5.1 Introduction

Casting is one of the oldest methods of manufacturing and even today it finds extensive applications in manufacturing industries.

In casting, metals or alloys are initially heated to melt them. The molten metal is then poured into a mould cavity, where it is allowed to solidify. After solidification, the product is taken out of the mould cavity and subjected to finishing operation as per requirement. The term casting is used to describe both the process and the product. Usually the mould is made of sand and the method of casting using sand mould is called sand casting.

Casting can produce complex shapes (internal or external), parts with hollow sections or internal cavities and parts having irregular curved surfaces. It can also make parts which are difficult to produce by any other methods. It offers high production rate with improved material properties, produces good surface finish and ensures close dimensional tolerances.

Casting parts have good compressive strength but poor tensile strength. Important casting materials include cast iron, copper alloys, aluminium, zinc, nickel and magnesium.

Pulleys, flywheels, engine blocks, crankshafts, pistons, carburetors, railroad wheels, machine tool beds, gear blanks and turbine blades are some of the important casting products.

There are many casting processes available today and the selection of the best method to produce a particular part depends on several basic factors, such as cost, size, finish (surface finish), production rate, tolerance, section-thickness, physical-mechanical properties, intricacy or design, machinability and weldability.

5.2 Casting Terminology

A ***moulding flask*** is a box that contains the moulding aggregate. In a two piece mould, *cope* refers to the top half of the pattern, flask, mould or core and drag, the bottom half of any of these features. The seam between them is called ***parting line*** or ***parting surface*** (Figure 5.1). When more than two pieces are used, the additional part is called cheek.

-A pattern may be defined as a model or replica of desired casting which when mould in sand forms an impression called mould.

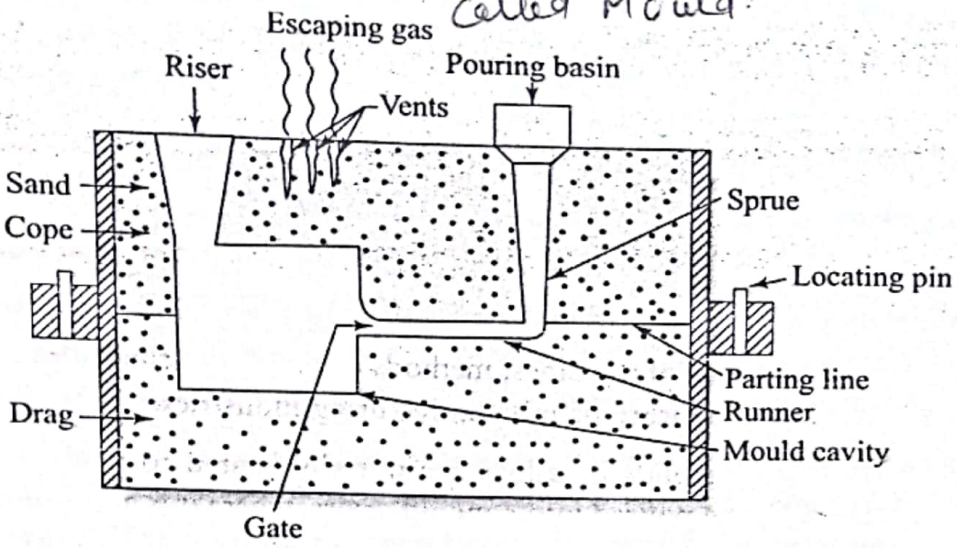

Figure 5.1: Cross-section of a sand mould

A *pattern* is the replica of the part to be cast. It is used to mould the sand mixture into the shape of the casting. The moulding material (usually sand) is packed around the pattern and then the pattern is removed to produce a mould cavity exactly of the size of the casting to be produced. A pattern may be made of wood, plastic or metal. The selection of a pattern material depends on the following factors :

- Size and shape of the casting,
- Desired dimensional accuracy,
- Number of castings to be produced, and
- Moulding process to be used

Since patterns are used repeatedly to make moulds; the strength and durability of the material selected for patterns are very important. Patterns are usually coated with a parting agent to facilitate their removal from the moulds. Pattern may be ***removable*** or ***disposable*** type.

In case of casting using removable pattern, sand is packed around the pattern. Later the pattern is removed and the cavity thus produced is filled with molten metal.

A removable pattern may be made of wood, plastic or metal. Disposable patterns are made from polystyrene (a type of plastic) and, instead of being removed from the sand, are vaporized when the molten metal is poured into the mould.

The following advantages are obtained using a disposable pattern:

- The process is fast since it consumes less time.
- No pattern allowances are required.

- Castings have better surface finish.
- No cores are required.
- Moulding is greatly simplified.

The disadvantages include the following:

- The pattern is lost in the process.
- Patterns are more delicate to handle.

A *mould* refers to a void created in a compact sand mass which, when filled with molten metal, will produce a casting. Obviously, it is the impression left behind by a pattern after the withdrawal of the latter from the mould. Mould can also be defined as an assembly of two or more metal blocks and is used to produce castings of good surface finish and detail. The *mould cavity* lies within the mould and holds the liquid material. A mould may be made of metal, plaster, ceramics and other refractive substances. The mould made of sand is called sand mould and is the most widely used type of mould in the foundry shop. The process of producing the mould or cavity is known as moulding.

Pouring Basin (Cup) is a small funnel shaped cavity at the top of the mould which contains the molten metal for casting.

Sprue is the vertical passage connected to the pouring basin through which the molten metal flows downward, hence also called downsprue.

Runner is the horizontal channel in the parting line to carry the molten metal from the sprue to the mould cavity.

Gates are the inlets into the mould cavity.

Gating system is the network of channels used to deliver the molten metal into the mould cavity. It consists of pouring basin, sprue, runner and gate.

Vents are the small openings in the mould to carry off gases when the hot molten metal comes into contact with the sand in the moulds and core. They also exhaust air from the mould cavity as the molten metal flows into the mould.

Core is a sand mass, which is inserted into the mould to produce identical shaped regions such as holes or passages for water cooling or otherwise define the interior surface of the casting. Cores are also used on the outside of the casting to form features such as lettering on the side of a casting or deep external pockets.

They are placed in the mould cavity before casting to form the interior surfaces of the casting and are removed from the finished part during shakeout

and further processing. Like moulds, cores must possess strength, permeability, ability to withstand heat and collapsibility. Therefore, cores are made of sand aggregates.

Core Box is the mould or die which is used to produce casting cores.

Core Prints are the projected parts added to the pattern, core or mould and are used to locate and support the core within the mould.

Riser is a reservoir of molten metal, which supplies additional metal to the casting so that hot molten metal can flow back into the mould cavity when there is a reduction in the volume of metal due to solidification.

If the riser is contained entirely within the mould, it is known as a *blind riser*, and if it is open to the atmosphere, it is called an *open riser* (conventional riser). The open riser derives feeding pressure from the atmosphere and from the force of gravity on the metal contained in the riser. Since the blind riser is closed from all sides, there is no question of atmospheric pressure. The pressure due to the force of gravity is also reduced due to the formation of vacuum within its body. Due to its permeable nature, air is able to enter the riser and exert some pressure. Sometimes, to create artificial pressure in the blind riser some explosive material is used which explodes while coming in contact with the molten metal, creating high pressure within the riser.

Blind risers are also known as ***side risers*** since they are horizontally located adjacent to the mould cavity usually along the parting line. An ***open riser*** also called ***top riser*** is one that sits on the top of a casting. Because of their location, top risers have shorter feeding distances and occupy less space within the flask.

The ***blind riser*** has the following advantages :

- The hottest metal lies in the riser and the coldest in the casting. This promotes directional solidification.
- A blind riser can be smaller than a comparable open riser.
- Blind risers can be removed more easily from a casting.

Risers may not be always required. For alloys with large freezing ranges, the risers would not be particularly effective, and one generally accepts the fine, dispersed porosity. Die casting, low pressure permanent moulding and centrifugal casting are the processes, where no risers are required and the positive pressures provide the feeding action that is required to compensate for solidification shrinkage.

A common problem with cores is that for certain casting requirements as in the case, where a recess is required, they may lack sufficient structural support

in the cavity. To keep the core from shifting, metal supports, known as ***chaplets***, may be used to anchor the core in place.

Chills are metallic objects of high-heat capacity and high thermal conductivity, which are placed in the mould or mould cavity to increase the cooling rate of castings or to provide uniform or to promote directional solidification. When the casting consists of both thick and thin sections, the thinner sections tend to solidify earlier than the thicker ones. This differential cooling rate produces uneven contraction of parts and gives rise to internal strains in the metal. It may even produce cracks, if the cooling of thinner parts is too severe. For rapid solidification of heavy sections and the achievement of directional solidification, chills are commonly used.

External chills are placed in the mould (adjacent to the casting). They can often be used to reduce the number of risers (by retarding the solidification process) required for a casting.

Internal chills are placed within the mould cavity to absorb heat and promote more rapid solidification. Since some of the chill metals will melt during the operation, it will absorb not only the heat-capacity energy, but also some heat of fusion. ***Internal chills*** must be made of same material as used for casting because they ultimately become part of the final casting.

Castability of a material is defined as the ease with which a metal can be cast into useful products. Important factors affecting casting include solidification rate, shrinkage, gas porosity and others. Gray cast iron has the best castability among the cast iron group, since it has high fluidity and slow solidification rate.

5.3 Types of Moulds and Moulding Processes

Sand moulds are classified on the basis of types of sand and the methods used to produce them. The following are the important types of moulds and moulding processes.

- The most common mould material is green sand which is nothing but a natural sand and the mould prepared by using green sand is called ***green sand mould***. The sand is called *green* not because of its colour but because of its water content. Green sand is a mixture of silica sand, clay and water and the moulding process using this sand is known as ***green sand moulding***, which is a least expensive method of making moulds.
- In the ***skin-dried moulding***, the mould surfaces are dried to a depth of about 25 mm or more, either by drying the mould with gas torches and heaters or by storing the mould in air (***Air-dried moulding***). *Skin-dried*