

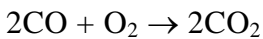
Q3 A gaseous fuel has the following percentage composition by volume:

CO 13%, H₂ 42%, CH₄ 25%, O₂ 2%, CO₂ 3%, N₂ 15%

Determine the wet and dry volumetric and gravimetric analyses of the products of combustion if 15% excess air is used. State all assumptions made and take air as 21% O₂ and 79% N₂ by volume. The relative atomic masses are hydrogen 1, carbon 12, nitrogen 14 and oxygen 16.

VOLUMETRIC

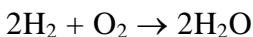
CARBON MONOXIDE



$$2 \text{ m}^3 + 1 \text{ m}^3 \rightarrow 2 \text{ m}^3$$

$$0.13 \text{ m}^3 + 0.065 \text{ m}^3 \rightarrow 0.13 \text{ m}^3$$

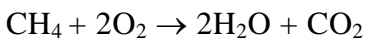
HYDROGEN



$$2 \text{ m}^3 + 1 \text{ m}^3 \rightarrow 2 \text{ m}^3$$

$$0.42 \text{ m}^3 + 0.21 \text{ m}^3 \rightarrow 0.42 \text{ m}^3$$

METHANE



$$1 \text{ m}^3 + 2 \text{ m}^3 \rightarrow 2 \text{ m}^3 + 1 \text{ m}^3$$

$$0.25 \text{ m}^3 + 0.5 \text{ m}^3 \rightarrow 0.5 \text{ m}^3 + 0.25 \text{ m}^3$$

Total oxygen required is $0.065 + 0.21 + 0.5 - 0.02 = 0.755 \text{ m}^3$

Air required = $0.755/0.21 = 3.595 \text{ m}^3$

Air supplied = $3.595 \times 1.15 = 4.135$

PRODUCTS

			WET	DRY
H ₂ O	$0.42 + 0.5 =$	0.920 m^3	18.9%	0
O ₂	$0.21 \times 4.135 - 0.755 =$	0.113 m^3	2.3%	2.9%
N ₂	$0.79 \times 4.135 + 0.15 =$	3.417 m^3	70.3%	86.7%
CO ₂	$0.13 + 0.25 + 0.03 =$	0.410 m^3	8.4%	10.4
Total		$4.86/3.94$	100%	100

GRAVIMETRIC

We convert volumes to masses using the formula $\frac{m_i}{m} = \frac{(V_i/V)\tilde{m}_i}{\sum \{(V_i/V)\tilde{m}_i\}_i}$

WET				
i	V _i /V	\tilde{m}_i	(V _i /V) \tilde{m}_i	\tilde{m}_i / m
H ₂ O	0.189	18	3.40	12.3%
O ₂	0.023	32	0.74	2.7%
N ₂	0.703	28	19.7	71.5%
CO ₂	0.084	44	3.7	13.4%
Total	1.0		27.54	100

DRY				
i	V _i /V	\tilde{m}_i	(V _i /V) \tilde{m}_i	\tilde{m}_i / m
O ₂	0.029	32	0.928	3.1%
N ₂	0.867	28	24.276	81.5%
CO ₂	0.104	44	4.576	15.4%
Total	1.0		29.78	100