



Cluster Profile Report

Chirkunda Refractory Cluster

Prepared for



Bureau of Energy Efficiency (BEE)
Ministry of Power, Government of India
New Delhi

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List of abbreviations

BOB	Bank of Baroda
BEE	Bureau of Energy Efficiency
CFC	Common Facility Centre
DPR	Detailed Project Report
DIC	District Industries Centre
EE	Energy Efficiency
FI	Financial Institute
GEF	Global Environmental Facility
GoI	Government of India
JPCB	Jharkhand Pollution Control Board
HT	High Tension
ITI	Industrial Training Institutes
ISO	International Standards Organization
JSEB	Jharkhand State Electricity Board
JUVNL	Jharkhand Urja Vikas Nigam Limited
JRRRDC	Jharkhand Refractories and Research Development Centre
LSP	Local Service Provider
LT	Low Tension
MSME	Micro Small and Medium Enterprises
MT	Million Tonnes
MNC	Multinational Corporations
SIDBI	Small Industries Development Bank of India
SPV	Special Purpose Vehicle
SCM	Standard Cubic Metre
SWOT	Strengths Weaknesses Opportunities and Threats
TERI	The Energy and Resources Institute
toe	Tonnes of Oil Equivalent

Acknowledgements

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Last, but not least, the interactions and deliberations with the industries associations, MSME entrepreneurs, technology providers, and all others who were directly or indirectly involved throughout the study, were exemplary and a rewarding experience on the whole, for TERI.

TERI Team

Certificate of originality

This is to certify that this report is an original work of TERI. The TERI team held detailed discussions and collected data from numerous industry stakeholders, which included MSME entrepreneurs, plant engineers, industries' associations, local energy distribution companies, key local bodies, local service providers, suppliers, fabricators, experts, testing labs, academic institutes/ITIs, and banks/FIs. In addition to this, the team reviewed secondary literature available in the cluster. The cluster profile is an end product of both first hand interactions/data and secondary literature in the cluster. Appropriate references have been indicated in places where TERI has utilized secondary sources of data and information.

Chapter 1

1.0 About the Project

1.1 Project overview

The Micro, Small, and Medium Enterprise (MSME) sector in India is a unique mix of enterprises using conventional as well as modern technologies. Most of the enterprises in the MSME sector are traditional and deploy technologies that are inefficient and resource intensive. The MSMEs are generally located as clusters. There are several such clusters that are highly energy intensive in their operations.

At the national level, the data/information of energy intensive MSME sectors on various parameters like production, type, and quantity of fuel consumption, energy saving potential, details on energy efficient technologies, future growth scenarios, etc. are not readily available. This in a way limits the design of appropriate policy instruments to ensure sustainable growth of these sectors. To address this barrier, the Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India, has initiated an ambitious project of mapping the energy intensive MSME sector across the country. Glass industry is one of the energy intensive sectors identified under the project. The BEE has entrusted The Energy and Resources Institute (TERI), New Delhi to undertake a detailed study of the glass industry sector in India.

1.2 Project objectives

The objectives of the study include the following:

- Map energy intensive glass and refractory manufacturing sector from energy perspective
- In-depth study of existing scenarios on energy consumption and identify opportunities for energy and resource saving
- Prepare a roadmap to develop the intervening sector energy and resource efficient as well as environment friendly

The five targeted glass & refractory clusters covered under the project are shown in table 1.2:

Table 1.2: Targeted clusters under the project

S. No.	Cluster	State	Sector
1	Chirkunda	Jharkhand	Refractory
2	Ambala	Haryana	Glass
3	E & W Godavari	Andhra Pradesh	Refractory
4	Jaipur	Rajasthan	Glass
5	Firozabad	Uttar Pradesh	Glass

1.3 Major components of the project

The major components of the project and their activities are shown in Table 1.3.

Table 1.3: Major component of the project

Components	Major activities
Component-1: Field study and data analysis	<ul style="list-style-type: none"> • Conduct detailed energy audits covering 10 representative units in each cluster • Conduct benchmark study to develop Key Performance Indicators (KPI) and Energy Efficiency (EE) benchmarks • Develop a sectorial profile for the refractory sector • Develop sectorial brochure
Component-2: Development of roadmap and outreach	<ul style="list-style-type: none"> • Prepare and publicize sectorial roadmap for refractory industry • Disseminate outreach and knowledge through; <ul style="list-style-type: none"> ○ Cluster level workshops <ul style="list-style-type: none"> ▪ Project inception workshops ▪ Post activities workshops ○ National workshops <ul style="list-style-type: none"> ▪ Stakeholder consultation ▪ Result dissemination

Chapter 2

2.0 Cluster Scenario

2.1 Background

Refractories provide resistance to thermal, mechanical, and chemical attacks in various industrial processes. Refractories can withstand high temperatures, ranging from 260°C to 1850°C, without major transformation in their physical properties. Refractory products are primarily used in iron & steel, non-metallic, non-ferrous metals, and others. The iron and steel industry is the major end-user of refractories, which accounts for around 75% of the market. Iron and steel require refractories to be used in blast furnaces, basic oxygen-making vessels, process gas heaters, troughs, and electric arc furnaces, etc.

The Indian refractory industry started its journey with the first line of production in West Bengal in 1874. Today, the industry comprises over 350 established units, with 13 large plants, 40 medium sizes, and about 300 small-scale manufacturing units. Currently, the Indian refractory industry has an aggregate production capacity of about 2.0-2.2 million tonnes per annum. The capacity utilization, however, currently stands at around 75 percent or 1.6-1.7 million tonnes per annum.

The important refractory clusters are located in different parts of the country include (1) Asansol (West Bengal), (2) Chirkunda (Jharkhand), (3) East & West Godavari (Andhra Pradesh), (4) Katni (Madhya Pradesh), (5) Ramgarh (Jharkhand) (6) Ranchi (Jharkhand), (7) Virudhachalam¹ (Tamil Nadu) and (8) Wankaner (Gujarat). Figure 2.1 shows the location of different refractory clusters in India.

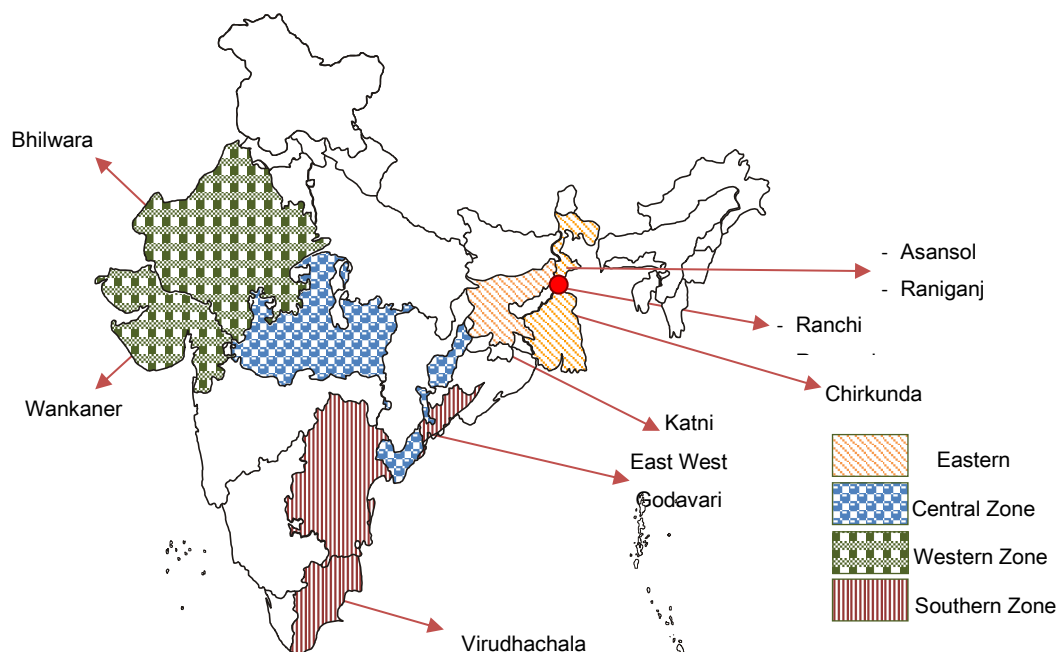


Figure 2.1 Major refractory MSME clusters in India

¹Production of Virudhachalam cluster is reported to be negligible due to limited and need based operation of refractory kilns.

2.2 Overview of Chirkunda refractory cluster

Chirkunda, in the Dhanbad district of Jharkhand, has a large number of industrial units-most of them MSMEs- as the area is rich in mineral resources such as coal, limestone, fire clay, china clay, granite, stone, and sand. Among the industries located in and around Chirkunda is a 100-year-old cluster of 68 refractory units, of which 52 units use downdraft (DD) kilns, 9 units use tunnel kilns and the remaining 7 units use other firings/processing technologies. Some of the large industries in and around the cluster include Kumardhubi Fire Silica Works (KFSW), Kumardhubi Metal Casting Limited (KMCL), Om Bosco (Railway Component manufacturer), Maithan Power Limited (JV of Tata Power and Damodar Valley Corporation), and McNally Bird Engineering (coal handling equipment).

The refractory products from the cluster are used across the country, with over 95% of products sold outside the state. The primary domestic market includes large steel manufacturing industries located within 200 kilometers of Chirkunda such as TISCO (Digwadih), TELCO (Jamshedpur), IISCO (Jamadoba), Bokaro Steel, SAIL (Durgapur), and Alloy Steels Plant (Durgapur). A small quantity of refractory products is also exported to neighbouring countries.

The other industries in this region under micro, small, and artisan categories include engineering & fabrication, mineral, leather, paper products, rubber goods, etc.

2.2.1 Classification of refractory units

The refractory units in the Chirkunda cluster are primarily classified based on the type of kiln used. It can also be categorized in terms of the type of products and production capacities. There are about 136 refractory industries in the cluster of which about 120 units use downdraft (DD) kilns, 9 units have tunnel kilns and 7 others. The industries are located within about 10 kilometers radius. Some of the prominent industrial locations are Mera, Kumardhubi, Maithan, Mugma, Taldanga, and Chirkunda, etc. (figure 2.2.1a).

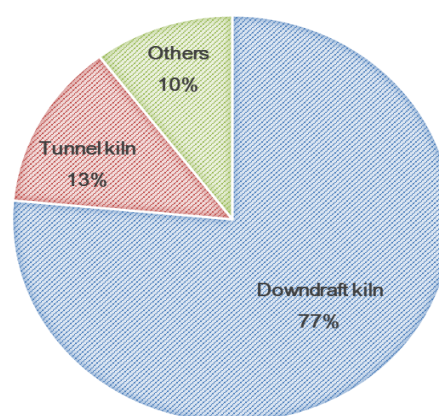


Figure 2.2.1a: Classification of units based upon the type of kiln

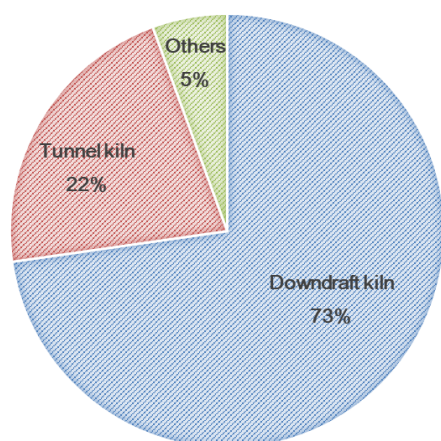


Figure 2.2.1b: Share of production based upon the type of kiln

The average production capacity of a DD kiln is about 130 tonnes per batch whereas the tunnel kiln is a continuous type of furnace and having an average production rate of 18.5-22.5 tonnes per day. The estimated average production of refractory products in the cluster is about 2,20,000 tonnes per year. The share of the production using different firing technologies is given in figure 2.2.1b.

The share of the production from downdraft technologies is about 73% of the total production whereas the share of tunnel kiln is only 22%.

2.2.2 Major products

The type of refractory products produced in the cluster includes refractory blocks & bricks, graphite stopper heads, insulation bricks, ladle, refractory mortar, ramming mass, roof bricks, sillimanite bricks, suspended roof bricks, monolithic, burner quarl, bottom pouring, silica brick, etc. Different type of the refractory products manufacturing in the clusters is shown in figure 2.2.2.



Figure 2.2.2: Different types of refractory products manufacturing in the cluster

2.2.3 Market scenario

The refractory materials produced in this cluster are consumed mostly within India and neighbouring countries including Nepal, Bhutan, and Bangladesh. Most of the end-users are located outside Jharkhand, and more than 95% of products are sold outside the state. The primary domestic markets include large steel manufacturing industries which lie within 200 kilometers of the area like TISCO (Digwadih), TELCO (Jamshedpur), IISCO (Jamadoba), Bokaro Steel, SAIL (Durgapur), Alloy steel plant (Durgapur), etc.

2.2.4 Raw materials

The raw material required for refractory includes fire clays of both plastic and non-plastic varieties, refractory grog (broken fire bricks), and other high alumina minerals like kyanite, sillimanite and bauxite are the raw materials for making fire clay bricks and blocks. Following are the raw material used by the user for manufacturing of major refractory products

- Kaolin
- Fireclay
- Aluminous materials
- Bauxite
- Laterite
- Sillimanite, kyanite, andalusite
- Zircon
- Silica

Owing to the rich mineral resources available in this region, most of the raw material is available in and around the cluster.

2.3 Cluster level initiatives

The programs and initiatives undertaken by various organisations are listed in table 2.3.

Table 2.3: Cluster level initiatives

Organisation	Programme/initiatives	Brief description	Status
Jharkhand Refractories and Research Development Centre (JRRDC)	Special Purpose Vehicle (SPV)	<p>The SPV is equipped with several testing equipments to undertake the chemical composition of different minerals used as raw material for refractory products and physical analysis of final products. The Centre has established a business model for its self-sustainability. Some of the equipment available at the SPV include</p> <ul style="list-style-type: none"> • Furnaces (1600 °C and 1450 °C), • Pyrometric, • Refractory under load, • Reverse thermal expansion, • Thermal conductivity meter, • Refractory cutting machine and • Minerals testing machine • Presently it has more than 35 registered members units. 	Operational
MSME – DI, Ranchi	Credit Linked Capital Subsidy Scheme (CLCSS)	<p>The objective of CLCSS is to;</p> <ul style="list-style-type: none"> • Encourage MSMEs in adopting energy efficient technologies • Encourage to improve product quality of manufacturing in MSMEs • Some of its salient features are; • Facilitate technology up-gradation in MSEs by providing an up-front capital subsidy of 15 % (on institutional finance of up to INR 1 crore) for induction of well-established and improved technology in the specified 51 sub-sectors/products approved • Upgrade the MSME plant & machinery with state-of-the-art technology, with or without expansion and also for new MSEs which have set up their facilities with appropriate eligible and proven technology duly approved under scheme guidelines. 	Operational

Organisation	Programme/initiatives	Brief description	Status
UNDP (United Nations Development Programme)	State Level Climate Change Action Plans	UNDP in partnership with MoEFCC and with support from the Global environment facility (GEF) is implementing a project on “Market Transformation and Removal of Barriers for Effective Implementation of the State Level Climate Change Action Plans” with an overall goal to reduce GHG emissions achieved through the implementation of Renewable Energy and Energy Efficiency solutions at the state level as identified in the State Action Plan on Climate Change (SAPCCs) of Manipur.	Completed

Chapter 3

3.0 Major cluster stakeholders

The primary stakeholders of the cluster are the refractory manufacturing units. The other stakeholders include industry associations, government agencies including regulatory bodies, research and academic institutions, and testing facilities and training institutes. These cluster level stakeholders provide a range of services to the refractory manufacturing units. Some of the major stakeholders in the Chirkunda refractory industry cluster along with their roles and activities are briefed below.

3.1 Industries associations

There are two major industry associations active in Chirkunda refractory cluster. The contact details of the industry associations are given in table 5.

3.1.1 Jharkhand Refractory Manufacturers Association

Jharkhand Refractory Manufacturers Association (JRMA) has been playing a key role in accelerating the growth in the Chirkunda Refractory cluster. Some of its key activities include (i) redressal of grievances of member industries, (ii) infrastructural development, and (iii) provide guidelines to members to fulfill legal requirements and green belt development.

3.1.2 Jharkhand Small Industries Association

Jharkhand Small Industries Association (JSIA) was formed in 1958. Its main purpose was i) to Unite & safeguard the interest of SSI, ii) to give voice to the existing problems, iii) cope up with day to day problems faced due to Kota & Permit Raj, iv) protect Industries from Inspector Raj and v) to advise and guide future entrepreneurs.

Table 3.1.2: Contact details of industries associations

Name of association	Contact details
Jharkhand Refractory Manufacturers Association	Chirkunda Dhanbad-826001, Jharkhand Email: jrma_india@yahoo.in Contact person: Mr. B.L Jalan (General Secretary)
Jharkhand Small Industries Association	Udyog Bhavan, Industrial Area, Kokar, Ranchi – 834001 Email: jsiaranchi2009@gmail.com Contact person: Mr. Philip Mathew (President)

3.2 Government bodies

The government agency involved in the cluster and their key activities in the cluster are given in table 3.2.

Table 3.2: Government bodies and key responsibilities

Name of organisation	Key roles
District Industries Centre (DIC), Dhanbad	<ul style="list-style-type: none"> Identify the new entrepreneurs and assisting them regarding their start-ups. Provide financial and other facilities to smaller blocks for industrialization at the district level. Enhance the rural industrialization and also the development of handicrafts. Reach economic equality in multiple areas of the district. Allow various government schemes to the new entrepreneurs. De-size the regional imbalance of development. Make all the necessary facilities to come under one roof
MSME-Development Institute (MSME-DI) Kokar Industrial Area, Ranchi, Jharkhand 834001	MSME-DIs field offices of the Ministry of Micro, Small & Medium Enterprises provide a wide range of extension/ support services to the MSMEs in their respective state of operation.
National Small Industries Corporation (NSIC) Udyog Bhavan, Kokar Industrial Area, Ranchi, Jharkhand 834001	<ul style="list-style-type: none"> Support and promote the MSME sector by providing combined support services encircling finance, marketing, technology, and allied services Aid, foster, and promote the growth of MSMEs all across the country Operates across the country through a network of technical centers and offices.

3.3 Technical, academic, and R&D institutions

Jharkhand Refractory Research & Development Centre (JRRDC), incorporated in the year 2011 is one of the R&D Centres providing technical product development solutions to the refractories units in the cluster.

Some well-known centrally funded technical institutes in the Dhanbad district are the Indian Institute of Technology (IIT), Central Institute of Mining and Fuel Research (CIMFR), Government Polytechnic College (3 colleges), and some industrial training institutes (ITIs).

3.4 Financial institutions

There are several nationalized, commercial, and cooperative banks operating in the cluster. Out of these, the Small Industrial Development Bank of India (SIDBI) plays a pivotal role with its various schemes on financing energy efficiency initiatives. Other prominent banks include the Bank of Baroda (BOB), Punjab National Bank (PNB), Canara Bank, etc. which not only provide adequate and affordable energy efficiency / green finance but also enhance awareness of the benefits of climate control amongst MSE clusters. In addition, a large number of cooperative banks also operate in the cluster to meet the financial requirements of the cluster.

Chapter 4

4.0 Production process and technology use

The production process in refractory industries includes (i) raw material preparation and shaping, and (ii) firing. The technologies and equipment used in different process steps of refractory product manufacturing are discussed in this section.

4.1 Manufacturing process

The refractory manufacturing process broadly consists of raw material preparation, shaping of green products, drying to remove the moisture, and firing to provide the strength and impart required properties. The raw materials include fire clays (plastic and non-plastic varieties), refractory grog (broken fire bricks), and other high alumina minerals like kyanite, sillimanite, and bauxite. A typical manufacturing process followed in the cluster for the production of refractory products is shown in the figure. 4.1.

The general manufacturing process of ceramic products is described below.

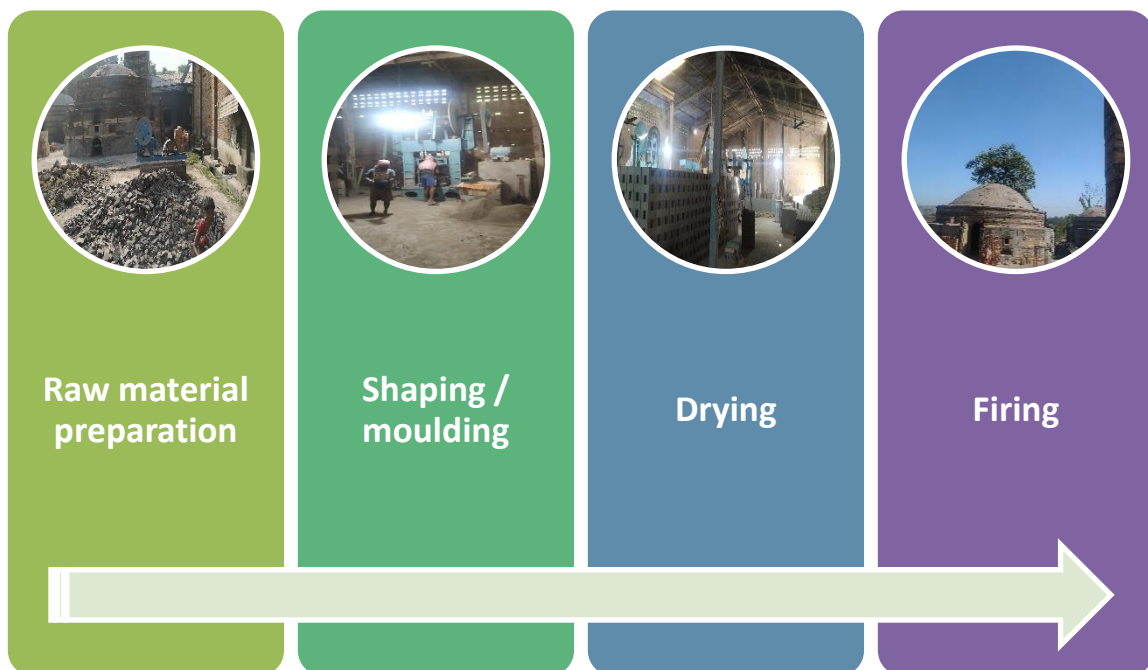


Figure 4.1: Typical production process in a refractory industry

4.1.1 Raw material preparation

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.

Grinding is a batch process used to maintain the particle size of batch material to ensure homogeneity. Jaw crushers (primary crushing) and disintegrators (fine particle sizing) are commonly used in the grinding process.

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

4.1.2 Shaping and formation

Pressing machines are used to provide shape to the product. Each refractory unit uses multiple press machines. The press machines are operated manually. Two types of press machines are commonly used namely (1) hydraulic press and (2) friction press. The type of press used is dependent on the 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 homogeneously mixed raw material in Muller is loaded manually in hydraulic or friction press based on the 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.

4.1.3 Drying

The moisture level of the green refractory products is in the range of 7-8% which must be reduced to 3-5% before firing. The shaped products from the shaping/formation process are stacked inside an open shed to allow slow and uniform drying. Tunnel kiln-based refractory units are equipped with dryers utilizing the waste heat available in flue gases for the removal of moisture from molded products.

4.1.4 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. The temperature profile of the refractory bricks varies in the range of 1150-1300 °C.

4.2 Major technologies and equipment

The refractory manufacturing industries in Chirkunda use both traditional and modern technologies. The technology and equipment used in different refractories manufacturing processes are described below.

4.2.1 Raw material preparation and shaping

The raw materials are crushed and sieved to achieve defined particle-size distribution according to the recipe. The raw material crushing process uses a jaw crusher and disintegrator. A jaw crusher is used to reduce the input feed sizes to 50 mm (maximum). An electric motor-driven disintegrator is used to achieve a defined

particle size of batch products. Most MSME units in the cluster are manpower intensive and use manual conveying of the raw material. About 12-15 manpower is required for the raw material preparation in a typical size MSME unit.

The grinded /prepared powder is stored in a chamber underneath the disintegrator, which requires additional manpower for material transfer as well as significant wastage of ready-to-use recipes. However, some of the progressive units use bucket elevators and silos reducing manpower requirements and minimising wastage. Figure 4.2.1a shows jaw crusher and disintegrator used in refractory industries.

Water is added to the mixture in Muller machines to prepare homogeneous batches as per the requirements of the final product composition. Press machines are used to provide shape to the product. Friction press and hydraulic screw press are primarily used in the shaping/moulding process of the products. The type of press used is dependent on the type of products being manufactured, density, and strength.



Figure 4.2.1a: Jaw crusher and disintegrator

Friction press is suitable for large-size refractory products. The common capacity of electric motor friction in the studied clusters is varying in the range of 80-250 tonnes. However, some of the medium and large units are using multiple cavities, friction presses of up to 800-tonne capacity. The hydraulic press is more suitable for refractory products that can be shaped generally within 30-180 tonnes in a single stroke. Figure 3.2.1b shows Muller machines and press machines used in refractory industries.



Figure 4.2.1b Muller & press machines

Electricity is primarily used in the raw material preparation and shaping sections. More than 90% of the total electricity used in electric motors is associated with jaw crushers, disintegrators, U-mixer, Muller machines, and press machines. The installed electric motors are standard efficiency class and more than 60% of the motors are old and multiple times rewind.

4.2.2 Drying

The refractory sector uses a natural drying process for the removal of moisture from the green refractory product. Due to the natural drying process, the drying duration and the final moisture level are generally dependants on ambient conditions. For example, the firing cycle and the associated energy consumption of the kilns increase significantly during the rainy season. Hence, most of the refractory kilns are generally not operated during the rainy season.

A few tunnel kilns in the cluster have been equipped with waste heat-based dryers for the removal of moisture. However, due to the non-availability of local service providers and skilled operators, the refractory units have kept it offline. The natural drying and tunnel drying arrangement is shown in Figure 4.2.2.



Figure 4.2.2 Natural drying and tunnel dryer

4.2.3 Firing

Different types of firing technologies such as downdraft kiln (batch firing) and tunnel kiln (continuous firing) are used by refractory industries in the Chirkunda cluster (Figure 4.2.3a).



Figure 4.2.3a: DD kiln and tunnel kiln

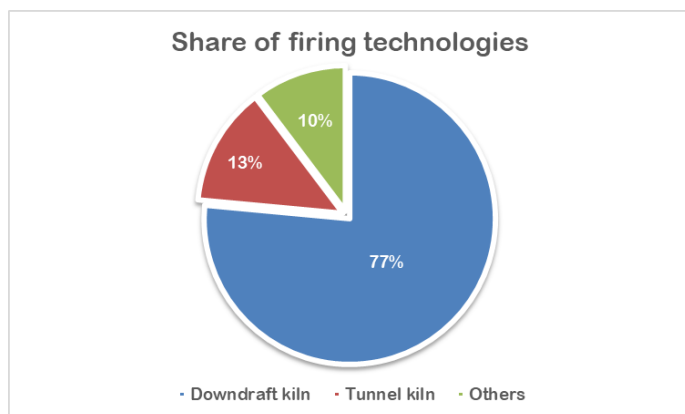


Figure 3.2.3b: Share of different kilns

Most of the refractory units in the cluster use DD kiln technology (77%) in the firing process (figure 4.2.3b). The tunnel kiln share is about 13%. A very few units are using tunnel dryers and other firing technologies for manufacturing different refractory products.

4.2.3.1 Downdraft kiln

The production capacities of downdraft kilns vary in the range of 40 tonnes to 250 tonnes per batch depending on the internal diameter of the kiln. Coal is used as the major fuel in downdraft kilns; however, a few units also use firewood along with coal. A typical batch cycle of downdraft kiln unit includes the following steps.

Loading: Green refractory products are being stacked inside the chamber. Most of the units transfer green products manually from the production shed to the kiln chamber which takes almost 2-3 days using 10-15 manpower. A few units have installed motorized flexible conveyor systems.

Smoking: Slow firing is initiated in the kiln for removal of moisture from green products (the initial moisture level of stacked products is in the range of 3-5%). The duration of slow firing is about 2-3 days.

Firing: The firing takes about 5-7 days wherein a temperature level of about 1,150-1,300 °C is achieved. Coal is generally fed at set intervals but without weighing. The downdraft kilns also do not have a provision for temperature monitoring to maintain the standard temperature profile of the kiln.

Soaking: On achieving the desired temperature, the kiln is sealed completely for soaking of products to attain uniform temperature and required physical and chemical properties.

Cooling and unloading: Cooling of the kiln is carried out for about 2-3 days which includes up to 1 day for natural draft cooling and 2 days for forced cooling using fans.

Since downdraft kilns are batch-based, their specific energy consumption (SEC) levels are generally observed to be higher than continuous type kilns.

4.2.3.2 Tunnel kiln

Tunnel kilns are continuous type kilns. Tunnel kilns in the refractory sector use mainly petcoke as fuel. A few refractory kiln units use gaseous fuels (natural gas and coal bed methane) and liquid fuels. The capacity of tunnel kilns used in the studied clusters is in the range of 10-20 tonnes per day.

A typical tunnel kiln has three zones, namely, preheating, firing, and cooling zones. The green products are stacked on trolleys and moved on rails inside the kiln. The product carrying capacity of each trolley is about 1.5-2.5 tonnes. The movement of the trolleys is controlled using an electrically operated pusher. The pushing time is adjusted to maintain the retention time.

Chapter 5

5.0 Energy consumption profile and conservation measures

5.1 Details of energy use

The refractory industries in the Chirkunda cluster use both thermal energy and electricity in the manufacturing processes. However, thermal energy accounts for a sizeable portion (99%) of the total energy consumption of the refractory units (figure 5.1a). Coal and petcoke are the major sources of this thermal energy. Coal is the main fuel used in downdraft kilns whereas petcoke is commonly used in tunnel kilns for the firing of refractory products. Electrically operated plant utilities include press, crusher, muller, vibrating screen, and belt conveyor. These are operated using a power supply from the local grid.

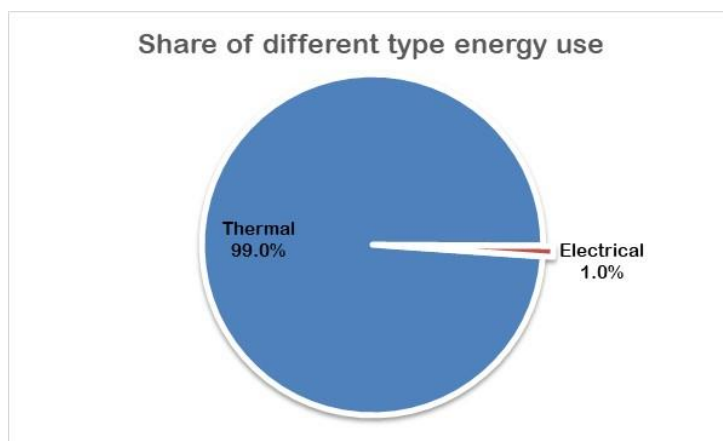


Figure 5.1a: Share of fuel type in Chirkunda cluster

The firing cycle of the DD kiln is manually operated using natural draft for combustion air supply and hence, power cut from grid does not interrupt the process. However, the tunnel kiln requires a standby power source (generally DG set) to continue its operations. The energy consumption in different kilns is also dependent on the type of products being processed and the firing temperature needed.

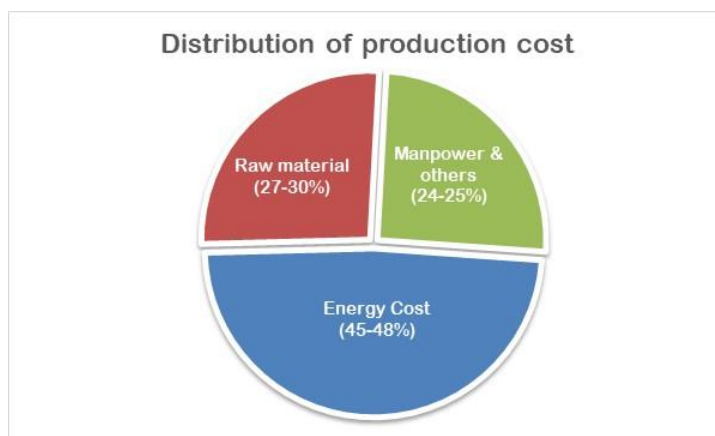


Figure 5.1b: Cost Share of a typical refractory unit

The share of energy cost is in the range of 45-48% of the total production cost followed by raw material (27-30%). The cost towards manpower and others is about 24-25%.

5.1.1 Thermal energy

Thermal energy is used in the kilns for the firing process in refractory manufacturing. The details of thermal energy use in the cluster are provided in Table 5.1.1.

Table 5.1.1: Details of fuels used for thermal energy requirements

Energy type	Source	Calorific value	Landed cost (Rs./unit)
Coal	Local market	4,514 kCal/kg	7.4
Petcoke	Domestic market	8,340 kCal/kg	17.3
HSD	Retail Outlet of Indian Oil, HPCL, etc.	8,739 kCal/L	77.0

5.1.2 Electricity

Electricity is used in the prime movers of all the auxiliary equipment being used in the refractory unit. Owing to the low electrical energy requirements most of the refractory units use LT connections. Electricity is supplied by Jharkhand Bijli Vitran Nigam Limited (JBVNL). The applicable tariff of various such categories is given in Table 5.1.2.

Table 5.1.2: Electricity tariff plans in Chirkunda Refractory cluster

Energy source	Availability	Tariff details
Electricity	Jharkhand Bijli Vitran Nigam Limited (JBVNL)	Tariff category: LTIS - Voltage supply: 0.415 kV - Fixed charges: Rs 100 per kVA - Energy charges: Rs 5.75 per kVAh
		Tariff category: HTS - Voltage supply: 11 kV - Fixed charges: Rs 350 per kVA - Energy charges: Rs 5.50 per kVAh

5.2 Energy consumption pattern

The energy consumption pattern across the refractory units does not vary significantly. Thermal Energy constitutes about the major share of the overall energy consumed. The unit level energy consumption of a typical refractory unit of the Chirkunda cluster is summarised below.

5.2.1 Unit level

The total energy consumption of a ceramic/refractory unit is 450 toe per year for downdraft kiln, 527 toe per year for tunnel kiln, and for others, it is about 81 toe per year (Table 5.2.1). Thermal energy accounts for 99% of total energy consumption of which coal and pet coke are used as the main fuel. Raw material preparation and Product forming/ moulding are done through electrical drives but operated manually. However, the share of electrical energy consumption is negligible as compared to the energy consumption required for the firing process.

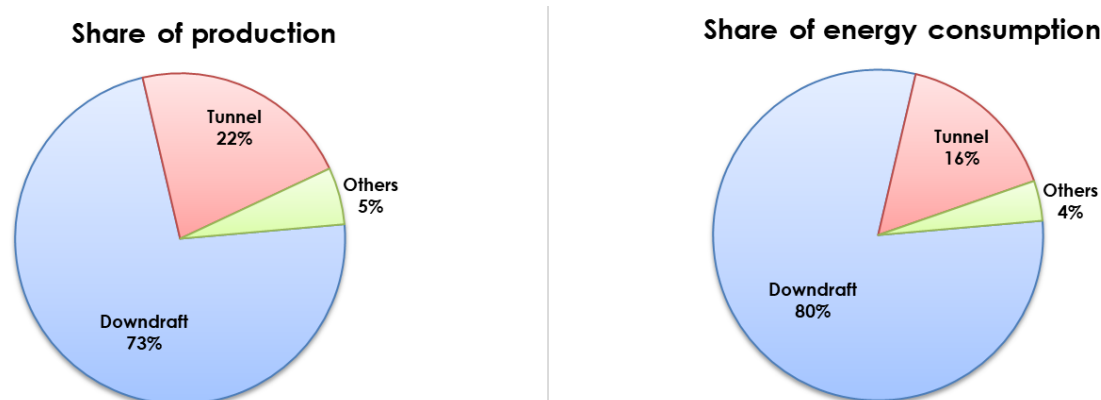
Table 5.2.1: Typical energy consumption of kilns

Type of unit	Thermal energy (tpy)	Diesel (kL/yr)	Electricity (kWh/yr)	Total energy (toe/yr/unit)
Downdraft kiln	Coal: 1,010	-	29,423	450
Tunnel kiln	Petcoke: 617	4.4	97,679	527
others	Coal: 360	-	45,547	81

5.2.2 Cluster level

The cluster uses coal and petcoke for kiln firing and uses mainly grid electricity for meeting the plant load. The tunnel kiln units have installed DG sets to operate tunnel kilns during power failure. The total energy consumption of the Chirkunda refractory cluster is estimated to be 29,774 tonnes of oil equivalent (toe) during 2019-20.

During the financial year 2019-20, Downdraft kilns account for about 73% of total production while consuming about 80% of total energy consumption. The share of production from tunnel kiln technology is about 22% and consuming only 16% of total energy (Figure 5.2.2). The break-up of energy consumption is provided in Table 5.2.2. The equivalent GHG emissions are estimated to be 121,069 tonnes of CO₂ per year.


Figure 5.2.2: Production Vs energy share of firing technologies in Chirkunda cluster
Table 5.2.2: Energy consumption of Chirkunda cluster

Kiln type	Number of units	Production (tpy)	Thermal (toe/yr)	Electricity (toe/yr)	Total energy consumption (toe)
Downdraft kiln	52	160,056	23,703	132	23,834
Tunnel kiln	9	47,723	4,630	110	4,775
Rotary kiln	7	12,264	1,138	27	1,165
Total	68	220,043	29,471	269	29,774

5.2.3 Specific energy consumption

The specific energy consumption for refractory production using different types of firing technologies i.e. downdraft and tunnel kiln is given in table 5.2.3.

Table 5.2.3: specific energy consumption

Parameters	Unit	Value
Downdraft kiln		
Firing of refractory product	GJ/ tonne of product	6.23
Raw material preparation	kWh/tonne of raw material	9.56
Specific energy consumption in vitrification of green refractories	GJ/ tonne of product	6.20
Tunnel kiln		
Firing of refractory product	GJ/tonne of product	4.19
Raw material preparation	kWh/tonne of raw material	18.42
Specific energy consumption in vitrification of green refractories	GJ/tonne of product	4.06

The weighted average specific energy consumption of the Chirkunda refractory cluster considering major firing technologies is estimated to be 5.76 GJ per tonne of product (Figure 5.2.3).

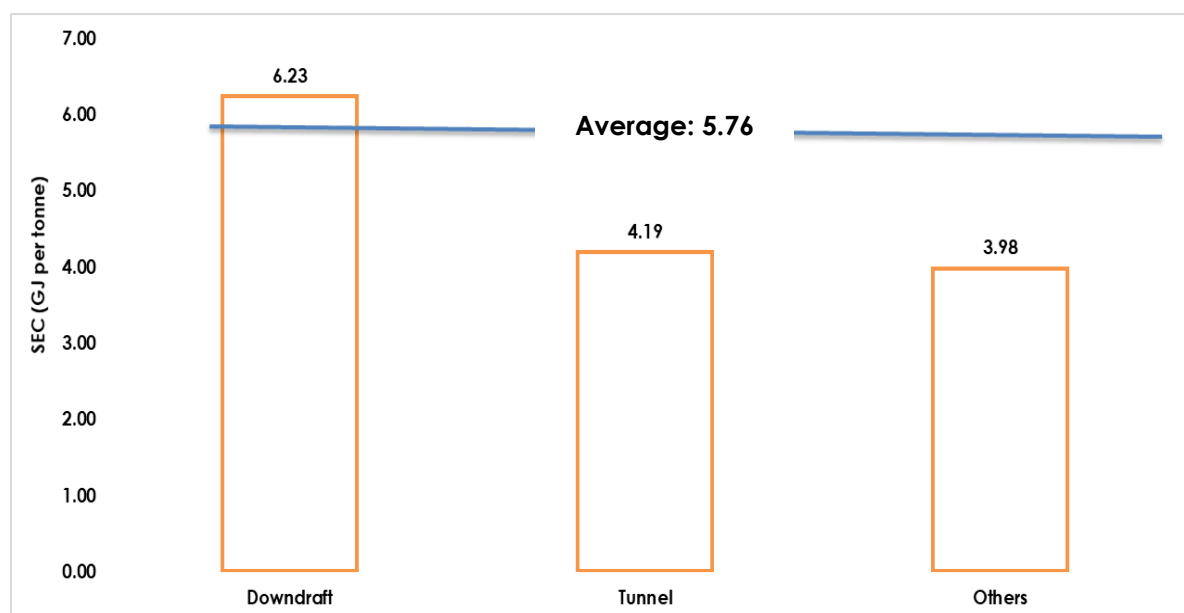


Figure 5.2.3 Technology wise trend of SEC in Chirkunda cluster

5.3 Other resources

Apart from thermal energy and electricity, no other major resources are utilized in the refractory industries of the Chirkunda cluster, as of date.

5.4 Energy conservation opportunities

The refractory units in the Chirkunda cluster mostly use locally fabricated equipment and machinery for their manufacturing processes. These technologies/equipment are often energy in-efficient and polluting in nature. Hence, the refractory units in the cluster offer significant scopes for energy saving. A list of different energy conservation measures applicable for Chirkunda refractory units is provided in table 5.4.

Table 5.4: Major energy conservation opportunities in the cluster

Equipment/section/utility	Energy conservation measures
Downdraft kiln	<ul style="list-style-type: none"> - Improving damper system - Use of correct size of coal and improving feeding practices - Installing temperature indicators for monitoring furnace temperature - Preheating of green refractory by flue gases - Technology up-gradation: Switch to tunnel kiln based firing technology
Tunnel kiln	<ul style="list-style-type: none"> - Use of low thermal mass cart - Low thermal mass kiln furniture - Improvement insulation - Use of alternative and/or gaseous fuels
Electrical distribution system	<ul style="list-style-type: none"> - Improvement of billing power factor
Other areas	<ul style="list-style-type: none"> - Replacement of rewind, old inefficient electrical motors with premium efficiency class (IE3) motors - Use of energy-efficient lighting system - Productivity enhancement in downdraft kiln - Installation of material feeding conveyor system

Chapter 6

6.0 Major challenges in the cluster

The cumulative energy consumption of the Chirkunda refractory cluster is quite significant. The analysis of energy consumption by various sub-processes reveals that the use of conventional firing technologies and equipment for raw material in the cluster units leads to higher specific energy consumption. Apart from energy, due to the manual material handling process, the cost of manpower is also significant. There exists significant scope for energy conservation using new firing technologies with process automation systems.

The major challenges related to technology, energy pricing, availability and quality of raw material, manpower skill sets, environmental, etc. are discussed in the subsequent section.

6.1 Technology

Most of the refractory units use locally designed/ fabricated technologies and machinery which are often less productive, outdated, and consume more energy. The process parameters and operating practices being followed are also not routinely monitored in the cluster units. Further, lack of awareness and availability of new and energy-efficient technologies, weak linkages with technology suppliers, limited knowledge of local service providers on modern technologies, etc., are the major bottlenecks hindering technology up-gradation in this cluster.

6.2 Energy pricing

The fluctuating price of fuel (coal and petcoke) poses a major challenge in this cluster. Further, poor quality (low calorific value, high coal dust share, and high ash content) fuel results in higher fuel consumption and consequently increases costs of production.

The recent change in the electricity billing tariff (kWh to kVAh billing) also resulted in a higher cost of raw material processing and green refractory formation. moreover, most of the entrepreneurs are not well aware of their unit-level power factor thus paying higher electricity charges,

6.3 Raw material cost

The rising prices and shortage of good quality additive materials pose a major challenge to the refractory units which directly influences the manufacturing costs. Further, the scale of operation of these micro and small-scale units hinders their capacity to purchase raw materials at the most economic price structure. The absence of a big business quantum prevents the cluster units from effective negotiation of terms and prices with raw material suppliers.

6.4 Manpower and skillsets

The refractory manufacturing facilities (especially tunnel kiln units) require a certain degree of skills to ensure quality control and to operate various equipment and systems. In addition to this, some of the sections/ processes such as pressing, drying, etc. require semi-skilled manpower. At present, there is a shortage of both skilled and semi-skilled workforce in this cluster.

6.5 Environmental issues

The refractory industries are among those industrial sectors which are identified as highly polluting. The industry associations have taken several initiatives to deal with the flue gas emission-related issues of the cluster. Environmental compliance remains an area of focus for most of the refractory units in the cluster alongside their challenges to adopt energy efficiency improvements.

Chapter 7

7.0 SWOT Analysis

The refractory industries in Chirkunda face several challenges about regulations on fuel pricing, pollution standards as well as production capacities, and exports that can affect the adoption of energy efficiency measures by the cluster units. The units also face challenges of increasing the cost of energy and raw materials, resulting in an increased level of imports in the domestic market. Chirkunda refractory cluster has many regional advantages that help the cluster remain at the forefront of the Indian refractory industry. There is a need for the refractory units to become efficient and maintain a better profit margin which would require the adoption of energy-efficient technologies in their processes and auxiliaries. A SWOT (Strength, Weakness, Opportunities, and Threats) analysis of the refractory manufacturing units in the Chirkunda cluster was performed to understand the cluster situation. The SWOT analysis of the Chirkunda refractory cluster is given below.

Strength	Weaknesses
<ul style="list-style-type: none">• Local availability of coal and basic raw material (mineral-rich zone)• Located in the largest steel manufacturing hub• Most of the units are 50+ years old, thus experienced entrepreneurs• Entrepreneurship zeal in the local community	<ul style="list-style-type: none">• Dependency on conventional technologies thus, the limited scope of expansion without change in firing technology• Unavailability of local service providers and operators for new and EE firing technologies• Limited product portfolio
Opportunities	Threats
<ul style="list-style-type: none">• Significant potential for energy saving• Potential for Technology Up-gradation• Growing end-use domestic market• Product customization and demand for new and alternative products• Upgradation of existing CFC for skill development and raw material banking	<ul style="list-style-type: none">• Escalating fuel (coal, petcoke, and electricity) prices• Competition with low-cost imported refractory products• Low turnover limiting to compete in NITs/national level procurement• Limited accessibility of gaseous fuels

Chapter 8

8.0 Conclusions

Chirkunda's refractory cluster with its more than 68 units, is an important industry cluster under the MSME sector in the country. The refractory units, producing refractory blocks & bricks, insulation bricks, graphite stopper heads, etc. use both thermal energy and electricity to meet their energy demands. The analysis of the Chirkunda refractory cluster shows that thermal energy accounts for a major share of energy consumption. The energy intensities of these units are also quite high which may be attributed to the use of inefficient technologies and equipment in both processes and utilities. This also results in increased energy costs.

Optimum use of energy and resource conservation emerge as appropriate solutions for Chirkunda refractory cluster to achieve competitive manufacturing costs through adoption of new and energy-efficient (EE) technologies in processes and utilities. However, to ensure large-scale adoption, the cluster needs to address some barriers which include non-availability of energy-efficient technologies, weak linkages with EE technology suppliers, lack of manpower and skillsets, etc.

The technical assistance with the support of the project would help the refractory industries in the Chirkunda cluster to (i) identify the potential process/ utility areas for energy saving, (ii) assess energy-saving potential through detailed energy audits of cluster units (iii) adopt EE technologies through increased awareness and by strengthening linkages with EE technology providers.



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