the state.

Ranchi refractory cluster in Jharkhand
Source: Google maps

Product types and production capacities

There are about 23 refractory industries operating in different industrial areas in the district. About 15 units are located in Tupudana and Ramgarh industrial areas. The type of refractory products produced in the cluster include Acid block, basic block, castable, monolithic, refractory mortar, burner quarl, bottom pouring, ladle, silica brick, etc. The average production capacities of downdraft (DD) kilns are about 150 tonne per month (tpm) whereas of tunnel kiln is 540 tpm (18 tonne per day). The total estimated production of different refractories from Ranchi cluster is about 46,440 tonne per year (tpy). The level of rejections from DD kilns is reported to be about 10%.

Location of refractory industries

Location	Number of units
Tupudana	7
Ramgarh	8
Ormanji	1
Hardag	1
Mahiloing	1
Neori Vikash	1
Chandol and Letehav	4
Total	**23**

[1] Brief industrial profile of Ranchi district, MSME-DI, Ranchi

Energy scenario in the cluster

The refractory units in located in different industrial areas of Ranchi cluster use coal as the major fuel in downdraft kilns. The tunnel kilns use mainly petcoke for the firing. Electricity from grid – Jharkhand State Electricity Board and Jharkhand Urja Vikas Nigam Limited - is used for all motive power requirements in the cluster. DG sets are used during power failure. The details of major energy sources and existing tariffs are shown in the table.

Prices of major energy sources

Energy source	Price
Coal	Rs 9,000 per tonne
Petcoke	Rs 15,000 per tonne
Diesel	Rs 55 per litre
Electricity	Rs 7.77 per kWh

Production process

Refractory manufacturing process broadly consists of batch preparation, grinding, pressing drying and firing. The general manufacturing process of ceramic products is described below.

(i) Raw material crushing

The refractory units procure basic raw materials such as plastic clay and other ingredients as lumps or powder which are generally tested in the laboratories to match customer requirements. Jaw crushers are used to reduce the size of lumps before they are sent for grinding.

(ii) Grinding and screening

Grinding is a batch process for reducing the size of batch materials. It ensures homogeneity of the material being processed. Ball mills are used for grinding process. In ball mills, the raw materials are grinded to reduce their size as per requirements for pressing. Screening is done to ensure the required size of raw materials for milling process.

Grinding and screening

(iii) Mixing in muller machines

Mixing of raw materials is carried out in muller machines. It is done in batches of fixed quantity. These machines are used for uniform and quick mixing of a heterogeneous mass of two or more materials of varying aggregate size mechanically into uniformly blended batch of raw materials. Mullers are fitted with large mulling rollers for mixing of raw materials. Water is added to raw materials in required proportions and loaded in muller machines to have homogeneous mass of raw material.

Muller machine

(iv) Pressing

Pressing machines are used to provide shape to the product. Each refractory unit uses 4 to 6 press machines. The press machines are operated manually. Two types of press machines are commonly used in Ranchi cluster namely (1) hydraulic press of of 30 to 150 tonne capacity and (2) friction press of 80 to 200 tonne capacity. The type of press used is dependent on type of product being produced by the unit. For large size products, friction press is used whereas for others hydraulic press is used. The required quantity of homogenously mixed raw material in muller is loaded manually in hydraulic or friction press based on type of product. The press is operated manually to provide shape and strength to the products. The pressed product is manually removed for further drying.

Friction press

Hydraulic press

(v) Drying

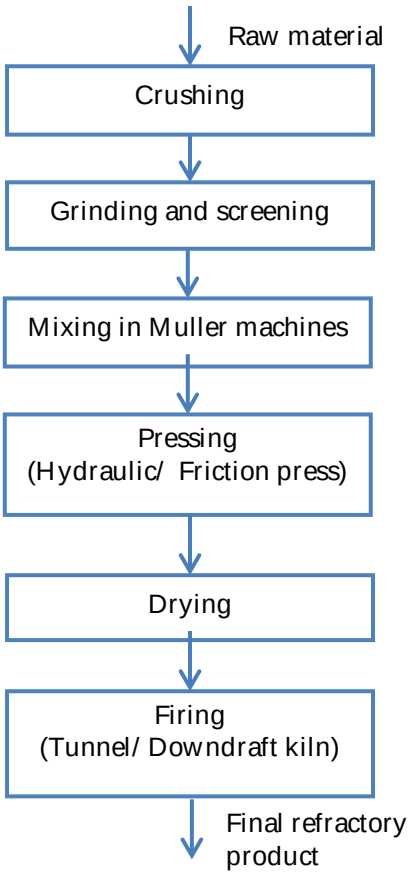
The green products are stacked inside sheds to allow slow and uniform drying in case of all downdraft kiln based refractory units. The dried products are manually loaded in downdraft kilns for further firing. Tunnel kiln based refractory units are equipped with dryers utilizing the waste heat available in flue gases for removal of moisture from moulded products.

Natural drying in downdraft kilns

(v) Firing

Firing is the process by which refractories are thermally consolidated into a dense, cohesive body composed of fine and uniform grains. This process also is referred to as sintering or densification. Refractories are generally fired at 50-75% of the absolute melting temperature of the body material. Downdraft kilns are commonly used by the refractory units in the cluster and a few units are using tunnel kilns for firing process.

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



Typical production process in a refractory industry

Technologies employed

Traditionally, Ranchi refractory industries are mainly using downdraft kilns for firing of refractory products. Downdraft kilns are batch type kilns, wherein loading and unloading of refractory products and firing are carried out manually. Coal is the fuel used in downdraft kilns. There are about 15 downdraft kilns operating in different locations such as Tupudana, Mahiloing, Neori vikash, Ormanji, Ramgarh, Chandol and Letehav.

Downdraft kiln

Tunnel kiln

There are about 3 number of tunnel kilns operating in the cluster which are located in Tupudana and Hardag. Tunnel kilns are continuous type kilns. The tunnel kilns in the cluster use pet coke as the fuel. The refractory products loaded in trolleys, after removal of moisture in the dryer, are pushed inside the tunnel kilns using an adjustable mechanical pusher mechanism. Inside the tunnel kiln, as the trolleys move along its length, the products are gradually preheated close to 700-800 ºC before reaching the firing zone. Pulverized pet coke is used as the fuel and is fed through an automatic fuel feeding system. The temperature of the firing zone is close to 1300 ºC wherein the products are soaked to about 1½-2 hours. The quantity of fuel is controlled through a feedback loop system with the temperature of firing zone. The products are gradually cooled down after the firing zone to about 50-60 ºC before they exit the kiln.

Kilns used in Ranchi refractory cluster

Type of kiln	Number of kilns
Downdraft kiln	20
Tunnel kiln	3
Total	23

Energy consumption

The refractory units use two types of energy for firing in the kilns viz. coal and petcoke as shown in the table. Electricity from grid is used to operate various drives. DG sets are used to meet electricity requirements only during power cuts. The energy consumption in different kilns is also dependant on type of products and the firing temperature requirements. The temperature requirements of different refractory products are in the range of 1280-1310 ºC.

Fuels used in kilns

Type of kiln	Fuel used
Downdraft kiln	Coal
Tunnel kiln	Pet coke

The cost of raw materials is predominant in the manufacturing of refractory products in the cluster accounting for about 40-50% of total production costs. The share of energy costs in overall production of refractories in the cluster is about 30-35%.

Share of different costs

Cost head	Share (%)
Energy	30-35
Labour	20-25
Raw material	40-50

(i) Unit level consumption

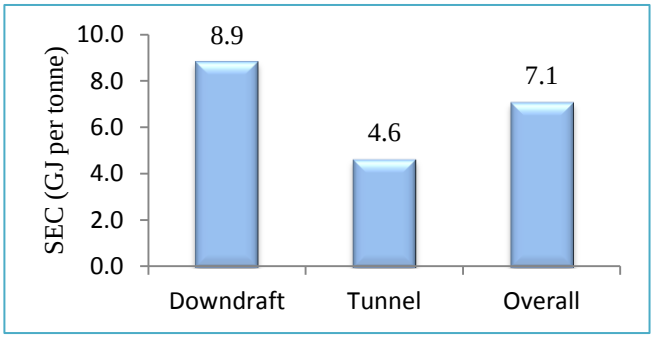
Product forming/ moulding is done through electrical presses but operated manually. However, the energy consumption due to electrical energy systems is negligible as compared to the energy consumption required for firing process. Thermal energy accounts for about 99% of share in total energy consumption in a refractory manufacturing industry. Thermal energy consumption is predominantly done through coal consumption in

downdraft kilns and pet coke consumption in tunnel kilns. The total energy consumption of a ceramic/ refractory unit varies between 381 toe per year (downdraft kiln) to 717 toe per year (tunnel kiln). The typical energy consumption by refractory industries in Ranchi is shown in table.

Typical energy consumption of kilns

Type of unit	Thermal energy (tpy)	Diesel (kL)	Electricity (kWh/yr)	Total energy (toe/yr/unit)
Down draft kiln	1,080 tonne coal	-	30,060	381
Tunnel kiln	862 tonne petcoke	3.6	98,496	718

With the batch type process, the 'specific energy consumption' (SEC) of downdraft kiln units is about 8.9GJ per tonne of refractory product whereas, the SEC of tunnel kilns of continuous type is about 4.6 GJ per tonne. However, with large number of refractory units use predominantly downdraft kilns, the weighted average of SEC is about 7.1 GJ per tonne as shown in the table. Higher SEC levels of refractory units may be attributed to a large mass of dead weight used in the kilns (support structure) along with the products. The typical energy consumption of downdraft kiln and tunnel kiln units and the SEC level of production are provided in table below.



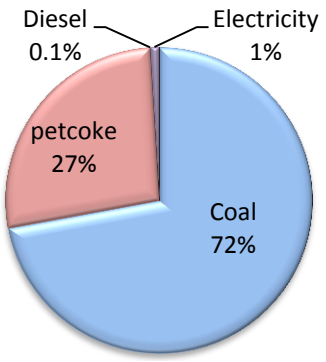
SEC variations at cluster level

Specific energy consumption of kilns

Kiln type	Specific energy consumption	
	kcal/kg	GJ/t
Downdraft kiln	2114	8.9
Tunnel kiln	1109	4.6
Overall	**1693**	**7.1**

(ii) Cluster level consumption

The total annual energy consumption at cluster level is estimated to be 7,864 toe. The share of energy consumption by coal is about 72% and of petcoke is 27% (figure). It may be noted that coal is consumed only by downdraft kilns and petcoke by tunnel kilns. The electricity consumption and diesel to meet power failure are negligible. The estimated GHG emissions from the cluster are about 38,234 tonne of CO_2. The break-up energy consumption and GHG emissions based on different energy sources is shown in table.



Share of energy forms at cluster level

Energy consumption of Ranchi refractory industry cluster (2016)

Energy type	Annual consumption	Equivalent energy (toe/yr)	GHG emissions (t CO_2/yr)	Annual energy bill (million INR)
Coal	16200 tonne	5,670	29,419	113.4
Petcoke	2586 tonne	2,121	8,061	38.8
Diesel	10.8 kilo litre	9	23	0.6
Electricity	0.75 Million kWh	64	731	5.8
	Total	**7,864**	**38,234**	**158.6**

Energy saving opportunities and potential

Some of the major energy saving opportunities in Ranchi refractory cluster are discussed below.

(i) Downdraft kilns

Enhanced insulation of downdraft kilns

The downdraft kilns are constructed mainly with refractory bricks. The large thickness of refractory of side walls and crown has led to considerable reduction in surface temperatures but lead to absorption of heat. It is suggested to provide insulating bricks in bottom layer and side wall of the kiln. Ceramic fibre blankets can be added between the layers of bricks in bottom layer, side wall and the crown that would help in reducing heat losses.

Improved fuel feeding practices

Coal is used as the fuel in downdraft kilns. Coal lumps are used in the firing process. Also, large quantities of coal are fed during firing which leads to formation of black smoke from chimney. Thus improper fuel size and feeding practices have affected the thermal performance of the kiln. It is suggested to use coal of about ¾ to 1 inch size and maintain suitable fuel feeding frequency that would avoid formation of black smoke from chimney.

Instrumentation to monitor kiln operating parameters

The downdraft kilns generally do not use temperature indictors to maintain temperatures and practice fuel feeding. It is done based on the skill of firemen. Non-use of temperature indicator can lead to large variations in required firing/ soaking temperature vis-à-vis actual temperature that may lead to higher fuel consumption or poor quality of products. It is suggested to install on-line temperature probes in at least 3 locations at crown level for monitoring the temperature of kiln which would help in adjusting fuel feeding as per needs.

Improved dampers for downdraft kilns

The dampers used in downdraft kilns are fabricated locally. They do not provide proper control of draft in the furnace. It is suggested to use ceramic board based damper system along with mechanical arrangement to increase or reduce the draft as per kiln requirements. This would further ensure saving of considerable time by firemen.

Switch over from downdraft kilns to tunnel kilns

The specific energy consumption of downdraft kilns is about 0.211 toe per tonne of refractory whereas the SEC of tunnel kiln is close to 0.111 toe per tonne. This indicates an energy saving of about 48% when compared with existing performance of tunnel kilns.

Further tunnel kilns offer other advantages such as kiln automation, close control of operating parameters such as firing temperatures, low rejections and enhanced production levels. The total energy saving potential with existing production level of downdraft kilns is about 2715 toe per year at cluster level.

(ii) Tunnel kilns

Use of low thermal mass cart

The weight reduction of the kiln carts in tunnel kilns provides significant amount of energy savings in tunnel kiln. Low thermal mass materials are now being used for kiln car construction, which reduces the weight of the kiln car considerably. The following modifications can be incorporated to reduce the weight of the kiln cars:

- Replacement of refractory bricks with the hollow ceramic coated pipes at the supporting pillars for holding the racks
- Use of ceramic fibre blankets at the base of the car instead of refractory brick base
- Use of cordierite (hollow) blocks to hold the raw-wares/ nano material instead of solid refractory mass

Reducing the dead weight by about 30%, heat losses from kilns can be reduced substantially. The envisaged fuel saving with dead weight reduction of trolleys in tunnel kilns is about 3% of total heat input equivalent to 64 toe per year.

Enhanced insulation of downdraft kilns

The surface temperatures of firing zone of tunnel kiln are observed to be high leading higher heat losses and hence higher fuel consumption. It is suggested to introduce ceramic fibre blankets in tunnel kiln that would help in reducing heat losses from kiln surfaces.

Optimum furnace loading

The loading of tunnel kilns was lower. However heat losses due to deadweight of trolley structure, surface heat losses, etc. would remain the same irrespective of loading of the kiln. Hence reduced loading would lead to higher specific energy consumption leading to higher production costs. It is suggested to plan optimum loading of tunnel kiln which would help in maintaining optimum SEC levels.

Fuel switch over

The tunnel kilns in the cluster use petcoke as fuel. There is a significant potential to use other fuels such as processed rubber oil which may be explored by the refractory industries. The fuel switch over would help in reducing energy costs as well as close control of fuel firing.

Other energy saving measures

Other energy saving measures relevant for refractory industries in the cluster include the following:

- Power factor improvement
- Use of 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 Ranchi refractory industry cluster include Jharkhand Small Industries Association and MSME Development Institute (Ranchi).

Cluster development activities

There are no specific cluster development activities focusing on energy efficiency in Ranchi refractory industry 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.

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