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Engineering Chemistry - II

Tutorial 1 - Fuel

1) A solid fuel coal containing 90% carbon, 8% hydrogen, 1.5% sulphur, 2% nitrogen, 5% oxygen and remaining ash. Calculate the high and low calorific value of the solid fuel.

Ans. Using Dulong's formula,

$$H.C.V = \frac{1}{100}\left[8080\,C + 34500\left(H - \frac{O}{8}\right) + 2240\,S\right]$$

$$= \frac{1}{100}\left[8080 \times 90 + 34500\left(8 - \frac{5}{8}\right) + 2240 \times 1.5\right]$$

$$= \frac{1}{100}\left[727200 + 34500\left(\frac{59}{8}\right) + 3360\right]$$

$$= \frac{1}{100}\left[727200 + 254437.5 + 3360\right] \text{ Kcal/kg}$$

$$= \frac{1}{100}\left[984997.5\right]$$

$$= 9849.975 \text{ kcal/kg}$$

$$L.C.V = \left[HCV - (0.09 \times H \times 587)\right]$$

$$= 9849.975 - 0.09 \times 8 \times 587$$

$$L.C.V = 9427.335 \text{ kcal/kg}$$

∴ High calorific value = 9849.975 kcal/kg
Low calorific value = 9427.335 kcal/kg.

DATE:

2) A sample of coal was analyzed for content of moisture, volatile matter and ash. From the following data, calculate the percentage of the above quantities.

(i) Weight of coal taken = 2.5 g.

(ii) Weight of coal after heating at 100°C = 2.368 g.

(iii) Weight of coal after heating covered crucible at 950±20 °C = 1.75 g.

(iv) Constant weight obtained at the end of the experiment = 0.95g.

Ans. i) Weight of coal taken = 2.5g

∴ Mass of moisture in coal sample = 2.5 - 2.368

= 0.132g.

∴ Percentage of moisture = $\frac{\text{Loss in weight of coal}}{\text{weight of coal}} \times 100$

= $\frac{0.132 \times 100}{2.5}$ = 5.28 %.

ii) Mass of volatile matter = 2.368 - 1.75

= 0.618g.

∴ Percentage of volatile matter = $\frac{\text{loss in weight due to volatile matter}}{\text{weight of coal}} \times 100$

= $\frac{0.618}{2.5} \times 100$

= 24.72 %.

DATE:

iii) Mass of ash = 0.95 g.

Percentage of ash = $\frac{\text{Weight of ash left}}{\text{Weight of coal taken}} \times 100$

$= \frac{0.95 \times 100}{2.5} = 38\%$.

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

$= 100 - (5.28 + 24.72 + 38)$

$= 100 - 68$

$\therefore$ % of carbon = 32%

$\therefore$ % of moisture = 5.28 %.

% of volatile matter = 24.72 %.

% of ash = 38 %.

% of carbon = 32 %.

3) 2.5 g of air dried coal sample was taken in a silica crucible, after heating it in an electrical oven at 105-110°C for 1 hour; the residue was weighed 2.410g. The residue was heated in silica crucible covered with vented lid at a temperature 950 ± 20°C for exactly 7 minutes. After cooling the weight of residue was found to be 1.78 g. The residue was then ignited at 700-750°C to a constant weight of 0.24g. Calculate the percentage of fixed carbon in coal sample.

DATE:

Ans Weight of coal taken = 2.5g

Mass of moisture in coal sample = 2.5 - 2.410

= 0.09 g.

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

$= \frac{0.09 \times 100}{2.5}$

$= 3.6\%$

Mass of volatile matter = 2.410 - 1.78

= 0.638.

$\therefore$ % of volatile matter = $\frac{\text{loss in weight due to volatile matter}}{\text{weight of coal}} \times 100$

$= \frac{0.63 \times 100}{2.5}$

$= 25.2\%$

Mass of residue after ignition at 700-750°C = 0.246g

% of ash = $\frac{\text{Weight of ash left}}{\text{Weight of coal taken}} \times 100$

$= \frac{0.246}{2.5} \times 100 = 9.84\%$

$\therefore$ % of fixed carbon = 100 - % (moisture + volatile matters + ash)

= 100 - (3.6 + 25.2 + 9.84)

= 61.36 %.

$\therefore$ Percentage of fixed carbon = 61.36 %