Day-6

→ Challenges with conventional SMR —

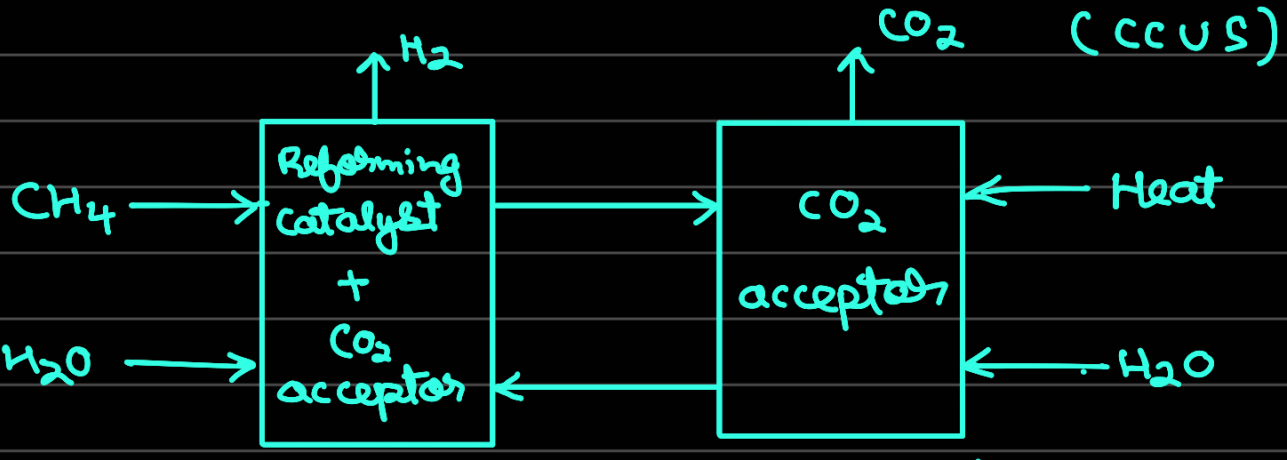
- Highly endothermic (lot of heat required)
- Heat recovery is very low
- Too many hardware/processes - complicated
- Large footprint required
- Integration related challenges (exo, endo)

→ Advanced SMR Technologies —

1) Sorption enhanced reforming (96% conversion, 650°C)

$$CH_4 + H_2O \rightleftharpoons CO + 3H_2 \;,\; \Delta H^\circ = 206\ kJ/mol$$

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$



Adiabatic fludized bed

$$A + CH_4 + 2H_2O \longrightarrow 4H_2 + ACO_2$$
$$CO_2 + A \longrightarrow ACO_2$$

A: Limestone, dolomite, zeolites

$$CaO + CO_2 \longrightarrow CaCO_3$$
$$CaCO_3 \longrightarrow CaO + CO_2$$

Advantages :

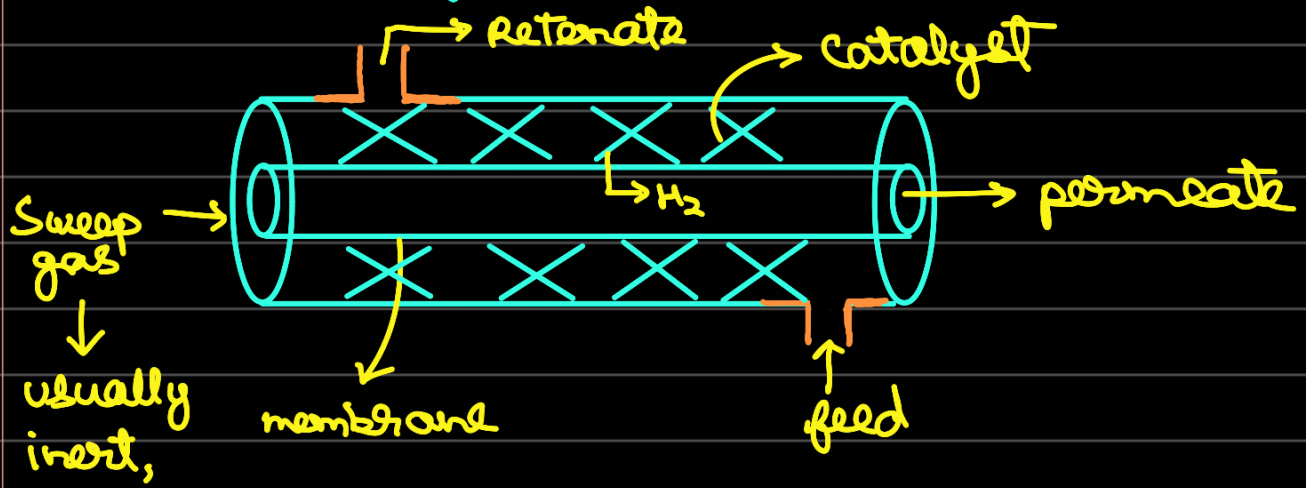
- Low temp. process
- Low footprint required
- Lower cost
- Lesser steps
- Lower heat

2) Hydrogen membrane reformer/reactor

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

Membrane should be —

- Thermally and mechanically stable
- Proper selectivity and permeability
- High flow of H_2



but issue is need of seperation

Membranes Used :

- Pd based (poisoning by impurity, cost are issues. Pd alloys like Pd–Cu, Pd–Ag are used)

→ **Partial Oxidation :**

$$CH_4 + \frac{1}{2}O_2 \longrightarrow CO + 2H_2 \quad \checkmark \Delta H^\circ = -36\ KJ/mol$$

~~$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$~~ ✗ $\Delta H^\circ = -802\ KJ/mol$

- Oxidant - O_2/air
- Exothermic process
- $H_2/CO = 2$
- Fuel flexibility.
- Useful when upgrading Heavy Residual Oils (HROs)

☆ **2 types** –

1.) Catalytic Partial Oxidation (CPO)
2.) Non-CPO (NCPO)

1.) CPO –
- Operates at lower T (600-900°C)
- Lower Hydrocarbons (HCs) used

2.) NCPO –
- Operates at high temp. (1200-1500°C)
- Wide range of feedstocks.