

## Flue gas analysis by Orsat Apparatus.

### Definition

Measuring the exhaust gas is an excellent way to optimize fuel and air input

A gas analyzer will help measure various gas pollutants in the exhaust for environmental reasons.

The mixture of gases such as  $\text{CO}_2$ ,  $\text{O}_2$ ,  $\text{CO}$ , etc., coming out from the combustion chamber is called flue gases. The analysis of a flue gas would give idea about the complete or incomplete combustion process. The analysis of flue gas is carried out by using Orsat's apparatus.

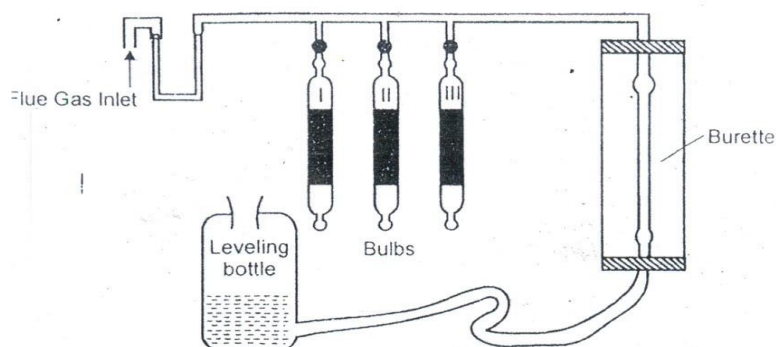
### Description of Orsat's Apparatus

It consists of a horizontal tube, having 3 way stopcock. At one end of this tube, U-tube containing fused  $\text{CaCl}_2$  is connected. The other end of this tube is connected with a graduated burette. The burette is surrounded by a water-jacket to keep the temperature of 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 I, II and III for absorbing  $\text{CO}_2$ ,  $\text{O}_2$ ,  $\text{CO}$ .

**Bulb- I:** It contains 'potassium hydroxide' solution, and it absorbs only  $\text{CO}_2$

**Bulb - II:** It contains 'alkaline pyrogallo' solution, and it absorbs only  $\text{CO}_2$  and  $\text{O}_2$

**Bulb: III:** It contains 'ammoniacal cuprous chloride' solution, and it absorbs only  $\text{CO}_2$ ,  $\text{O}_2$  and  $\text{CO}$ .



**Orsat's Apparatus**

### Working

The 3-way stopcock is opened to the atmosphere and the reservoir is raised, till the burette is completely filled with water and air is excluded from the burette. The 3-way stopcock is now connected to the flue gas supply, the flue gas is sucked into the burette, and the volume of flue gas is adjusted to 100 cc by raising and lowering the reservoir. Then the 3-way stop cock is closed.

**a) Absorption of CO<sub>2</sub> .**

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

**b) Absorption of O<sub>2</sub>**

Stopcock of bulb-I is closed and stopcock of bulb-II is opened. The gas is again sent into the absorption bulb-II, where O<sub>2</sub> present in the flue gas is absorbed by alkaline pyrogallol (925 g of pyrogallol + 200g of KOH in 500 ml distilled water). The decrease in volume of the flue gas in the burette indicates the volume of O<sub>2</sub>.

**c) Absorption of CO**

Now stopcock of bulb-II is closed and stopcock of bulb-III is opened. The remaining gas is sent into the absorption bulb-III, where CO present in the flue gas is absorbed by ammoniacal cuprous chloride (100 g CuCl<sub>2</sub> + 125 mL liquor ammonia + 375 mL distilled water). The decrease in volume of the flue gas in the burette indicates 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.

**Importance and Significance of Flue gas analysis**

1. Flue gas analysis gives an idea about the complete or incomplete combustion process of a fuel.
2. If there is a presence of CO in flue gas, it indicates that incomplete combustion of fuel. It reveals the short supply of O<sub>2</sub>.
3. If there is a presence of oxygen in flue gas which ensures the complete combustion of fuel and excess supply of O<sub>2</sub>.