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Importance of Foundry

History and Development of Metal Casting

The casting of metals is one of the oldest industries in the world. This is evidenced by the fact that metal castings were made by the Egyptians about the year 4000 B.C. The huge columns that supported King Solomon's Temple are recorded as having been made of bronze, 9 metres high and 2.75 metres in diameter, the thickness of metal being about 100 millimetres. Throughout the history of the Greeks and Romans reference is made to the use of metal bells and ornaments for adornment of the ancient temples of worship.

A life size portrait made of cast bronze from Mesopotamia dates back to about 2250 B.C. By the end of the medieval period, decorated bronze castings were seen in the European church and domestic life. Earlier castings of cast iron were perhaps those of common shots and grave slabs.

The first use of metal, because of its beauty, was for ornamental purposes, and, as man became more familiar with it, he developed it for use as a weapon to protect his family against enemies.

Craftsmen have been making metal casting for either artistic or utilitarian purposes for more than five thousand years. Specimens, which cover this period, are housed in museums throughout the world, not for portraying the development of foundry industry but for illustrating the art of ancient China, the earliest types of machinery, medieval kitchenware, Roman civilization, etc.

The first foundry centre came into existence in the days of the Shang dynasty in China (1766-1822 B.C.). History of Greeks and Romans reveal the use of decorative ornaments and metallic bells. In about 1540, Biringuccio wrote on metal founding. Prior to that, founding was an art and a craft with all its secrets confined to certain families.

Development of the art of founding progressed slowly by the *'rule of thumb'* method until about the seventeenth century. Scientists began to study the peculiarities of the metal known as cast iron. Experiments with types of furnaces and fuels have been carried on contmuously since that time. Modern foundries and their products are the results of these experiments.

The first known cast iron casting made in America is reported to have been an iron cooking pot cast in the year 1642.

Reumur (1683-1757) worked on metal founding and produced malleable cast iron. He studied various factors which influenced the production of grey, white and mottled cast iron. In 1709, Abraham Darby succeeded in smelting in coke-fired blast furnace, which opened a route for large-scale use of cast iron in construction.

A number of cast iron foundries came into being after the Industrial Revolution in Britain. In 1 79, the collapse of the Tay Bridge made the people go beyond the rudimentary judgement of the moulders and study the founding variables and their effects on the structural properties.

Middle of twentieth century saw marked developments in founding. Newer techniques were invented, casting phenomenon could be understood better, more and more young men took interest and training in this field. Many engineering institutes started teaching metal casting as an independent subject.

Castings are made in innumerable alloys. But for commercial purposes, they fall into the following groups :

(*i*) Iron which includes ordinary grey iron, white iron, black heart and white heart malleable.

(*ii*) Special-purpose grey iron which includes Mechanite, spheroidal-graphite and all types of alloyed iron.

(*iii*) Steel, both plain carbon and alloyed.

(*iv*) Copper-base non-ferrous metals *e.g.*, brass, bronze, gunmetal, etc.

(*v*) Light alloys *e.g.*, aluminium and magnesium.

(*vi*) Miscellaneous groups *e.g.*, zinc-base die casting alloys and white metals.

The smallest commercial castings regularly made will weigh 2 gm, while the heaviest in Great Britain are ingot moulds weighing 100 to 160 tonnes. After being poured, these large castings will require about three weeks to cool down. For melting the above range of alloys, furnaces ranging from a tiny crucible to a tilting type open-hearth having a capacity of more than 100 tonnes, are used.

Most of castings are made in moulds compounded of green sand (*i.e.*, moist sand), dry sand, or specially-bounded sands (*i.e.*, by resin, linseed oil, or sodium silicate). Moulds are consolidated either by mechanical or hand ramming around a removable pattern, or by loam moulding.

Hollows are formed by inserting cores carrying the shape of the desired hollow. A mixture of dried sand and linseed oil, starch, dextrin, synthetic resin or proprietory bond is formed to the desired shape in a core box, then baked in an oven to form a hard transportable compact mass.

All castings are not made in sand. Thousands of tonnes of pipe castings are made by centrifugal process in metal moulds. Many new methods of bonding sands to form moulds and cores have been developed. Die-casting utilizes metal moulds and an advance on this is '*mounting of metal moulds on turntables*'.

Modern Foundries

The modern foundry is a well-organised business, efficiently operated to maintain quality as well as quantity production of castings at a low cost.

In order to maintain these standards modern buildings have been constructed to house the several departments in a manner that will provide efficient production. Mechanised units have been installed whenever possible to relieve the worker of great physical strain. Laboratories have been established in which tests are constantly being made of all materials used in the production of castings.

Much thought has been given to the physical conditions under which the foundry worker is to be employed, such as heating, lighting and ventilation. In general, the working conditions in the modern foundry compare favourably with those in all other industries.

Great developments have been made in the foundry industry during the last fifty years : One of the most promising of these new processes is the *'Shell-moulding system'* invented by Cronin in Germany during the World War II. It produces a casting of closer dimensional tolerances that is obtained in normal foundry practice, thus much reducing or even eliminating machining costs. The process finds its major use in the manufacture of small repetition castings.

Another development of recent years is the *'Carbon Dioxide (CO_2) Process'*, which admits of the hardening or setting of a mould or core form by gassing it with CO_2. Sand is compounded by adding sodium silicate. CO_2 converts it into a viscous material which hardens the mould or core in seconds. Considerable degree of mechanization has been applied to its operation on a repetitive scale for large and small moulds and cores.

"Lost Wax Process" has been greatly expanded to cover such work as the making of thousand of small components accurate as cast to hundredths of a millimetre. In modern process, material placed around wax-pattern (the investment) is such that, after processing (which involves the use of very high temperature baking), the casting is produced repetitively to accuracy possible only by machining.

With development of all types of moulding machinery, including those which lead to automation, there have been outstanding developments in core-blowing and in making of hollow cores by shell and CO_2 processes much in demanded in die-casting.

Inspection facilities have been reinforced by more powerful X-ray sets, gamma-radiography, mass spectrography, application of ultrasonics, etc.

Foundry can shape parts weighing from a few grams to hundreds of tonnes. A cast steel mill housing manufactured by British Steel Corporation weighed 200 tonnes whereas an investment casting for dental implant in cobalt-chromium alloy weighed only 9 grams.

In United States, foundry industry produces more than 30 million tonnes of castings every year and employs more than half a million people. There are more than 7000 foundries (both ferrous and non-ferrous).

Today, in India, there are more than 8000 foundries (both ferrous and non-ferrous). Indian ferrous foundries produce about 12.5 lac tonnes of castings. Big foundries in India are at :

(*i*) Hindustan Machine Tools Ltd., Bangalore (now it is Bengaluru).

(*ii*) Bharat Heavy Electricals Ltd., Bhopal.

(*iii*) Chittaranjan Locomotive Works, Aasansol.

(*iv*) Steel Plants at Durgapur, Rourkela and Bhilai.

Uses of Foundry to Modern Industry

Foundry work is a branch of engineering that deals with the melting of metals and the pouring of molten metal into moulds from which castings are obtained. Casting is one of the basic tools of shaping metals and alloys.

It is basic industry. Let us consider its importance in the world of today, which depends extensively upon metal and metal products. These products would be non-existent if it were not for the foundry, as we cannot obtain metal in a usable form from the earth.

The basic simplicity of casting process proved to be a boon for growth of foundry industries. Today, a wide variety of components from domestic use to space vehicles are produced by founding.

The conveniences enjoyed in the modern home depend largely on foundry products :

(*i*) Grey iron castings appear in the form of bath tubs, sinks, wash basins, soil pipe, furnaces, cooking utensils etc.

(*ii*) Brass and bronze castings are found in the form of hardware, parts of washing machines, and other household mechanical equipment.

(*iii*) Aluminium and magnesium castings appear in the form of cooking utensils and parts of refrigerators, food mixers and vacuum cleaners.

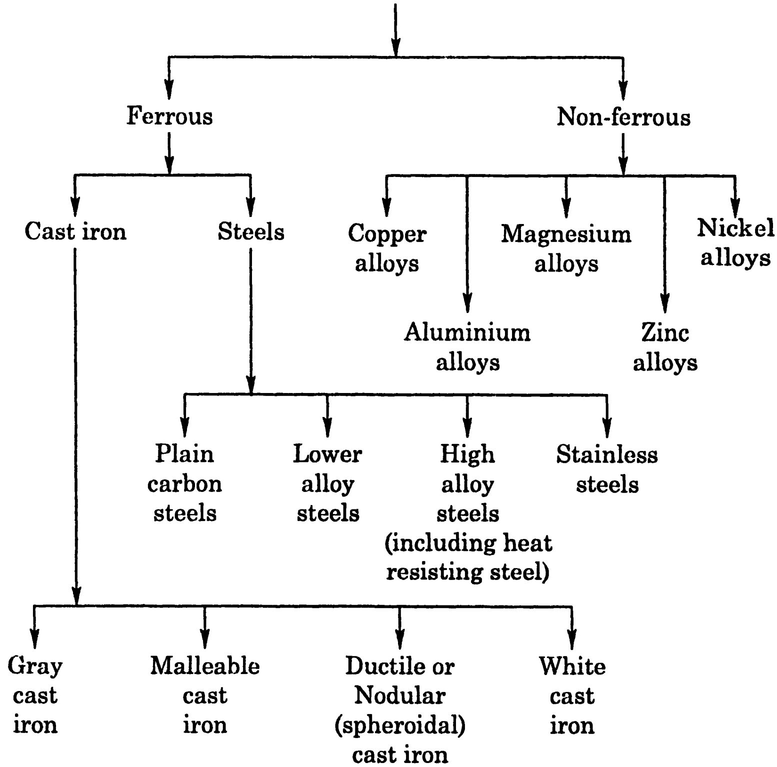
(*iv*) Our modern land, sea and air transportation systems depend upon castings for their operation. An average automobile has 300 kg or more of cast metal parts in its construction.

Modern communication and lighting systems would be impossible without castings. Modern civilization would not be so far advanced as it is today if it were not for the foundry and its products.

The foundry industry is a progressive one, always, looking ahead, and, as it improves, so will civilization.

CHART

Classification of Casting Metals and Alloys



Advantages of Casting Process

1. Products with intricate shapes are produced at a cheaper rate.

2. The process of casting if done with accuracy reduces the machining time.

3. Certain metals and alloys, due to their metallurgical properties cannot be shapped by mechanical working but these can be cast easily. Cast iron is difficult to fabricate because of its brittle behaviour but can be easily cast into different shapes.

4. The casting technique is simple, as the number of operations in this technique are less.

5. The total per unit of production is less as it gives faster rate of production.

6. The wide range of alloys having different compositions and properties can be cast easily.

7. In some light metals, strength, lightness and good bearing qualities can only be produced by casting.

8. It is possible to make a cast-weld product. Complicated parts can be cast as 2 or 3 pieces and then joined by welding.

9. Castings weighing a few grams to several tonnes can be produced. Hence size is not a limitation.

10. As the metal can be placed exactly where it is required, large saving in weight is obtained.

11. This process is ideally suited to the production of models or prototypes required for developing a new design.

Disadvantages

1. This process is not economical, when parts casted are very small in *quality*.

2. Casted products are susceptible to defects like blow holes, hob tears, porosity and shrinkage etc.

The complete process of producing castings is divided into five stages, these are :

(*a*) Pattern making

(*b*) Moulding and core making

(*c*) Melting and casting

(*d*) Fettling

(*e*) Testing and inspection

Each process is explained in detail in the subsequent chapters of the book.

QUESTIONS

1. Give the main advantages and disadvantages of the casting process over other methods of fabrication.
2. Explain the main stages by which the metal flows in a foundry.
3. Describe in what circumstances casting will prove to be the most economical manufacturing process.
4. Give the applications of casting process.
5. Explain in short the history of foundry.