Cluster Profile
Belgaum foundries

Promoting Energy Efficiency in SMEs
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Belgaum foundries

Overview of cluster

Belgaum, located in the state of Karnataka, is an important foundry cluster in India. The foundry industry at Belgaum has it origin to 1940s, when the first cupola was set-up there to manufacture agricultural implements for local farming community. The industry grew rapidly between 1950 and 1960 with demand for castings for machine tools, diesel oil engines, electric motors and pump sets by Original Equipment Manufacturers (OEMs) such as Kirloskars. The growth in automobile industry in and around Pune, gave a further boost to the demand for C.I castings from the Belgaum cluster. Setting up of public sector plants such as BHEL and HMT in Bangalore also helped in the growth of foundry industries at Belgaum.

Product types and production capacities

There are about 160 foundry units operating in Belgaum cluster. Majority of the units in Belgaum are located in three industrial estates: (1) Udyambag Industrial Estate, (2) BEMCIEL (Belgaum Manufacturers Cooperative Industrial Estate Limited) and (3) Macche Industrial Estate. In addition a few more foundry units are also located in Honga Industrial estate and in Navage area. These areas are depicted in the figure.

Apart from Ashok Iron Works which is a large scale foundry, all other units are in micro, small and medium scale categories. The distribution of foundries based on production capacity is shown in the table.

Major concentrations of foundry industry in Belgaum

Distribution of foundries based on production capacities

The production of casting at cluster level (including the large foundry) is about 1,250 tonne per day (about 0.36 million tonnes per year). The industry employs provides direct employment to about 7,500 people. The estimated turnover of foundry cluster is about Rs 20 billion per annum.

Distribution of foundries

Production (tonne per month)	Number of foundries
600 -700	10
300 - 400	20
100-150	60
Below 100	70

A majority of the foundries in the cluster produce cast iron castings although the share of SG iron has been raising steady in recent years. There are about 25 foundries producing SG iron castings in the cluster and about 30 foundries producing steel castings. Automobile components accounts for the major share of castings produced in the cluster. Apart from automotive castings, the foundries also produce castings which are used in pumps and valves, gears, machine tools, elevators, food processing and other industrial applications.

Energy scenario in the cluster

Coke and electricity are the major sources of energy in the cluster. Small about of diesel and biomass are also used for sand drying and other operations. The use of biomass gasification for sand drying and other some other applications like resin sand coating, hot air generation and has been increasing. The other major raw materials used in the foundry include base metals (pig iron, steel, borings, scrap and foundry returns) and alloys (ferro-silicon, ferro-manganese, etc). The table shows details of major energy sources and approximate price. The cluster does not face the problem of power cuts. However, some foundries mentioned that problem of voltage fluctuations is there.

Prices of major energy sources

Energy type	Price
Coke	Rs 26,000 per tonne
Electricity	Rs 7.00 per kWh

Production process

The major steps in the production process include mould sand preparation, charge preparation, melting, pouring, knockout and finishing. The steps are briefed below.

1 **Mould sand preparation**. Fresh sand is mixed with bentonite and other additives and mixed in muller to make green sand.

2 **Moulding.** The mould sand is pressed by machines or manually on the pattern to prepare the mould. The upper and lower halves of mould are assembled together to prepare the complete mould.

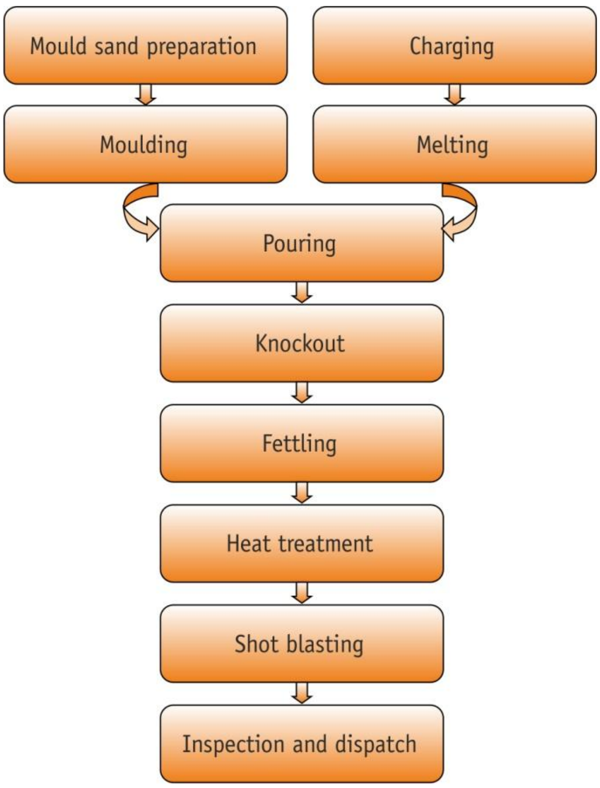
3 **Charging.** The charging includes metallic such as pig iron, scrap, foundry returns and other alloys which are weighted and charged in the furnace for melting.

4 **Melting.** The metal charge is melted either in a cupola or induction furnace.

5 **Pouring.** After melting, the molten metal is transferred and poured into the moulds using ladles operated either manually or with cranes.

6 **Knock-out.** The moulds are left to cool for certain time after which the castings are knocked-out from the mould either manually or using a machine.

7 **Finishing.** The finishing operation involves removal of runners/risers, shot blasting and cleaning of the castings.



Process flow chart

A simplified process flow diagram of a typical foundry is given in the figure.

Technologies employed

The major foundry processes/equipment are described below.

(i) Melting furnace

The melting of raw material is either done using electricity in an induction furnace or coke in a cupola (conventional or divided blast type), which are provided below.

Induction furnace: Induction furnaces run on medium frequency three phase electrical supply. The size or connected load of induction furnace varies from 150 kg (100 kW) to 3 tonne (2 MW). The most common specification of induction furnace used is 500 kg (550 kW). The theoretical electrical energy required for melting one tonne of iron and heating upto 1500ºC is 396 kWh. Due to various energy losses occurring in the furnace, the specific energy consumption (SEC) of an induction furnace is generally in the range of 550-850 kWh per tonne of iron.

Cupola: The capacity of cupola is generally indicated by the internal diameter of the shaft. Majority of the cupolas falls in the size range of 21 inch (2.2 tph) to 40 inch (6 tph). Cupolas are of two types based of blasting mechanism i.e. conventional blast and divided blast. The metal tapping could be intermittent or continuous based on operation of foundry. Cupolas generally use coke as the fuel.

(ii) Moulding and core preparation

Preparation of the mould is an important process in casting industry. The mould is divided into two halves - the cope (upper half) and the drag (bottom half), which meet along a parting line. Both mould halves are contained inside a box, called flask, which itself is divided along this parting line. The mould cavity is formed by packing sand around the pattern (which is a replica of the external shape of the casting) in each half of the flask. The sand can be packed manually, but moulding machines that apply pressure or impact to pack the sand are commonly used. Cores are placed inside the moulds to create void spaces. Cores are baked in ovens which are usually electrical fired.

(iii) Sand preparation

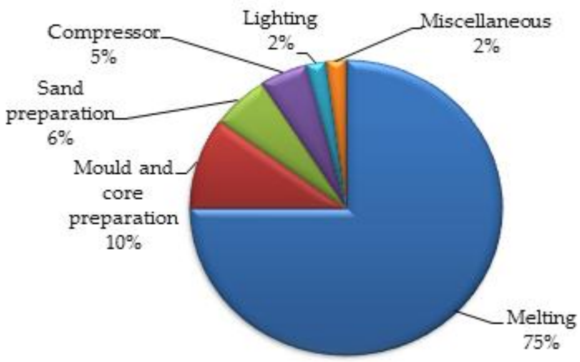
Some foundries have installed sand plants for sand preparation. The sand plant consists of sand muller, sand mixer, conveyors, bucket elevators, knockout and sand sieve. Sand mixers have typical batch size of 200 to 1000 kg. The connected load of these mixers is in the range of 10 to 100 kW.

(iv) Air compressors

Compressed air is mainly used to operate moulding machines, pneumatic grinders, mould cleaning and for other miscellaneous uses in a foundry. The connected load of an air compressor size may range from a few kW (single air compressor) for a small-scale cupola foundry unit to 55 kW (2-4 air compressors) for a medium-scale foundry having moulding machines.

Energy consumption

Foundries use two main forms of energy namely coke and electricity. Melting accounts for about 70-80% in a foundry unit. The other important energy consuming areas include moulding, core preparation and sand preparation. The share of energy usage in a typical small and medium foundry is given in the figure.



Typical energy use in a foundry

i) Unit level consumption

The specific energy consumption (SEC) varies considerable in a foundry unit depending on the type of furnace used and degree of mechanisation. On an average, induction furnace based foundry units consume about 900–1,200 kWh per tonne of good castings. Out of this, about 550–850 kWh (0.05-0.07 toe per tonne) is consumed per tonne of molten metal and the balance is consumed in other associated operations and in rejections and wastages. In cupola, the average coke consumption varies between 10-15% (0.06-0.09 toe per tonne) of the metal melted and 15-20% on good castings. Typical energy consumption of an induction furnace based unit is given in the table.

Typical energy consumption in induction furnace based foundry units

Production – saleable castings (tonne/year)	Electricity (kWh/yr)	Total energy (toe/yr)	Annual energy bill (million INR)
200	2,20,000	19	1.5
500	5,50,000	47	3.9
1000	11,00,000	95	7.7
2000	22,00,000	189	15.5

ii) Cluster level consumption

The total energy consumption of Belgaum foundry cluster is estimated to be 34,436 toe. The breakup of energy consumption in the cluster is shown in the table.

Energy consumption* of the Belgaum foundry cluster (2014-15)

Energy type	Annual consumption	Equivalent energy (toe)	Annual energy bill (million INR)
Electricity	356 million kWh	30,656	2,494
Thermal (Coke)	6,300 tonne	3,780	163
Total		**34,436**	**2,657**

* *Castings produced by induction route is 90%*

Energy saving opportunities and potential

Some of the major energy-saving opportunities in Belgaum foundry units are discussed below.

i) Adoption of divided blast cupola

For the cupola based foundry units, replacement of the existing conventionally designed cupola with properly designed 'divided blast cupola' (DBC) system is an attractive option. The investment made for a new DBC generally has a simple payback period of about year due to coke savings alone. Induction based foundry units, having a high molten metal requirement, may consider duplexing operation (cupola for melting and induction furnace for adjustment of metal chemistry). This would result in considerable energy savings.

ii) Replacement of inefficient induction furnace

Inefficient induction furnaces, having specific energy consumption of 750 kWh per tonne of molten metal or higher should be replaced with new energy efficient induction furnaces. With new furnaces, SEC of about 550 kWh per tonne of molten metal is achievable. The investment in the new furnace will have an attractive payback period in most cases.

iii) Lid mechanism for induction furnace

Most of the induction furnaces used in the cluster do not have lid mechanism resulting in increased radiation and convection losses (about 4-6% of heat input). A hydraulic lid mechanism for the induction furnace will help in reduciing these losses. The investment in a lid mechanism usually has a payback period of less than one year.

iv) Reduction in rejections

Usually foundries have high rejection levels (between 6-9%) compared to an achievable figure of less than 5%. A process control exercise aimed at identifying, categorising and implementing corrective action results in attractive savings with modest investments.

v) Cleaning of runner and risers before re-melting

The foundry returns i.e. runners and risers constitute a significant share of charge material in induction furnaces. The foundry returns have moulding sand sticking to them (2-4% by weight), which if not cleaned would lead to increased slag formation and high energy consumption. Shot/tumble blast is used for cleaning foundry returns, which require marginal investments.

vi) Providing glass wool cover for ladle

The ladles used for transfer of molten metal from furnace to the moulds are usually not covered resulting in radiation losses. The heat loss can be reduced by placing glass wool to cover ladles, thereby reducing heat losses. The investment requirement will be marginal.

vii) Retrofitting existing air compressor with variable frequency drive (VFD)

During normal operation, an air compressor operated on unloading position for more than half the time. Installation of variable frequency drive (VFD) to the air compressor will help in minimising power consumption. The investment of VFD is typically about Rs 2-3 lakhs and has a simple payback period of less than 2 years.

viii) Arresting the compressed air leakage

Compressed air is an expensive utility in a plant. However, in most cases, the air leakages in the compressed air piping system are high (above 20% of rating of air compressor) but ignored. The compressed air leakage can be brought down to about 5% by adopting good house-keeping practices which would require no or marginal investments.

ix) Reduction in pressure setting of air compressor

The pressure setting of air compressors are often much higher than the actual air pressure requirement in the plant. The typical unload and load pressure setting are 7.5 and 6.5 bar respectively. Adjusting compressed air pressure to lower level would result in energy savings. Reduction of generation pressure by one bar can lead to energy saving of 6-10%.

x) Replacement of rewound motors with energy efficient motors

Rewinding of motors result in a drop in efficiency by 3-5%. It is beneficial for the foundry unit to replace old motors which has undergone rewinding two times or more with energy efficient motors (IE3 efficiency class). This would result in significant energy saving with a simple payback period of 2-3 years for the investments made.

xi) Replacement of inefficient pumps with energy efficient pumps

The pumps used in cooling water circuit of induction furnace are generally inefficient since the selection is not done on technical basis. This results in higher energy consumption of the system. The inefficient pumps may be replaced with energy efficient pumps, which will have a payback peirod of 1-2 years.

Major stakeholders

There are a number of industry associations in the cluster, the important ones include (1) Belgaum Chambers of Commerce and Industries (BCCI), (2) Belgaum Small Scale Industries Association (BSSIA) and (3) Belgaum Foundry Cluster (BFC). The BFC is more active as compared to other two industry assoications although they are older than BFC. The Institute of Indian Foundrymen (IIF), Belgaum actively promotes technical information exchange and networking among the foundry industries in the cluster. It works closely with BFC and is locatd within the premises of BFC.

The District Industries Centre (DIC), Belgaum provides registration certificate to MSMEs in the cluster. The MSME Development Institute, Hubli is responsible for the industrial activities in Belgaum. The office of the MSME-DI provides techno-commercial assistance to local MSMEs under the various schemes of the Ministry of MSME.

Cluster development activities

Belgaum Foundry Cluster (BFC) is the most active body promoting the interests of the foundry industry in the cluster. BFC was formed in the year 2004 to implement common facilities for the cluster under the Industrial Infrastructure Upgradation Scheme (IIUS) of the Ministry of Commerce and Industry. A number of common facilities such as sand reclamation plant, common tool room, testing laboratory, casting simulation facility and building housing a convention hall have been established under the project.

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

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Swiss Agency for Development and Cooperation 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