

UNIT IV

4.2 Ultimate analysis

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

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 .



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



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,

% of carbon in coal =

Increase in weight of KOH tube / Weight of coal sample $\times \frac{12}{44} \times 100$

% of Hydrogen in Coal =

Increase in weight of CaCl_2 tube / Weight of coal sample $\times \frac{12}{18} \times 100$

Determination of nitrogen

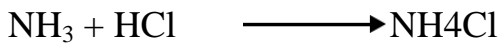
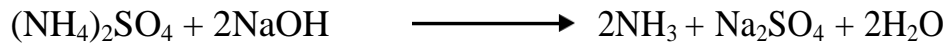
Nitrogen content is determined by kjeldahl's method.

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).



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



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,

% of nitrogen in coal =

$$1.4 \times \text{volume of acid consumed} \times \text{Normality of acid} /$$

Weight of coal sample

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,

$$\% \text{ of sulphur in coal} = \frac{\text{Weight of } \text{BaSO}_4}{\text{weight of coal sample}} \times \frac{32}{233} \times 100$$

Ash content

A known weight of coal sample is heated without lid at $700 \pm 50^\circ \text{C}$ 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.

% of ash content =

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

Oxygen

The percentage of oxygen is calculated as,

$$\% \text{ of oxygen in coal} = 100 - \% \text{ of } (\text{C} + \text{H} + \text{N} + \text{S} + \text{ash})$$

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.

