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# Review on Foundry Waste Treatment

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## ABSTRACT

India's rapid economic growth and soaring demand by sectors like infrastructure, real estate and automobiles, at home and abroad, has put Indian steel industry on the global map. According to the latest report by International Iron and Steel Institute (I ISI), India is the seventh largest steel producer in the world. A foundry is a casting manufacturing system. Casting is the process of forming objects by pouring liquid metal into prepared mould and allowing the melt to solidify. Foundry is a factory which produces metal castings from either ferrous or non- non-ferrous alloys. Metals are turned into parts by melting the metal into a liquid, pouring the metal in a mould, and then removing the mould material or casting. The most common metal alloys processed are aluminium and cast iron. However, other metals, such as steel, magnesium, copper, tin, and zinc, can be processed. The foundry operations generate different kinds of air pollution, depending upon the kinds of furnace in use and the kinds of energy inputs that they use. Foundry is one of the most energy intensive metallurgical industries. Various sections of Foundry namely Pattern making, moulding, melting, core making, compressed air etc. consume energy in the form of electricity or through burning of fuel. Among these largest amount of energy to the tune of 65 – 70 % of the total Foundry energy is consumed in melting operation. As the Foundries are growing with mechanization and automation, the requirement of energy is also increasing day by day. On the other hand today the whole world is frightened of climate change and global warming due to $CO_2$ generation from burning of fuel as source of energy or for producing electricity.

**Keywords:** Infrastructure, Casting, Foundry, moulding, $CO_2$

## I. INTRODUCTION

In foundries, molten metals are cast into objects of desired shapes. Castings of iron, steel, light metals (such as aluminium), and heavy metals (such as copper and zinc) are made in units that may be independent or part of a production line. Auto manufacturing facilities usually have foundries within their production facilities or as ancillaries. The main production steps include:

- Preparation of raw materials
- Metal melting
- Preparation of moulds
- Casting

Finishing (which includes fettling and tumbling).

Electric induction furnaces are used to melt iron and other metals. However, large car component foundries and some small foundries melt iron in gas or coke-fired cupola furnaces and use induction furnaces for aluminium components of engine blocks. Melting capacities of cupola furnaces generally range from 3 to 25 metric tons per hour (t/hr.). Induction furnaces are also used in zinc, copper, and brass foundries. Electric arc furnaces are usually used in stainless steel and sometimes in copper foundries. Flame oven, which burns fossil fuels, are often used for melting nonferrous metals. The casting process usually employs non-reusable moulds of green sand, which consists of sand, soot, and clay (or water glass). The sand in each half of the mould is packed around a model, which is then removed. The two halves of the mould are joined, and the complete mould is filled with molten metal, using ladles or other pouring devices. Large foundries often have pouring furnaces with automatically controlled pouring. The mould contains channels for introducing and distributing the metal a "gating system." For hollow casting, the mould is fitted with a core. Cores must be extremely durable, and so strong bonding agents are used for the core, as well as for the moulds themselves. These bonding agents are usually organic resins, but inorganic ones are also used. Plastic binders are being used for the manufacture of high-quality products. Sand cores and chemically bonded sand moulds are often treated with water-based or spirit-based blacking to improve surface characteristics. Aluminium and magnesium, as well as copper and zinc alloys, are frequently die-castor gravity-cast in reusable steel moulds. Finishing processes such as fettling involves the removal from the casting of the gating system, fins (burrs), and sometimes feeders.

## II. METHODS AND MATERIAL

### A. Foundry

### 2.1 Manufacturing process

A generalized block flow diagram of the sand casting process is shown in Figure 2.1. The sand casting process begins with patternmaking. A pattern is a specially made model of a component to be produced. Sand is placed around the pattern in a split container, called a flask, to make a mild. Melds are usually produced in two halves so that the pattern can be easily removed. When the two halves are reassembled, a cavity remains inside the mild in the shape of the pattern. Cores are made of sand and a binder and must be strong enough to be inserted into a mold.Cores shape the interior surfaces of a casting that cannot be shaped by the mild cavity surface. The patternmaker supplies core boxes which are filled with specially bonded sand for producing precisely dimensioned cores. Cores are placed in the mild, and the mild disclosed. Molten metal is then poured into the mild cavity, where it is allowed to solidify within the space defined by the sand mild and core. The melds used in sand casting consist of a particulate refractory material (sand) that is bonded together to hold its shape during pouring. The most common type of melding process is green sand melding. Green sand is typically composed of sand, clay, carbonaceous material and water. Sand constitutes 85 to 95 present of the green sand mixture. Often the sand is silica, but olivine and zircon are also used. Approximately 4 to10 present of the mixture is clay. The clay acts as a binder, providing strength and plasticity.

The foundry or metal casting process begins with melting of the metal to be poured into foundry melds. During melting, the metal may be alloyed by the addition of other metals, refined when undesirable impurities are present or inoculated to improve their final solidification structure. Cupola, electric arc, induction, hearth (reverberator), and crucible furnaces are all used to melt metals. Once the molten metal has been treated to achieve the desired properties, it is tapped from the furnace and transferred to the pouring area in refractory-lined ladles. Sometimes the molten metal is poured directly from the furnace into a mild or melds without subsequent transfer by ladles. After cooling, risers and runners are removed from the casting using band saws, abrasive cut-off wheels, or arc cut-off devices. Parting line flash is removed with chipping hammers. Contouring of the cut-off areas and parting line is done with grinders. Castings may be repaired to eliminate defects by welding, brazing or soldering.

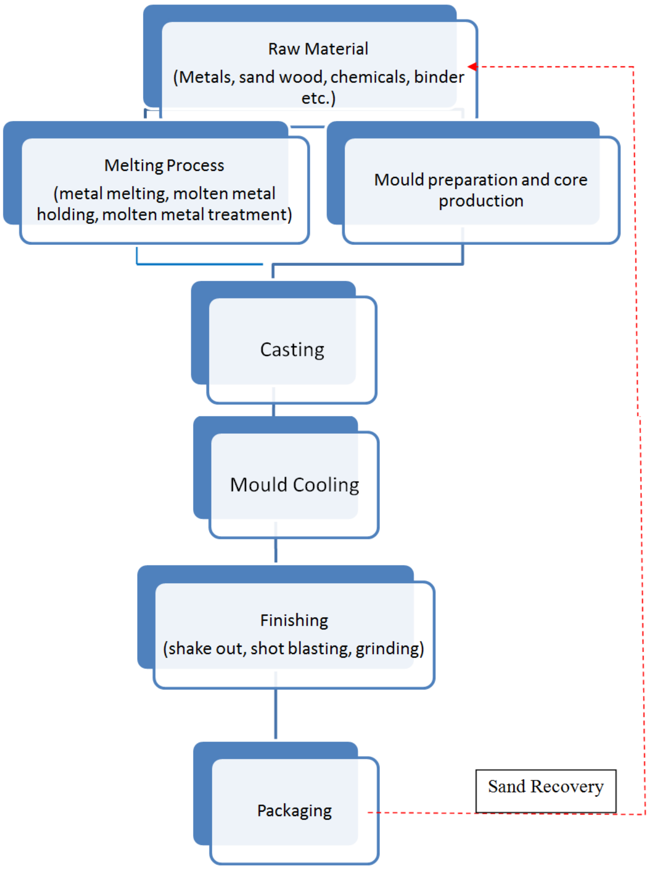


**Figure 1 :** Flow Diagram for Casting Manufacturing Process.

### 2.2 Sources of Waste

Product castings manufactured by foundries generate the following wastes:

- Spent system sand from melding and core making operations and used core sand Not returned to the system sand (sweepings, core butts)

- Investment casting shells and waxes
- Cleaning room waste (spent shot, grinding wheels, dust)
- Dust collector and scrubber waste
- Slag
- Miscellaneous waste.

### 2.2.1 Spent Foundry Sand

Most foundries reuse some portion of their core making and melding sand; in many cases most of the sand is reused. Green sand is reused repeatedly. Fines build up as sands are reused, and a certain amount of system sand must be removed regularly to maintain the desired sand properties. The removed sand, combined with the sand lost to spills and shakeout, becomes the waste sand. Dust and sludge produced from melding sand are often collected as part of an air pollution control system located over the melding and shakeout operations. Waste canals are in the form of large clumps that are screened out of the melding sand recycle system or in the form of sand that has been cleaned from the castings.

### 2.2.2 Investment Casting Waste

Investment casting shells can be used only once and are disposed of in landfills as a non-hazardous waste unless condensates from heavy metal alloy constituents are present in the shells. Waxes that are removed from the casting shells can be recycled back into wax sprees and runners for further reuse or can be sent to a wax recycling operation for recovery.

### 2.2.3 Cleaning Room Waste

Cleaning room waste that is ultimately disposed of in a landfill includes used grinding wheels, spent shot, floor sweepings and dust from the cleaning room dust collectors. This waste may be hazardous if it contains excessive levels of toxic heavy metals.

### 2.2.4 Dust Collector and Scrubber Waste

During the melting process, a small percentage of each charge is converted to dust or fumes collected by bag houses or wet scrubbers. In steel foundries, this dust may contain varying amounts of zinc, lead, nickel, cadmium and chromium. Carbon-steel dust tends to be high in zinc and lead as a result of the use of galvanized scrap, while stainless steel dust is high in nickel and chromium. Dust associated with non-ferrous metal production may contain copper, aluminium, lead, tin and zinc. Steel dust may be encapsulated and disposed of in a permitted landfill, while non-ferrous dust is often sent to a recycler for recovery of metal.

### 2.2.5 Slag Waste

Slag is a relatively inert, glassy mass with a complex chemical structure. It is composed of metal oxides from the melting process, melted refractory's, sand, coke ash (if coke issued), and other materials. Slag may also be conditioned by fluxes to facilitate removal from the furnace. Hazardous slag may be produced in melting operations if the charge materials contain significant amounts of toxic metal such as lead, cadmium and chromium. To reduce the sulphur content of iron, some foundries use calcium carbide desulphurization in the production of ductile iron. The calcium carbide desulphurization slag generated by this process may be classified as a reactive waste.

### 2.2.6 Wastewaters

Cooling water, such as that from cooling of induction furnaces, is usually discharged to a storm sewer system without treatment. Most foundries generate little or no process wastewater. Water quenching baths, if employed, when purged or discarded, may require treatment depending on the nature of contaminants and regulations governing discharges. Storm water, if uncontaminated by contact with waste materials, such as spent foundry sand, usually can be discharged directly to municipal storm sewers.

### 2.2.7 Miscellaneous Waste

Most foundries generate miscellaneous waste that varies greatly in composition, but makes up only a small percentage of the total waste. This waste includes welding materials, waste oil from forklifts and hydraulics, empty drums of binder and scrubber lime.

## 3. Process

### 3.1.1 Raw Material Receipt

Raw metal is primarily in the form of metal and alloy ingots with any further treating or alloying occurring in the melting furnace. The use of ingots, as opposed to scrap, as feed, keeps emissions from the melting furnace at a low level.

### 3.1.2 Pattern Tooling

The patterns of different moulds to be casted are prepared with help of different machines such as lathe, grinders etc. These patterns are thoroughly checked as the quality of product depends on these patterns.

### 3.1.3 Moulding & Core Shop

In this part, different moulds of sand are prepared according to the requirements of the part. The sand used for making moulds is recycled thus minimising the solid waste generated.

### 3.1.4 Liquid Metal Pouring

Different raw materials such as Pig Iron, Mild steel, Etc. are melted in an electric arc furnace. This molten metal is then poured into different moulds to give them the desired shape.

### 3.1.5 Cooling

The metal casting and the sand mould is separated in a separator and the sand is then carried to the sand depot where it is cooled and reused to make the mould. The ready casting is then passed on to the cooling tower where small water droplets are sprayed so as to bring down the temperature of the casting.

### 3.1.6 Dispatch and Delivery

The casting is the carried to the dispatch shop where final finishing such as shot blasting; grinding is done in order to make the finishing of the product very smooth. This finished product is then dispatched through the trucks.

## III. RESULT AND DISCUSSION

### Effluent Treatment Plant

Foundry effluent contains soluble organics, suspended solids, trace organics. All these components contribute largely towards their high biological oxygen demand (BODS) and chemical oxygen demand (COD). Foundry wastes are dark black in colour and usually slightly alkaline in nature and become acidic quite rapidly due to the addition of different oils. The characteristics of a dairy effluent contain Temperature, Colour, PH (6.5-8.0), DO, BOD, COD, Dissolved solids, suspended solids, chlorides, sulphate, oil & grease. Uncontaminated cooling water is usually discharged to municipal storm sewers or ditches. Some foundries employ static water quench tanks. The frequency of static quench tank dumps, quench water characteristics when dumped and receiving facility or medium are unknown. One foundry has a permit for the discharge of process wastewater to a ditch after clarification and oil separation.The operation of the ETP is such that it will give an effluent of such standard, prescribed by the Maharashtra Pollution Control Board (MPCB). The following prescribed standard by the board or under EP Act, 1986.

Table 1: Norms for Foundry.

| Sr. No. | Parameters | Standards Prescribed by Board |
|---|---|---|
| | | Limiting concentration in mg/l, except for pH |
| **1.** | **pH** | 6-9 |
| **2.** | **Oil & Grease** | <10 |
| **3.** | **BOD (3 days 27$^0$C)** | 25 |
| **4.** | **Suspended Solids** | 100 |
| **5.** | **COD** | <250 |

Padmavati Castings Pvt. Ltd. has provided an ETP in order to treat the waste water coming out of the foundry. This water is recycled and reused for different purposes such as cooling tower, gardening, etc. The units of the ETP are:

1. Equilization Tank
2. Settling Tank
3. Sludge Drying Beds

The flow diagram of the ETP is shown in the diagram below (fig 2).

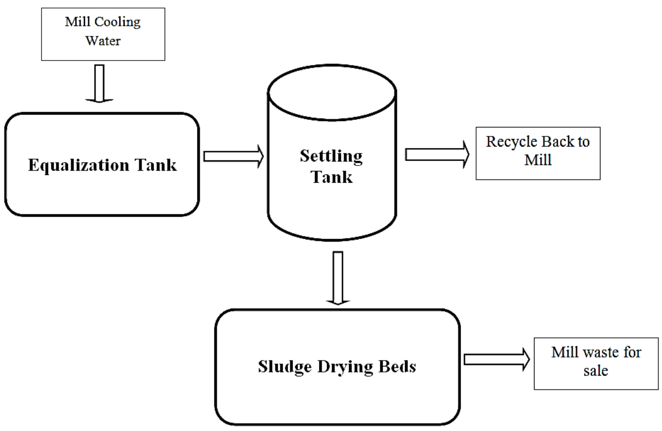


**Figure 2 :** Process Flow Diagram of ETP of Industry

### A. Equalisation Tank

ETPs are usually designed to treat wastewater that has a more or less constant flow and a quality that only fluctuates within a narrow range. The equalization tank overcomes this by collecting and storing the waste, allowing it to mix and ensuring that it becomes less variable in composition before it is pumped to the treatment units at a constant rate. The purpose of equalization for industrial treatment facilities are therefore:

- To minimize flow surges to physical-chemical treatment systems and permit chemical feed rates that are compatible with feeding equipment.
- To help adequate pH control or to minimize the chemical requirements necessary for neutralization.
- To provide continuous feed to biological systems over periods when the manufacturing plant is not operating.
- To prevent high concentrations of toxic materials from entering the biological treatment plant.The purpose of providing equalization tank is that self-neutralization & dilution will take place due to discharge of regeneration cycles& cooling water blow down. Oil and grease if any, will be skimmed off from top. After collection in equalization tanks the waste water will be pumped to neutralization tanks. Depending upon pH, addition of acid (H2SO4) or alkali (lime solution) will be done. The contents of neutralization will be stirred for at least one hour.

### B. Settling Tank

After neutralization tank, the waste water will be allowed to settle in a setting tank of about 6 hours retention period. There claimed water is used for slag cooling / or land irrigation.

### C. Sludge Drying Beds

The sludge drying beds are used for dewater the settled sludge. The excess sludge from the clarifier is discharged to sludge drying beds at intervals so that the concentration of MLSS is maintained in aeration tank. These are the sand beds of 250 mm of sand over about equally thick well-graded gravel layer, underlain by perforated drainage lines spaced 2.5 to 6 m apart. The bed should slope towards the discharge end at rate of 1 in 200.

### D. Economic Consideration

The costs of wastewater treatment are a factor of the major importance for the selection the appropriate treatment system. Estimates should be made the investment costs and the expected annual costs. The investment costs are largely determined by construction costs will depends on the price of the energy and chemicals required for the operation of the plant, the discharge fees and the capital costs on investment. A problem for the estimation of the costs of treatment plants is that prices are rapidly changing. Cost estimates should therefore be referenced to an index.

## IV. CONCLUSION

The study concerned with the ETP for Foundry Industry. It can be concluded that, the overall performance of the effluent treatment plant was satisfactory. The individual units are also performing well and their removal efficiencies are satisfactory. The treated effluent meets the MPCB standard for discharge in inland surface water hence it can be said that the plant is working efficiently. This treatment plant is high potential for, reduction for pH, Temperature, TDS, and COD.

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