against the squeezer head. Thus, the flask with the pattern is squeezed between the squeezer head and the table. Then the table returns to its original position.

1.18.4 Sand Slinger

Moulding process is performed by using a sand slinger, as shown in Figure 1.40. In this, the pattern is placed on a board. The flask is placed over it. Now, the slinger is operated. The slinger has an impeller which can be rotated with different speeds. When the impeller rotates, it will throw a stream of sand at greater velocity into the flask. Hence, the sand is packed in the flask.

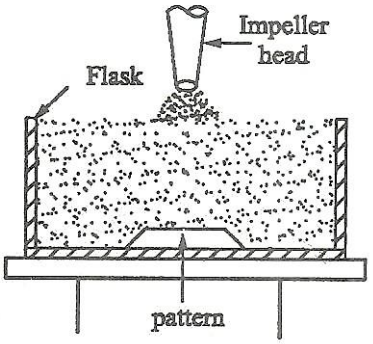

Figure 1.40 Sand Slinger

The slinger can be moved to pack the sand uniformly around the pattern. The density of sand is controlled by the speed of the impeller. In this method, the ramming will be uniform with good strength. It is used for large and medium size moulds.

1.19 Melting Furnaces

Various types of melting furnace are used in the foundry shop. The type of furnace used depends upon the type of metal and the quantity of metal to be melted. The metal melting furnaces used in foundries are:

1. Blast furnace – For smelting iron to produce pig iron
2. Cupola furnace – For cast iron
3. Open hearth furnace – For steel
4. Crucible furnace – For non-ferrous metal
    a) Pit type furnace
    b) Coke fired stationary furnace
    c) Oil fired tilting furnace
5. Pot furnace
6. Electric furnace
    a) Direct are furnace
    b) Indirect are furnace
    c) Induction furnace

1.19.1 Blast Furnace

A blast furnace shown in Figure 1.41 is a type of furnace used for smelting metal ore, usually iron ore. The combustion material and ore are supplied from the top while air flow is supplied from the bottom of the chamber, so that the chemical reaction takes place, not only at the surface throughout the ore. This type of furnace is typically used for smelting iron to produce pig iron, the raw material for wrought and cast iron.

Blast furnace is named so because very high temperature developed inside the furnace by means of forcing a blast of heated air. Its height is about 30 m and interior diameter is of 8 m.

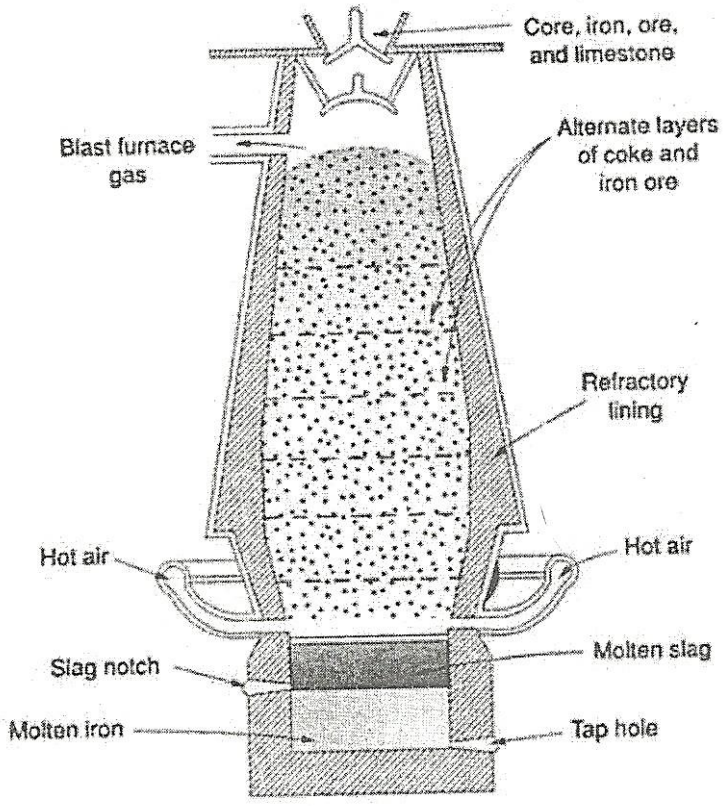

Figure 1.41 Blast Furnace

Working process

In this furnace the unwanted silicon and other impurities are lighter than the molten iron (pig iron) which is its main product. The furnace is builit in the form of a tall, chimney – like structure lined with refractory bricks. Coke, limestone and iron ore (iron oxide) are poured in at the top. Air is blown in through tuyers near the base. This "blast" allows combustion of the fuel. This reduces the oxide in the metal, which is being heavier sinks into the bottom of the furnace. The nature of reaction takes place inside the furnace is;

$$Fe_2O_3 + 3CO \;\; 2Fe + 3CO_2$$

More precisely, the compressed air blown into the furnace reacts with the carbon in the fuel to produce carbon monoxide, which then mixes with the iron oxide, reacting chemically to produce iron and carbon dioxide, which leaks out of the furnace at the top. The temperature in the furnace is typically about 1500°C, which is also enough to decompose limestone (calcium carbonate) into calcium oxide and additional carbon dioxide:

$$CaCO_3 \rightarrow CaO + CO_2$$

The calcium oxide reacts with various acidic impurities in the iron (notably silica), forming a slag containing calcium silicate, $CaSiO_3$ which floats on the iron.

The pig iron produced by the blast furnace is not very useful due to its high carbon content (around 4-5%) which makes it very brittle. It is used to make cast iron goods, often being remelted in a foundry cupola. The blast furnace remains an important part of modern production. Modern furnaces include Cowper stoves to pre-heat the blast air to high temperatures in order to avoid cooling (and the having re-heat) the mix they use fairly complex systems to extract the heat from the hot carbon dioxide when it escapes from the top of the furnace, further improving efficiency. The largest blast furnaces produce around 60,000 tonnes of the iron per week.

1.19.2 Cupola Furnace

This type of furnace is used for melting cast iron.

Construction

It is a vertical, cylindrical shell made of 10mm thick steel plate. It is lined with refractory bricks inside. Two bottom doors close the bottom of the cupola. A sand bed is laid over the bottom doors sloping towards the tap hole. Molten metal stays over this bed. The legs are set at the bottom of the furnace using a concrete. There is a tap hole for taking the molten metal. A plug made of clay closes the tap hole. The slag hole is provided in the shell above the tap hold. The slag floating over the molten metal is removed through this slag hole. The opening called tuyeres are provided one meter above the bottom. Fuel is supplied through these tuyeres for making complete combustion of fuel. There is a wind box and blower for the supply of air into the furnace. For charging the metal and fuel into the furnace, a separate charging door is made.

Preparation

The slag and waste from previous melting are cleaned. Broken bricks are repaired or replaced, if necessary. Then bottom doors are closed. A sand bed with sloping towards tap hole is prepared up to a height of 200 mm. a tap hole is formed and lined with clay. Then a slag hole is prepared. Finally, the cupola is dried thoroughly.

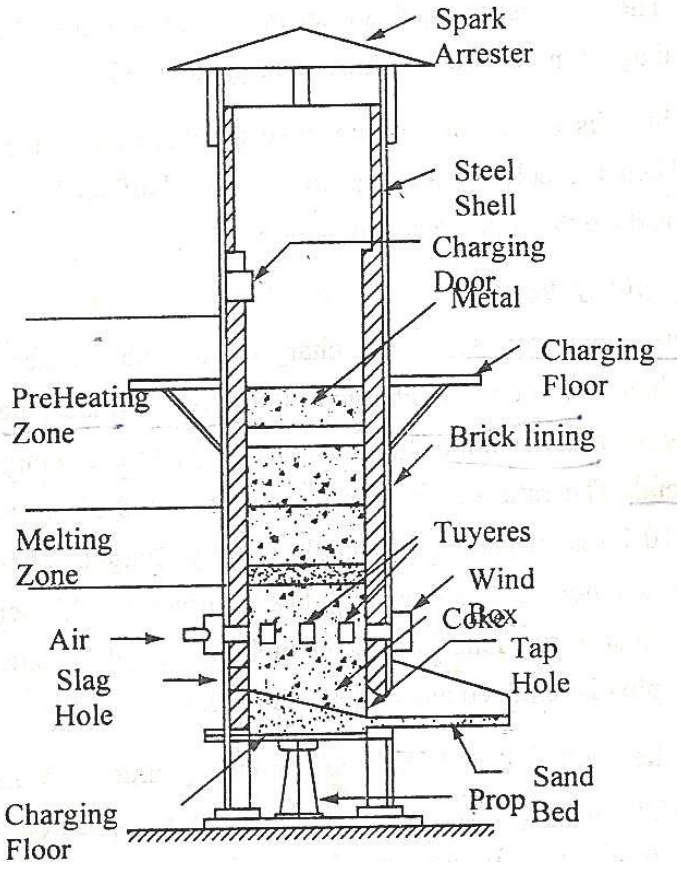

Figure 1.42 Cupola Furnace

Firing

Oil waste and wooden pieces are placed at the bottom and the fire is started. Now, the sufficient amount of air is supplied when the wood starts burning. The coke is charged at several portions. Now, the coke burns. Again and again more coke is added up to the tuyere level. The blast is turned off. Coke is again added up to the level of bed charge. Then, the coke is allowed to burn for half an hour. Finally, the charging is done through the changing door.

Charging and Melting

Pig iron and iron scrap are charged into the furnace through the charging door. Then coke is charged alternatively. Limestone is added to the charge to remove impurities and also to ensure thorough mixing of molten metal. The ration of pig iron to limestone and pig iron to coke are 25:1 and 10:1 respectively. The cupola is fully charged. Then, the iron is soaked for one hour. After that, the blast is turned on. The molten metal will begin to collect at the sand bed. After melting enough quantity of molten metal, clay plug is removed and collected in ladles.

Then the molten metal can directly be poured into moulds. The floating slag on the top layer of the molten metal is tapped out through the slag hole. Again the furnace should be charged to the full level for repeating the same procedure.

At the end, the cupola is shut off by stopping the air blast. Then, the remaining molten metal is removed, the bottom doors are opened, the wastes are dropped down and they are quenched by water.

Application

Cupola is used to melt cast iron.

Advantages

1. Initial cost is comparatively less than other type of furnaces.
2. It is simple in design.
3. It requires less floor area.
4. Operation and maintenance are simple.
5. It can be operated continuously for many hours.

1.20 PRINCIPLE OF SPECIAL CASTING PROCESSES

1.20.1 Shell Mould Casting

The shell mould casting is a semi-precise method for producing small castings in large numbers. The process involves the use of a match plate pattern similar to cope and drag patterns which are used in green sand mould casting.

Initially, the patterns are machined from copper alloys, aluminum or cast iron depending upon the lift of the pattern. They are made with usual allowances and polished surfaces. Then it is attached to the metal match plate.

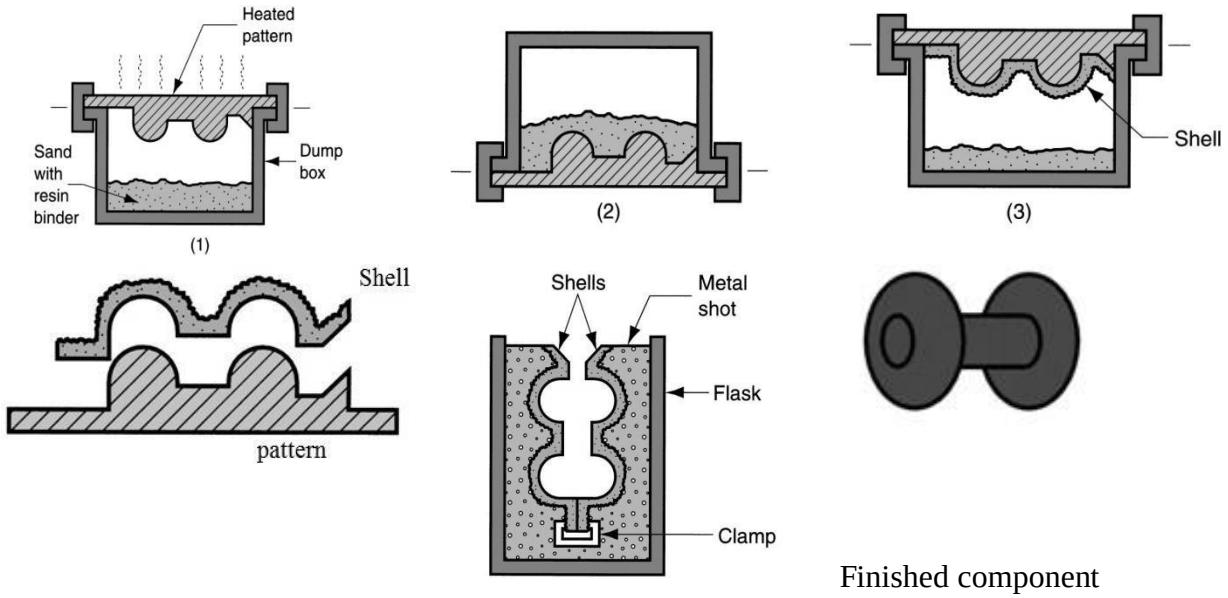

Figure 1.42 Shell Mould Casting

The mould material contains 5 to 10% of phenolic resin mixed with fine dry silica. These are mixed with either dry oil or alcohol. It should be noted that there is no water used.