LECTURE 27 (16/03/2023)

125] Steel Making

1. Bessemer Process → Acid Bessemer, Basic Bessemer
   (became totally obsolete > 50 years ago (but it's imp. bez it is the mother of all other processes))
2. Open Hearth Process → Acid O.H., Basic O.H.
3. Oxygen steel making
   - (a) Top Blown Process – LD, LD-AC (Linz-Donawitz)
   - (b) Bottom Blown Process – Q-BOP, OBM (Q: "quiet") (Oxygen Bottom Maxhuette) → name of the German company that developed it
   - (c) Combined Blowing
   - (d) Kaldo Process
   - (e) Rotor Process
   (have become obsolete)
4. Electric Steel Process → electric furnace, induction furnace

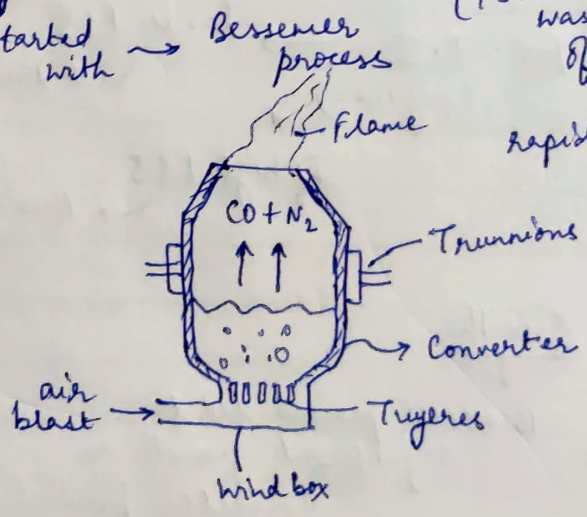
{Basic oxygen furnace} or even more commonly as BOF ↑ Now more commonly known as BOP (Basic oxygen process) ↑

World Steel Production: BOF – 55%, Electric Steel – 45%

126] Changing Pattern of Steel Making

Growth & Decay:

Started with → Bessemer process (1860–1910 was 2nd phase of Industrialization → rapid growth occurred during this period)



(blowing time is ~25 mins.) this entire refining process takes place in 1 hour

$C + \frac{1}{2}O_2 \rightarrow CO\uparrow$
$Si + O_2 \rightarrow SiO_2$
$Mn + \frac{1}{2}O_2 \rightarrow MnO$
$2P + \frac{5}{2}O_2 \rightarrow P_2O_5$
} exothermic (1300–1550°C)

* (when room temp. air is passed through molten metal ore → it does NOT freeze the molten metal
↓
instead: the impurities in it get oxidized
↓
which is an exothermic process)

127] When Bessemer come up with this process

↓

He used SiO_2 as flux

(∵ it came from Sweden & he wasn't aware of other kinds of flux)

→ this is not that good as it can't remove P from ore

→ lead to Acid slag & acid lining

→ that is why it was called

Acid Bessemer Process

↓

Later on a scientist S. G. Thomas (in 1878) come up with CaO as the basic flux to be used in this process

↓

Can remove Phosphorous (as: $CaO \cdot P_2O_5$)

* leading to **Basic Bessemer process**

(basic slag & basic lining)

↓

The Basic lining consists of: MgO or $MgO \cdot CaO$ (Dolomite)

NOTE: For P.I (pig iron) → has low P & S → thus Acid Bessemer is okay to use

If high P & S → Basic Bessemer used

128] **Growth**

↓

(i) Bessemer process led to significant growth in converter production & steel production

↓

(ii) But after about 1910 decay of converters started (i.e. Generation of scrap)

↓
However this couldn't be recycled (bez Bessemer converters couldn't generate enough heat-
↓
it only had enough heat to melt original metal
↓
& the cold scrap couldn't be melted)

(iii) No composition control (leading to bad quality of steel)

(iv) High nitrogen content
↓ dissolved from air
→ about 0.018%.
↓ which was enough to produce Brittleness in steel
(Thus it couldn't be used for Deep wire drawing)

{ LECTURE 28 attached on next page (From Manish Verma's Notes) }

LECTURE 28 (17/03/2023)

Lecture - 27

Changing pattern of Steel making process →

Bessemer process → Growth and decay.

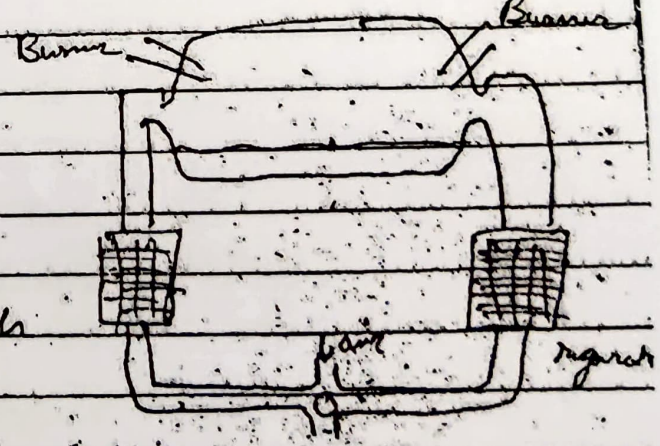
Disadvantages →

(I) Scrap could not be processed from cold.
(II) Control of composition of Steel was poor due to process being very fast
(III) High nitrogen content - 0.012% N making it stiff and harder to process.
(IV) Sensible heat was lost in the flame / Burning of CO outside the converter.

Despite it all, it remained ruling for 100 years (1860-1960)

(established in 1861 by Martin brothers and Siemens Brothers)

* Open Hearth Process → In 1817 John Stearling invented regenerative system. That means the heat going out in puddling or Glass making furnace, was not utilised. The maximum temperature that could be attained was 1400°C and the slag and metal become a paste due to metal solidifying which was separated by beating as much as possible and Wrought Iron was produced. The outgoing gases were allowed to pass through the checkerwork and the bricks are heated. At one time, bricks of one side is used while the other side heats from the exhaust. Then the process is reversed. This allowed the temperature to reach 1600°C. Now, it was possible to melt the metal and slag.



[written from Manish Verma's Notes]

Initially its use was to melt the steel scrap.
Later on the pig iron refining could also be done.

Similar to other methods → Acid open hearth
→ Basic open hearth

Initially it was Acidic, but later modified to Basic by K.G. Thomas in 1884. Removal of phosphorous and buffer by using Calcium oxide was possible.
Basic refractories were must;— Magnesite and Dolomite
(MgO) (MgO·CaO)

Magnesite ⇒ $MgCO_3$ is calcinated at 1000°C to produce MgO, but MgO is not Magnesite still it is called this; why?

* Magnesite is a misnomer
(misnomer: "false name")

It is called open hearth because the hearth is wide and shallow compared to converter with long pear shape.

It does not depend on the oxidation of impurities to produce heat. Therefore it can take any type of charge:

(i) 100% scrap
(ii) 50% scrap + 50% P.I.
(iii) 100% P.I.

Here the heating is done immediately.

A layer of slag was allowed to form and the oxygen has to...

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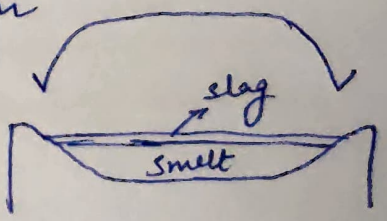
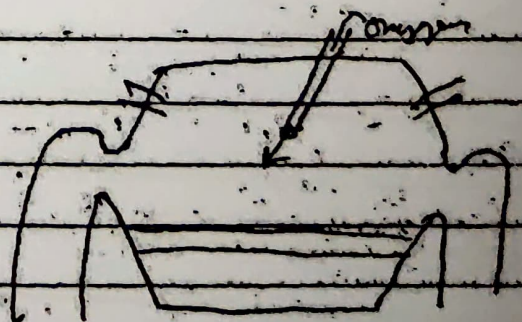


diffuse through the slag layer of slag. Due to slow rate of oxidation, the process is controlable. It takes 6-10 Hours to complete one cycle and produces one batch of steel.

* Advantages →
1) Any amount of Scrap can be added
2) Control of composition. A very good quality of steel could be made.
3) Here, the nitrogen content is confined to 0.003%. So the steel is very ductile.

* Drawbacks (Limitations) →
1) It has a high capital investment.
2) Low productivity due to the process being slow and produces very small quantity.
3) High fuel consumption.
4) Longer time is required (6-10 hrs) to do one batch.

This technology's limitations were reduced by using oxygen lancing which reduced the impurity even further and oxygen in the air was combined and used to be used to burn the fuel.



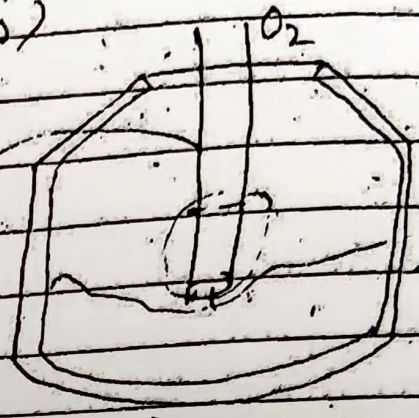
Later open hearth became obsolete and oxygen & steel making furnaces were adopted.

* Oxygen Steel Making → It started in 1950's

Oxygen before 1942 could only be produced in labs and after 1942, oxygen could be produced in commercial amount. Oxygen was introduced in steel making in 1950

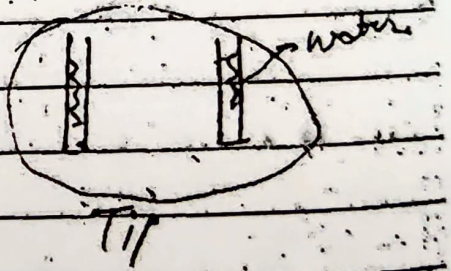
The first experiment was done in Europe in Austria in Linz and Donawitz (LD process)

Solid bottom like bessemer converter, there are just no holes.



If in Bessemer, the oxygen was used instead of air, the iron would have melted due to heat and it was not available commercially. So people realising this started using oxygen through water cooling lance. The tip was made of copper which was double layered so water could be passed

The oxygen was injected at jet speed to make the oxygen go deeper.



1952, 1954 Kaldo Rotor