Day - 2

- If state not mentioned in reaction, assume gaseous state.

- **Stoichiometric air-fuel mixture:**

Fuel and oxidiser are in proportion, such that after complete combustion, all fuel and oxidiser are consumed and ??

↓

CO_2, H_2O ← { the products should have highest -ve $\Delta H_{formation}$ and no other products in addition to these should be formed

Eg: $C + \frac{1}{2} O_2 \rightarrow CO$

$2C + 2O_2 \rightarrow CO + CO_2 + \frac{1}{2} O_2$

$2C + 1.5 O_2 \rightarrow CO + CO_2$

} Not stoichiometric

$$C_\alpha H_\beta O_\gamma + a(\underbrace{O_2 + 3.76 N_2}_{air}) + \cdots$$

$$\longrightarrow \alpha CO_2 + \frac{\beta}{2} H_2O + 3.76\left(\alpha + \frac{\beta}{4} - \frac{\gamma}{2}\right) N_2$$

So $a = \alpha + \frac{\beta}{4} - \frac{\gamma}{2}$

→ **Air-fuel ratio (A/F)**

$$A/F = \frac{m_{air}}{m_{fuel}} = \frac{4.76 \times M_{air} \times a}{1 \times M_{fuel}}$$

☆ $0.95\,CH_4 + 0.05H_2 + a(O_2 + 3.76H_2)$

$\longrightarrow bCO_2 + cH_2O + a \times 3.76\,N_2$. Balance!

Ans) $CH_4 + 2(O_2 + 3.76N_2) \longrightarrow CO_2 + 2H_2O$

$+ 2 \times 3.76\,N_2$ — (1)

$H_2 + 0.5(O_2 + 3.76N_2) \longrightarrow H_2O + 0.5 \times 3.76\,N_2$ — (2)

$0.95 \times$ (1) + $0.05 \times$ (2) gives

$0.95\,CH_4 + 0.05\,H_2 + 1.925(O_2 + 3.76N_2)$

$\longrightarrow 0.95CO_2 + 1.95\,H_2O + 7.238N_2$

- Equivalence ratio (ϕ)

$$= \frac{(\text{Fuel-air ratio})_{actual}}{(\text{Fuel-air ratio})_{stoich}}$$

→ Inverse of air-fuel ratio

$\phi = 1 \longrightarrow$ Stoichiometric mixture

$\phi < 1 \longrightarrow$ lean-mixture (excess air)

↳ $H_2 + O_2 \longrightarrow H_2O + \frac{1}{2}O_2$

$\phi > 1 \longrightarrow$ Rich _mixture

↳ $2CH_4 + O_2 \longrightarrow aCO + bCO_2 + cCH_4$

- Excess air ratio (λ)

$$\lambda = 1/\phi = \frac{(A/F)_{actual}}{(A/F)_{stoich}}$$

→ iso-octane + air in stoich. ratio

(a) χ_{fuel} (b) F/A (c) χ_{water} in products

(d) Temp. of prod. below which H_2O vap. condenses at 1 atm pressure.

Ans) a.) $a = \alpha + \frac{\beta}{4} - \frac{\gamma}{2} = 8 + \frac{18}{4} = 12.5$

(C_8H_{18})

$$\chi_{fuel} = \frac{1}{1 + 12.5 \times 4.76} = 0.0165$$

b) $$F/A = \frac{1 \times 114}{12.5 \times 4.76 \times 29} = 0.066$$

c.) $$\chi_{water} = \frac{9}{8 + 9 + 12.5 \times 3.76}$$

$$= 0.141$$

d.) $P_{water} = 101.325 \times 0.14$

$= 14.287$ kPa

$= 0.14287$ bar

So $T \sim 53^\circ C$

(Book: S.R. Turns → Intro to Combustion)