Cluster Profile
Pune aluminium casting industries

Promoting Energy Efficiency in SMEs
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Pune aluminium casting industries

Overview of cluster

Pune, located in the western region of Maharashtra is a hub for industry, comprising over 3000 energy intensive industries covering different industry sub-sectors. These industries comprise mainly of automotive, engineering components, forging, aluminium castings, sugar industries, pharmaceuticals & chemicals and IT industries. There are 25 industrial estates in Pune, of which ten are Maharashtra Industrial Development Corporations (MIDC) and three are (Government. IT Parks) and others are private industrial estates. Major large Indian companies have established presence in Pune including Tata Motors, Volkswagen, Mercedes Benz, Mahindra, Bajaj auto, Bharat Forge, Force Motors, Jayhind Industries etc.

Pune is a significant contributor to total aluminium castings production in India. It is one of the prominent aluminium casting clusters with allied machining processes for manufacturing auto-components, electrical components, etc. in the country. The total production of Pune aluminium cluster is estimated to be 4,00,000 tonnes per annum accounting for about 22% of total aluminium casting production in the country. A majority of the aluminium casting units in the cluster cater to automotive sector along with other sectors such electrical & electronics, etc. Automobile giants such as TATA, M&M, Bajaj Auto, Honda and electrical majors like Siemen, Crompton Greaves, etc. source critical castings for their industries from Pune aluminium casting industries.

The automobile sector has been the key driver for aluminium castings demand in the country. India's emergence as a hub for the manufacture of automobiles and the global drive towards reducing the curb weight of automobiles, will act as growth vectors for this sector. As car manufacturers have sought to improve fuel efficiency, use of aluminium has grown every year. This has resulted in a positive impact on the turnover, exports and employment in the industry. Almost 20% of production is being exported to a number of countries. Apart from direct employment, the foundry cluster provides indirect employment to about 50,000 people.

Product types and production capacities

The aluminium casting industry in Pune, though initially were few in numbers and catered casting parts to auto and electrical industries, has increased in in numbers and capacity with development of automobiles companies and use of aluminium casting component in vehicles. Majority of the aluminium casting units in the cluster cater to automotive sector. Many units in Pune are producing castings for cylinder heads, engine body, suspension forks, engine pipes and electrical component castings of electrical motor body, pump body, fans etc. and a few of the larger and highly mechanized units are also producing aluminium alloy wheels and cylinder heads.

There are about 50 aluminium casting and allied units located in the Pune cluster. Majority of these units falls under the MSME definition of the Ministry of MSME. Based on the annual production capacity, the foundry units are also categorized into the following:

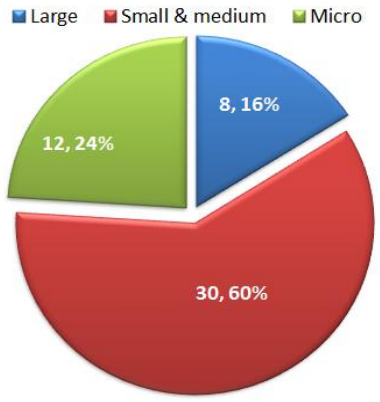
Categorisation of casting units

Category	Production capacity range (tonne/year)	Number of units	Total production capacity (tonne/year)
Micro	Upto 100	12	1,500
Small & medium	100 to 5000	30	54,000
Large	Above 5000	8	3,40,000
Total		**50**	**3,95,500**

About 60% of the units fall under 'small & medium' category. Aluminium casting units are located mainly in the following major industrial estates:

(1) Pimpri Chinchwad, MIDC
(2) Bhosari, MIDC
(3) Chakan, MIDC
(4) Sanaswadi and Shikrapur Industrial areas
(5) Priangut and Satara industrial areas.

Close to 35 Aluminium casting units (about 70% of the total) are mainly located in two industrial clusters namely Pimpri-Chinchwad Bhosari MIDC and Chakan MIDC.



Distribution of Al casting units in Pune cluster

Raw material usage in cluster

The major raw materials used are aluminium alloys and scrap aluminium. The aluminium alloy grades as per British standards in LM series and as per Japanese industrial standards in ADC and AC series are used. These have varying percentage of alloying elements like Cu, Mg, Si, Fe, Mn, Ni, Zn, Pb, Sn because of properties like hardness, strengths etc. required for various parts in automobiles. The price and sourcing of aluminium raw material used in the cluster are shown in the table.

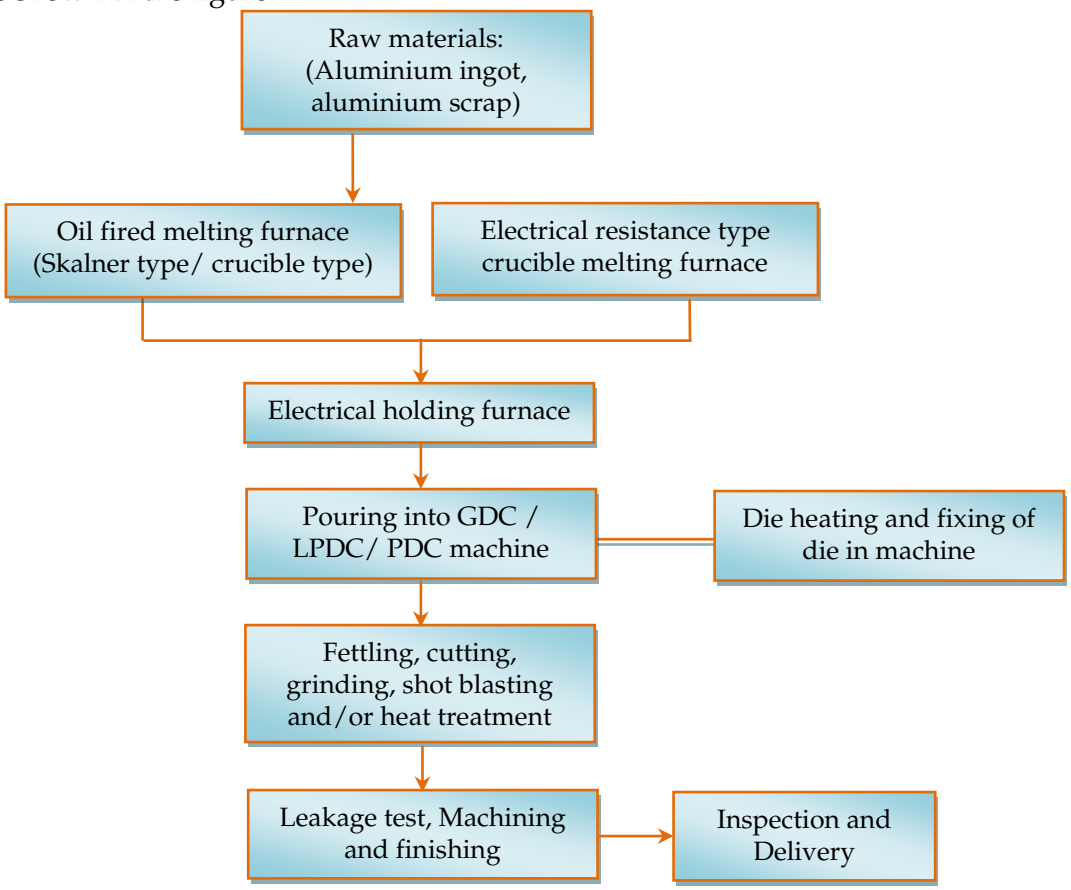
Sources and prices of major raw materials

Raw material	Source (city/region)	Price (INR/tonne)
Aluminium Alloys	Pune / Mumbai	1,50,000 to 1,80,000
Scrap Aluminium	Pune / Mumbai	80,000 to 1,25,000
Sand*	Konkan/Western ghats	1,250

* *only few units use sand*

Production process

The general production process followed in the cluster is briefed below. The process flow diagram is shown in the figure.



Process flow chart in aluminium die casting unit

(i) Raw material charging and melting stage

In most of the aluminium-casting units in Pune cluster, raw material in the form of aluminium alloy ingots is used for melting except for few units, which use scrap aluminium. For the units using oil-fired furnaces, aluminium is charged in the furnace for melting. Either direct heating furnaces (skalner type) or indirect heating furnaces (crucible type) are used for melting. Molten metal temperature is maintained at about 750-800 C. Molten metal is transferred to electrical holding furnaces. Degassing of molten metal is done by purging inert gas and stirring of liquid aluminium in holding furnaces. Some units are using electrical melting cum holding furnaces for melting aluminium. The liquid aluminium metal is sent to die casting process.

(ii) Die casting stage

Three types of die casting process are used namely

(i) Gravity die casting (GDC)
(ii) Low pressure die casting (LPDC)
(iii) High pressure die casting (HPDC)

In gravity die-casting, either sand cores or direct steel grade dies are used for producing the castings. The sand cores are held in plates and the molten metal is poured manually using the pan into the core or dies. Some gravity die casting machines are operated by hydraulic oil pressure for closing and opening of the dies and some are operated manually. After curing, the casting is removed from the die and sent for further processing.

Similarly in low-pressure die-casting, the molten metal is poured into the die. Low pressure is applied on the melt by closing the die using hydraulic oil. After curing for 2-5 minutes, the casting is removed.

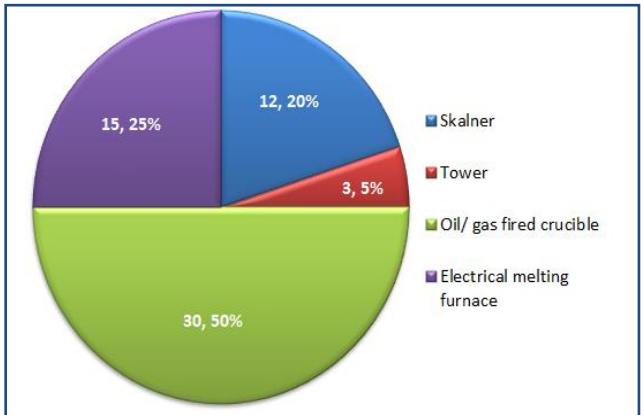
In high-pressure die-casting, special PDC machines are used in which high hydraulic pressure is used for making the shot of poured metal in the die. In these machines, piston plunger is used for applying pressure on molten metal during filled. Cooling water is flowing through the dies for cooling hot dies after the melt is filled in the die and casting is formed. The die is opened and the casting shot is removed from the die. The die is cleaned using compressed air and water and the cycle is repeated. In some PDC machines automatic molten metal pouring system is used and in some PDC machines manual pouring is used.

(iii) Finishing and machining stage

The casting is sent for finishing operations, which include cutting of or runners and risers, fettling, grinding using pneumatic or electric grinders and de-coring for some sand castings. Shot blasting is done for some aluminium castings to impart surface finishing. Some aluminium castings are also sent for heat treatment for stress relieving. After finishing, quality check for dimensions and leakages, the castings are dispatched or sent to the machining centre for operating like boring, drilling and surface finishing.

Technologies employed

The main technology in aluminium casting process is 'furnace' which is used for melting and holding of aluminium metal. The melting furnace is of direct heating or crucible type indirect heating by flame using oil/gas or crucible heating by electrical resistance coil. Many large and medium aluminium casting units are using oil/gas fired furnaces for melting and electrical resistance furnaces for holding. Whereas, small-scale castings are using either oil fired or electrical furnaces for melting as well as holding. Oil/gas fired furnaces represent about 70% of total furnaces used in the cluster; the remaining 30% are electrical resistance furnaces for melting. Most of the holding furnaces are electrical type.



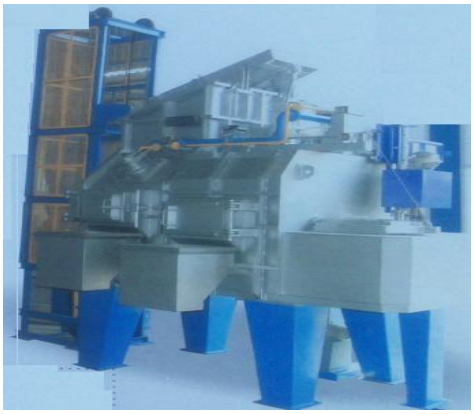
Technology share in cluster – melting

(i) Oil fired furnaces

Skalner furnace: Most of the large and some of the medium scale-casting units are using skalner furnaces for melting aluminium. These furnaces use direct flame inside the furnace for heating the metal and melting either using oil or gas. For higher quantities of melting from 500 kg/hr to 4 tonne/hr (tph), skalner furnaces are preferred. Scrap aluminium can also be melted in skalner furnaces. Molten aluminium is sent to holding furnace. A number of large and medium industries have either shifted or in the process of shifting towards tower type melting furnaces. Some units are also have duplexing.

Skalner furnace

Tower furnace: Few of the large and medium units have started using tower type melting furnace, which has advantage of continuous melting with low fuel consumption and less material loss upto 2% compared to the skalner furnace having 4% material loss. Direct flame is used for heating the metal either with oil/ natural gas (NG)/ LPG. There are various types of tower furnaces like standalone stationary or tilting type is used for melting or direct bale out having melting cum holding facility for medium scale operation of 100 kg/hr to 1 tph. Limitation of tower furnace is that only same alloy ingots can be melted and scrap of certain quality and thickness can be melted.



Tower furnace

Crucible furnace with oil/gas firing: Many of small and medium units are using oil or gas fired crucible type melting furnaces. In this type, the metal is placed in the crucible, which is heated by the surrounded flame. Aluminium ingots in batches of 100 to 500 kg/hr are melted and bale out for pouring or transferred to the holding furnaces. A number of small units have started shifting from oil fired to electrical furnaces.

Electrical furnaces with crucible: some smaller units are using electrical heating crucible type furnaces for melting and holding molten aluminium. Medium/ large units are using electrical resistance furnaces for holding the molten aluminium. About 40 numbers of electrical holding furnaces are used in the cluster.

Crucible furnace

Energy consumption

Aluminium die-casting units in Pune cluster use two major forms of energy namely (1) thermal (oil/ LPG/CNG) and (2) electricity. In units using oil/gas fired furnaces with

crucible type, thermal energy accounts for about 70-80% of total energy consumption which is used for melting and the balance 20-30% is accounted by electricity (in which 10-15% for electrical holding furnaces and 10-15% for associated machines in GDC/PDC and utilities like air compressor, pumps, etc. Some units having GDC/LPDC are using LPG for die heating.

For units using oil/gas fired skalner furnaces, thermal energy accounts for 40-80% of total energy consumption for melting. The balance 20-60% is accounted by electricity. The wide range is due to different processes used like PDC, GDC, core shooters, shot blasting, machining, heat treatment etc. For units having electrical melting furnaces, about 70% electricity is used in melting furnaces and remaining for machines and utilities.

Electricity is purchased from grid and diesel based generator sets are used during load shedding (scheduled power outages) in Bhosari, Chakan industrial areas. Furnace Oil/ piped NG/ LPG is used for melting in skalner, tower and crucible type melting furnaces. Electricity is used in units where melting is done in crucible type furnaces. Other processes such as holding of molten metal, pressure die casting, gravity die casting and core heating, machining, shot blasting, etc., are all operated using electricity, irrespective of the type of furnaces.

(i) Unit level consumption

Oil, piped NG, LP and electricity are the major energy forms used in Pune aluminium die casting cluster. Typical energy consumption of different types of units is given below.

a) Oil/Gas Crucible furnace unit (2014)

NG consumption	**150,000 scm/year**
Gross calorific value	8,500 kcal/scm
Equivalent energy consumption of NG	127.5 toe/year
FO consumption	1,80,000 lit/year
Gross calorific value	9,870 kcal/lit
Equivalent energy consumption of FO	177.66 toe/year
Electricity consumption	492,000 kwh
Equivalent energy consumption of electricity	42.3 toe/year
Total production	1500 tonne/year
SEC	0,212 toe/tonne (or) 8.86 MJ/kg
total energy	347.472 toe/year

b) Oil/Gas Skalner furnace unit (2014)

FO consumption	**2,12,868 ltr/year**
Gross calorific value (per unit)	9,870 kcal/ltr
Equivalent energy consumption of FO	209.2 toe/year
Electricity consumption	2,779,310 kwh
Equivalent energy consumption of Electricity	230 toe/year
Total production	2391 tonne/year
Total energy	439 toe/year
SEC	0.183 toe/tonne (or) 7.66 MJ/kg

c) Electrical crucible furnace unit (2014)

Electricity consumption	695466 kwh
Equivalent energy consumption of electricity	59.8 toe/year
Total production (melting)	807 tonne/year
total energy	59.8 toe/year
SEC	550 kwh/tonne

(ii) Cluster level consumption

The energy consumption pattern of Pune casting cluster shows that energy consumption in the aluminium casting industry is considerably large. On an average, skalner furnace based unit consumes about 90 to 110 ltrs/tonne of furnace oil or 100 SCM of natural gas per tonne for melting, while crucible type oil/gas fired furnace based unit consumes about 150 to 220 ltrs/tonne for melting.

Share of energy consumption

In electrical crucible heating furnace about 500–550 kWh per tonne is consumed for melting and about 50–100 kWh per tonne is consumed for holding furnaces. Based on the number of units operating with skalner and crucible type either with oil or gas firing the total consumption of the thermal energy is 47400 toe which is 61% of the total energy consumption in the cluster. The total energy consumption of the cluster is estimated to be 77,800 toe. Electricity accounts for about 39% of the total energy consumption in the cluster.

Energy consumption of Pune aluminium cluster (2014)

Energy type	Annual consumption	Equivalent energy (toe)	Annual energy bill (million INR)
Electricity	350 million kWh	30,063	2,971
FO	44,153 KL	43,579	1,590
NG	1.206 million SCM	1,025	54
LPG	210 tonne	263	18
HSD	2592 KL	2536	143
Total		**77,466**	**4,776**

Energy saving opportunities and potential

There is significant energy saving potential exists in skalner and crucible type oil/gas fired melting furnaces by adopting tower type furnace technology with automation and also by incorporating efficient burner with automated control system. Energy savings through precise temperature control using thyristor based control system and using better insulation to electrical melting and holding furnaces etc. are possible in casting units. There is also considerable scope for improving other process technologies in the plant such as core heating, pneumatic grinding, machining etc. Most of the units are still using conventional machines for these processes, and hence there is a scope for adoption of EE designs in the cluster. In addition to process technologies, aluminium-casting units also use numerous cross-cutting technologies such as compressors, motors, pumps, etc. It is observed that these types of technologies are generally outmoded and inefficient, especially in the smaller units.

Overall, there are only a few casting units that are mechanized and automated, while the rest are employing manual processes and hence there is good scope for technology enhancement.

Energy saving opportunities and potential

S No	Energy saving measure
1	Replacement of crucible type oil fired furnaces with EE tower furnaces/ electrical furnaces
2	Replacement of conventional skalner furnace with EE tower furnace
3	Use of EE burners with automation in oil/gas fired furnaces
4	Use of thyristor for electrical heating for better temperature control
5	Use of lid mechanism in electrical melting and holding furnaces
6	Use of better refractory and insulation for furnaces
7	Installation of recuperators for skalner furnaces
8	Use of energy efficient motor
9	Replacement of inefficient air compressor with EE compressor (reciprocating with screw type)
10	Switching over to EE lighting and controls
11	Adoption of 'best operating practices' (BOP)
12	Installation of 'variable frequency drives' and automation
13	Compressed air system optimization
14	Replacement of metal blades with 'fibre reinforced blades' (FRP) in cooling towers
15	Insulation of core shooters and heater optimization
16	Voltage regulators for transformers and OLTC

Major stakeholders

The major industry associations in the cluster are given in the table. Mahrashtra Chamber of Commerce Industries and Agriculture (MCCIA) has about 3000 members comprising foundries, automotive, sugar, textile, agricultural implements, engineering, and other industries. Aluminium Casters' Association of India (Alucast) has about 100 members comprising foundry units as well as individual foundry consultants, equipment suppliers, and 'local service providers' (LSPs). The government body includes District Industries Centre (DIC), Pune. There are about 20 main LSPs comprising fabricators, equipment suppliers, technology providers, testing centres and energy auditors. The major industry associations in Pune aluminium die casting cluster are as follows.

- Aluminium Casters' Association of India (Alucast)
- Mahrashtra Chamber of Commerce Industries and Agriculture (MCCIA)
- The Institute of Indian Foundrymen (National Centre for Technical Services)
- Pimpri Chinchwad Small Industries Association
- Deccan Chamber of Commerce Industries & Agriculture Pune

Cluster development activities

ALUCAST organises an annual event 'International conference and exhibition on aluminium die castings' for the benefit of aluminium casting industries in India. It further conducts regularly various training programmes at zonal level. Arkeycell (Trust) in Pune cluster is conducting technology related conferences for aluminium casting. It also conducts aluminium die casting technology course with Vishwakarma Institute of Technology in Pune.

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

Promoting Energy Efficiency in SMEs
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