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 acombustion apparatus.

Carbon and hydrogen present in the coal sample is converted intoCO_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 andanhydrous $CaCl_2$ 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 CO2. The increase in weight of $CaCl_2$ tube is due to the absorption of H_2O.From the increase in weights of KOH & CaCl2 tubes the percentageof carbon and hydrogen present in the coal can be calculated as,

% of carbon in coal =

Increase in weight of KOH tube /Weight 0f coal sample X12/44X100

% of Hydrogen in Coal =

Increase in weight of $CaCl_2$ tube /Weight of coal sample X 12/18 X100

Determination of nitrogen

Nitrogen content is determined by kjeldahl's method.

A known amount of powdered coal sample is heated with conc.H_2SO4 in a long necked flask.

Nitrogen in the coal is converted into Ammonium sulphate (clearsolution).

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

The clear solution is then heated with excess of NaOH and theliberated 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 titratingagainst std. NaOH.

Thus the amount of acid neutralized by liberated ammonia from coalis determined.

From this the percentage of nitrogen is calculated as,

% of nitrogen incoal=

1.4x volume of acid consumed X 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 isextracted with water.

The extract is then treated with $BaCl_2$ solution so that the sulphatesare precipitated as $BaSO_4$.

The precipitate is filtered, dried and weighed.

From the weight of $BaSO_4$, sulphur present in the coal is calculatedas,

% of sulphur in coal= Weight of $BaSO_4$/weight of coal sample x 32 /233 x100

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 sampleis found out and the percentage of ash content is calculated.

% of ash content =

Weight of ash formed/ weight of air dried coal x 100

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 ofcoal 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 areharmful and corrodes the equipment.

Presence of oxygen in coal is undesirable because it increases themoisture holding capacity.