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DATE:

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Engineering chemistry

Tutorial - 3

1>

Constituent	% by volume	Volume per kg of fuel
CO	40	40/100 = 0.40
H_2	42	42/100 = 0.42
C_3H_8	4	4/100 = 0.04
CH_4	4	4/100 = 0.04
N_2	4	Does not contribute
O_2	6	6/100 = 0.06

Combustion reaction:

i> $CO + 1/2\,O_2 \longrightarrow CO_2$

1 vol. 0.5 vol

i.e. 1 volume of CO requires 0.5 volume of oxygen.

$\therefore$ 0.4 volume of CO requires $0.4 \times 0.5 = 0.2\ m^3$ of oxygen.

ii> $H_2 + 1/2\,O_2 \longrightarrow H_2O$

1vol 0.5vol

i.e. 1 volume of H_2 requires 0.5 volume of oxygen.

$\therefore$ 0.42 volume of H_2 requires $0.42 \times 0.5 = 0.2\ cm^3$ of oxygen.

iii> $C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$

1vol 5vol

i.e. 1 volume of C_3H_8 requires 5 volume of oxygen.

$\therefore$ 0.04 volume of C_3H_8 will require $0.04 \times 5 = 0.2 m^3$ of oxygen

iv> $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

1vol 2vol

i.e. 1volume of CH_4 requires 2 volume of oxygen.

$\therefore$ 0.04 volume of CH_4 require $0.04 \times 2 = 0.08 m^3$ of oxygen.

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$\therefore N_2$ is non combustible. Therefore, does not contribute

$\therefore$ Volume of oxygen required $= 0.2 + 0.21 + 0.2 + 0.08 = 0.69\ m^3$.

But $0.06\ m^3$ of oxygen is already present in the fuel.

$\therefore$ Actual volume of oxygen required $= 0.69 - 0.06$

$= 0.63\ m^3$

To find volume of air:

$21\ m^3$ of oxygen is present in $100\ m^3$ of air.

$\therefore 0.63\ m^3$ of oxygen will be present in $\frac{0.63}{21} \times 100$

$\therefore$ $= 3\ m^3$ of air.

$\therefore$ Volume of air required $= 3.0\ m^3$.

To find weight of air:

Molecular weight of air $= 28.989\ g$.

$\therefore 22.4\ m^3$ of air weighs $28.949\ kg$.

$\therefore 3.0\ m^3$ of air weighs $\frac{3.0}{22.4} \times 28.949$

$\therefore$ Weight of air required $= 3.8771\ kg$.

$\therefore$ Volume of air required $= 3.0\ m^3$

Weight of air required $= 3.8771\ kg$.

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2)

Constituent	% by Volume	Volume of each per kg of fuel.
H_2	25	0.25
CH_4	30	0.3
C_3H_8	20	0.2
CO	20	0.2
CO_2	2	Does not contribute
N_2	1	Does not contribute
O_2	2	0.02

Combustion reactions:

i) $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$

1vol   0.5 vol

$\therefore$ 0.25 vol H_2 will require $0.25 \times 0.5 = 0.125$ m^3 of oxygen.

ii) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

1vol   2vol

$\therefore$ 0.3 vol of CH_4 will require $0.3 \times 2 = 0.6$ m^3 of oxygen.

iii) $C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$

1vol   5vol

$\therefore$ 0.2 vol of C_3H_8 will require $0.2 \times 5 = 1$ m^3 of oxygen.

iv) $CO + \frac{1}{2}O_2 \longrightarrow CO_2$

1vol   0.5vol

$\therefore$ 0.2 vol of CO will require $0.2 \times 0.5 = 0.1$ m^3 of oxygen.

~~v) CO + 1/2O~~

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N_2 and CO_2 don't contribute as they are non-combustible.
∴ Volume of oxygen required $= 0.125 + 0.6 + 1 + 0.1$
$= 1.825\ m^3$

But $0.02\ m^3$ of oxygen is already present.
∴ Oxygen required $= 1.825 - 0.02$
$= 1.805\ m^3$

Volume of air:
$21\ m^3$ of oxygen present $100\ m^3$ of air
∴ $1.805\ m^3$ of oxygen will be present in $\frac{1.805 \times 100}{21} = 8.59\ m^3$ of air.

mol. weight of air $= 28.94\ g$.
$22.4\ m^3$ of air weighs $28.94\ kg$
∴ $8.6\ m^3$ will weight $\frac{8.6 \times 28.94}{22.4} = 11.11\ kg$.

∴ Volume of air required $= 8.6\ m^3$
Weight of air required $= 11.11\ kg$.

3)

Constituent	% by weight	Weight of each per kg fuel.
C	82	0.82
H	3	0.03
O	8	0.08
S	2	0.02
N	2	Does not contribute
Ash	3	Does not contribute

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Amount of air required $= \frac{100}{23}[2.67C + 8H + S - O]$ kg

$= \frac{100}{23}[2.67(0.82) + 8(0.03) + 0.02 - 0.08]$

$= \frac{100}{23}[2.3694]$ kg

$= 10.3$ kg.

∴ ~~Amount of air required~~

∴ Amount of air per kg of fuel $= 10.3$ kg.

∴ Amount of air for 2 kg of fuel $= 10.3 \times 2$

$= 20.6$ kg.

Now,

28.949 kg occupies $22.4 m^3$ of air.

∴ 10.3 kg occupies $\frac{10.3}{28.949} \times 22.4 = 7.97 m^3$ of air.

∴ Volume of air per kg of fuel $= 7.97 m^3$

∴ Volume of air for 2 kg of fuel $= 7.97 \times 2$

$= 15.94 m^3$.