

# **Steel melting and casting process:**

**A) Steel melting by induction furnace process.**

**B) CONTINUOUS CASTING MACHINE (CCM):**

## A) STEEL MELTING BY INDUCTION FURNACE – PROCESS:

The greatest advantage of the Induction Furnace is its low capital cost compared with other types of Melting Units. Its installation is relatively easier and its operation simpler. Among other advantages, there is very little heat loss from the furnace as the bath is constantly covered and there is practically no noise during its operation. The molten metal in an Induction Furnace is circulated automatically by electromagnetic action so that when alloy additions are made, a homogeneous product is ensured in minimum time. The time between tap and charge, the charging time, power delays etc. are items of utmost importance are meeting the objective of maximum output in tones/hour at a low operational cost. The process for manufacturing steel may be broadly divided into the following stages:

- ⇒ Melting the charge mixed of steel & Iron scrap.
- ⇒ Ladle teeming practice for Casting (OR)
- ⇒ Direct teeming practice for Ingot Casting unloadable teeming machine.

### | CORELESS INDUCTION FURNACE

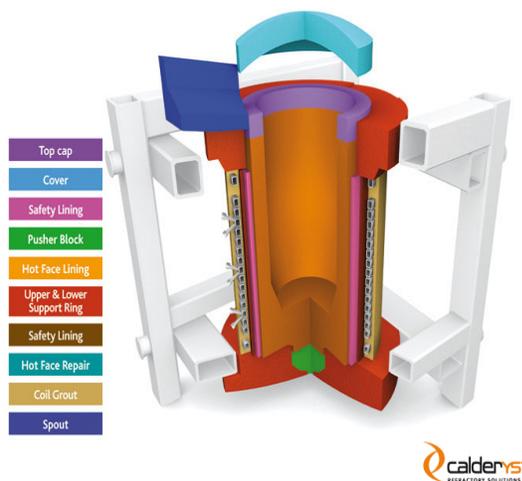


Fig. 1 Induction Furnace Parts



Medium Frequency Induction Melting Furnace

Fig. 2 Induction Furnace

## 1- Melting The Charge

The furnace is switched on, current starts flowing at a high rate and a comparatively low voltage through the induction coils of the furnace, producing an induced magnetic field inside the central space of the coils where the crucible is located. The induced magnetic fluxes thus generated out through the packed charge in the crucible, which is placed centrally inside the induction coil.

As the magnetic fluxes generated out through the scraps and complete the circuit, they generate and induce eddy current in the scrap. This induced eddy current, as it flows through the highly resistive bath of scrap, generates tremendous heat and melting starts. It is thus apparent that the melting rate depends primarily on two things (1) the density of magnetic fluxes and (2) compactness of the charge. The charge mixed arrangement has already been described. The magnetic fluxes can be controlled by varying input of power to the furnace, especially the current and frequency.

In a medium frequency furnace, the frequency range normally varies between 150-10K cycles/second. This heat is developed mainly in the outer rim of the metal in the charge but is carried quickly to the center by conduction. Soon a pool of molten metal forms in the bottom causing the charge to sink. At this point any remaining charge mixed is added gradually. The eddy current, which is generated in the charge, has other uses. It imparts a molten effect on the liquid steel, which is thereby stirred and mixed and heated more homogeneously. This stirring effect is inversely proportional to the frequency of the furnace and so that furnace frequency is selected in accordance with the purpose for which the furnace will be utilized.

The melting continues till all the charge is melted and the bath develops a convex surface. However as the convex surface is not favorable to slag treatment, the power input is then naturally decreased to flatten the convexity and to reduce the circulation rate when refining under a reducing slag. The reduced flow of the liquid metal accelerates the purification reactions by constantly bringing new metal into close contact with the slag. Before the actual reduction of steel is done, the liquid steel which might contain some trapped oxygen is first treated with some suitable deoxidizer. When no purification is attempted, the chief metallurgical advantages of the process attributable to the stirring action are uniformity of the product, control over the super heat temperature and the opportunity afforded by the conditions of the melt to control de-oxidation through proper addition.

As soon as the charge has melted and de-oxidising ions have ceased, any objectionable slag is skimmed off, and the necessary alloying elements are added. When these additives have melted and diffused through the bath of the power input may be increased to bring the temperature of metal up to the point most desirable for pouring. The current is then turned off and the furnace is tilted

for pouring into a ladle. As soon as pouring has ceased, any slag adhering to the wall of the crucible is scrapped out and the furnace is readied for charging again.

As the furnace is equipped with a higher cover over the crucible very little oxidation occurs during melting. Such a cover also serves to prevent cooling by radiation from the surface heat loss and protecting the metal is unnecessary, though slags are used in special cases. Another advantage of the induction furnace is that there is hardly any melting loss compared with the arc furnace.



Fig. 3 Melted Steel Surface

## 2- Ladle Teeming Practice

The molten metal from crucible taken out in a ladle by tilting the crucible and crucible is made free for further charge of next batch.



Fig. 4 Ladle Teeming Practice

### 3- Direct Teeming Practice

In addition to the bottom pouring Ladle Teeming process, Direct Teeming process can also be used as and when required. Direct teeming of liquid metal from induction furnace to mould assemble is another process of the Billet casting practice. In this process the mould assemble comprising bottom plate; Billet mould and trumpet properly lined with refractories are placed on top of a rail bound transfer trolley moving across in front of the crucible which is supported properly from the furnace structure.

While teeming the mould bogie transfer car is so positioned that the trumpet of the mould assembly is properly aligned with the outlet nozzle of the tundish. The liquid metal from the spout is directed through the tundish to the trumpet for casting of Billets. After the teeming is over, the car is moved aside for stripping and removal of Billets. Normally two (2) such transfer cars are provided. While one is engaged for casting purposes the other is kept ready for next melt. Direct teeming practice obviates the use of stopper sleeve, stopper head and ladle refractory and requires only a nominal quantity of refractory for lining the tundish and thus affects substantial savings in refractory costs.



Fig. 5 Direct Teeming Practice

## **B) CONTINUOUS CASTING MACHINE (CCM):**

The molten steel from the IF or the ladle metallurgical facility is cast in a continuous casting machine (6/11 2 stand Billet Caster) to produce cast shapes including billets. In some processes, the cast shape is torch cut to length and transported hot to the hot rolling mill for further processing. Other steel mills have reheat furnaces. Steel billets are allowed to cool, and then be reheated in a furnace prior to rolling the billets into bars or other shapes.

**Castings operations consist of following: -**

- ⇒ **Preparation.**
- ⇒ **Match Plates (Patterns)**
- ⇒ **Preparation of Moulds**
- ⇒ **Pouring of molten steel into prepared moulds**
- ⇒ **Solidification of molten steel**
- ⇒ **Knocking of moulds**
- ⇒ **Removal of runners & risers.**
- ⇒ **Finishing of castings/Ingots**

- 1.** The process is continuous because liquid steel is continuously poured into a 'bottomless' mould at the same rate as a continuous steel casting is extracted.
- 2.** Before casting begins a dummy bar is used to close the bottom of the mould.
- 3.** A ladle of molten steel is lifted above the casting machine and a hole in the bottom of the ladle is opened, allowing the liquid steel to pour into the mould to form the required shape.
- 4.** As the steel's outer surface solidifies in the mould, the dummy bar is slowly withdrawn through the machine, pulling the steel with it.
- 5.** Water sprays along the machine to cool/solidify the steel.
- 6.** At the end of the machine, the steel is cut to the required length by gas torches.

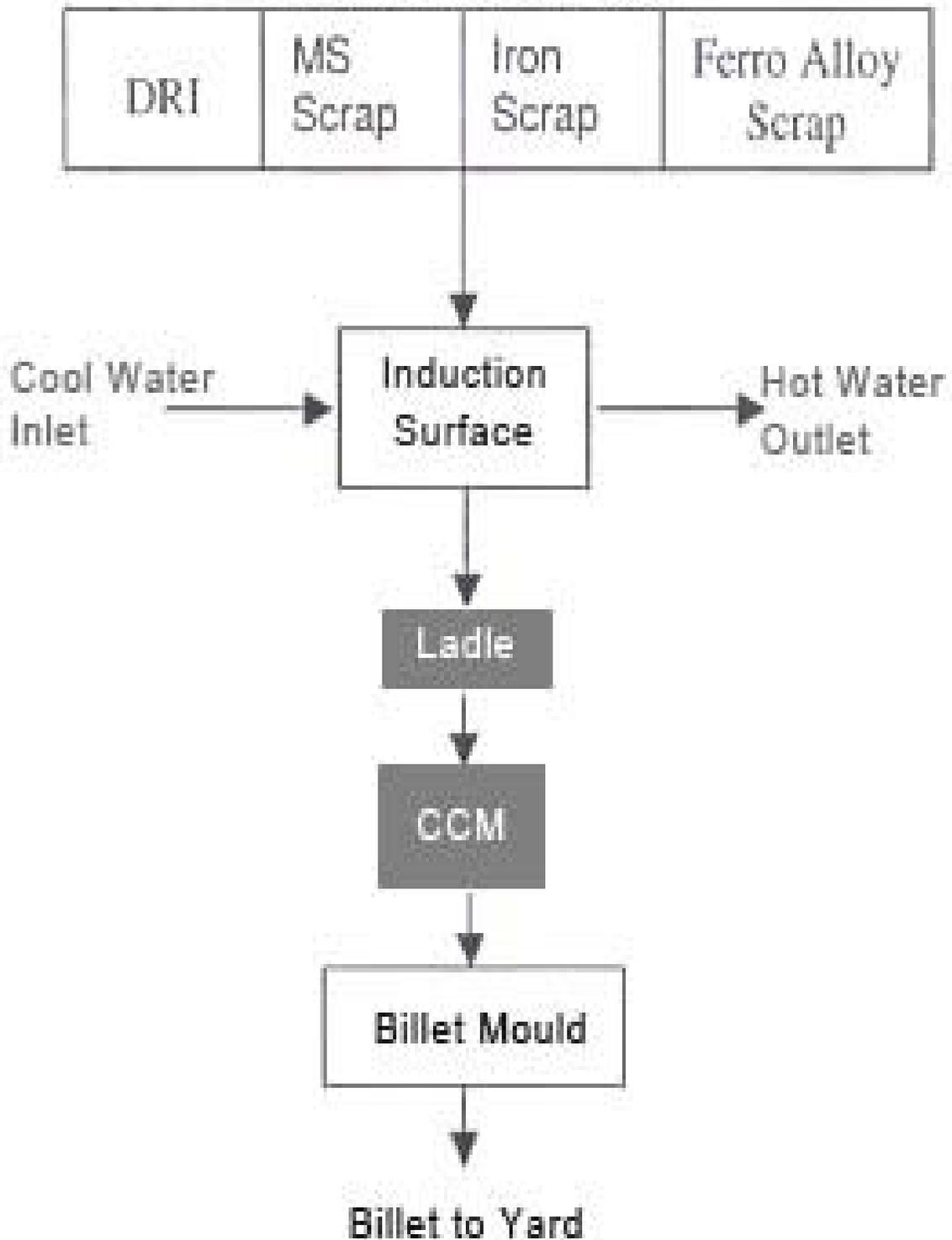


Fig. 6 CCM Line



Fig. 7 cutting by gas torches

## Raw Meterial Yard



Steel Milting and Casting Process Diagram