L-5

CUPOLA

Pig Iron is not capable of being cast directly to give suitable castings for Engineering use.

Cupola used for remelting pig iron billets made from molten pig iron received from the blast furnace.

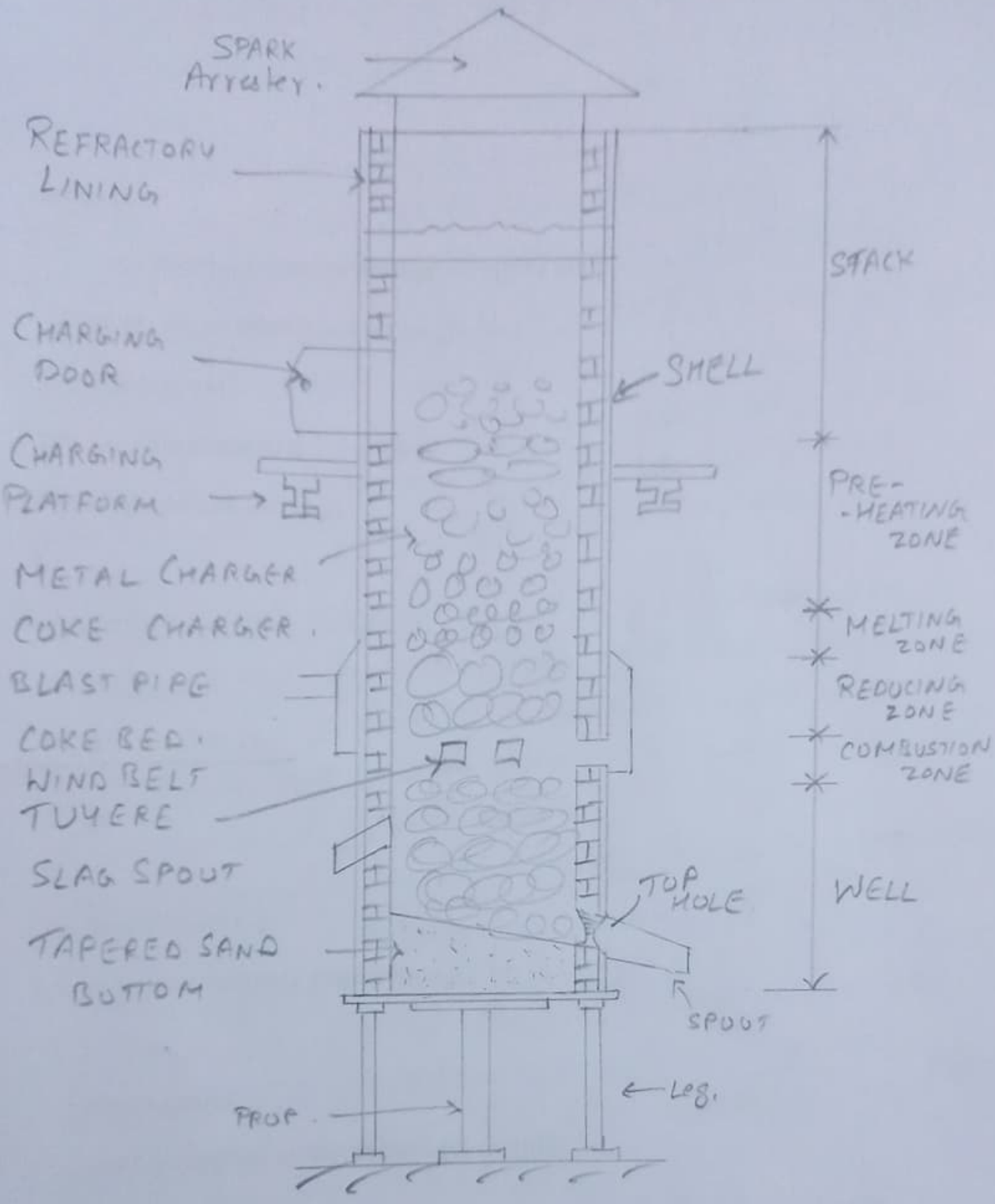
Pig Iron + Additives. → Cast Iron

Additives:
- Limestone (flux)
- Steel scrap
- Spoiled Casting
- etc.

Cast Iron:
- C → 2-4.5%
- Si → 1-3%
- S → 0.02-0.15%
- P → upto 1%
- Mn → 0.5 to 1.0%

* Very Brittle.
* has low resistence to tension. but is good in tension.
* Sufficiently hard. and cannot be worked with a hand file.
* has no plasticity. hence.
* Unsuitable for forging work.

Cast Iron is available in different forms, such as Grey Cast Iron
White Cast Iron.


SPARK Arrester.
REFRACTORY LINING
CHARGING DOOR
CHARGING PLATFORM
METAL CHARGER
COKE CHARGER.
BLAST PIPE
COKE BED.
WIND BELT
TUYERE
SLAG SPOUT
TAPERED SAND BOTTOM
PROP
SHELL
TOP HOLE
SPOUT
Leg.
STACK
PRE-HEATING ZONE
MELTING ZONE
REDUCING ZONE
COMBUSTION ZONE
WELL

Construction

It has a construction in the form of a hollow vertical cylinder mild steel plates and riveted or welded at the seams.

The lower portion is made of comparatively thicker plates so as to make it strong enough to hold the upper structure and fire brick lining.

* The Bottom Door of the shell can be in one piece, hinged at a supporting legs, or in two pieces.

When the cupola is in operation, the bottom door is supported by a prop so that it may not collapse due to the large weight of the charge and coke etc.

When the cupola is not in operation, air supply cut off and the prop removed, the door drops down providing a clear space for the coke fire, residue of the molten metal with slag and the sand bed to fall down.

* Wind Chamber or Wind Belt: The belt is connected to the furnace blower by means of a Blast pipe. The amount of air required is forced into the chamber by the blower, which enters the furnace through openings called Tuyeres.

Charging door is located at a suitable height above the charging platform.

* The top of the cupola is a cone shaped. facilitates a free escape of the waste gases at the same time deflects the dust back.

Small cupola → 500 kg to 10000 kg capacity] Cuppolettes.

Working

CHARGING THE CUPOLA

Preparation of the cupola

To start with, Examine the firebrick Lining. If any brick is noticed to have been burnt to the extent of being unusable, it is a replaced by a new brick.

After the repair of the lining is over the bottom door is brought and secured in position, followed by the ramming of a properly riddled and tempered floor sand to form a tapered sand Bed.

The Moisture of the sand mixture is kept about 5%. Average thickness of the bed is 10cm sloping towards spout to ensure better flow of the molten metal.

Charging the cupola

Dry piece of wood is first placed over the sand bed followed by a small amount of coke charge, known as Bed Charge.

The coke for this charge is put gradually in the furnace through the charging door.

The kindling material is ignited through the tap hole.

This fire spreads slowly into the coke around the kindling material.

Additional coke is fired untill the bed charge acquires the required height.

Cover plates, opposite the tureyers, are opened to allow the free entry of air to aid combustion and they are left open till the entire bed charge is fully ignited.

A carefully weighed proportionate amount of metal, pig iron, scrap and flux is then fired over the bed charge followed by a weighed quantity of coke.

They are repeated in alternate layers, of course a predetermined quantity of each, until the cupola is full to the charging door.

If the cupola, on account of its fixed capacity, is unable to take up the entire material to be melted at a time, the remainder is fed into it after the initial charge has been melted.

Metal charge to the coke. [8 to 1, 10 to 1]
8/10 to 1/1

tuyeres is continued for about 1 to 2 hours so that brick work in the furnace is uniformly pre-heated before the blower is started.

The cover plate are then replaced in position and the blower started. Within the 10 minutes after the start of the forced draught the molten metal starts tickling down and collecting in the well.

The height of coke charge in the cupola in each layers varies generally through 10cm to 15cm.

Usually
40kg-50kg of limestone → per metric ton of (as a flux) the metal charged.

The first charge received of the molten metal is either allowed to drain out or used for rough castings.

(5) Pre-heating Zone:
Locate above the melting zone to the bottom level of the charging door and contains a number of alternate layes of coke and metal charge.
The function of this zone is to preheat the charges from atmospheric temp. to about 1093°C before they settle downwards to enters the melting zone.

(6) Stack:
The empty portion of cupola above the preheating zone, which provides the passage to hot gases to go to atmosphere, is known as stack.

Advantages of using a cupola.
(1) Initial cost is comparatively lower than other types of furnaces of same capacity.
(2) operation and maintenance of this furnace does not involve too many complications.
(3) Cost of operations and maintenance are low.
(4) The floor required is less comparatively others.
(5) It can be operated for a number of hours at a stretch.
(6) Does not involve very complicated problems in its design.

Cupola Zones

(1) **Well**: Space between the bottom of the tuyeres and the sand bed.

(2) **Combustion Zone / Oxidizing Zone**:
Located between the top of tuyers and a theoretical level above it. The total height of this zone is normally from 15cm to 30cm.
The actual combustion takes place in this Zone, consuming all free oxygen from the blast (air blast) and producing a lot of heat.
More heat is evolved due to oxidation of silicon and maganese (Mn).
A temperature of about 1540°C to 1870°C is produced in this zone.

$$C + O_2 \longrightarrow CO_2 + \text{heat}.$$
$$Si + O_2 \longrightarrow SiO_2 + \text{heat}.$$
$$2Mn + O_2 \longrightarrow 2MnO + \text{Heat}.$$

(3) **Reducing Zone / Protective Zone**.
Located blw the top of the combustion zone and the top level of the coke bed.

$$CO_2 + C \text{ (of coke)} \longrightarrow 2CO - \text{Heat}$$

the temp. falls from combustion zone temp. to about 1200°C.

(4) **Melting Zone**:
The first layer of metal charge over the coke bed constituents this zone.

$$3Fe + 2CO \longrightarrow Fe_3C + CO_2.$$