Previous year JEE questions 7

A 20.0 cm^3 mixture of CO, CH$_4$ and He gases is exploded by an electric discharge at room temperature with excess of oxygen. The volume contraction is found to be 13.0 cm^3. A further contraction of 14.0 cm^3 occurs when the residual gas is treated with KOH solution. Find out the composition of the gaseous mixture in terms of volume percentage.
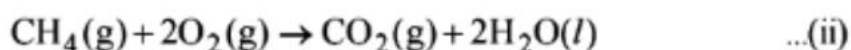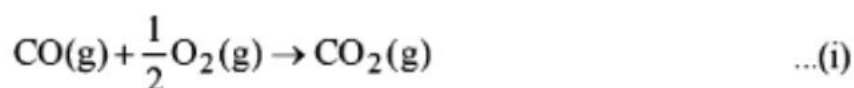
(1995 - 4 Marks)

TIPS/Formulae :

(i) He does not react with oxygen.

(ii) KOH absorbs only CO$_2$.

NOTE : When the mixture of CO, CH$_4$ and He gases (20 ml) are exploded by an electric discharge with excess of O$_2$, He gas remains as such and the other reactions involved are :

$$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g) \qquad\qquad ...(i)$$

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l) \qquad ...(ii)$$

Let the volumes of CO and CH$_4$ to be 'a' ml and 'b' ml in the mixture then

Volume of He gas = $[20 - (a + b)]$ ml
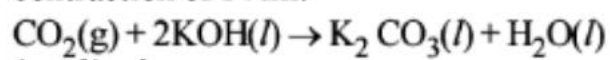
For the initial contraction of 13 ml,

Volume of left hand side in the above reactions $- 13 =$ Volume of right hand side.

$$\therefore \quad [20 - (a+b)] + \left(a + \frac{1}{2}a\right) + (b + 2b) - 13$$

$$= [20 - (a + 2b)] + a + b \quad \text{[neglect the volume of H}_2\text{O}\,(l)]$$

(Since for gases, volume α no. of moles)

$$\therefore \quad \frac{1}{2}a + 2b = 13 \quad \text{or} \quad a + 4b = 26 \qquad\qquad ...(iv)$$

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NOTE THIS STEP : The CO_2 produced above in reactions
(ii) & (iii), $(a + b)$ ml, reacts with KOH sol for a further
contraction of 14 ml.

$$CO_2(g) + 2KOH(l) \rightarrow K_2CO_3(l) + H_2O(l)$$
$(a + b)$ ml
$\therefore \quad a + b = 14 \qquad\qquad\qquad ...(v)$

Solving (iv) & (v) we get, $a = 10$ ml & $b = 4$ ml

$$\therefore CH_4 = \frac{4}{20} \times 100 = \mathbf{20\%} , \quad CO = \frac{10}{20} \times 100 = \mathbf{50\%}$$

& $He = 100 - (20 + 50) = \mathbf{30\%}$