UNIT V

5.2 ANALYSIS OF COAL

5.2.1-PROXIMATE ANALYSIS

Determination of

(i) Moisture Content

(ii) Volatile matter

(iii) Ash Content

(iv) Fixed Carbon

5.2.2- ULTIMATE ANALYSIS

Determination of

(i) **Carbon and Hydrogen**

(ii) Nitrogen

(iii) Sulphur

(iv)Ash content

(v)Oxygen content

To assess the quality of coal two types of analysis are made,

1. Proximate analysis
2. Ultimate analysis

5.2.1 Proximate analysis

Proximate analysis is a qualitative analysis which involves the determination of percentage of moisture content, volatile matter, ash content and fixed carbon in coal. Based on the results obtained the coal can be ranked as best or least variety.

(i)Moisture content

About 1g of powdered, air dried coal sample is taken in a crucible and heated to 100 - 105˚C in an electric hot air oven for 1 hour. The loss in weight of the sample is found out and the percentage of moisture is calculated as,

$$\% \text{ of moisture} = \frac{\text{loss in weight of coal}}{\text{weight of coal taken}} \times 100$$

(ii)Volatile matter

After analyzing moisture content, the crucible with residual Coal sample is converted with a lid and is heated to 950 + 20°C for 7 minutes in an electric furnace .The loss in weight of the sample is found out and percentage of volatile matter is calculated as

$$\% \text{ of volatile moisture} = \frac{\text{Loss in weight of coal}}{\text{Weight of moisture free coal}} \times 100$$

(iii)Ash content

After analyzing volatile matter, the crucible with residual coal sample is heated without lid at 700+50°C for 30 minutes in an electric furnace. The loss in weight of the sample is found out and the percentage of ash is calculated.

$$\% \text{ of ash} = \frac{\text{Weight of ash formed}}{\text{Weight of air dried coal}} \times 100$$

(iv)Fixed carbon

It is determined by subtracting the sum of moisture, volatile matter and ash contents from 100.

% of fixed carbon = 100- % of (moisture + volatile matter + ash)

5.2-Ultimate analysis

It involves the quantitative determination of percentage of carbon, hydrogen, nitrogen, Sulphur, ash content and oxygen in coal.

(i) Determination of carbon and hydrogen

A known amount of coal sample is burnt in a current of oxygen in a combustion apparatus. Carbon and hydrogen present in the coal sample is converted into CO_2 and H_2O.

$C + O_2 \longrightarrow CO_2\uparrow$

$H_2 + ½\ O_2 \longrightarrow H_2O\uparrow$

The liberated CO_2 and H_2O vapours are absorbed by KOH and anhydrous $CaCl_2$ tubes of known weights.

$2KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$

$CaCl_2 + 7H_2O \longrightarrow CaCl_2.7H_2O$

The increase in weight of KOH tube is due to the absorption of CO_2. The increase in weight of $CaCl_2$ tube is due to the absorption of H_2O.From the increase in weights of KOH & $CaCl_2$ tubes the percentage of carbon and hydrogen present in the coal can be calculated as,

$$\% \text{ of carbon in coal} = \frac{\text{Increase in weight of KOH tube}}{\text{Weight of coal sample}} \times \frac{12}{44} \times 100$$

$$\% \text{ of Hydrogen in Coal} = \frac{\text{Increase in weight of } CaCl_2 \text{ tube}}{\text{Weight of coal sample}} \times \frac{12}{18} \times 100$$

(ii) Determination of nitrogen

Nitrogen content is determined by Kjeldahl's method.

A known amount of powdered coal sample is heated with conc.H_2SO_4 in a long necked flask.

Nitrogen in the coal is converted into Ammonium Sulphate (clear solution).

$2N + 3H_2 + H_2SO_4 \longrightarrow (NH4)_2SO_4$

The clear solution is then heated with excess of NaOH and the liberated ammonia absorbed in a known volume of N/10 HCl.

$(NH_4)_2SO_4 + 2NaOH \longrightarrow 2NH_3 + Na_2SO_4 +$

$2H_2O\ NH_3 + HCl \longrightarrow NH4Cl$

The volume of unused N/10 HCl is then determined by titrating against std. NaOH.

Thus the amount of acid neutralized by liberated ammonia from coal is determined. From this the percentage of nitrogen is calculated as,

$$\% \text{ of nitrogen in coal} = \frac{1.4 \times \text{volume of acid consumed} \times \text{Normality of acid}}{\text{Weight of coal sample}}$$

(iii) Determination of Sulphur

A known amount of coal sample is burnt in a bomb calorimeter. During this process, Sulphur is converted to sulphate which is extracted with water. The extract is then treated with $BaCl_2$ solution so that the sulphates are precipitated as $BaSO_4$.

The precipitate is filtered, dried and weighed.

From the weight of $BaSO_4$, Sulphur present in the coal is calculated as,

$$\% \text{ of Sulphur in coal} = \frac{\text{Weight of } BaSO_4}{\text{weight of coal sample}} \times \frac{32}{233} \times 100$$

(iv)Ash content

A known weight of coal sample is heated without lid at 700 ± 50˚ C for 30 minutes in an electric furnace. The loss in weight of the sample is found out and the percentage of ash content is calculated.

$$\% \text{ of ash content} = \frac{\text{Weight of ash formed}}{\text{weight of air dried coal}} \times 100$$

(v)Oxygen

The percentage of oxygen is calculated as,

% of oxygen in coal = 100 - % of (C + H + N + S + ash)

Significance of ultimate analysis

- Higher the percentage of carbon and hydrogen, better is the quality of coal and greater is its calorific value.
- Presence of nitrogen in coal is undesirable.
- Presence of Sulphur in coal is undesirable because SO_2 and SO_3 are harmful and corrodes the equipment.
- Presence of oxygen in coal is undesirable because it increases the moisture holding capacity.