CLUSTER PROFILE

KOLHAPUR FOUNDRY CLUSTER

Background

Foundries manufacture various types of metal castings. The castings are used in different industries such as automobiles, railways, pumps, compressors and valves, diesel engines, cement, textile machinery, sanitary pipes and fittings, power generation, construction, etc. The Indian foundry industry produces over 9 million tonnes of castings annually, accounting for about 8–9% of global castings production. There are around 4500 foundry units dispersed across various geographical clusters in the country; about 3600 units (80%) are small-scale, 675 (15%) medium-scale, and 225 (5%) large-scale.

One of the biggest and most important foundry clusters is located in Kolhapur (Maharashtra). Kolhapur was traditionally an agro-based economy. The steady increase in sugarcane cultivation and jaggery manufacture in the region, coupled with progressive industrialization in the latter half of the 20th century, resulted in an increasing use of oil engines and agricultural machinery and a demand for locally available castings. This led to the emergence of the foundry industry in Kolhapur in the 1960s. Today, there are around 300 foundries in the Kolhapur cluster. The total annual production of the Kolhapur foundry cluster is estimated at 600,000 tonnes, which represents about 7–8% of India's total casting production. According to industry estimates, the Kolhapur foundry cluster provides direct employment to over 40,000 people and indirect employment to nearly 100,000 people.

Almost all the Kolhapur foundry units fall under the MSME category as defined by the Ministry of MSME in terms of total investment in plant and machinery. The units may also be categorized as small, medium and large on the basis of annual production (table).

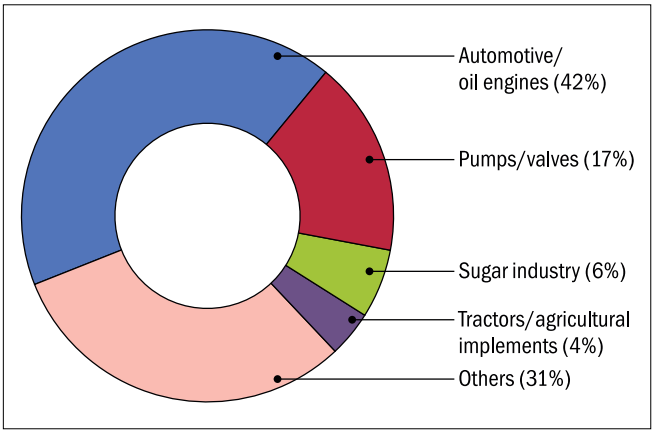
Profile of foundry units in Kolhapur cluster

Unit size	*Annual production (tpa★)*	*No. of units*
Small	Up to 1000	195
Medium	1001–10,000	75
Large	Above 10,000	30
	Total	300

★tonnes per annum

Finished castings

The Kolhapur foundry units primarily manufacture ferrous (iron) castings, comprising spheroidal graphite (SG) iron as well as grey-iron castings. A majority of the foundry units cater to the automotive sector, supplying castings for engines, clutch housing, gears, etc. for automobile giants like Ashok Leyland, Eicher, Hyundai, Maruti, M&M, and Tata. Castings are also manufactured for other industrial sectors like pumps/valves, sugar, textiles, etc. Almost 30% of the cluster production is exported.



End-use distribution of castings produced by Kolhapur foundry cluster

The major industries associations in the cluster are:

- Kolhapur Engineering Association (KEA)—the apex cluster organization, with over 500 members from industries including foundries, automotive, sugar, textile, engineering, agricultural implements, etc.

- Institute of Indian Foundrymen (IIF)—Kolhapur Chapter. It has about 275 members comprising foundry units as well as consultants, LSPs and equipment suppliers. IIF Kolhapur provides support to the local foundry units in different areas such as technology, raw materials, labour, training programs, workshops, trade fair visits, information dissemination, etc.
- Gokul Shirgaon Manufacturers Association (GOSHIMA)
- Shiroli Manufacturers Association of Kolhapur (SMAK)
- Manufacturers Association of Kagal Hatkanangale (MAKH)
- Ichalakaranji Engineering Association

Other important cluster-level stakeholders include:

- MSME testing lab, which offers a range of physical and chemical testing facilities
- Government Polytechnic, which offers a certificate course in foundry technology for workers/fresh graduates in collaboration with IIF, Kolhapur
- District Industries Centre (DIC)
- Financial institutions—there are about 20 banks operating in the cluster. They provide units with financial assistance for expansion and upgrading of infrastructure.

Cluster development initiative

The Kolhapur foundry units, in partnership with KEA and other industry associations, have formed a Special Purpose Vehicle titled 'Kolhapur Foundry and Engineering Cluster' and obtained government approval for a project to provide quality infrastructure in the Kolhapur cluster under the Industrial Infrastructure Upgradation Scheme of the Department of Industrial Policy and Promotion (DIPP), Ministry of Commerce and Industry. The project, currently under way, will:

- Set up two sand reclamation facilities, in Gokul Shirgaon and in Shiroli
- Establish a Common Facility Centre (CFC) for testing, CAD/CAM training and electronic library
- Improve general infrastructure like roads and water supply

Induction furnace

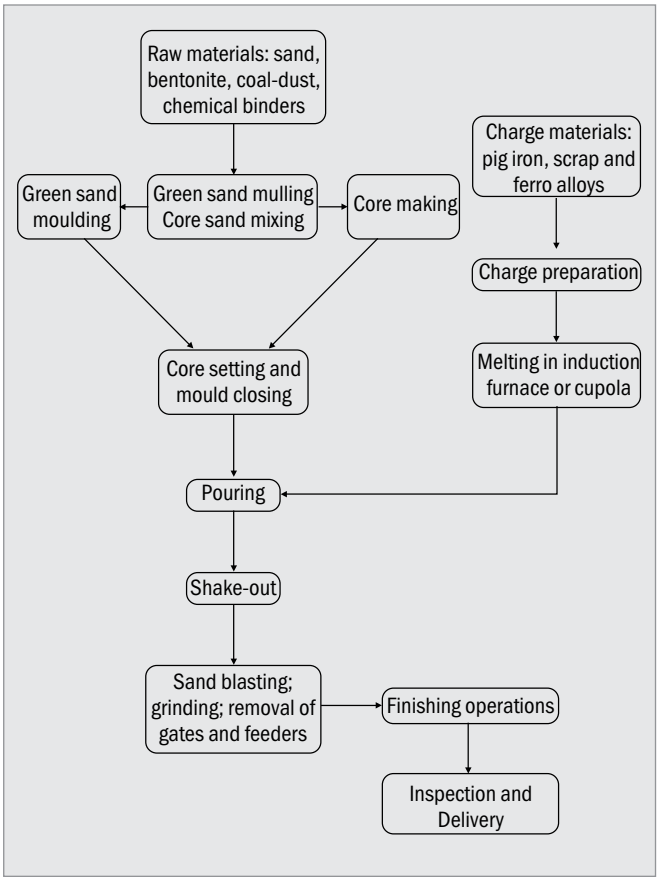
Technology status and energy use

The main technology in a foundry is the melting furnace system. The melting furnace may either be coke-fired (cupola) or powered by electricity (induction furnace). Iron-containing materials are heated in the furnace to produce molten metal, which is drawn off and poured into moulds to make castings. There are three broad components in the foundry process:

1. *Preparation of moulds and charge material*. Fresh sand is mixed with bentonite (a kind of absorbent clay) and other additives in 'sand mullers' to prepare green sand, which is then processed in 'shell moulding machines' to make the mould casings (shells) for the castings. Cores for the moulds (which give the castings their interior shape) are made by mixing sand with binders, water and other ingredients in 'intensive mixers'. Simultaneously, the charge materials comprising metal scrap, pig iron, and other alloys are loaded in the furnace for melting. The ratio between raw materials depends on final casting properties.

2. *Melting*. The charge is melted in the furnace, and the molten metal is poured into the sand moulds using a ladle (manual, automatic, or semi-automatic). The moulds are allowed to cool and harden to allow the metal to take the shape of the moulds.

3. *Finishing stage*. The metal castings are removed from the moulds and cleaned, using 'shot blasting machines' and 'knock-out' machines to remove the sand and cores. The castings are machined if required, tested and packed for dispatch. The sand from the moulds is either disposed of or treated in a sand reclamation plant for reuse.



Process Flow Chart

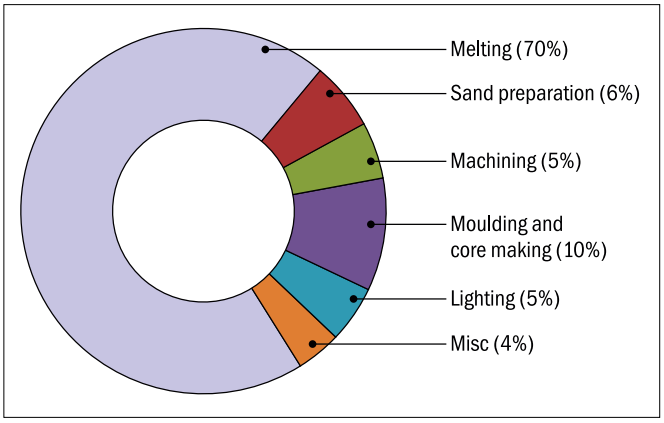
The induction furnace entails a higher energy cost per tonne of molten metal than the coke-based cupola, but offers advantages like faster start-up, lower manpower requirement, and reduced emissions. Also, the induction furnace is a better option for producing SG iron castings, which are increasingly in demand. Hence, about 70% of the Kolhapur foundry units (210 units) are using induction furnaces, with only about 30% (90 units) using coke-based cupolas. Some units also practice 'duplexing', i.e., the cupola is used for basic melting, and the induction furnace is used for refining the properties of the molten metal.

Metal pouring

The main raw materials used in the Kolhapur foundries are pig iron and scrap, sand and bentonite, which are sourced from different parts of the country. Coke for the cupola furnaces is usually imported.

Energy use

The Kolhapur foundry units consume two main forms of energy: coke and electricity. Coke is used for cupola furnaces. Electricity is used for the induction furnaces, and also to operate the various machines for sand mixing, mould preparation and finishing. The melting process accounts for most of the energy consumption (above 70%) in a foundry unit. Moulding, core making, and sand preparation are also significant consumers of electrical energy (see figure).



Utility-wise energy consumption in a foundry unit

The specific energy consumption (SEC) of induction furnace-based foundries ranges between 1000–1200 kWh per tonne of good castings. In cupola-based foundries, the average coke to melt ratio (i.e. the amount of coke consumed per tonne of metal charged) ranges between 1:8 and 1:9. Overall, the cluster consumes around 166,000 tonnes of oil equivalent (toe) annually.

Annual energy consumption in Kolhapur foundry cluster

Energy source	*Annual consumption*	*toe*⋆
Electricity	1185 million kWh	101,910
Coke	128,111 tonnes	65,000
	Total	166,910

⋆ toe—tonnes of oil equivalent

Options for energy saving

Considering the high share of energy in the total production costs, and in the backdrop of rising energy costs, there is an urgent need to improve the energy efficiency of foundry units in the Kolhapur cluster. TERI has conducted a number of walk-through and detailed energy audits in the cluster. These studies suggest that there is significant scope for energy efficiency improvement in induction furnaces and other process technologies such as sand mixing, pneumatic grinding, machining, and sand reclamation. There is also scope for energy savings in cross-cutting technologies such as compressors, pumps, motors, etc. The main energy conservation measures carrying potential for replication are summarized below:

Key energy conservation options in Kolhapur cluster

No.	*Energy conservation option*	*Energy saving potential*
Melting furnace		
1	Replacement of inefficient induction furnace	High
2	Replacement of convention cupola with DBC cupola	High
3	Optimization of burner of diesel fired Aluminum furnace	Medium
4	Automation in metal pouring system	Medium
5	Lid mechanism for induction furnace crucible	Medium
6	Melting optimization in induction furnace	Low
7	Utilization tum/shot blast for foundry return	Low
Cooling water circuit		
1	Replacement of inefficient pump with energy efficient one	High
2	Replacement of cooling tower fan blades (aluminum) with FRP blades	Low
Compressed air system		
1	Replacement of fixed speed air compressor with variable speed air compressor	High
2	Down-sizing of air compressor	High
3	Retrofitting of air compressor with VFD	Medium
4	Reducing pressure drop by resizing the pipe lines	Medium
5	Optimizing pressure setting of air compressor	Medium
6	Arresting compressed air leakage	Medium
Others		
1	Replacement of inefficient transformer with low loss transformer	Medium
2	Down-sizing of sand mixture drive motor	Medium
3	Replacement of inefficient sand mixer with semi-automatic sand mixer	Medium

Compiled by TERI based upon its ongoing activities under the World Bank–GEF–SIDBI project titled 'Financing Energy Efficiency at MSMEs'