Some questions on oxidation of fuel and calorific value

1. Calculate the volume of air required for complete combustion of 1 m^3 of gaseous fuel having the composition CO 46%, CH_4 10%, H_2 40%, C_2H_4 2%, N_2 1% and remaining CO_2. (Assume air contains 21% O_2.)

Amount of CO in 1 m^3 fuel = 0.46 m^3

" CH_4 " " " = 0.1 m^3

" H_2 " " " = 0.4 m^3

" C_2H_4 " " " = 0.02 m^3

CO_2 will not burn.

Combustion reactions		O_2 (m^3)
	$CO + \frac{1}{2}O_2 \rightarrow CO_2$	$0.46 \times \frac{1}{2} = 0.23$
O_2 required as per stoichiometric ratio	$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$	0.2
	$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$	0.2
	$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$	0.06
		0.69 m^3

% of O_2 in air = 21%

$\therefore$ 21 m^3 O_2 present in 100 m^3 air

$\therefore$ 0.69 m^3 " " " $\frac{100}{21} \times 0.69 = 3.286$ m^3 air

Ans: Volume of air required = 3.286 m^3

% composition: C 75% , H 5.2% , O 12.1% , N 3.2% and ash 4.5% . Calculate the min. amount of air necessary for complete combustion of 1kg of coal sample. (Assume air contains 23% O_2).

1kg coal contains $1000 \times \frac{75}{100} = 750$ gm C , 52 gm H, 121 gm O and 32 gm N.

Only C & H will burn.

12gm 32gm
$C + O_2 \rightarrow CO_2$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$

Weight of O_2 needed

12 gm C needs O_2 32 gm

∴ 750 gm " " " $\frac{32 \times 750}{12} = 2000$ gm

2 gm H needs O 16 gm

∴ 52 gm " " " $\frac{16 \times 52}{2} = 416$ gm

Total O_2 needed = 2416 gm

O available in fuel = 121 gm

∴ Net O needed = 2416 − 121 = 2295 gm

23 gm O_2 present in 100 gm air

∴ 2295 " " " " $\frac{100}{23} \times 2295 = 9978.3$ gm air

Ans: Minimum amount of air needed for complete combustion of coal = 9978 gm.

fuel of 0.9 gm is burnt. It is observed that increase of temp. is 3.8°C of 4000 gm. The fuel contains 1% of H. Calculate HCV and LCV values. Equivalent wt. of H_2O = 385 gm, latent heat of steam = 587 cal/gm.

wt. of fuel (x) = 0.9 gm
wt. of water in calorimeter (W) = 4000 gm
Eq. wt. of water (w) (for apparatus) = 385 gm.
Rise in temp. $(T_2 - T_1)$ = 3.8°C.

∴ High calorific value or gross Calorific value $= \frac{(4000 + 385) \times 3.8}{0.9}$

= 18514.4 Cal/gm.

For net calorific value H content = 1% = y

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$
2 gm → 18 gm
1 gm → 9 gm.

If y is % of H in fuel
$\frac{y}{100} \times 1 = 0.0y$ gm H present

∴ 0.0y gm hydrogen produces 9 × 0.0y gm water

Heat taken by H_2O in forming steam
= 0.0y × 9 × 587 Cal.
(latent heat of steam = 587 cal/gm)

Here y = 1%.
∴ heat taken up by H_2O in forming steam = 0.09 × 587
= 52.83 Cal

∴ LCV or net calorific value
= 18514.4 − 52.83 Cal/gm
= 18461.6 Cal/gm

Calorimeter, the temp. of 3500 gm of H_2O rises from 26.5 °C to 29.2 °C. Water equivalent of calorimeter and latent heat of steam are 385 gm and 587 Cal/gm respectively. If the fuel contains 0.7% hydrogen, calculate its gross and net calorific value.

$x = 0.83$ gm

$W = 3500$ gm

w (for apparatus) $= 385$ gm

$\Delta T = 2.7$ °C

$$HCV = \frac{(3500 + 385) \times 2.7}{0.83}$$

$$= 12637.95 \text{ Cal/gm}$$

$$LCV = (12637.95 - 0.07 \times 9 \times 587)$$

$$= 12637.95 - 36.981 = 12600.97 \text{ Cal/gm}$$

$$\simeq 12601 \text{ Cal/gm}$$

<u>Artificial / Secondary fuels</u> : Prepared from primary fuels.

- Solid
  - Coke
- liq.
  - Diesel
  - petrol
  - Kerosene
- gas
  - Coal gas
  - water gas
  - oil gas.