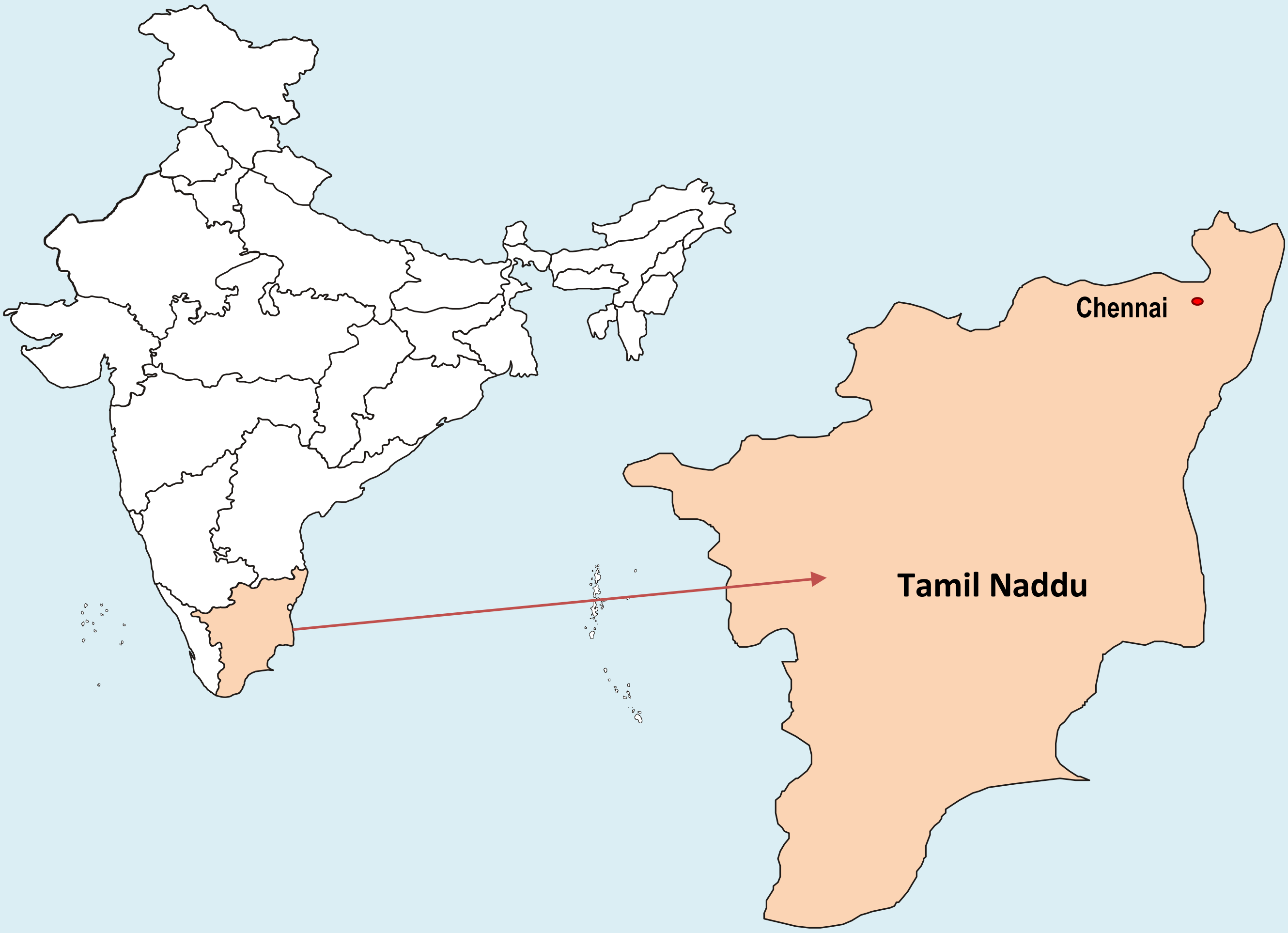
Cluster Profile
Chennai aluminium casting industries



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Promoting Energy Efficiency in SMEs
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Suggested format for citation

TERI. 2015
Cluster Profile Report – Chennai aluminium casting industries
New Delhi: The Energy and Resources Institute 8 pp.
[Project Report No. 2014IE15]

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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

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Acknowledgements

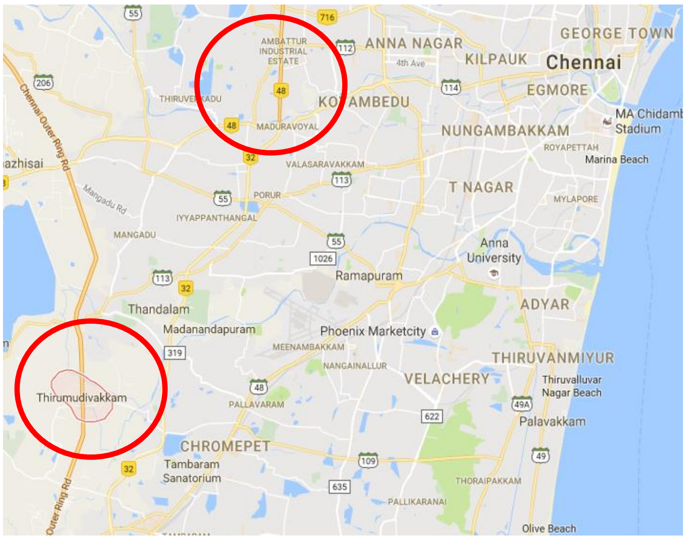
TERI places on record its sincere thanks to the Swiss Agency for Development and Cooperation (SDC) for supporting the long-term partnership project focusing on energy intensive MSME clusters in India.

TERI team is indebted to Mr A Pari (Managing Director, C R P India Pvt Ltd), Mr Bakul Shah (Partner, BMwayAuto Components) and Mr S Kandaswami (Director, Flowwell Castings Pvt Ltd) for providing permission for collection of data from their units. The support provided by the managerial and support staff of the units is highly appreciated.

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

Chennai aluminium casting industries

Overview of cluster



There are about 2000 small scale aluminium casting units operating in India. These units are mostly located in clusters. The major clusters involved in production of aluminum castings include Ahmedabad, Bangalore, Chennai, Coimbatore Delhi/ NCR and Pune. Chennai, the capital of Tamil Nadu has more than 200 aluminum casting units located in two different areas namely Thirumudivakkam and Ambattur. The cluster mainly caters to the requirement of large automobile industries. Some of the main customers of aluminium castings from the cluster include Lucas TVS, Maruti Suzuki and SMR Rotork.

Product types and production capacities

There are about 120 “Pressure Die Casting” (PDC) units and 60 “Gravity Die Casting” (GDC) units operating in the cluster. The cluster uses different types of raw materials like ADC-12, LM-6 and Mazak-5 for production of castings, each requiring different melting temperatures. ADC-12 is predominantly used in the cluster. The billets are either procured from market or are provided by the large industries in order to meet their stringent product specifications.

Different types of products manufactured by the die-casting units in the cluster include automotive components like oil pump and gear box, water pump, flange, starter motor, motor cover, assorted engineering equipment and assorted utensil products. The installed capacities of aluminium die casting units vary from 360 tpy to 2400 tpy. It mainly depends on number of furnaces installed in the unit. The total production capacity of the cluster is estimated to be 100,000 tonne per year (tpy). Studies and discussions with stakeholders in the cluster show that the average capacity utilisation of the cluster is close to 60% indicating a production level of 60,000 tpy.

Energy scenario in the cluster

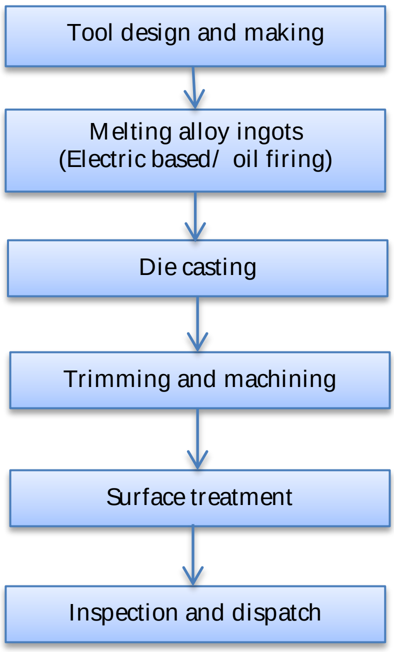
The cluster mainly uses grid electricity for melting operation in furnaces. Few larger units use diesel for bulk melting of aluminium ingots followed by holding of melt through electrical furnaces. The source of grid electricity is Tamil Nadu Generation and Distribution Company (TANGEDCO).

Details of energy used in the cluster

Energy form	Source/ availability	Tariff details
Electricity	TANGEDCO	Tariff category: TH-I A Demand charges: Rs 350 per kVA (Excess demand 700 Rs/ kVA) Energy charges: Normal - Rs 6.35/ kWh Peak - Rs 7.62/ kWh Night - Rs 6.0325/ kWh Beyond quota - Rs 12.70/ kWh PF Penalty For every 0.01 pf reduction below 0.9-0.85:1.0% of energy charges For every 0.01 pf reduction below 0.85-0.75:1.5% of energy charges For every 0.01 pf reduction below 0.75:2.0% of energy charges
Diesel	Retail Market	Rs 55 per litre

Production process

Aluminium castings are produce by mainly two routes – PDC and GDC. PDC is used for production of automobile components, electrical connectors, washing machine parts etc. GDC is suited to medium to high volumes products and typically parts are of heavier sections than PDC, but thinner sections than sand casting e.g. dies and tools. The temperature requirement in GDC is higher than PDC process. The majority of production capacities in the cluster are based on PDC based castings.



Aluminium casting process (PDC process)

Aluminium billets are melted in electric resistance type furnaces in smaller and medium size units. In larger units, bulk melting is carried out in diesel fired furnaces after which the melt is shifted in transfer ladle to holding furnaces of electric resistance type. The temperature of melt is maintained using auto control system. The melt is poured manually or automatically in pressure die-casting machines. The size of scooping ladle used during the production process is dependent on type of castings required. The liquid alloy is forced under high-pressure into a steel tool wherein it solidifies rapidly and takes the form of the tool. Nitrogen degassing is required in these processes, which is done through addition of a degassing agent in melting furnaces. The runners and risers are removed from castings. After cooling, the castings are sent to various finishing operations.

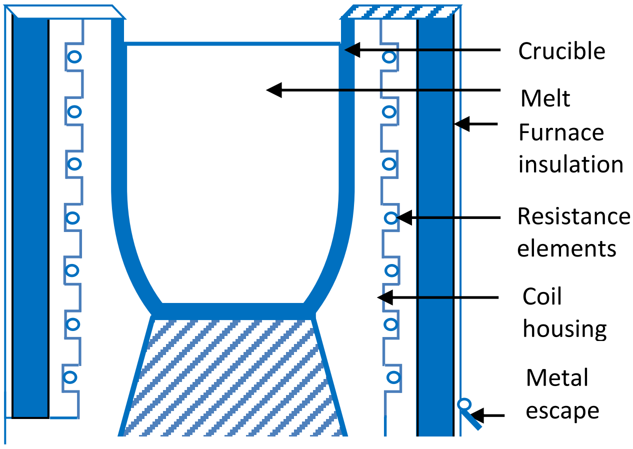
Technologies employed

The major equipment/ system used in an aluminium die casting unit is melting furnace which accounts for 50-65% of energy consumption in the unit. A majority of the units use electric resistance type furnaces for melting and few larger units use diesel fired furnaces for bulk melting. The other important equipment in a die-casting unit are Pressure Die Casting (PDC) machines which provide shape to liquid aluminium.

(i) Electric resistance type crucible furnace

In a resistance type furnace, banks of electrical heating elements of nickel chrome alloy fitted in refractory bricks are provided around the furnace. Other better option in place of nickel chrome alloy is use of silicon carbide heaters. Aluminium billets or scraps (including runners and risers from different finishing operations) are poured inside refractory crucible of the furnace wherein the temperature of metal is raised and melted using resistance coils.

Automatic temperature controls are used to maintain required temperature of the melt. Depending on type of aluminium alloy used, the temperature requirement for melting would vary. Crucible type furnaces are of smaller capacities and generally a bank of furnaces is used to meet total load requirements. Moreover, it provides flexibility for production of different types of castings in parallel. The Specific Energy Consumption (SEC) of electric resistance furnaces is about estimated to be 600 kWh per tonne.



Electric resistance furnace

(ii) Reverberatory or slakner furnace

Reverberatory or slakner furnaces are used for bulk melting industries having generally large production capacities. The capacities of these furnaces range from 100 kg to 5 tonne. The melting loss in these furnaces is less than 5%. Raw material charging is done from top and molten metal is discharged through hydraulic tilting arrang3ment provided with the furnace. The specific energy consumption of these furnaces is about 80-100 litre of HSD per tonne of molten metal in continuous operation with heel metal in brick lining type and 60-80 litre of HSD per tonne in monolithic non wettable refractory lining. The thermal efficiencies of reverberatory furnaces used for aluminium melting is about 15-39%. The flue gas losses associated with reverberatory furnaces are quite high due to very high temperature of exit gases. The efficiency of these furnaces can be improved by incorporating Waste Heat Recovery (WHR) systems such as recuperators or regenerative burners.

Reverberatory/ Slakner furnace

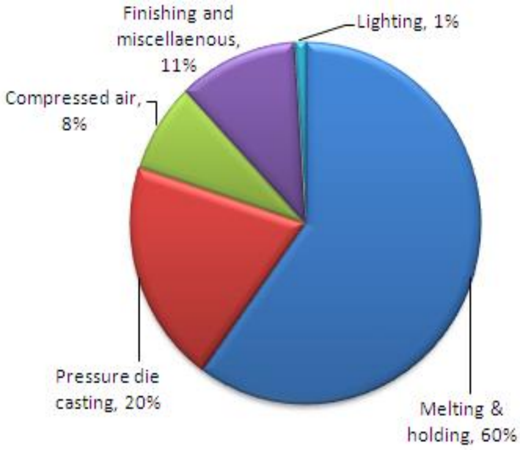
(iii) Pressure die casting machines

In a Pressure Die Casting (PDC) machine, the liquid metal is scooped from the furnace into the machine either manually or using semi or automatic systems. The quantity of melt scooped is dependent on the size of mould. The pressure at which the liquid metal is forced to flow into the mold is very high of the order of 7MPa to 350MPa. This pressure is accountable for the tremendously intricate surface detail and thin walls that are often observed in metal castings manufactured by this technique. Once the mold has been filled with molten metal, the pressure is maintained until the casting has hardened. The mold is then opened and the casting is removed. Ejector pins built into the mold assist in the removal of the metal casting. In most manufacturing operations, the internal surfaces of the mould are sprayed with a lubricant before every cycle. The lubricant will assist in cooling down the dies as well as preventing the metal casting from sticking to the mold. After the casting has been removed and the lubricant applied to the mold surfaces, the die are clamped together again then the cycle will repeat itself. Cycle times will differ depending upon the details of each specific die casting manufacturing technique.

Pressure die casting machine

Energy consumption

Aluminium die casting units in Chennai cluster predominantly use electricity for melting and holding process. About 60% of energy requirements is accounted by melting and holding. A number of large units in the cluster use diesel for bulk melting of aluminium. The pressure die casting is the next energy intensive process step in a die casting unit,



which provides the shape of the castings as per requirements. About 20% of energy (as electricity) is accounted by PDC machines. On utility front, compressed air system consumes close to 8% of total energy consumption in an aluminium die casting unit.

i) Unit level consumption

The specific energy consumption (SEC) varies significantly considerable in an aluminium die casting unit depending on type of furnace, type & size of casting and other finishing operations. On an average, resistance type furnace based foundry units consume about 1050–2,000 kWh per tonne of good castings. Out of this, about 530–550 kWh (0.092-0.173 toe per tonne) is consumed per tonne of molten aluminium and the balance is consumed in other associated operations and in rejections and wastages.

Typical annual energy consumption in aluminium die casting units

Production (tonne/yr)	Electricity (kWh/yr)	Diesel (lit/yr)	Total energy (toe/yr)	Annual energy bill (million INR)
600	382,000	360	33	2.9
1200	1445,0000	500	125	10.9
2400	2664,000	210,000	421	31.6

ii) Cluster level consumption

The total energy consumption of Chennai aluminium die casting cluster is estimated to be 12,340 toe. Electricity accounts for more than 75% of total energy consumption in the cluster.

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

Energy type	Annual consumption	Equivalent energy (toe)	Annual energy bill (million INR)
Electricity	110 million kWh	9,426	824
Diesel	3,200 kL	2,914	176
Total		**12,340**	**1,000**

Energy saving opportunities and potential

Some of the major energy saving options for Chennai aluminium die casting industries are discussed below.

i) Replacement of electric resistance furnaces with energy efficient furnaces

The average SEC of resistance type electric furnaces employed in the cluster is 530-550 kWh per tonne, which is quite high. Furnaces accounting for about 60% of total energy consumption in the unit for both metlign and holding liquid metal. There exists substnatial opportunities for improvements of exiting furnace system that would lead to substantial energy efficiency improvements in production of aluminium castings. Some of the best available resitance furances in market have an SEC level of 400 kWh per tonne, indicating an enrgy saving potential of about 25% in resistance furnace energy consumption with a simple payback period of 3 to 4 years. This is equivalent to an annual energy saving of 12 million kWh of electricity (about 1000 toe) at cluster level.

ii) Installation of lid system for induction furnace

Furnace without lid mechanism

The electric furnaces operating in the cluster have top opening to enable drawing of molten aluminium into pressure die casting machines. The temperature of furnace openings is about 400-600 °C resulging in considerable heat losses. By providing a suitable lid system in electric furnaces without obstructing drawing of molten metal into die casting machines, the heat losses from furnace openings can be reduced by about 40%. The equivalent annual energy saving at cluster level is about 600 toe.

iii) Waste heat recovery system for oil fired bulk melting furnace

The bulk melting furnaces in the cluster are generally diesel fired. Although some of these furnaces have been given provisions at chimney for preheating of raw material i.e. aluminium billets and scraps, the recovery of waste heat from flue gases are generally quite low. The heat loss due to hot flue gases is almost 50% of total heat input to the furnace, thereby substantially reducing the thermal efficiency of the furnace. The waste heat in flue gases can be recovered effectively using an appropriate Waste Heat Recovery (WHR) system for (i) preheating of charge material, or (ii) preheating of combustion air or both. WHR system helps in improving thermal efficiency of the furnace by about 15% equivalent to an annual energy saving of 400 toe at cluster level. The investments on WHR systems have a simple payback period of less than one year.

iv) Servo pump system in place of hydraulic system in PDC machines

The pressure die casting machines (PDC) use hydraulic system for production of castings, which is generally inefficient. A PDC machine requires different flow and pressure at different stages of casting processing. For the pump motor, the load of PDC will be chanding continuously. In fixed displacement pump system, the oil pump controls oil volume in constant speed, and redundant oil returns through the relief valve. This means high-pressure throttling leading to an energy loss of 35-65%. The power allocation directly results in energy loss and affects the work condition of machine. The energy consumption of PDC machines can be considerably reduced by replacing hydraulic system with servo motor mechanism. In this, by adjusting frequency and speed, large torque output is achieved with efficient conversion of mechaincial energy. Servo control technology can be a preferable for the driving unit of die casting machines, which is an important breakthrough of hydraulic driving technology of die casting machines. There exists at least 30% energy saving with use of servo pump system in PDCs. The annual estimated energy saving at cluster level is about 700 toe.

iv) Other potential energy saving options

Other energy saving options in aluminium die casting units in the cluser include improvements in compressed air system (e.g. reduced leakages, use of compressed air at reduced pressure based on needs of the plant, installation of variable frequency drives(VFD)) and energy efficint lighting system.

Major stakeholders

The District Industries Centre (DIC), Chennai provides registration certificate to MSMEs in the cluster. The MSME Development Institute, Chennai is responsible for the industrial activities in the cluster. 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

There is very little cluster level development activities in aluminium die casting industries. TERI has conducted energy audits in the cluster for identifying energy saving opportunities in the cluster.

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.

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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