

Problem 1

Find the gross and net calorific values of a fuel which an ultimate analysis gave the following results : C = 80 %, H = 6 %, O = 8 %, S = 1.5 %, N = 1.0 %, Ash = rest.

(M.U. May 2008)

Solution : Using Dulong formula,

$$\begin{aligned} \text{GCV} &= \frac{1}{100} \left[8080C + 34500 \left(H - \frac{O}{8} \right) + 2240S \right] \\ &= \frac{1}{100} \left[8080 \times 80 + 34500 \left(6 - \frac{8}{8} \right) + 2240 \times 1.5 \right] \\ &= \frac{1}{100} [646400 + 34500 (6 - 1) + 2240 \times 1.5] \\ &= \frac{1}{100} [646400 + 172500 + 3360] \\ &= \frac{1}{100} [822260] \end{aligned}$$

$$\therefore \text{GCV} = 8222.60 \text{ kcal / kg.}$$

$$\begin{aligned}\text{And } \text{NCV} &= \left[\text{GCV} - \frac{9}{100} \text{H} \times 587 \right] \\ &= [8222.60 - 0.09 \times 6 \times 587] \\ &= [8222.60 - 316.98]\end{aligned}$$

$$\therefore \text{NCV} = 7905.62 \text{ kcal / kg.}$$

$$\text{Ans : } \text{GCV} = 8222.60 \text{ kcal / kg.}$$

$$\text{NCV} = 7905.62 \text{ kcal / kg.}$$

Problem 2

A sample of coal contains C = 70 %, O = 20 %, H = 6 %, S = 2.5 %, N = 1.5 %. Calculate the gross and net calorific value of the coal. (M.U. Dec. 2009)

Solution : Using Dulong formula,

$$\begin{aligned}\text{GCV} &= \frac{1}{100} \left[8080 \text{C} + 34500 \left(\text{H} - \frac{\text{O}}{8} \right) + 2240 \text{S} \right] \\ &= \frac{1}{100} \left[8080 \times 70 + 34500 \left(6 - \frac{20}{8} \right) + 2240 \times 2.5 \right] \\ &= \frac{1}{100} [565600 + 34500 (6 - 2.5) + 2240 \times 2.5] \\ &= \frac{1}{100} [565600 + 120750 + 5600] \\ &= \frac{1}{100} [691950]\end{aligned}$$

$$\therefore \text{GCV} = 6919.50 \text{ kcal / kg.}$$

$$\begin{aligned}\text{And } \text{NCV} &= \left[\text{GCV} - \frac{9}{100} \text{H} \times 587 \right] \\ &= [6919.50 - 0.09 \times 6 \times 587] \\ &= [6919.50 - 316.98]\end{aligned}$$

$$\therefore \text{NCV} = 6602.52 \text{ kcal / kg.}$$

$$\text{Ans : } \text{GCV} = 6919.50 \text{ kcal / kg.}$$

$$\text{NCV} = 6602.52 \text{ kcal / kg.}$$

Problem 3

A sample of coal has the following composition by mass, C = 85 %, H = 7 %, O = 3 %, S = 3.5 %, N = 2.1 % and Ash = 4.4 %. Calculate HCV and LCV using Dulong formula.

(M.U. May 2010)

Solution : Using Dulong formula,

$$\begin{aligned} \text{HCV} &= \frac{1}{100} \left[8080C + 34500 \left(H - \frac{O}{8} \right) + 2240S \right] \\ &= \frac{1}{100} \left[8080 \times 85 + 34500 \left(7 - \frac{3}{8} \right) + 2240 \times 3.5 \right] \\ &= \frac{1}{100} [686800 + 34500 (7 - 0.375) + 2240 \times 3.5] \\ &= \frac{1}{100} [686800 + 34500 (6.625) + 7840] \\ &= \frac{1}{100} [686800 + 228562.5 + 7840] \\ &= \frac{1}{100} [923202.5] \end{aligned}$$

$$\therefore \text{HCV} = 9232.025 \text{ kcal / kg.}$$

$$\begin{aligned} \text{And, LCV} &= \left[\text{HCV} - \frac{9}{100} H \times 587 \right] \\ &= [9232.025 - 0.09 \times 7 \times 587] \\ &= [9232.025 - 369.81] \end{aligned}$$

$$\therefore \text{LCV} = 8862.215 \text{ kcal / kg.}$$

$$\text{Ans. : HCV} = 9232.025 \text{ kcal / kg.}$$

$$\text{LCV} = 8862.215 \text{ kcal / kg.}$$

Problem 4

A sample of coal has the following composition by mass : C = 80 %, H = 7 %, O = 3 %, S = 3.5 %, N = 2.1 % and Ash 4.4 %. Calculate HCV and LCV using Dulong formula.

(M.U. Dec. 2010)

Solution : Using Dulong formula,

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

$$\begin{aligned}
 \text{HCV} &= \frac{1}{100} \left[8080 \times 80 + 34500 \left(7 - \frac{3}{8} \right) + 2240 \times 3.5 \right] \\
 &= \frac{1}{100} [646400 + 34500 (7 - 0.375) + 2240 \times 3.5] \\
 &= \frac{1}{100} [646400 + 34500 (6.625) + 2240 \times 3.5] \\
 &= \frac{1}{100} [646400 + 228562.5 + 7840] \\
 &= \frac{1}{100} [882802.5]
 \end{aligned}$$

$$\therefore \text{HCV} = 8828.025 \text{ kcal / kg.}$$

$$\begin{aligned}
 \text{And } \text{LCV} &= \left[\text{HCV} - \frac{9}{100} \text{H} \times 587 \right] \\
 &= [8828.025 - 0.09 \times 7 \times 587] \\
 &= [8828.025 - 369.81]
 \end{aligned}$$

$$\therefore \text{LCV} = 8458.215 \text{ kcal / kg.}$$

$$\text{Ans. : } \text{HCV} = 8828.025 \text{ kcal / kg.}$$

$$\text{LCV} = 8458.215 \text{ kcal / kg.}$$

Problem 8

A sample of coal has the following composition by mass : C = 85 %, H = 6 %, O = 8 %, S = 0.5 % and Ash = 0.5 %. Calculate HCV and LCV using Dulong formula.

(M.U. May 2011)

Solution : Using Dulong formula,

$$\begin{aligned}
 \text{HCV} &= \frac{1}{100} \left[8080 \text{C} + 34500 \left(\text{H} - \frac{\text{O}}{8} \right) + 2240 \text{S} \right] \\
 &= \frac{1}{100} \left[8080 \times 85 + 34500 \left(6 - \frac{8}{8} \right) + 2240 \times 0.5 \right] \\
 &= \frac{1}{100} [686800 + 34500 (6 - 1) + 2240 \times 0.5] \\
 &= \frac{1}{100} [686800 + 172500 + 1120]
 \end{aligned}$$

$$= \frac{1}{100} [860420]$$

$$\therefore \text{HCV} = 8604.20 \text{ kcal / kg.}$$

$$\begin{aligned} \text{And } \text{LCV} &= \left[\text{HCV} - \frac{9}{100} \text{H} \times 587 \right] \\ &= [8604.20 - 0.09 \times 6 \times 587] \\ &= [8604.20 - 316.98] \end{aligned}$$

$$\therefore \text{LCV} = 8287.22 \text{ kcal / kg.}$$

$$\text{Ans. } \therefore \text{HCV} = 8604.20 \text{ kcal / kg.}$$

$$\text{LCV} = 8287.22 \text{ kcal / kg.}$$

Problem 6

A sample of coal contains C = 70 %, O = 23 %, H = 5 %, S = 1.5 %, N = 0.4 %, Ash = 0.1 %. Calculate the gross and net calorific value of the coal.

(M.U. Dec. 2011; May 2018)

Solution : Using Dulong formula,

$$\begin{aligned} \text{GCV} &= \frac{1}{100} \left[8080 \text{C} + 34500 \left(\text{H} - \frac{\text{O}}{8} \right) + 2240 \text{S} \right] \\ &= \frac{1}{100} \left[8080 \times 70 + 34500 \left(5 - \frac{23}{8} \right) + 2240 \times 1.5 \right] \\ &= \frac{1}{100} [565600 + 34500 (5 - 2.875) + 2240 \times 1.5] \\ &= \frac{1}{100} [565600 + 34500 (2.125) + 3360] \\ &= \frac{1}{100} [565600 + 73312.5 + 3360] \\ &= \frac{1}{100} [642272.5] \end{aligned}$$

$$\therefore \text{GCV} = 6422.725 \text{ kcal / kg.}$$

$$\begin{aligned} \text{And } \text{NCV} &= \left[\text{GCV} - \frac{9}{100} \text{H} \times 587 \right] \\ &= [6422.725 - 0.09 \times 5 \times 587] \end{aligned}$$

Problem 7

A sample of coal contains 90 % C, 8 % H, 1.5 % S, 2 % N, 5 % O and remaining ash. Calculate the high and low calorific values of the solid fuel.

(Latent heat of condensation of steam = 587 cal / gm)

(M.U. May 2012)

Solution : Using Dulong formula,

$$\begin{aligned} \text{HCV} &= \frac{1}{100} \left[8080C + 34500 \left(H - \frac{O}{8} \right) + 2240S \right] \\ &= \frac{1}{100} \left[8080 \times 90 + 34500 \left(8 - \frac{5}{8} \right) + 2240 \times 1.5 \right] \\ &= \frac{1}{100} [727200 + 34500 (8 - 0.625) + 2240 \times 1.5] \\ &= \frac{1}{100} [727200 + 34500 (7.375) + 3360] \\ &= \frac{1}{100} [727200 + 254437.5 + 3360] \\ &= \frac{1}{100} [984997.5] \end{aligned}$$

$$\therefore \text{HCV} = 9849.975 \text{ kcal / kg.}$$

$$\begin{aligned} \text{And } \text{LCV} &= \left[\text{HCV} - \frac{9}{100} H \times 587 \right] \\ &= [9849.975 - 0.09 \times 8 \times 587] \\ &= [9849.975 - 422.64] \end{aligned}$$

$$\therefore \text{LCV} = 9427.335 \text{ kcal / kg.}$$

$$\text{Ans : } \text{HCV} = 9849.975 \text{ kcal / kg.}$$

$$\text{LCV} = 9427.335 \text{ kcal / kg.}$$