

IMPROVEMENT IN ENERGY EFFICIENCY IN FOUNDRY INDUSTRY USING Energy Management Practices and Energy Conservation

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ABSTRACT:

There are about 35000 Foundries in the world with annual production of 69 million metric tones, providing employment to mote than 20 lakhs people. In terms of number of operating foundries; China tops the list (12000) followed by India (7000) and USA (2700). China and USA tops in casting production in the world. Iron foundries share maximum number (56.21%) followed by non-ferrous (29.48%), steel foundries (14.31%), Out of 7,000 foundry units in India, 5000 are in the small-scale [SME]. Most of the foundry units are spread over 20 disparate geographically clusters in different parts of the country. The foundry industry is an important activity in the SME sector in India. The annual production is worth of Rs. 10,000 Crores.

Majority of the foundries being operated are highly energy-inefficient and hence there is a large potential for energy conservation in theses SMEs. Out of the total power consumed by the units, 60% to 75% is utilized in melting processes either by primary energy sources like coal, oil, gas or electrical energy. On a conservative scale, it is possible to save about 25% of the coke by adoption of the energy efficient technology.

This paper discusses a few options to improve energy efficiency of the melting operation and concludes that EC techniques are must. By employing the method of DUPLEXING in foundries, the total operation can be made energy efficient. Small activities in a foundry can lead to a considerable saving of energy. Various measures have been suggested which are practical and can be adopted without much investment. Involvement of personnel at all levels in the operation of a foundry is very important.

Continuous training in newer technologies and processes by EC through EMP is very essential.

Key words: Energy Conservation, Energy Management Practices, Induction Furnace, Energy Efficiency.

Introduction

The power required in heating and melting of metals in all types of metallurgical units is the main area in which 60% to 75% of the total power is used in the unit. Hence any energy conservation activity should be concentrated in the melting area so that considerable amount of energy is saved. This paper discusses various units like the steel plants and foundries where metal is melted and suggestions are given where energy conservation measures can be applied to save considerable amount of energy. The paper covers the Improvement in Energy Efficiency in Foundry Industry using Energy Management Practices (EMP) & Energy Conservation (EC) techniques.

It is suggested that units requiring molten iron can relocate to a nearby place where a blast furnace is located so that molten metal can be transferred to the point thereby saving almost 350 to 450 units of electrical power per MT of casting made.

Background

The alarming situation of CLIMATE CHANGE has resulted in attracting the immediate attention by an individual and company towards optimizing the scarce recourse. The production of electricity by thermal based units itself is so low and is associated with the generation of lot of fly ash. Disposal of fly ash is another major problem. The efficiency of cupola as a melting unit is very high and induction furnace as a superheating unit is also very

high. Thus by employing the method of DUPLEXING in foundries, the total operation can be made energy efficient. Small activities in a foundry can lead to a considerable saving of energy. Various measures have been suggested which are practical and can be adopted without much investment. This paper deals with them.

Structure of Industry

- I. Pattern Makers: Patterns are made mainly, from Wood & Aluminum.
- II. Raw Materials Suppliers: There are who supplies raw materials, like Pig-iron, coke, sand & foundry chemicals.
- III. Casting Units: The castings are made as per design provided by the buyers.

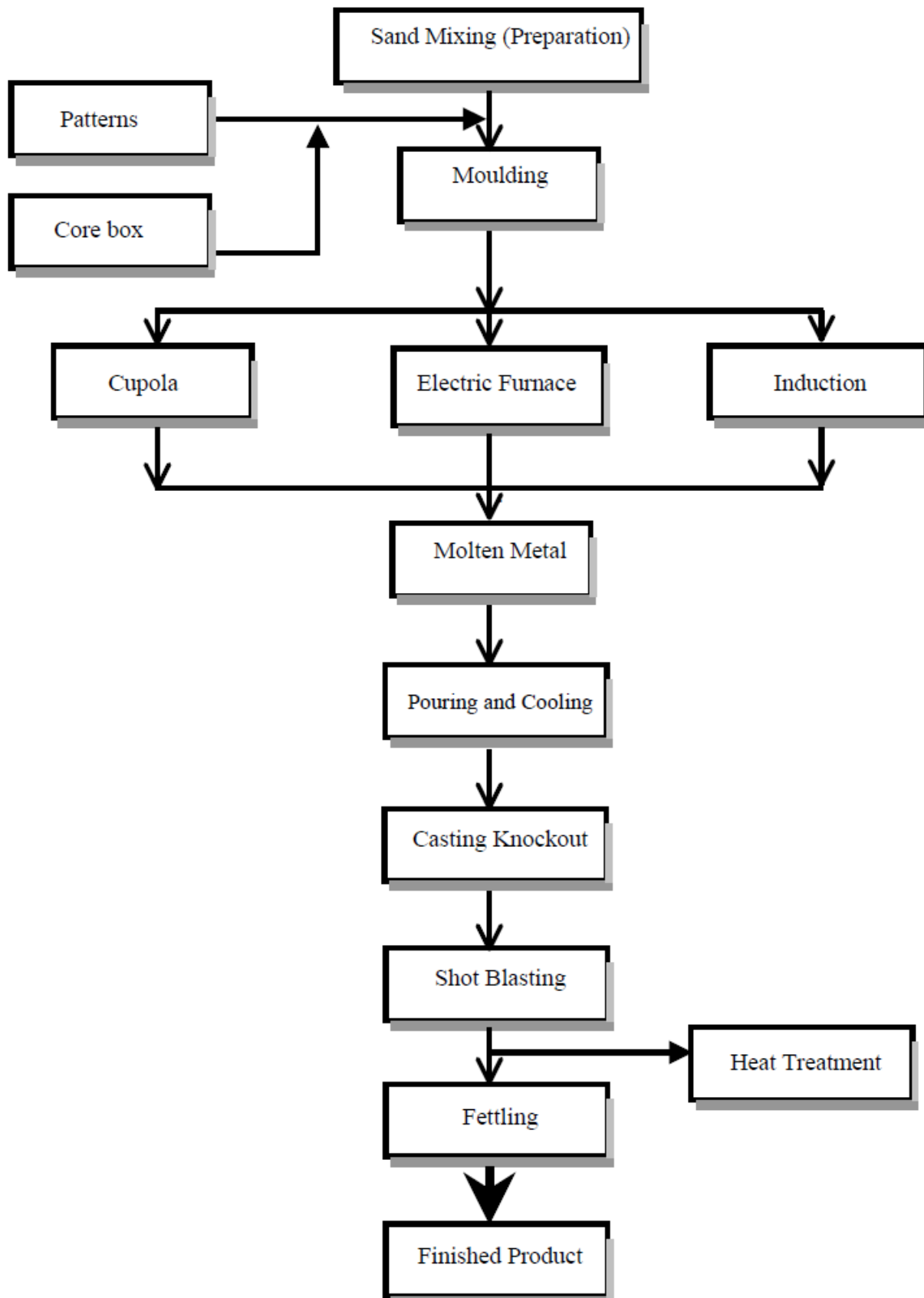
The white process of producing castings can be classified into six stages -

1. Designing system: The design supplied by customer is further designed to provide with necessary allowances and selection of parting line. Method and gating are the tools for achieving this process while methoding consists of feeders, which compensates the shrinkage in the castings; the gating system consists of spruce and runner and in gates which allows the molten metal into the mould.
 2. Pattern making: Replica of the castings is prepared on the basis of drawings given by the customers. Patterns are made with wood and aluminum.
 3. Molding and Core making: Moulds are prepared in the sand with the help of patterns to get the same shapes to pattern. Core making will be useful for getting hollowness in the casting.
 4. Melting and Casting: Metals will be melted in suitable furnaces to get the required composition and molten metal will be poured into the molds.
 5. Fettling: After solidification of castings, these will be removed from mold boxes and unwanted metal attachments like runners and raisers will be removed and sand adhered to the castings will be cleaned. Later these castings will be sent for further operations like heat treatment and machining.
 6. Testing and Inspection: Before dispatching of the castings, visual and dimensional inspection carried out. As per customer requirement non destructive test like ultrasonic radiography tests are carried out to know the internal soundness of the castings.
- IV. Machining Units: These units give final finish to the castings manufactured by Foundry Cluster units.

Unit Operation of Typical Foundry ~

Sl. No.	Name of Operation	Process
1.	Stores Management	Supply of material to the production unit, records are kept for the supplied material and inventory control
2.	Mould sand preparation	Sand preparation for the mould making
3.	Core preparation	Sand preparation for core making
4.	Melting	Preparation of the molten metal of desired quality
5.	Molding	Making of the mould
6.	Knock out / shake out	Eliminating sand from the casting
7.	Tumbling and shot blasting	Cleaning the surface of the casting
8.	Inspection	Inspection of the casting
9.	Fettling	Grinding for dimensioning and good finish of the product
10.	Machining	Preparation of the product

: FLOW CHART OF FOUNDRY :~



Thermal Efficiencies for Common Industrial Furnaces

Furnace Type	Typical thermal efficiencies (%)
1) Low Temperature furnaces	
a. 540–980 °C (Batch type)	20–30
b. 540–980 °C (Continuous type)	15–25
c. Coil Anneal (Bell) radiant type	5–7
d. Strip Anneal Muffle	7–12
2) High temperature furnaces	
a. Pusher, Rotary	7–15
b. Batch forge	5–10
3) Continuous Kiln	
a. Hoffman	25–90
b. Tunnel	20–80
4) Ovens	
a. Indirect fired ovens (20°C–370°C)	35–40
b. Direct fired ovens (20°C–370°C)	35–40

Table -1

Energy Pattern in a Foundry

The energy consumption in various operations of a foundry reveals that the major consumption of electrical energy is in the melting operation.

Energy required for Melting

The theoretical energy required for melting of metals from fundamental calculations is given in Table 2. The actual power being consumed in a foundry is also given. In some cases it may be more than that mentioned in the table. This vast difference is in the operation variables and can be controlled to a large extent by proper planning.

Typical energy data for various metals is as under

Metal	Temp 0 C	Theoretical Heat KWh/T	Actual Gas/Oil KWh/T	Actual Electric KWh/T	Practical Requirement of Energy	
					D/B	C/B
		(B)	(C)	(D)		
Al	750	295	1406-2138	500	170%	477 to 725 %
Copper	1260	190	1523	334	176%	801%
Grey Iron	1510	340	801	500	147%	236%
SG Iron	1649	36	-----	606	N.A.	1684%

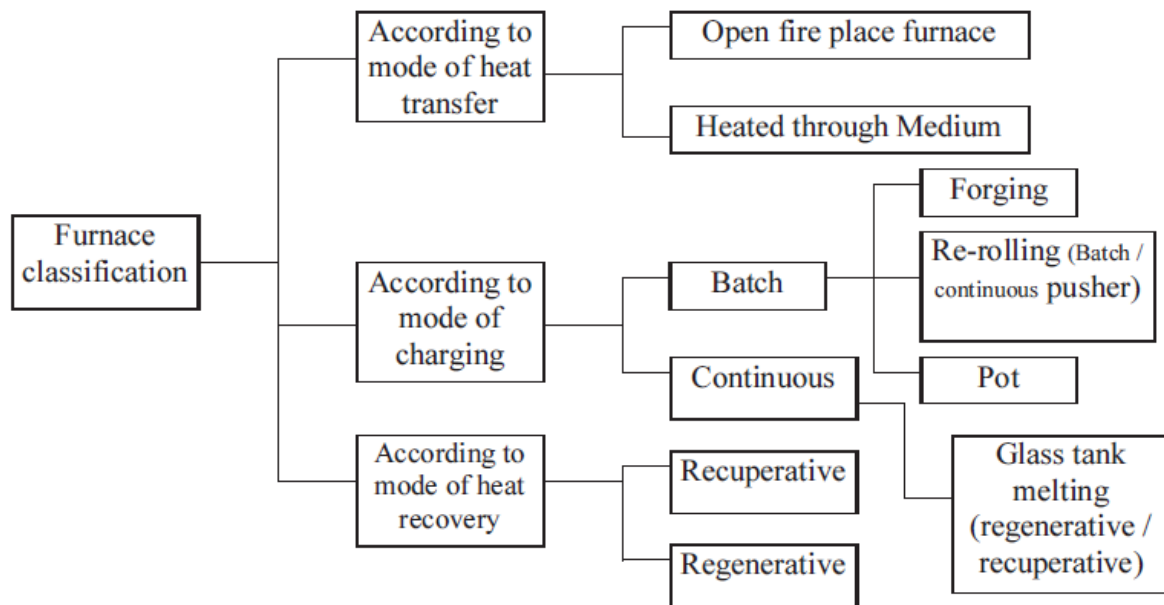
Table-2

Types and Classification of Different Furnaces

Based on the method of generating heat, furnaces are broadly classified into two types namely combustion type (using fuels) and electric type. In case of combustion type furnace, depending upon the kind of combustion, it can be broadly classified as oil fired, coal fired or gas fired.

Based on the mode of charging of material furnaces can be classified as (i) Intermittent or Batch type furnace or Periodical furnace and (ii) Continuous furnace.

Based on mode of waste heat recovery as recuperative and regenerative furnaces. Another type of furnace classification is made based on mode of heat transfer, mode of charging and mode of heat recovery as shown in following figure-1



It is clear from the table -2, that the theoretical Energy required for melting iron is only 340kWH per Ton for Grey Iron whereas the actual Power required is around 600 to 900 units. This vast difference is due to two factors-one inherent in the principle of melting in an Induction Furnace and the other operational. The inherent reasons in the furnace include the inefficiency in (I) Electrical Bus bar losses, (II) Eddy Current losses (III) Refractory losses (IV)Cooling water losses. The operational losses are largely due to unnecessary and excessive holding of molten metal in the furnace. This will be discussed later in the paper.

Operating Temperature of Various Furnaces

Table-3

Slab Reheating furnaces	1200°C
Rolling Mill furnaces	1200°C
Bar furnace for Sheet Mill	800°C
Bogey type annealing furnaces	650°C–750°C

Characteristics of an Efficient Furnace

Furnace should be designed so that in a given time, as much of material as possible can be heated to a uniform temperature as possible with the least possible fuel and labour.

To achieve this end, the following parameters can be considered.

- Determination of the quantity of heat to be imparted to the material or charge.
- Liberation of sufficient heat within the furnace to heat the stock and overcome all heat losses.
- Transfer of available part of that heat from the furnace gases to the surface of the heating stock.
- Equalization of the temperature within the stock.
- Reduction of heat losses from the furnace to the minimum possible extent.

Furnace Energy Supply

Since the products of flue gases directly contact the stock, type of fuel chosen is of importance. For example, some materials will not tolerate sulphur in the fuel. Also use of solid fuels will generate particulate matter, which will interfere the stock place inside the furnace. Hence, vast majority of the furnaces use liquid fuel, gaseous fuel or electricity as energy input. Melting furnaces for steel, cast iron use electricity in induction and arc furnaces. Non-ferrous melting utilizes oil as fuel.

Oil Fired Furnace

Furnace oil is the major fuel used in oil fired furnaces, especially for reheating and heat treatment of materials. LDO is used in furnaces where presence of sulphur is undesirable. The key to efficient furnace operation lies in complete combustion of fuel with minimum excess air. Furnaces operate with efficiencies as low as 7% as against upto 90% achievable in other combustion equipment such as boiler. This is because of the high temperature at which the furnaces have to operate to meet the required demand. For example, a furnace heating the stock to 1200°C will have its exhaust gases leaving at least at 1200°C resulting in a huge heat loss through the stack. However, improvements in efficiencies have been brought about by methods such as preheating of stock, preheating of combustion air and other waste heat recovery systems.

Typical Furnace System

i) Forging Furnaces

The forging furnace is used for preheating billets and ingots to attain a 'forge' temperature. The furnace temperature is maintained at around 1200 to 1250°C. Forging furnaces use an open fireplace system and most of the heat is transmitted by radiation. The typical loading in a forging furnace is 5 to 6 tonnes with the furnace operating for 16 to 18 hours daily. The total operating cycle can be divided into (i) heat-up time (ii) soaking time and (iii) forging time. Specific fuel consumption depends upon the type of material and number of 'reheats' required.

ii) Rerolling Mill Furnace

a) Batch type

A box type furnace is employed for batch type rerolling mill. The furnace is basically used for heating up scrap, small ingots and billets weighing 2 to 20 kg. for rerolling. The charging and discharging of the 'material' is done manually and the final product is in the form of rods, strips etc. The operating temperature is about 1200 C. The total cycle time can be further categorized into heat-up time and rerolling time. During heat-up time the material gets heated upto the required temperature and is removed manually for rerolling. The average output from these furnaces varies from 10 to 15 tonnes / day and the specific fuel consumption varies from 180 to 280 kg. of coal / tonne of heated material.

b) Continuous Pusher Type:

The process flow and operating cycles of a continuous pusher type is the same as that of the batch furnace. The operating temperature is about 1250 °C. Generally, these furnaces operate 8 to 10 hours with an output of 20 to 25 tonnes per day. The material or stock recovers a part of the heat in flue gases as it moves down the length of the furnace. Heat absorption by the material in the furnace is slow, steady and uniform throughout the cross-section compared with batch type.

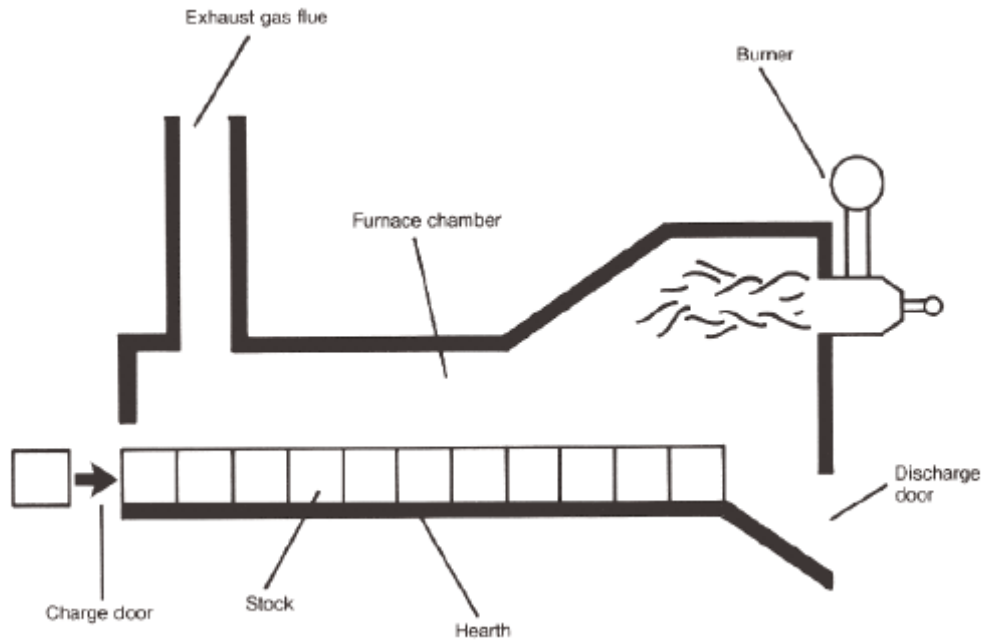
c) Continuous Steel Reheating Furnaces

The main function of a reheating furnace is to raise the temperature of a piece of steel, typically to between 900°C and 1250°C, until it is plastic enough to be pressed or rolled to the desired section, size or shape. The furnace must also meet specific requirements and objectives in terms of stock heating rates for metallurgical and productivity reasons. In continuous reheating, the steel stock forms a continuous flow of material and is heated to the desired temperature as it travels through the furnace.

All furnaces possess the features shown in **Figure-2**

- a) A refractory chamber constructed of insulating materials for retaining heat at the high operating temperatures.
- b) A hearth to support or carry the steel. This can consist of refractory materials or an arrangement of metallic supports that may be water-cooled.
- c) Burners that use liquid or gaseous fuels to raise and maintain the temperature in the chamber. Coal or electricity can be used for reheating.
- d) A method of removing the combustion exhausts gases from the chamber.
- e) These facilities depend on the size and type of furnace, the shape and size of the steel being processed, and the general layout of the rolling mill.
- f) Common systems include roller tables, conveyors, charging machines and furnace pushers.

Figure-2

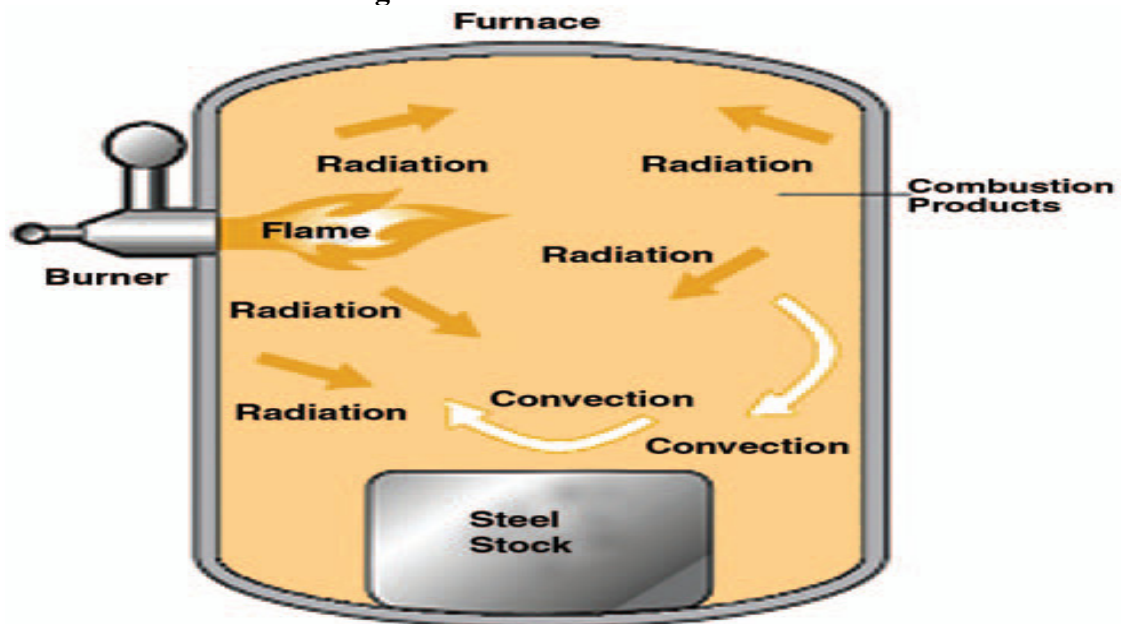


Heat Transfer in Furnaces

The main ways in which heat is transferred to the steel in a reheating furnace are shown in Figure 3. In simple terms, heat is transferred to the stock by:

- a) Radiation from the flame, hot combustion products and the furnace walls and roof.
- b) Convection due to the movement of hot gases over the stock surface. At the high temperatures employed in reheating furnaces, the dominant mode of heat transfer is wall radiation. Heat transfer by gas radiation is dependent on the gas composition. (Mainly the carbon dioxide and water vapour concentrations), the temperature and the geometry of the furnace.

Figure-3 Heat Transfer in Furnace



General Fuel Economy Measures in Furnaces

Typical energy efficiency measures for an industry with furnace are:

- 1) Complete combustion with minimum excess air
- 2) Correct heat distribution
- 3) Operating at the desired temperature

- 4) Reducing heat losses from furnace openings
- 5) Maintaining correct amount of furnace draught
- 6) Optimum capacity utilization
- 7) Waste heat recovery from the flue gases
- 8) Minimum refractory losses
- 9) Use of Ceramic Coatings

Duplexing

This operation is to use the melting efficiency of Cupola and superheating efficiency of induction furnace. The net Melting Efficiency by combining the high efficiency of melt down of Cupola and super heating efficiency of Induction Furnace is called the Duplexing operation. This results in the lowest cost per MT of liquid metal production.

- Cupola as a Meltdown unit is very efficient to the extent of 60 to 70%
- Induction Furnace as a Super Heating Unit is very efficient to the extent of 60 to 70%.

Duplexing principle combines the high efficiency of melt down of Cupola and super heating efficiency of Induction Furnace resulting in a considerable saving to the Unit.

Casting Rejection

Casting rejection is another major area where considerable amount of energy is wasted.

In fact the casting rejection at the final stage has absorbed all energy in various operations of the foundry like moulding, core making, melting and pouring, fettling, shot blasting and sometimes machining. From the energy point of view, a rejection at the machine shop is of high energy content compared to the one at the casting stage.

Rejection control in a foundry is a big area and involves the study of the production process at every stage in the foundry. Preparation of Pareto Chart is a short route to identify the high rejection items and selective process standardization will give quick result. In this method the rejection in every item reduces considerably while the steps taken will improve the general process and helps in the reduction of rejection in all the components. A history card is another effective tool to identify and follow up the performance. In this card the history of a casting is recorded from the pattern stage, methoding stage, moulding process, type of core used, the chemistry and temperature of metal poured to the process adopted in fettling is recorded. The rejection is recorded at each batch production and a PDCA technique will yield improvements at each stage. All the techniques mentioned below can be adopted individually and severally to get the desired result of lower rejection consistently.

- Pareto analysis of rejection
- Classify high rejection few and trivial many
- Study individual item and individual reason
- Actions on reason-will be general in action and helps in overall process improvement-like sand fall, cold shut etc
- Individual item-History Card is very useful

Casting Yield

Casting yield is defined as the weight of casting divided by the total weight of metal poured to the mould. This is generally presented in percentage. This virtually indicates that how much of metal is converted to saleable casting and how much comes back to the foundry as gate, runners, risers etc. Higher the Casting Yield better is the profitability in the casting. Efforts are always made in improving the Casting Yield by employing better techniques.

- Consider a foundry with 100MT /month
- Select items to cover 40% of high volume items
- Improve the yield by 5%
- Amount saved= 40MT X 5% X 50,000/MT= Rs.100, 000 per month
- The net saving for the Foundry is Re.1.00 per kg of the total output of 100MT
- The competitiveness of a foundry is decided by the energy conservation and waste reduction activities.
- One unit of energy saved is equal to three units generated
- Unit having respect for energy will survive the international competitiveness

Some of the techniques are briefly described below:

Use of aided feeders

One of the major developments that have taken in reducing the quantity of feeder metal required to produce sound casting is in the development of aided feeders. The aided feeder effectively increases the time of solidification of the feeder so that the feed path is kept open

and availability of liquid metal is ensured for a longer time in the riser. There are two types of feeders- insulating feeders and exothermic feeders. The insulating feeder will maintain the heat in the feeder so that the cooling of feeder is avoided and the solidification time of the feeder is extended by a factor of, say, 1.1. An exothermic feeder initially supplies heat to the metal and increases the temperature of the liquid and later acts as insulating feeder and prevents the cooling of the feeder. This extends the time of solidification of the feeder significantly by a factor, say, 1.2. This implies that if a sound casting is produced by the use of 120mm diameter feeder, it is enough to use a 110 mm diameter insulating feeder or a 100mm diameter exothermic feeder. Thus the weight of feeder reduces considerably and the Casting Yield improves drastically.

Use of Ceramic Foam Filters

The use of ceramic foam filter to increase the casting yield is rarely used and is many times considered as a secondary effect and the primary reason for use is removal of inclusions. In fact the use of ceramic foam filter has improved the yield drastically and may be that this advantage has not been thought of as the primary effect by the use of ceramic foam filters. It has been established that use of ceramic foam filters makes the molten metal flow laminar. Thus use of ceramic foam filters results in dual benefit of reducing the velocity and turbulence to make the flow laminar and the other effect is the removal of inclusions to produce clean castings. Earlier designs of gating with a longer stepped runner bar can be easily be replaced by a shorter and almost near the casting with a foam filter so that the efficiency of filtration is drastically improved and the weight of runner bar is reduced. Serious study has to be made in each component to improve the yield by employing Ceramic Foam Filters.

Review of Gating and Feeding system, Use of softwares for methoding

A very important step in this direction of improving the Casting Yield is systematically studying the present Gating and Feeding systems, subject it to approval by the use of software available and to make improvements. This is long drawn exercise in an existing foundry whereas the method helps in standardization in a new foundry.

Technical Training and upgradation

Involvement of personnel at all levels in the operation of a foundry is very important. Continuous training in newer technologies and processes is very essential in the implementation of all schemes.

Furnace Instrumentation

Sl. No.	Parameters to be measured	Location of Measurement	Instrument Required	Required Value
1.	Furnace soaking zone temperature (reheating furnaces)	Soaking zone side wall	Pt/Pt-Rh thermocouple with indicator and recorder	1200–1300°C
2.	Flue gas	Flue gas exit from furnace and entry to re-cuperator	Chromel Alummel Thermocouple with indicator	700°C max
3.	Flue gas	After recuperator	Hg in steel thermometer	300°C (max)
4.	Furnace hearth pressure in the heating zone	Near charging end side wall over hearth level	Low pressure ring gauge	+0.1 mm. of Wg
5.	Flue gas analyser	Near charging end side wall end side	Fuel efficiency monitor for oxygen & temperature	0 ₂ % = 5 t = 700°C (max)
6.	Billet temperature	Portable	Infrared Pyrometer or optical pyrometer	----

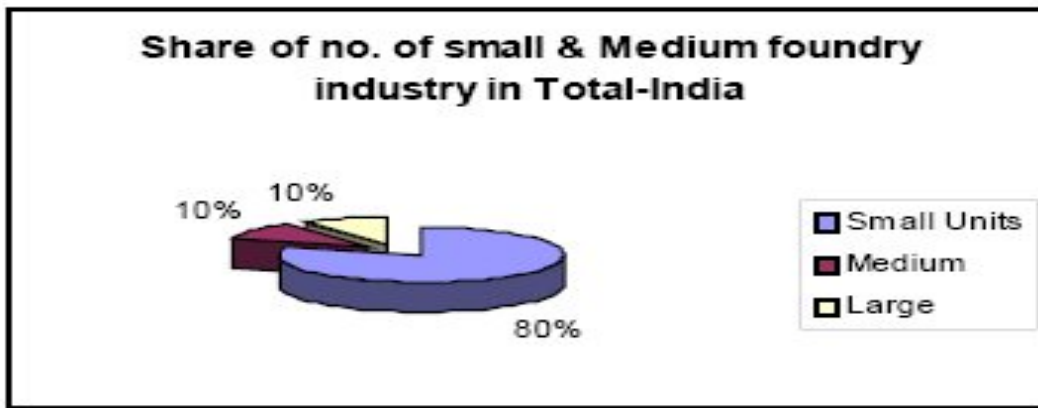
Table-4

Profile of Indian Foundry Industry

The Indian Metal Casting (Foundry Industry) is well established. According to the recent World Census of Castings by Modern Castings, USA India ranks as no 6 country in the world producing an estimated 6 Million MT of various grades of Castings as per International standards.

The various types of castings which are produced are Ferrous, Non-Ferrous, Aluminium Alloy, Graded Cast Iron, Ductile Iron, Steel etc for application in Automobiles, Railways, Pumps Compressors & Valves, Diesel Engines, Cement / Electrical /Textile Machinery, Aero & Sanitary pipes & Fittings etc & Castings for special applications. However, Grey iron castings are the major share approx 70 % of total castings produced.

There are approx 4500 units out of which 80% can be classified as Small Scale units & 10% each as Medium & Large Scale units. Approx 500 units are having International Quality Accreditation. The large foundries are modern & globally competitive & are working at nearly full capacity. Most foundries use cupolas using LAM Coke. There is growing awareness about environment & many foundries are switching over to induction furnaces & some units in Agra are changing over to cokeless cupolas.



The country's foundry exports to the US, the UK and the Middle East have gone down by almost 50% owing to the global financial meltdown.

Castings worth @Rs1600 Crores (\$400 million) were exported during the first half of 2008-09, but the same period in 2009-10 may see the exports fall to Rs.1200 Crores (\$300 million). Total exports in 2007-08 were around Rs.2960 Crores (\$740 million). The figure is 10% of the overall industry value.

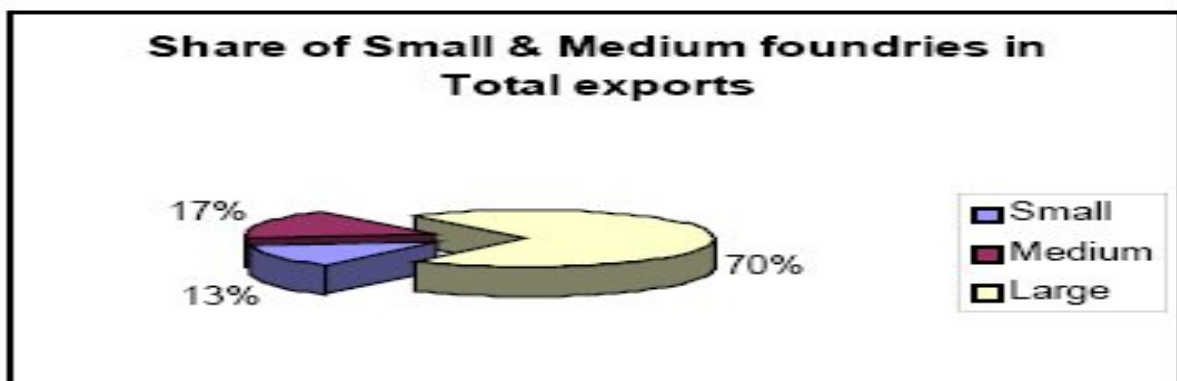
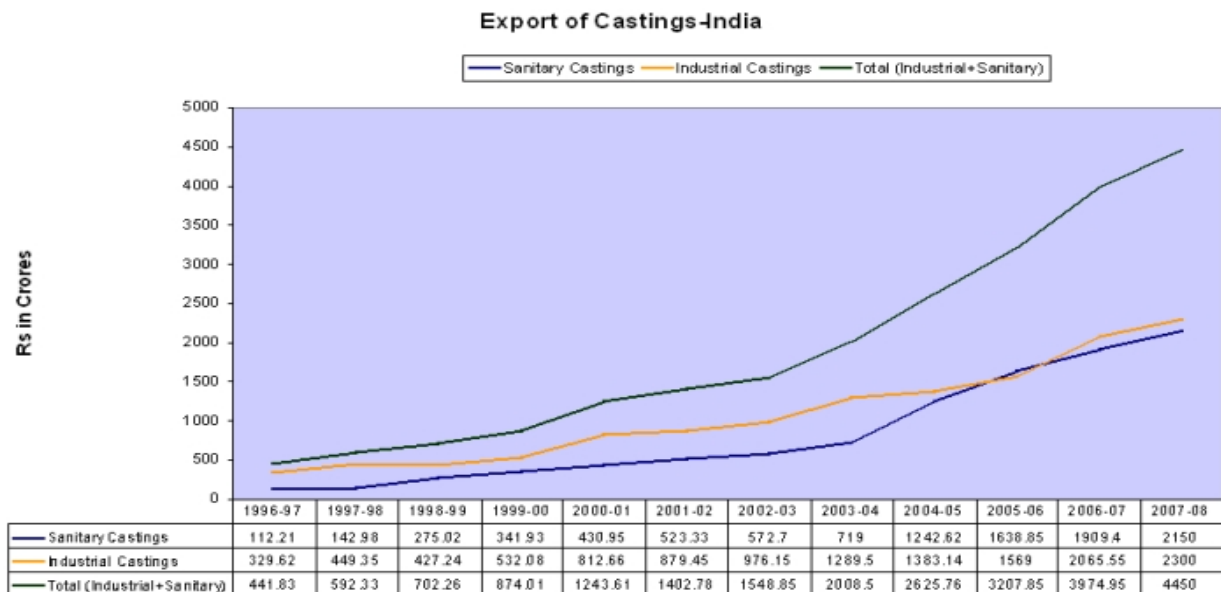
The foundries will take two years to get back the market position in exports in the first half of 2008-09.

There are 4,550 foundries in the country, out of which 25% have shut down owing to the crisis. Around 1.5 lakhs jobs have been lost.

There are 400 registered foundries in the east. Seventy have closed down, resulting in the loss of around 40,000 jobs.

The main factors behind the closures are a fall in exports and lack of domestic demand for castings. Sales have gone down by 70% in the auto sector and by 35-40% in infrastructure.

Nationally, foundries produce around 7.8 million tonne per annum.



Employment

The industry directly employs about 5,00,000 people & indirectly about 1,50,000 people & is labour intensive. The small units are mainly dependant on manual labour. However, the medium & large units are semi/ largely mechanized & some of the large units are world class. Most foundries use cupolas using LAM Coke. There is growing awareness about environment & many foundries are switching over to induction furnaces & some units in Agra are changing over to cokeless cupolas.

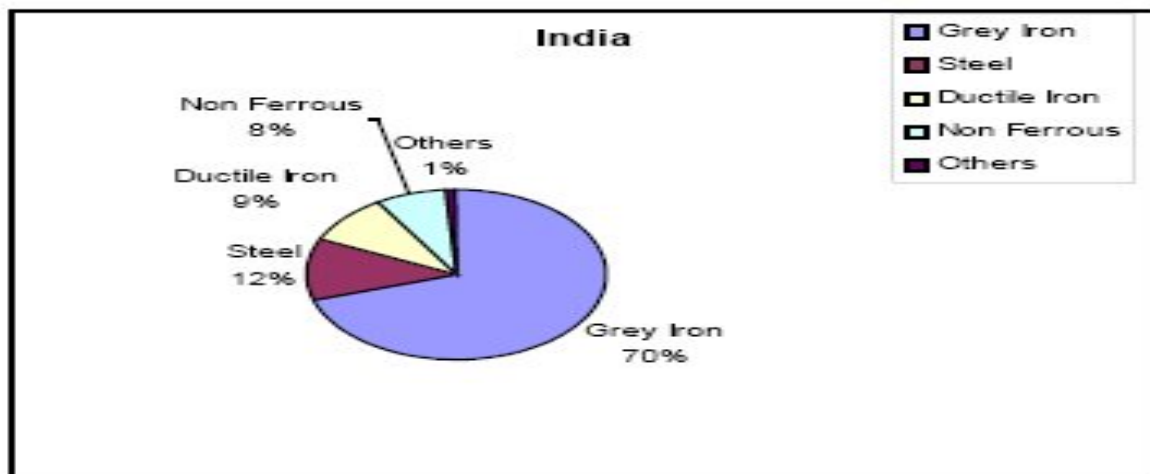
Important Clusters

There are several foundry clusters. Some of the major clusters are as below. Each cluster is known for its type of products. Out these clusters our state Maharashtra has lion share as two clusters are from our state i.e. Pune & Kolhapur & one very near to state i.e. Belgaum.

Batala	Jalandhar	Ludhiana
Belgaum	Chennai	Kolhapur
Rajkot	Coimbatore	Howrah
Agra	Pune	Rajkot

Product Mix

Grey iron is the major component of production followed by steel, ductile iron & non ferrous as shown below



The Indian Foundry Industry is trying to focus on higher value added castings to beat the competition

Investments

India would need approx. @Rs12000Crores (\$ 3 Billion) in investment to meet the demand of growing domestic industry and strong export drive.

Following the economic reforms the Govt. of India has reduced tariffs on imported capital goods as a result the annual average amount of FDI is reported to have increased but is still one tenth of the annual FDI in China. The reforms also encourage the privatization of industry enabling foreign companies to invest or enter into joint ventures with Indian Foundries. FDI projects are permitted an automatic approval process. Several International corporates from USA, EU and East Asian Countries have increased overseas foundry operations in India. i.e. VOLVO foundries in Chennai and Suzuki in Haryana. Sundaram Clayton has joined hands with Cummins, Hyundai Motors, Delphi, Ford India, Tata-Cummins, GM and Ford have contracts of foundry products for export with a value of @ Rs.160 crores (\$ 40 Million.)

Raw material & Energy

since 2003 the steep increase in cost of raw materials and energy have resulted in the closure of approx. 500 units, Overall India is exporter of Pig Iron but must import Scrap metals and Coke etc. Cost recovery for material and energy is very difficult as most contracts are long term contracts with out any clause for price adjustment. India has to import coke & scrap. Moulding sand is locally available & India has an advantage on this account. Energy cost typically vary between 12-15%

Labour

India has major competitive advantage over the foundry industries in the developed countries.

The total labour cost account for 12-15%

Technology

Govt. of India (GOI) has encouraged technology transfer through JV with foreign Companies and GOI has cooperated with UNIDO with many foundry clusters. Indian foundry industry has an edge over China for producing complex machined and precision castings as per international quality standards. The GOI also helps upgrade foundry clusters. The clusters in Belgaum, Coimbatore and Howrah are undergoing modernization under the industrial infrastructure upgradation scheme. More of such clusters are likely to follow

The Institute of Indian Foundry men has plans to strengthen and develop various foundry clusters.

Conclusion

There is a large scope for energy conservation & implementation of energy management program in foundry industry considering the fact that large amount of power is being wasted in furnace. As majority of the foundries being operated are highly energy-inefficient; there is a large potential for energy conservation in these Small Scale Foundries. Out of the total power consumed by the units, 60% to 75% is utilized in melting processes either by primary energy sources like coal, oil, gas or electrical energy. On a conservative scale, it is possible to save about 25% of the coke by adoption of the energy efficient technology like cupola or dual track Furnaces. The energy intensity & energy security can be increased by following better EM & EC techniques. Our study further concludes that by just employing better Energy Management Technique & Energy Conservation Measures; we can save 10% to 20% energy without upgrading the present technical status. As per the data available to us each foundry consumes about 1000 KWh/Ton to 1100 KWh/Ton electrical energy. The cost of all fuels per Ton lies between Rs. 4300 to 4800.

If we produce @ 7.8 million tonne per annum then if we are able to save 10% to 20% cost of production or 10% to 20% savings in energy consumption we can save large inputs in terms of national energy consumption as well as in terms of pollution & environmental degradation. The amount of savings we can achieve in terms of rupee value is 335.4 crores. In terms of energy saving front it is 780 million to 858 million units can be easily saved which costs @ 312 crores to 343 crores.

If same units are meaningfully utilized for other national purpose like irrigation, education, literacy the effects will be multidimensional & multidirectional.

Energy saved is Energy Generated not only that we are saving Earth & protecting the future generations to come.

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