

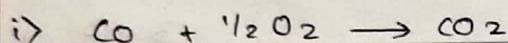
15/07/2021

Engineering chemistry

Tutorial - 3.

i>	Constituent	% by volume	Volume per kg of fuel
	CO	40	$40/100 = 0.40$
	H ₂	42	$42/100 = 0.42$
	C ₃ H ₈	4	$4/100 = 0.04$
	CH ₄	4	$4/100 = 0.04$
	N ₂	4	Does not contribute
	O ₂	6	$6/100 = 0.06$

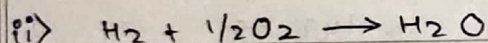
Combustion reaction:



1 vol. 0.5 vol

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

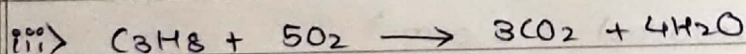
\therefore 0.4 volume of CO requires $0.4 \times 0.5 = 0.2 \text{ m}^3$ of oxygen.



1 vol 0.5 vol

i.e. 1 volume of H₂ requires 0.5 volume of oxygen.

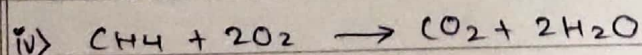
\therefore 0.42 volume of H₂ requires $0.42 \times 0.5 = 0.21 \text{ m}^3$ of oxygen.



1 vol 5 vol

i.e. 1 volume of C₃H₈ requires 5 volume of oxygen.

\therefore 0.04 volume of C₃H₈ will require $0.04 \times 5 = 0.2 \text{ m}^3$ of oxygen.



1 vol 2 vol

i.e. 1 volume of CH₄ requires 2 volume of oxygen.

\therefore 0.04 volume of CH₄ require $0.04 \times 2 = 0.08 \text{ m}^3$ of oxygen.

$\therefore \text{N}_2$ is non combustible. Therefore, does not contribute

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

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

\therefore Actual volume of oxygen required $= 0.69 - 0.06$
 $= 0.63 \text{ m}^3$

To find volume of air:

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

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

$\therefore = 3 \text{ m}^3$ of air.

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

To find weight of air:

Molecular weight of air $= 28.989 \text{ g}$.

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

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

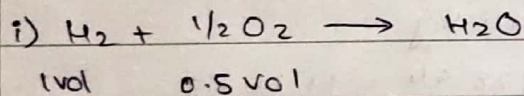
\therefore Weight of air required $= 3.8771 \text{ kg}$.

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

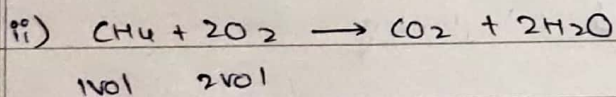
Weight of air required $= 3.8771 \text{ kg}$.

2)	Constituent	% by Volume	Volume of each per kg of fuel.
	H ₂	25	0.25
	CH ₄	30	0.3
	C ₃ H 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

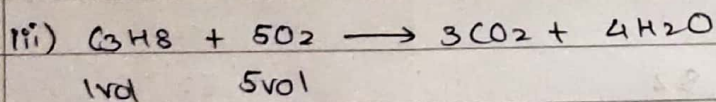
Combustion reactions:



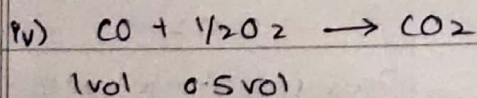
\therefore 0.25 vol H₂ will require $0.25 \times 0.5 = 0.125 \text{ m}^3$ of oxygen.



\therefore 0.3 vol of CH₄ will require $0.3 \times 2 = 0.6 \text{ m}^3$ of oxygen.



\therefore 0.2 vol of C₃H₈ will require $0.2 \times 5 = 1 \text{ m}^3$ of oxygen.



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

~~CO + 1/2 O2~~

N_2 and CO_2 don't contribute as they are non-combustible.

$$\therefore \text{Volume of oxygen required} = 0.125 + 0.6 + 1 + 0.1$$

$$= 1.825 \text{ m}^3$$

But 0.02 m^3 of oxygen is already present.

$$\therefore \text{Oxygen required} = 1.825 - 0.02$$

$$= 1.805 \text{ m}^3$$

Volume of air :

21 m^3 of oxygen present 100 m^3 of air

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

mol. weight of air = 28.94 g .

22.4 m^3 of air weighs 28.94 kg

$$\therefore 8.6 \text{ m}^3 \text{ will weight } \frac{8.6 \times 28.94}{22.4} = 11.11 \text{ kg.}$$

\therefore 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

$$\begin{aligned}
 \text{Amount of air required} &= \frac{100}{23} [2.67C + 8H + S - O] \text{ kg} \\
 &= \frac{100}{23} [2.67(0.82) + 8(0.03) + 0.02 - 0.08] \\
 &= \frac{100}{23} [2.3694] \text{ kg} \\
 &= 10.3 \text{ kg.}
 \end{aligned}$$

~~\therefore Amount of air required~~

\therefore Amount of air per kg of fuel = 10.3 kg.

\therefore Amount of air for 2 kg of fuel = 10.3×2
= 20.6 kg.

Now,

28.949 kg occupies 22.4 m³ of air.

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

\therefore Volume of air per kg of fuel = 7.97 m³

\therefore Volume of air for 2 kg of fuel = 7.97×2
= 15.94 m³.