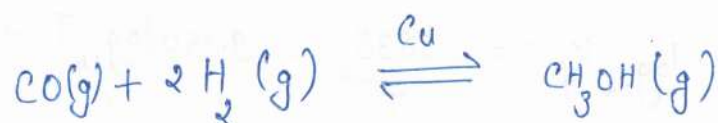


Quiz 1. Given Reaction:



$$P_T = 200 \text{ bars}$$

$$T = 275^\circ\text{C}$$

$$\Rightarrow T = (275 + 273) \text{ K} = 548 \text{ K}$$

Now,

	$T_c (\text{K})$	$P_c (\text{bar})$	$T_{\text{red}}$	$P_{\text{red}}$	$\phi$
$\text{H}_2$	33	35	18.61	5.71	1.05
$\text{CO}$	134	13	4.09	15.38	1.05
$\text{CH}_3\text{OH}$	513	82	1.07	2.44	0.45

Note:  $P_{\text{red}} = P/P_c$  and  $T_{\text{red}} = T/T_c$

$$K_f = K_a = \frac{\left( \frac{\hat{f}_{\text{CH}_3\text{OH}}}{1} \right)}{\left( \frac{\hat{f}_{\text{CO}}}{1} \right) \left( \frac{\hat{f}_{\text{H}_2}}{1} \right)^2} = \frac{\hat{\phi}_{\text{CH}_3\text{OH}} \cdot \gamma_{\text{CH}_3\text{OH}} \cdot P_T}{\hat{\phi}_{\text{CO}} \hat{\phi}_{\text{H}_2}^2 P_T \cdot P_T^2 \cdot \gamma_{\text{CO}} \gamma_{\text{H}_2}^2}$$

\*. For Ideal solution: fugacity coeff. in mixture of  $i^{\text{th}}$  component is same as that for pure component.

Thus,

$$K_f = \frac{\phi_{\text{CH}_3\text{OH}} \cdot \gamma_{\text{CH}_3\text{OH}}}{\phi_{\text{CO}} \phi_{\text{H}_2}^2 \gamma_{\text{CO}} \gamma_{\text{H}_2}^2 \cdot P_T^2} = \frac{(0.45)}{(1.05)(1.05)^2} \frac{\gamma_{\text{CH}_3\text{OH}}}{\gamma_{\text{CO}} \gamma_{\text{H}_2}^2 \cdot P_T^2}$$

$$\Rightarrow \boxed{K_f = \frac{0.389 \gamma_{\text{CH}_3\text{OH}}}{\gamma_{\text{CO}} \gamma_{\text{H}_2}^2 \cdot P_T^2}} \quad - \text{①}$$

also,  
=

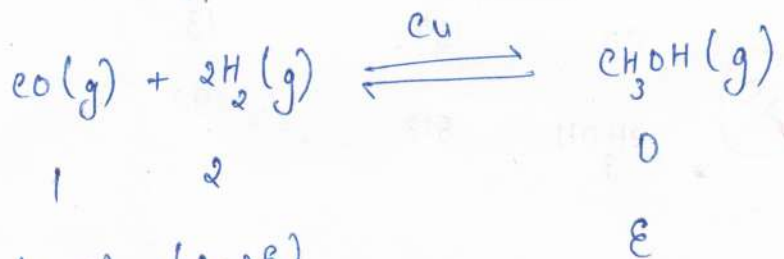
$$\log_{10} K_f = \frac{3835}{T} - 9.150 \log_{10} T + (3.08 \times 10^{-3} T) + 13.20$$

$$= \frac{3835}{548} - 9.150 \log_{10} (548) + \left( \frac{3.08 \times 548}{1000} \right) + 13.20$$

$$\Rightarrow \log_{10} K_f = -3.174$$

$$\text{or, } \boxed{K_f = 6.7 \times 10^{-4}} \quad \text{--- (i)}$$

from the reaction:



initially

finally

$$\begin{array}{cc} 1 & 2 \\ (1-\epsilon) & (2-2\epsilon) \end{array}$$

0

$\epsilon$

$$Y_{\text{CO}} = \frac{(1-\epsilon)}{(3-2\epsilon)} ; \quad Y_{\text{H}_2} = \frac{(2-2\epsilon)}{(3-2\epsilon)} \quad \text{and} \quad Y_{\text{CH}_3\text{OH}} = \frac{\epsilon}{(3-2\epsilon)}$$

from (i)

$$K_f = \frac{0.389 \epsilon (3-2\epsilon) (3-2\epsilon)^2}{(3-2\epsilon) (1-\epsilon) (2-2\epsilon)^2 \cdot P_T^2}$$

$$\Rightarrow K_f = \frac{0.389 \epsilon (3-2\epsilon)^2}{(1-\epsilon) (2-2\epsilon)^2 \cdot P_T^2}$$

from (ii):

$$\frac{6.7}{10000} = \frac{0.389 \varepsilon (3-2\varepsilon)^2}{4(1-\varepsilon)^3 \cdot P_T^2}$$

$$\Rightarrow 275.578 = \frac{\varepsilon (9+4\varepsilon^2-12\varepsilon)}{(1-3\varepsilon+3\varepsilon^2-\varepsilon^3)}$$

or,

$$279.578 \varepsilon^3 - 838.734 \varepsilon^2 + 835.734 \varepsilon - 275.578 = 0$$

Thus  
+20

$$\varepsilon = 0.824$$

or  $\varepsilon = 1.088$

Thus

$\varepsilon = 0.824$

Ans.

Thus Effluent composition:

$$\rightarrow \text{CH}_3\text{OH} = \frac{0.824}{3-2(0.824)} = 0.61 = 61\%$$

$$\rightarrow \text{H}_2 = \frac{2-2(0.824)}{3-2(0.824)} = 0.26 = 26\%$$

$$\rightarrow \text{CO} = \frac{(1-0.824)}{3-2(0.824)} = 0.13 = 13\%$$

Ans.

+10

(4)

\* MARKING SCHEME :-

→  $T_{red}$ ,  $P_{red}$  and  $\phi$  from graph → (+10)

→ Ideal sol.<sup>N</sup> assumption → (+10)

→  $K_f$  (mole fr.) → (+10)

→  $K_f$  ( $\epsilon$  extent of reactn) → (+10)

→  $K_f$  from given relation → (+20)

→ Mole fr. as function of  $\epsilon$  → (+10)

→  $\epsilon$  value → (+20)

→ outlet composition → (+10)