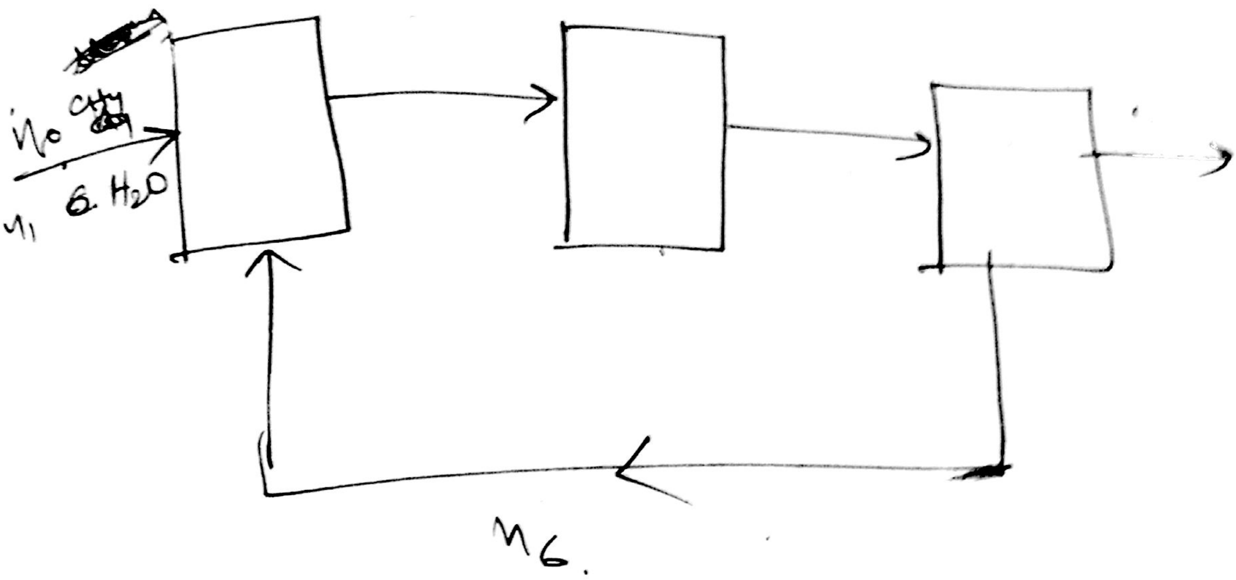


$$\cancel{C_2H_6 \rightleftharpoons C_2H_4 + H_2}$$

$$\overset{1}{CH_4} + \overset{1}{H_2O} \rightleftharpoons \overset{0}{CO} + \overset{0}{3H_2}$$

$$A + B \qquad C \quad 3D$$

0.01   0.01   0.99   2.97

for 99%

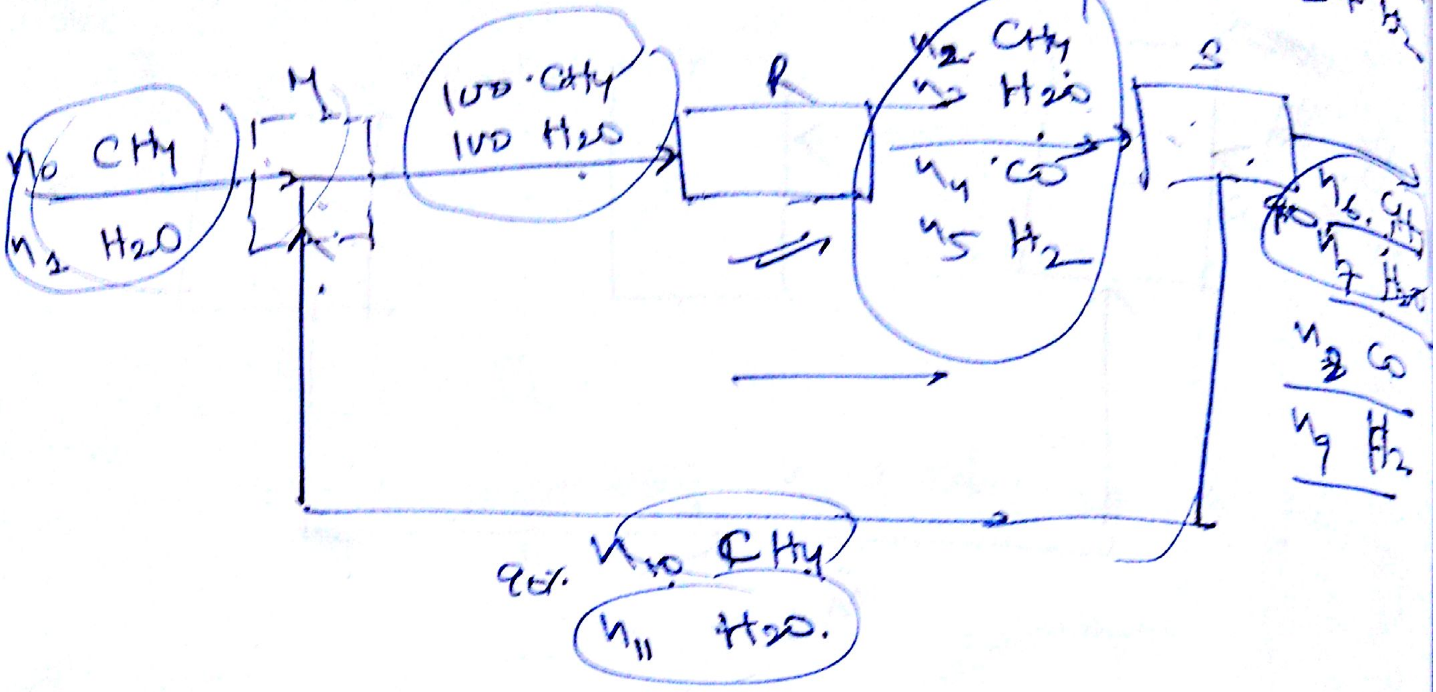
$$\frac{0.99 \times 2.97^3}{0.01 \times 0.01}$$

for 90%

$$\frac{0.9 \times 2.7^3}{0.1 \times 0.1}$$

$\Rightarrow CH_4 + H_2O \rightarrow CO + 3H_2$

$CO + H_2O \rightarrow CO_2 + H_2$



fresh methane

recycled methane

Mixer

$$① \quad n_0 + n_{10} = 100 \qquad ⑧ \quad n_0 = n_1$$

$$② \quad n_1 + n_{11} = 100 \qquad ⑨ \quad n_{10} = n_{11}$$

fresh steam

recycled steam

Reactor

$$n_2 = 100 - \xi_1$$

$$n_3 = n_2 = 100 - \xi_1$$

$$n_4 = \xi_1$$

$$n_5 = 3\xi_1 = 3n_4$$

$$n_{tot} = n_2 + n_3 + n_4 + n_5$$

$$= 200 + 2\xi$$

Assuming 90% conversion

$$CH_4 + H_2O \rightleftharpoons CO + 3H_2$$

t_0	100	100	0	0
t_e	$100-\varepsilon$	$100-\varepsilon$	ε	3ε

for 90% conv.

$$\frac{\varepsilon\,(3\varepsilon)^3}{(200+2\varepsilon)^2(100-\varepsilon)(100-\varepsilon)} = \frac{0.9 \times (3\times0.9)^3}{(1+1.8)^2(1-0.9)(1-0.9)}$$

or simply

$\cancel{\boxed{\varepsilon = 0.9}}$ $\varepsilon = 90$

Separator (assuming separator efficiency 90%)

Methane / Steam split

$$\left.\begin{aligned} n_6 &= 0.01\, n_2 \\ n_2 &= n_6 + n_{10} \end{aligned}\right] \text{for } CH_4$$

$$\left.\begin{aligned} n_7 &= \cancel{0.08}\ 0.01\, n_3 \\ \cancel{n_3} &= \cancel{0.01\, n_1} \\ n_3 &= n_7 + n_{11}. \end{aligned}\right] \text{for } H_2O$$

~~Typita~~ Typically

→ Temperature ~ 800 – 1000 °c

$\equiv$ 900 °c (average)

$\equiv$ 1173 K

→ Pressure ~ 30 – 40 bar

$\equiv$ 35 bar (average)

From "cache Modules on energy in the curriculum"

$$K_{SR} = \frac{y_{H_2}^3 \, y_{CO}}{y_{CH_4} \, y_{H_2O}} P_{Tot}^2$$

$$= \frac{n_{H_2}^3 \, n_{CO}}{n_{CH_4} \, n_{H_2O} \, n_{Tot}^2} P_{Tot}^2$$

$$= \exp\left(30.42 - \frac{27106}{\cancel{R}T}\right)$$

$$= \exp\left(30.42 - \frac{27106}{1173}\right) \quad \left[\text{For } T = 1173\,K\right]$$

$$= 1617.2$$

Going by this approach

$$\frac{\varepsilon(3\varepsilon)^3}{(200+2\varepsilon)^2(100-\varepsilon)(100-\varepsilon)} = 1617.2$$

becomes our equilibrium relation