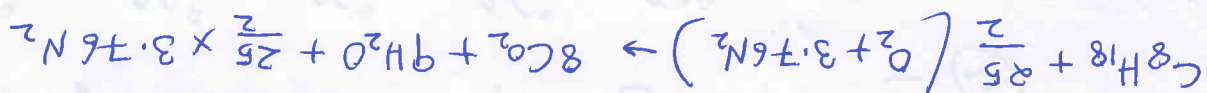


## Quiz-I solution (ME301A)

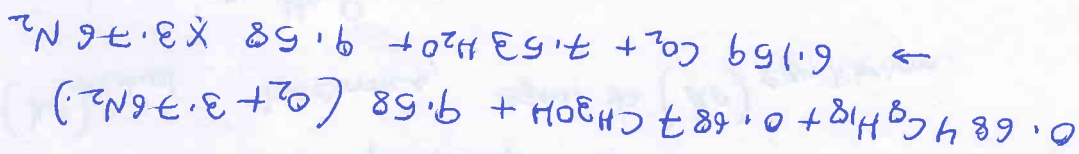


$$(A/F)_{\text{stoic}} = \frac{25}{2} \times 137.28 = \frac{1 \times 114}{15.052}$$

(b) Assume 100 gm of fuel mixture having 78 gm  $C_8H_{18}$  and 22 gm  $CH_3OH$  by mass. So,

$$\text{moles of } C_8H_{18} = \frac{78}{114} = 0.684 \text{ moles}$$

$$\text{" " } CH_3OH = \frac{22}{32} = 0.687 \text{ moles}$$



$$(A/F)_{\text{stoic}} = \frac{100}{9.58 \times 137.28} = 13.151$$

$$\text{equivalence ratio, } \phi = \frac{(A/F)_{\text{st.}}}{(A/F)} = \frac{13.151}{15.052} = 0.8737$$

note:- any arbitrary amount of fuel mixture can be chosen instead of 100 gm,  $(A/F)_{\text{st.}}$  remains unchanged.

②

Total pressure = 5 atm

Partial pressure,  $p_{H_2} = 1.3 \text{ atm}$ ,  $p_{CO_2} = 0.5 \text{ atm}$ ,  $p_{CO} = 3 \text{ atm}$

$$p_{H_2O} = 5 - (1.3 + 0.5 + 3) = 0.2 \text{ atm}$$



$$K_p (\text{for given state of mixture}) = \left( \frac{p_{H_2O}}{p_{CO}} \right) \left( \frac{p_{H_2}}{p_{CO_2}} \right) = \frac{0.2 \times 3}{1.3 \times 0.5} = 0.9231$$

③ —

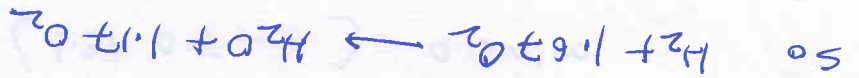
$$\Delta H_{\text{reactants}} = h_{f, H_2}^{\circ} + 1.67 h_{f, O_2}^{\circ}$$

$$T_1 = 298$$

$$\Delta H_{\text{reactants}} = \left[ h_{f, H_2}^{\circ} + (T_1 - 298) \bar{c}_{p, H_2} \right] + 1.67 \left[ h_{f, O_2}^{\circ} + (T_1 - 298) \bar{c}_{p, O_2} \right]$$

$$\Delta H_{\text{reactants}} = \Delta H_{\text{products}}$$

for adiabatic combustion, at const. pressure,



$$\text{and } m = 1.17$$

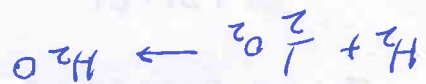
$$\left( \frac{A}{P} \right) = \frac{80}{3} = \frac{2}{m \times 3} \Rightarrow m = 1.67$$



for lean mixture,

$$\phi = 0.3 = \left( \frac{A}{P} \right)_{\text{st.}} \left( \frac{A}{P} \right) = \left( \frac{A}{P} \right) = \frac{0.3}{8} = \frac{3}{80}$$

$$\left( \frac{A}{P} \right)_{\text{st.}} = \frac{\frac{1}{2} \times 32}{8} = 2$$



until  $(K_p)_{\text{actual}}$  becomes equal to  $(K_p)_{\text{equilibrium}}$ .

therefore reaction will proceed in forward direction

$$(K_p)_e > (K_p)_{\text{actual}}$$

$$50 \quad (K_p)_e = \frac{e^{\frac{6063}{8134 \times 1300}}}{1.753}$$

$$R_4 = 8134 \text{ kJ/kmol-K}$$

$$= -176.852 - 226453 + 396236 - 0 = -6069 \text{ kJ/kmol}$$

$$\Delta G_p^{\circ} = \Delta G_{H_2O}^{\circ} + \Delta G_{O_2}^{\circ} - \Delta G_{H_2}^{\circ} - \Delta G_{O_2}^{\circ}$$

⑤ -

$$K_p (\text{at equilibrium state}) = e^{-\frac{\Delta G_p}{R_4 T}}$$

$$\Delta H_{\text{Products}} = \left[ h_{f, H_2O}^0 + \bar{C}_{p, H_2O} (T_{ad} - 298) \right] + 1.17 \left[ h_{f, O_2}^0 + \bar{C}_{p, O_2} (T_{ad} - 298) \right]$$

$h_f^0$  = enthalpy of formation at 298K and 5 atm

$$\therefore dh = d\bar{u} + v dp$$

for adiabatic process,  $dh = v dp$

$$dh = v dp = \frac{R}{M} \frac{dp}{p}$$

$$h_2 = h_1 + \frac{R}{M} \ln \left( \frac{p_1}{p_2} \right)$$

$$h_1 + m \cdot 8.314 \times 298 \ln 5 = h_1 + 3987.67$$

so  $\Delta H_{\text{reagents}} = h_{f, H_2}^0 + 1.67 h_{f, O_2}^0 + 2.67 \times 3987.67$

$$= 10646.62 \text{ kJ/kmol} \quad \text{--- (1)}$$

$$\Delta H_{\text{Product}} = h_{f, H_2O}^0 + \bar{C}_{p, H_2O} (T_{ad} - 298) + 1.17 \left[ h_{f, O_2}^0 + \bar{C}_{p, O_2} (T_{ad} - 298) \right]$$

$$+ 2.17 \times 3987.67$$

$$= -267329.3 + 85152 T_{ad} + 8652.875$$

--- (2)

from (1) + (2)

$$T_{ad} = 3149.24 \text{ K}$$