Cluster Profile
Rajkot foundries

teri

Promoting Energy Efficiency in SMEs
SAMEEEKSHA

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

Certificate of originality

Original work of TERI done under the project "INDIA: TERI-SDC Partnership: Scaling up Energy Efficient Technologies in Small Enterprises (EESE)"

Suggested format for citation

TERI. 2015
Cluster Profile Report – Rajkot foundries
New Delhi: The Energy and Resources Institute 10 pp.
[Project Report No. 2014IE15]

Disclaimer

Published by

T E R I Press
The Energy and Resources Institute
Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi-110 003
India

For more information

Project Monitoring Cell
T E R I
Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi – 110 003
India

Tel. 2468 2100 or 2468 2111
E-mail pmc@teri.res.in
Fax 2468 2144 or 2468 2145
Web www.teriin.org
India +91 • Delhi (0)11

Contents

Acknowledgements

TERI places on record its sincere thanks to the Swiss Agency for Development and Cooperation (SDC) for supporting the long-term partnership project focusing on energy intensive MSME clusters in India.

TERI team is indebted to IIF–Rajkot Chapter, Rajkot Engineering Association (REA) for providing support and information related to foundry units in Rajkot cluster. TERI extends its sincere thanks to Mr Gokul Sagapariya, President, REA; Mr Samir Monpara, Chairman, IIF-Rajkot Chapter for organizing field visits and interactions with unit members during the study for the preparation of this cluster profile report.

Last but not least, our sincere thanks to MSME entrepreneurs and other key stakeholders in the cluster for providing valuable data and inputs that helped in cluster analysis.

Rajkot foundries

Overview of cluster

Rajkot, in the state of Gujarat, is one of the largest clusters of MSMEs (micro, small and medium enterprises) in the country. Earlier Rajkot was known for diesel engines all over the world. It was exporting diesel engines to African and Gulf countries. Diesel engine manufacturing was at its peak during the 1980s and early 1990s. However, the industry was severely affected after the farmers switched to electric pumps after expansion of the grid. Therefore, the foundries that were catering to diesel engine manufacturers were diversified to other products like pumps, automobiles, electric motors and so on. The bearing industry also developed locally due to the demand for bearings in the diesel engine and pump set industry.

There are an estimated 14,000 MSME units in Rajkot cluster, of which around 5,500 are engineering units. The cluster is spread within Rajkot and neighboring Metoda and Shapar The engineering industry is diverse in nature. Some of the major engineering segments include foundry, investment casting, pump sets, forging, machine tools, auto components, building hardware, kitchenware, plastics and diesel engines generating sets, bearings, sheet metal, cables and wires, printing and packaging and food machinery.

Major concentrations of pump set units in Rajkot

Product types and production capacities

There are about 700 grey iron foundry units in Rajkot cluster. The foundry industries are scattered both within and outside the city. Some of larger geographical concentration of foundry units include Aji and surrounding Bamanbore, Kuvadwa and Manda Dungar, Shapar and surrounding Atika, Samrat and Vavdi and GIDC Lodhika (Metoda) areas as shown in the figure.

There are about 10 foundries are in large-scale, about 50 foundries are under medium scale and balance in small & micro category. The production of castings in the cluster is estimated to be 1,500 tonnes per day (about 0.46 million tonnes per annum). The industry employs close to 30,000 direct employees. The estimated turnover of the foundries is about Rs 4,000 crore per annum.

Most of the foundries in Rajkot produce castings for OEMs (original equipment manufacturers) in diverse engineering sectors like automotive, pump sets, electric motors, air compressors, machine-tools, agricultural machines, electrical transmission and so on.

Energy scenario in the cluster

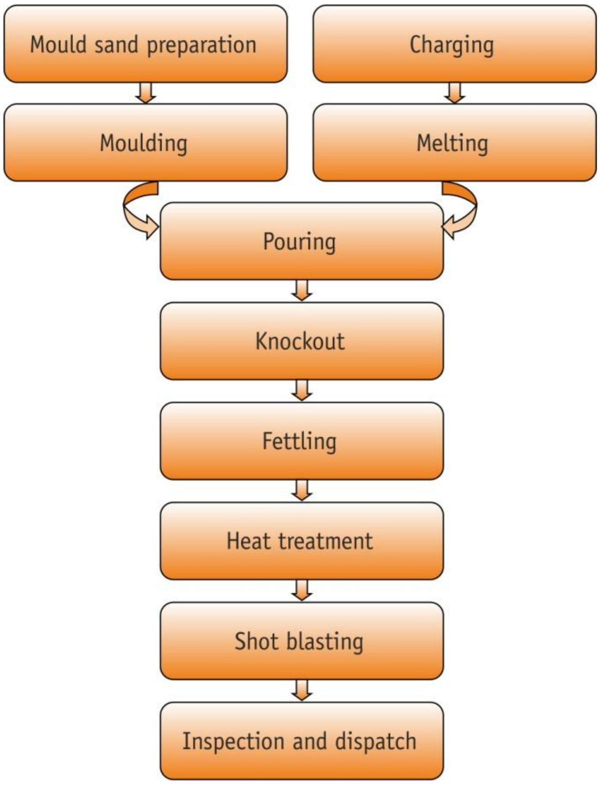
Coke and electricity are the major sources of energy in foundries. The major raw materials used include base metals (pig iron, steel, borings, scrap and foundry returns) and alloys (ferro-silicon, ferro-manganese, iron sulphide, silicon carbide etc). In addition, small quantities of other metals like copper and tin are also added for special grades and SG iron castings. The table provides details of major energy sources and prices.

Prices of major energy sources

Energy type	Remarks	Price
Coke	Hard coke	Rs 23,000 – 25,000 per tonne
	'Nut' (small sized) coke	Rs 18,000 – 20,000 per tonne
Furnace oil	Used in oil fired melting furnaces	Rs 35,000 per KL
Electricity	HT	Rs 8.00 per kWh (inclusive of demand charges)
	LT	Rs 9.00 per kWh (inclusive of demand charges)

Production process

The major steps of process are mould sand preparation, charge preparation followed by melting, pouring, knockout and finishing. The steps are explained below. A simplified process flow diagram of a typical foundry is given in the figure.



Process flow chart

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 manually or by machines on the pattern to prepare the mould. The upper and lower halves of mould are assembled together to prepare the complete mould.
3. *Charging.* Raw materials such as pig iron, scrap, foundry returns and other alloys are weighted and charged inside the furnace for melting.
4. *Melting.* The metal charge is melted in either a cupola (coke based) or induction furnace (Electricity based).
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 which involves removing the runners/risers, shot blasting and cleaning of the castings after which are dispatch.

Technologies employed

Some of the foundry processes/equipment are described below.

i) Melting furnaces

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

Induction furnace

Induction furnaces operate on medium frequency, three phase electrical supply. The size or crucible capacity of induction furnaces in the cluster varies from 300 kg to 3 tonne. However, the most common size of the furnace is 500 kg. Some of the suppliers of induction furnaces include inductotherm, electrotherm and Powermelt. Some foundries also have installed furnaces supplied by Oritech and Priyanka. The theoretical specific energy required for melting one tonne of iron and heating upto 1500ºC is 396 kWh. In an induction furnace, a number of energy losses take place which increase the specific energy consumption (SEC) of the furnace to about 650–850 kWh per tonne of iron. However, due to rejections and lower yield, SECs of good castings are generally higher in the range of 1100 to 1350 kWh per tonne.

Cupola

Majority of the cupolas falls in the size (internal diameter) range of 18 inch to 33 inch. The capacity of cupola is generally indicated by the internal diameter of the shaft. Most cupolas used in the cluster were of conventional design. However, TERI's divided blast cupola (DBC) design has become quite popular in the cluster.

Conventional cupola

Divided blast cupola

Oil fired furnace

Oil fired furnace

A small number of about 10 foundry units in the cluster use oil fired furnaces. These furnaces are outmoded and are inefficient resulting in higher specific energy consumption level. These furnaces are operated in batches with batch size varying between 300-500 kg. However, the oil fired units are gradually switching over to induction melting.

ii) Moulding and core preparation

Preparation of the mould is an important process in casting industry. The mould is divided into two halves i.e. cope (upper half) and the drag (bottom half), which meet along a parting line. Both mould halves are contained inside a box, called a 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. Moulding machines are commonly used by foundries that use pressure or impact to pack sand; alternatively sand can be packed manually.

Hand moulding

Cores are placed inside moulds to create void spaces. They are baked in ovens which are usually electrical fired. For making cylindrical castings, some foundries use centrifugal casting process.

iii) Sand preparation

Hand moulding

Some foundries have installed sand plants for sand preparation. The sand plant consists of sand muller, 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

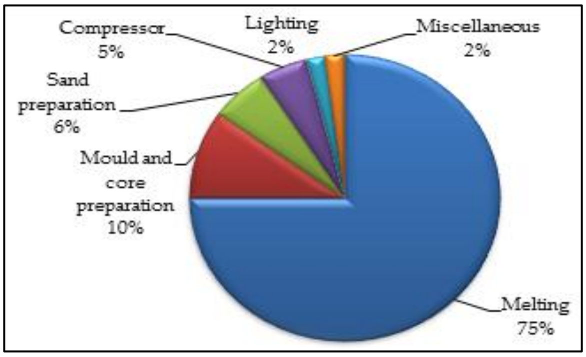
Compressed air is mainly used to operate moulding machines, pneumatic grinders, mould cleaning and other miscellaneous uses. The connected load of an air compressor may range from a few kW (single air compressor) for a small scale cupola based foundry unit to 55 kW (3-4 air compressors) for a medium scale foundry having moulding machines.

Energy consumption

Foundry uses two main forms of energy, namely coke and/or electricity. Melting accounts for a major share of about 70-80% in a foundry unit (figure) The other important energy consuming areas include moulding, core preparation and sand preparation.

Unit level consumption

The specific energy consumption (SEC) varies considerably in a foundry depending on the type of furnace and degree of mechanisation. On an average, induction furnace based foundry units consume about 1,000–1,200 kWh per tonne of good castings. Out of this, about 600–700 kWh is consumed in melting and about 400-500 kWh is accounted by other associated operations and in rejections and wastages.



Typical energy use in a foundry

In cupola, the average coke consumption varies between 10-15% 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 (tonnes/year)	Electricity (kWh/yr)	Total energy (toe/yr)	Annual energy bill (million INR)
500	5,50,000	47	4.7
1000	11,00,000	95	9.4
2000	22,00,000	189	18.7

There are about 12 number of oil fired furnaces operating in the cluster, having an average production capacity of 45 tonne per month consuming about 9000 litre of furnace oil per month.

Cluster level consumption

The total energy consumption of Rajkot foundry cluster mainly including induction based units and coke based units is estimated to be 45,660 toe. The break-up of energy consumption is given in the table.

Energy consumption of the Rajkot foundry cluster (2014-15)

Energy type	Annual consumption	Equivalent energy (toe)	Annual energy bill (million INR)
Electricity	297 million kWh	25,550	2524
Thermal (Coke)	31,500 tonnes	18,900	756
Thermal (Furnace oil)	1, 296 kL	1,210	45
	Total	**45,660**	**3,325**

Energy saving opportunities and potential

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

i) Replacement of conventional cupola with divided blast cupola

For cupola based foundry units, replacement of conventionally/ locally designed cupolas with a higher efficiency 'divided blast cupolas' (DBC) is the major option. The investment on a new DBC is generally paid back within a year on account of coke savings alone.

ii) Replacement of inefficient induction furnace with efficient induction furnace

Old induction furnaces have a specific energy consumption of 750 kWh or more per tonne of molten metal. These inefficient induction furnaces can be replaced with new induction furnaces which consume less electricity per tonne of melting. With energy efficient furnaces, SEC level of about 550 kWh per tonne of molten metal can be achieved. The capital investment made on new induction furnaces have a simple payback period of about one year in most cases.

iii) Lid mechanism for induction furnace

Most of the induction furnaces do not have lid mechanisms in induction furnaces which results in higher heat losses due to radiation and convection (about 4-6% of input energy). A lid mechanism installed in an induction furnace will help in reducing radiation and convection losses. The investments required for lid mechanism have an attractive payback period of less than one year.

iv) Reducing rejections and improving yields

There is a wide variation in the rejection (3-10%) and product yield (50-80%) across the foundry units in the cluster. It is possible to reduce energy consumption by increasing the product yield and decreasing the rejection. A detailed analysis of rejections and their causes is needed. A study to identify, categorise and implement corrective action will result in attractive energy savings with no or low investments.

v) Cleaning of runner and risers before re-melting

Runner and risers (foundry returns) constitute a significant percentage of the charged material of induction furnaces. The foundry return have moulding sand sticking to it (2-4% by weight), which if not cleaned by shot/tumble blast leads to slag formation and high energy consumption. Considerable energy can be saved by cleaning the foundry returns with no or low investment.

vi) Glass wool cover for ladle

The ladles used for transfer of molten metal from furnace to moulds are usually not covered resulting in radiation losses. By providing glass wool insulation cover for ladle, the radiation heat losses can be reduced substantially with quite low investments.

vii) Retrofitting air compressor with variable frequency drive

During normal operation, air compressor operates on unloading position for 30-50% of the time. The energy consumption due to unloading can be minimised by installing a 'variable frequency drive' (VFD) for the air compressor. The investment requirement for VFD is typically about Rs 2-3 lakh and it pays back in about 2 years.

viii) Arresting the compressed air leakage

Compressed air is an expensive utility in a plant. However, compressed air leakage of above 20% is common in a large number of foundry units. This level is very high and must be kept below 5% through good housekeeping practices. By arresting leakages in compressed air network, considerable amount of energy can be saved without any 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 was 7.5 and 6.5 bar. Analysing and reducing the compressed air pressure will result in high energy savings. Reduction of generation pressure by one bar can lead to energy saving of 6%.

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

Industry associations

There are several industry associations in Rajkot foundry cluster. The major industry associations, related to foundry industry, are the following:

(i) Rajkot Engineering Association

Rajkot Engineering Association (REA) is the apex industry association for engineering industry in Rajkot and has a membership of over 1600 industrial units. The association was incorporated in 1963 with an objective of extending help to its members for the promotion and development of its manufacturing activities. The association also supplies raw materials like pig iron to its members on 'no-profit-no-loss' basis. The association is centrally located in Bhaktinagar Industrial Area of Rajkot and has its own building and conference facilities. It regularly arranges meetings, seminars and workshops for its members. It publishes a monthly 'Information Bulletin' in Gujarati to communicate with its members on a regular basis.

(ii) Institute of Indian Foundrymen (IIF), Rajkot Chapter

The IIF, Rajkot Chapter is active in promoting information exchange and networking among foundry industries in the cluster. It works closely with REA and is also located within the association premises.

(iii) GIDC (Lodhika) Industrial Association (GLIA)

GLIA was established in 1996 in GIDC (Lodhika) Estate. The estate was setup by Gujarat Industrial Development Corporation in 1990 and has about 1000 member industries consisting of engineering, plastics, packaging, food-processing, building material, pharmaceutical, cold storage, etc. There are about 50 foundry units located within this estate.

(iv) Aji GIDC Industries Association.

Aji GIDC is one of the oldest industrial estates established 40 years before. The industrial estate covers an area of about 270 acres and has about 80 foundry units.

(v) Shapar Veraval Industrial Association (SVIA)

SVIA includes various types of industries ranging from investment castings, plastics and packaging, auto parts, engineering, bearings, brass parts, kitchenware and so on. There are almost 300 foundries located Shapar Veraval and surrounding areas.

The District Industries Centre (DIC), Rajkot provides several incentives to MSMEs like capital investment subsidy, interest subsidy, venture capital quality certification, energy and water audits and so on. There is a branch office of the MSME Development Institute, Ahmedabad in Rajkot.

Cluster development activities

The industry associations in the cluster are active in networking and outreach activities. A centre has been established several years before by the National Small Industries Corporation Ltd (NSIC) in Rajkot which. The centre used to offer many courses. However, most of the courses were discontinued and the existing facilities in the centre are being used sub-optimally at present. The centre mainly focuses on testing of materials and pump sets and vendor registration services for MSMEs. Vendor certification is mandatory for submitting quotation for DGS&D (Directorate General of Suppliers & Disposal) government rate contracts. A testing laboratory of CMTI (Central Manufacturing Technology Institute), Bangalore, has been established within the campus with assistance under the UNIDO a few years back.

A 'common facility centre' (CFC) is coming up that would have testing facility for pump sets and foundry materials. The CFC was conceived by TERI and REA in 2010 in order to cater to the needs of local pump manufacturers who were facing difficulties obtaining BIS certification due to long delays in testing of their products. A Special Purpose Vehicle (SPV) named 'Rajkot Engineering, Testing and Research Centre' was formed with the partnership of local industry, state and central government; and land for the CFC was provided by REA. The CFC project, with a total cost of about Rs 7.2 crores, was approved in March 2014. Over Rs 74 lakhs was contributed by 62 local industries; Rs 3.82 crores by the central government towards testing equipment; and Rs 2.45 crores by the state government towards the building.

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