CARBONISATION OF COAL

E-Content
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Some of the organic components of Coal have **Fusion Properties (REACTIVE)** when heated, while others donot (**Non-Fusible** or **INERT).**
The ability of a Coal to **swell and melt on being heated** and to **form a Coherent Residue** on cooling is called **CAKING.**

Therefore, Coal is called CAKING or NON-CAKING depending on its action when heated in absence of air. When coal softens and solidifies into a Cake, under such heating conditions, it is CAKING or COKING Coal, but when it crumbles or forms a weakly coherent mass it is called NON-CAKING Coal.

CARBONISATION – the destructive heating of coal in the absence of air, with the production of COKE and the evolution of VOLATILE PRODUCTS.

COKING & NON COKING COALS :

Lignites / brown coals and **Long-Flame Bituminous coals** are two classes of Coals that are **NON-COKING** Coals have properties like – Immature Coals, Non-Coherent nature, Vol. Matter - > 40% & F.C.- <60% . The **Anthracites** are also Non-coking coals giving off little or no Vol. Matter when heated upon.
However, **Bituminous Coals** are the **COKING COALS** with properties like –Mature Coals, Coherent, Fused nature (of Coke), Vol. Matter (20 - 40%).

COKE MAKING - COAL CARBONISATION :

- **Coking coals** are the coals which when **heated in the absence of air**, **first melt**, go in the **plastic state**, **swell and resolidify** to produce a **solid coherent mass called <u>coke</u>.**
- When **coking coal is heated** in absence of air, a **series of physical** and **chemical changes** take place with the **evolution of gases** and **vapours**, and the **solid residue** left behind is called **<u>coke</u>**.
- **Conventional coke making** is done in a **coke oven battery** of ovens sandwiched between **heating walls**.
- They are carbonised at a **temperature** around **1000^{o}-1100^{o} C** upto a certain degree of **devolatization** to produce **metallurgical coke** of desired **mechanical** and **thermo-chemical properties**.

<u>Objectives of Carbonisation –</u>

- To produce **Carbon-rich product** that will provide heat for the Blast Furnace – by removal of Volatile Matter i.e. **Devolatilisation**
- To produce **Carbon Monoxide** for the **reduction of the Iron Ore**.

⇒ **During carbonisation**, coking coals undergo transformation into **plastic state** at around **350^{o}-400^{o} C swell** and then **resolidify** at around **500^{o}-550^{o} C** to give **semi-coke** and then **coke.**

Depending upon the temperature range to which raw coal is subjected to during the combustion process, carbonization is of **2 types** –

1. **Low Temperature Carbonisation** –400–800 deg.C
2. **High Temperature Carbonisation** – 900–1300 deg.C

LOW TEMPERATURE CARBONISATION

(400 – 800 degrees C)

Objective :- Production of **Semi-Coke** (Primary Objective) ; especially suitable for **Domestic Fuel or Boiler Use.**

Products :-

1. **Semi-Coke** or **Char**
2. **Tar -- the most important By-product of Low Temp. Carbonisation**
3. **Light Oil**
4. **Other products** **--** some **Gases, Benzene and Tar acids**

HIGH TEMPERATURE CARBONISATION

- In this process, the **chief aim** is to have **very little Volatiles** in the Coke.
- Generally, **the V.M. content** of Cokes formed by the process ranges from **2.5-3.0 %.**
  - Coke is **coherent, hard, dense, silver grey** in colour and can neither be ignited nor crushed easily.
  - **Product** is known as – **"Hard Coke"**
  - Production of Metallurgical (Hard) Coke through high-temperature carbonization process can be through :

1. **Bee-hive Coke-oven Process (** An older process which had a total loss of By-Products, later replaced by)
2. **By-product Coke-oven Process**

By-product Coke-oven Process

Construction :-

- OVENS – which are long, narrow **insulated refractory structures** with **removable doors** at each end and **charging ports** in the roof

- Ovens – are arranged in **batteries** of **30-100 ovens** side by side
- **Coking** through **Fuel gas circulating through Heating flues in walls** (1150- 1350 deg. C)
- **Capacity of Each Oven – 4-20 tons** per charge
- **Coking Process :- 13-48 hrs**

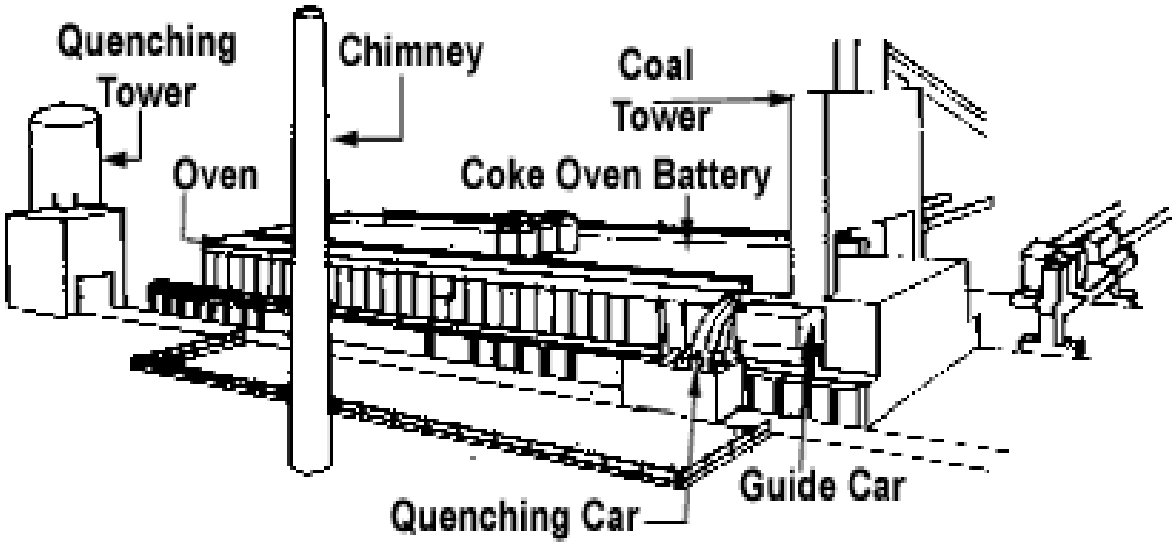

Fig: **Schematic Diagram of Coke Oven Battery**

COKE-OVEN BY-PRODUCTS

Carbonisation -- produces **Metallurgical Coke** (as Main Product)

Principal By-products :

1. **Coal Gas** (Mixture high in Hydrogen + Methane; some CO)
2. **Ammoniacal Liquor –** converted by reaction with H_2SO_4 to Ammonium Sulphate (used in Fertiliser or as Fire retardant)
3. **Crude Benzol (C_6H_5OH)** – mixture of **Benzene, Xylene** & **Toluene;** used in Plastic Industry)
4. **Coal Tar**