



## **COMBUSTION**

Combustion is an exothermic oxidation reaction in which a fuel burns in the presence of oxygen with the evolution of heat and light.

### **Calorific value**

The total quantity of heat of liberated when unit mass of fuel is burnt completely.

### **Units for calorific value**

- i) Calorie / gram.
- ii) Kilocalorie / kg.
- iii) British thermal unit(for solid or liquid fuels)

### **1. Higher calorific value (HCV) or Gross calorific value (GCV)**

The total amount of heat produced when unit mass of the fuel is burnt completely and the products of combustion are cooled to room temperature.

### **2. Lower calorific value (LCV) or Net calorific value (NCV)**

The net heat produced when unit mass of the fuel is burnt completely and the products of combustion are allowed to escape.



### Flue gas analysis (orsat method)

The mixture of gases (like  $\text{CO}_2$ ,  $\text{O}_2$  &  $\text{CO}$ ) coming out from the combustion chamber is called flue gas.

- The analysis of a flue gas would give an idea about **the complete or incomplete combustion process.**
- The analysis of flue gas is carried out by using **Orsat's apparatus.**

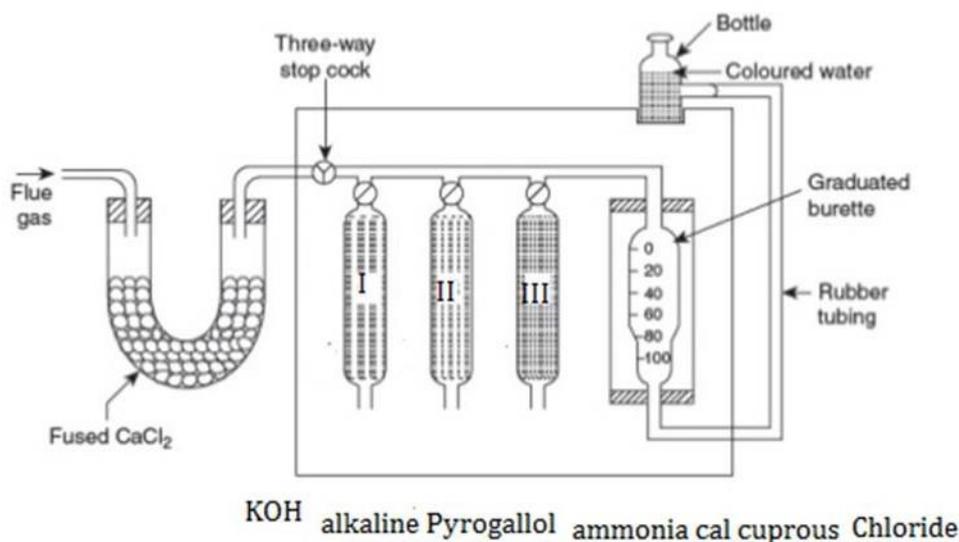
### Description of Orsat's apparatus

- It consists of a horizontal tube.
- At one end of this tube, 'U' tube containing fused  $\text{CaCl}_2$  is connected through 3 – way stop cock.
- The other end of the tube is connected with a graduated burette.
- The burette is surrounded by a water jacket to keep the temperature of the gas constant.
- The lower end of the burette is connected to a water reservoir by means of a rubber tube.
- The level of water in the burette can be raised or lowered by raising or lowering the reservoir.
- The horizontal tube is also connected with three different absorption bulbs 1, 2 and 3 for absorbing  $\text{CO}_2$ ,  $\text{O}_2$  and  $\text{CO}$ .

**Bulb 1** contains **KOH** and it absorbs  **$\text{CO}_2$**  only.

**Bulb 2** contains **alkaline pyrogallol** and it absorbs  $\text{CO}_2$  and  $\text{O}_2$ .

**Bulb 3** contains **ammoniacal cuprous chloride** and it absorbs  **$\text{CO}_2$ ,  $\text{O}_2$  and  $\text{CO}$ .**



### Working



- The three way stop cock is opened to the atmosphere and the burette is completely filled with water and air is sent out.
- The burette is filled with flue gas to 100 cc by raising or lowering the reservoir. Now the 3- way stop cock is closed.

### 1. Absorption of CO<sub>2</sub>

- The bulb 1 is opened and all the gas is passed into bulb1 by raising the level of water in the burette.
- The gas enters into bulb1 where CO<sub>2</sub> is absorbed by KOH. The gas is again sent to the burette.
- The process is repeated several times to ensure complete absorption of CO<sub>2</sub>.
- The decrease in volume of the flue gas = the volume of CO<sub>2</sub> in 100cc of the flue gas.

### 2. Absorption of O<sub>2</sub>

- Bulb 1 is closed and bulb 2 is opened.
- The gas is again sent into bulb 2 where O<sub>2</sub> in the flue gas is absorbed by alkaline pyrogallol.
- The decrease in volume of the flue gas = the volume of O<sub>2</sub>.

### 3. Absorption of CO

- Bulb 2 is closed and bulb 3 is opened.
- The remaining gas is sent into bulb 3, where CO is absorbed by ammoniacal cuprous chloride.
- The decrease in volume of flue gas = the volume of CO.
- The remaining gas in the burette after the absorption of CO<sub>2</sub>, O<sub>2</sub> and CO is taken as nitrogen.

### Significance

- i) It gives an idea about the complete or incomplete combustion.
- ii) If the flue gas contains considerable amount of CO, it indicates incomplete combustion and short supply of O<sub>2</sub>.
- iii) If the flue gas contain considerable amount of O<sub>2</sub>, it indicates complete combustion and excess supply of O<sub>2</sub>.