Energy Profile

Howrah Foundry Cluster

The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

Promoting Energy Efficiency in SMEs
SAMEEEKSHA

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Contents

Abbreviations

APFC	Automatic Power Factor Controller
BOP	Best Operating Practices
CFM	Cubic feet per minute
CO	Carbon monoxide
CO_2	Carbon dioxide
DBC	Divided Blast Cupola
GHG	Greenhouse Gas
HT	High Tension
IGBT	Insulated Gate Bipolar Transistor
kVA	Kilo Volt Ampere
kVAh	Kilo Volt Ampere hour
kW	Kilo Watt
kWh	Kilo Watt hour
LT	Low Tension
MSME	Micro Small and Medium Enterprise
PF	Power Factor
SCR	Silicon Controlled Rectifier
SEC	Specific Energy Consumption
SO_2	Sulphur dioxide
SPM	Suspended Particulate Matter
toe	tonne of oil equivalent
tpy	tonne per year
TPD	Tonne Per Day
VFD	Variable Frequency Drive
WBSEDCL	West Bengal State Electricity Development Corporation Limited

Howrah Cluster

1.0 Overview of the cluster

The Howrah district, located in the state of West Bengal, is among the most urbanized regions in the state. Howrah has long served as a major industrial center since 19th century. There are more than 3,000 registered industries operating in the cluster. Some of the key industries in the cluster include foundry, steel re-rolling and engineering-based manufacturing. The foundries are mainly located in Liluah, Salkia, Belgachia, Dasnagar, Balitikuri, Jangalpur and Santragachi providing direct employment to about 15,000 people.

Figure 1: Cluster map

The cluster is a major producer of sanitary castings, which are exported to various markets. Despite facing several operational challenges, the Howrah foundry cluster remains a critical component of West Bengal's industrial landscape. With targeted efforts toward modernization, skill development and improved infrastructure, the cluster holds significant potential for sustained growth and achieve global competitiveness.

2.0 Product, market and production capacities

The Howrah foundry cluster, comprising around 320 operational units, produces more than one million tonne of castings annually. These foundries serve a diverse range of municipal castings like manhole frames and covers sanitary pipes and fittings, agricultural implements, machinery bodies, counterweights, pump and valve bodies, jute mill spares, as well as components for the railway, defence, and mining industries. The foudries procure pig iron from steel plants and source coke through local dealers (Table 1).

Table 1: Raw material sources

Raw material	Supplier
Pig iron and scrap	Tata Metaliks, SAIL, Rashmi Metaliks, Neo Metaliks
Coke	Dhanbad coke through local dealers
Limestone	Local dealers
Ferro alloys	Local dealers

Figure 2: Major raw materials used in foundry

Based on the production of castings the foundries may be categorised as micro, small and medium categories. The total esitmated production from Howrah foundry cluster is estimated as 480,000 tonne per year (tpy) (Table 2).

Table 2: Production from Howrah foundry cluster

Category	Production per month	Number of units	Production (tpy)
Micro	100	200	2,40,000
Small	300	80	2,88,000
Medium	1000	40	4,80,000

Although majority of the foundries are of micro category (62%) (Figure 3), they account for only 24% of total production (Figure 4).

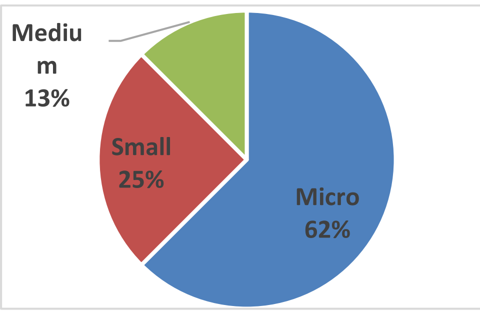

Figure 3: Share of categories of industries

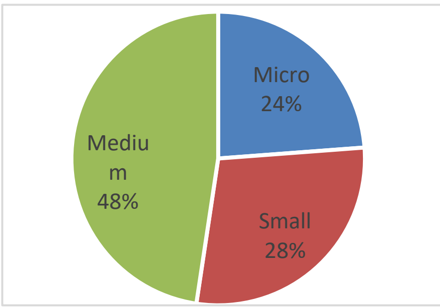

Figure 4: Production share of industries

The small foundries get payments on weight basis of finished castings, which is generally a fixed amount, which is unique to Howrah cluster. This practice provides hardly any incentives for the foundry, restricting the adoption of modernisation in moulding and melting operations.

3.0 Production Process

The major process steps in a foundry include moulding and melting in a foundry unit, followed by pouring and finishing (Figure 5).

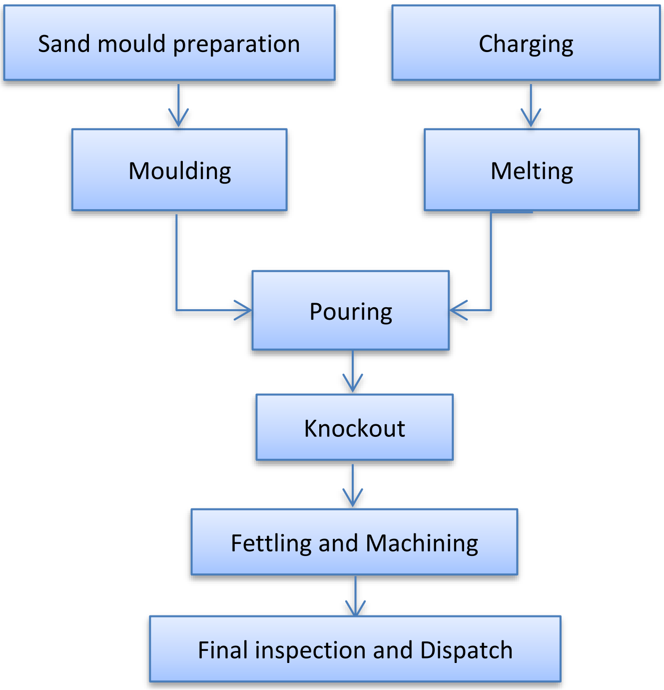

Figure 5: Process flow diagram of a typical foundry

3.1 Moulding

Howrah foundries use green sand moulds in the production process. Green sand is composed of high-quality silica sand, approximately 0.9% bentonite clay (as a binder), 0.3–0.5% coal dust (to enhance surface finish) and water. Since most foundries produce low value-added castings, they recycle nearly 90% of the sand. Only a few foundries, involved in value-added engineering castings require higher quality sand and have installed mechanized sand plants for treatment and recycling of moulding sand (Figure 6 and Figure 7).

3.2 Melting

Cupola furnace is the most commonly used technology in the cluster. Cupolas are charged manually or mechanically with materials like pig iron, cast iron scrap and internal foundry returns (rejected castings). High-ash Indian coke is used as the primary fuel. The temperature

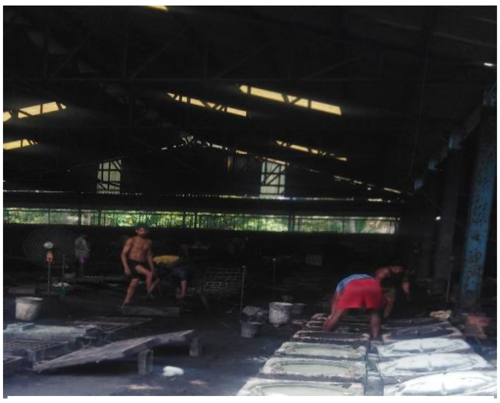

Figure 7: Manual Moulding practices

Figure 7: Mechanized moulding line

of cupola is in the range of 1480°C at the melting zone. After transfer of heat, the hot flue gases leave the cupola at about 450°C.

Few other units have also installed induction furnace for melting the raw materials. The material is manually charged in the induction furnace. The batch time typically varies from 40 mins to 90 mins depending on the size and capacity of the furnace. The slag is removed, and the molten metal is taken out and poured in the moulds for casting (Figure 8).

Figure 8: Pouring practices in Howrah foundry cluster

It may be noted that majority of the foundries do not have sufficient resources as well as technical capacity to adopt energy efficient technology options and practices. This has led to the use of cheap raw material, energy sources and non-standard equipment.

4.0 Technologies employed

Some of the major foundry processes/equipment are described below.

4.1 Melting furnace

(i) Cupola

A majority of the foundry units in Howrah cluster uses energy efficient Divided Blast Cupola (DBC) furnaces. Only a fraction of units still continues with conventional or single blast cupola. About ¾thof cupolas are over a decade old, with their blower motor rewound multiple times. The specific energy consumption of DBCs varies in range of 100 – 140 kg coke per tonne for molten metal equivalent to a coke to melt ratio of 1:10 to 1:7. All the figures are on charging coke (i.e. total coke used during a batch except bed coke).

Figure 9: Cupola furnace

(ii) Induction furnace

A few foundries employ induction furnaces for melting. The size of connected load of an induction furnace varies from 150 kg (100 kW) to 1 tonne (750 kW). However, the most common specification of induction furnace used in the foundry industry is 500 kg (550 kW). The average specific energy consumption of induction furnaces in the cluster is about 600–650 kWh per tonne of melt.

4.2 Moulding and core preparation

Mould preparation is an important process in the casting industry. Cores are placed inside the moulds to create void spaces. Moulds are either prepared manually or using pneumatic moulding machines. Cupola furnace units are more commonly practicing hand moulding while the induction melting furnace has pneumatic moulding machines or high-pressure moulding lines.

4.3 Sand preparation

Sand preparation is done using sand mixers and sand sieves. Sand mixers have typical batch sizes of 100 to 500 kg. The connected load of these mixers is in the range of 10 to 30 kW. Few plants have sand handling plants along with sand cooler of capacity 5 to 20 tonnes per hour, the connected load of such plant is about 75 to 100 kW.

4.4 Auxiliary system

Air compressors: Foundry utilizes compressed air in number of process applications which includes mould preparation, pneumatic fettling and application of cleaning of mould, core and general cleaning. Typically, foundries have compressors of FAD rating 70 to 300 cfm with power rating of 11 to 45 kW.

Pumps: Induction furnace-based foundries necessitate the cooling of coils within the crucible and the electronic panels. This cooling process is facilitated by two pumps operating on demineralized (DM) water. One pump circulates raw water through a cooling tower to cool the DM water via a heat exchanger. Typically, foundries employ end-suction mono-block pumps to fulfill these cooling requirements.

5.0 Energy scenario

Coke is the major source of energy used by cupola-based foundries and electricity by induction furnace-based units. Coke is sourced from local distributors who procure the same from Dhanbad and other areas. Electricity is source from West Bengal State Electricity Distribution Company (WBSEDCL). The major energy sources and tariffs are shown in Table 3.

Table 3. Tariffs and prices of energy sources

Raw material	Tariffs and prices
Electricity	Tariff category: Rate – Industry (IDIT) Demand charges: INR 270 per kVA per month Energy charges: INR 6.83 per kWh Peak charges: INR 8.20 per kWh Off-peak charges: INR 5.12 per kWh

Raw material	Tariffs and prices
	Tariff category: Rate – B(I-U) Demand charges: INR 75 per kVA per month Energy charges: First 500 units – INR 5.23 per kWh Next 1500 units – INR 7.86 per kWh Above 2000 units – INR 7.83 per kWh
Coke	Rs 20,000 - 22,000 per tonne (with an ash content of about 28%)

6.0 Energy consumption

The melting furnace accounts for a major share (75-90%) of total energy consumption in a foundry unit. Cupola melting furnaces consume coke while induction melting furnaces use electricity. The specific energy consumption (SEC) varies considerably in a foundry depending on the type of furnace and degree of mechanization. The average SEC of cupola melting furnace averages about 110 kg of coke per tonne of molten metal or 1:9 coke to melt ratio. The average SEC of induction melting furnace is about 600 kWh per tonne of molten metal.

6.1 Cluster level energy consumption

Coke is the major contributor for energy consumption in the cluster. The coke consumption is estimated to 93,984 tonnes while the electricity consumption is 117 million kWh. The total energy consumption of foundry units in the cluster is estimated to be 66,446 tonnes of oil (toe) equivalent. The total carbon dioxide emissions is estimated to be 356,512 tonne CO_2/year as shown in Table 4.

Table 4: Energy consumption and CO_2 emissions of the Howrah foundry cluster

Energy type	Annual consumption	Equivalent energy (toe)	GHG emissions (tonne CO_2/yr)
Electricity (million kWh)	117	10,056	83,019
Therma (Coke in tonnes)	93,984	56,390	2,73,493
Total		**66,446**	**3,56,512**

The share of thermal energy consumption in the cluster is 85% of the total energy consumption while the share of emissions is 77% of the total emissions (Figure 10 and 11).

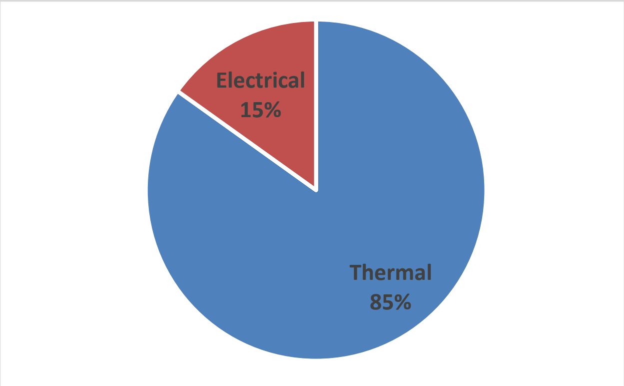

Figure 10: Energy consumption share

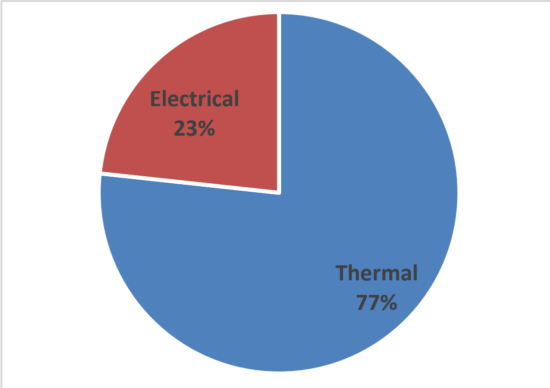

Figure 11: Share of emission in the cluster

6.2 Energy saving opportunities in the cluster

(i) Adopt energy efficient melting furnace

The adoption of energy-efficient divided blast cupola (DBC) technology is recommended for single blast cupola-based foundries. Current conventional cupolas use approximately 100 to 140 kg of coke per tonne of liquid metal. By adopting DBC coke consumption is expected to reduce to around 80 kg per tonne, resulting in significant cost savings. The simple payback period for DBC adoption is about one year.

(ii) Installing energy efficient induction furnace

Some facilities utilize traditional SCR-based induction furnaces running on high specific power consumption levels. There is significant scope of improvement in the specific energy consumption of the melt by replacing SCR based furnace with IGBT furnace. Transitioning to IGBT-based induction furnaces involves higher initial capital expenditure. Nonetheless, the considerable energy efficiency improvements, lower operational expenses and enhanced productivity contribute to a favorable return on investment, typically within two to three years, driven by significant reductions in energy costs and maintenance requirements.

(iii) Adopt best operating practices in melting

Efficient operation of melting furnaces largely depends on the adoption of the best operating practices (BOP) at each stage of the metal melting process. Charging material sizes should not be more than one-third of the diameter or opening of the induction furnace. Practices such as maintaining detailed records for each melt, proper preparation of charge materials and optimizing tapping temperature can result in significant energy savings with minimal investment. In induction furnaces, the installation of a lid mechanism helps reduce radiation heat losses. Additionally, the lid cover lowers the ambient temperature around the furnace, creating a more comfortable working environment for operators.

(iv) Replacement of rewound motors with energy efficient motors

Most electric motors utilized in foundries typically conform to standard efficiency class. Motor failure due to burnout is a common issue, often caused by factors such as power quality fluctuations and overloading. Rewinding motors is a cost-effective solution frequently employed by foundry personnel; however, this process can reduce motor efficiency by approximately 3-5%. It is advisable to replace motors that have been rewound multiple times, as their performance degrades over time. Upgrading to energy-efficient motors, specifically those with IE3 efficiency class can lead to energy savings, with a typical payback period of 2 to 3 years.

(v) Arresting compressed air leakages

Compressed air represents a significant operational expense within industrial facilities. Typically, air leakages in piping systems exceed 20% and often remain undetected. Implementing effective leak management and maintaining rigorous housekeeping standards can reduce leakage rates to below 10%. Such measures enable foundries to achieve energy savings without requiring additional investment, thereby enhancing operational efficiency and cost-effectiveness.

(vi) Reduction in pressure setting of air compressor

The pressure setting of the air compressor is configured above the maximum required air pressure to account for pressure losses within the distribution system. Adjustments to the compressed air piping can reduce the generation pressure to approximately 1 bar above the end-use requirement. A reduction of the generation pressure by one bar may result in energy savings of up to 10%.

(vii) Adopt energy efficient pumps

Water circulation pumps are employed in induction furnaces for the cooling of raw water, such as panel cooling and soft water for coil cooling. It is advisable to replace outdated and inefficient pumps with energy-efficient pumps to enhance operational efficiency. The investment in upgraded pumps typically yields a payback period of less than one year.

(viii) Power factor improvement

Low power factor can result in increased electricity costs and may disqualify consumers from receiving power factor rebates. When the measured power factor falls below 0.99, it is advisable to enhance it by installing capacitor banks with appropriately rated capacitors at the main supply point. To sustain a power factor near unity, implementing an Automatic Power Factor Correction (APFC) system is recommended. Such investments typically achieve a return within less than one year.