Combustion of Fuels.

		Molecular weight
Carbon	C	12
Oxygen	O_2	32
Hydrogen	H_2	2
Nitrogen	N_2	28
Sulphur	S	32

1) Combustion of Hydrogen

$$2H_2 + O_2 \longrightarrow 2H_2O$$

~~[illegible]~~

$$4\,kg\ H_2 + 32\,kg\ O_2 \longrightarrow 2(2+16)\ H_2O$$

$$4\,kg\ H_2 + 32\,kg\ O_2 \longrightarrow 36\,kg\ H_2O$$

$$1\,kg\ H_2 + 8\,kg\ O_2 \longrightarrow 9\,kg\ H_2O$$

2) Complete Combustion of Carbon

$$C + O_2 \longrightarrow CO_2$$

$$12\,kg\ C + 32\,kg\ O_2 \longrightarrow 44\,kg\ CO_2$$

$$1\,kg\ C + \frac{8}{3}\,kg\ O_2 \longrightarrow \frac{11}{3}\,kg\ CO_2$$

3) Partial/Incomplete Combustion of Carbon

$$2C + O_2 \longrightarrow 2CO$$

$$2(12\,kg)\ C + 32\,kg\ O_2 \longrightarrow 2(12+16)\,kg\ CO$$

$$24\,kg\ C + 32\,kg\ O_2 \longrightarrow 56\,kg\ CO$$

$$1\,kg\ C + \frac{4}{3}\,kg\ O_2 \longrightarrow \frac{7}{3}\,kg\ CO$$

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Constituents of Air

By weight $N_2 = 77\%$
$O_2 = 23\%$

By volume $N_2 = 79\%$
$O_2 = 21\%$

$$\frac{23}{100} kg\ O_2 + \frac{77}{100} kg\ N_2 = 1 kg\ air$$

$$\frac{100}{23}\left(\frac{23}{100} kg\ O_2 + \frac{77}{100} kg\ N_2\right) = \frac{100}{23} kg\ air$$

$$1 kg\ O_2 + \frac{77}{23} kg\ N_2 = \frac{100}{23} kg\ air$$

$\therefore$ 1 kg O_2 is accompanied by $\frac{77}{23}$ kg N_2

Stoichiometric quantity of air is that quantity which is required for complete combustion of 1 kg of fuel without any oxygen appearing in the products of combustion

Excess air → common practice to use 25% - 50% excess air.

Weight of air required for given requirement of O_2

for x kg O_2 → y kg air

1 kg O_2 → $\frac{100}{23}$ kg air

air required $= x \times \frac{100}{23}$ kg

Example:

The percentage composition of sample of liquid fuel by weight is C = 84.8% and H_2 = 15.2%. Calculate i) Weight of air needed for complete combustion of 1 kg fuel.
ii) The volumetric composition of products of combustion if 15% excess air is supplied

Element	Weight (kg)		O_2 required		Products	
C	84.8%	0.848	$0.848 \times \frac{8}{3} =$	2.261	$CO_2 \rightarrow 0.848 \times \frac{11}{3} =$	3.109 kg
H_2	15.2%	0.152	$0.152 \times 8 =$	1.216	$H_2O \rightarrow 0.152 \times 9 =$	1.368 kg

Total O_2 required = 3.477

i) Weight of air required for combustion $= 3.477 \times \frac{100}{23} = 15.11$ kg

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Excess air supplied = 15%

$$= \frac{15.11 \times 15}{100} = 2.266\ kg \text{ excess air}$$

Weight of O_2 in excess air $= 2.266 \times \frac{23}{100} = 0.521\ kg$

Total air supplied for combustion = Minimum air required + Excess air

$$= 15.11 + 2.266 = 17.376\ kg$$

Weight of Nitrogen N_2 in flue gases $= 17.376 \times \frac{77}{100} = 13.38\ kg$

ii)

	Weight	Molecular weight	Proportional Vol $= \frac{Wt}{Mol\ wt}$	Percentage vol $= \frac{\text{Proportional}}{\text{Total vol}}$
CO_2	3.109	44	0.07	12.43 %
O_2	0.521	32	0.016	2.84 %
N_2	13.38	28	0.477	84.72 %
H_2O				

Σ vol = 0.563

Normally volumetric analysis is done on dry basis, yielding the volume percentage of all products except water vapour. This allows a simple method of determining the actual air-fuel ratio and excess air used in a combustion process.

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