6. Hydrogen Energy, Production, Storage

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HYDROGEN ENERGY

- Eco-friendly . no carbon emissions

Advantages

- High availability
- Compatibility w/ fuel cells
- High efficiency (65%) compared to diesel (45%) and gasoline (22%

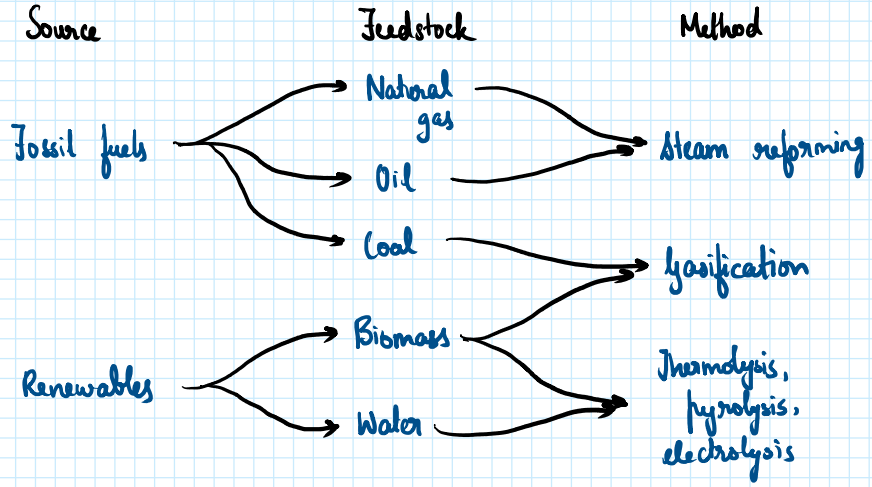
Disadvantages

- High cost
- Highly flammable
- Still requires fossil fuels

HYDROGEN ECONOMY

- Vision of energy delivery system that uses hydrogen as a carbon free energy carrier
- It provides:
  - → Alternative energy economy in the form of a parallel energy and transport infrastructure
  - → Technical developments for energy efficient hydrogen production, storage tech, and delivery infrastructure

HYDROGEN PRODUCTION



Steam reforming (grey hydrogen): Uses natural gas; most common method

Gasification (black hydrogen): Coal $\longrightarrow CO_2 \xrightarrow{\text{gasification}} CO \xrightarrow[\text{shift}]{\text{water gas}} H_2 + CO_2 \xrightarrow{\text{purify}} H_2$

Thermolysis: High temps (500-2000°C); carried out in closed system, only water is consumed

STEAM REFORMING

① Desulphurisation

Natural gas is taken in and desulphurised to avoid poisoning of catalysts.

② Steam reforming

+ steam + fuel + air } → forms syngas in presence of catalyst

Natural gas ⟶ $CO + H_2$

$CH_4 + H_2O \longrightarrow CO + 3H_2$

Temp: 800 - 900°C Catalyst: Ni

Nature: Endothermic (high temp., low pressure)

③ Shift (water gas shift)

$+ CO + H_2$

$CO + H_2O \longrightarrow CO_2 + H_2$

Temp: 350°C (low) Catalyst: Cr_2O_3 / Fe_3O_4

H_2 produced will have small traces of carbon monoxide as impurities

④ CO_2 removal

$+ CO_2 + H_2$

CO_2 is removed

⑤ Methanation

$+ H_2$ (traces of CO)

$CO + 3H_2O \longrightarrow CH_4 + H_2O$

Temp: 350 - 450°C

Advantages

- General produces higher yield H_2 (50%)
- Heat generated can be recycled to increase efficiency
- Relatively stable during process

Limitations

- High level of carbonaceous materials are formed
- External heat source is needed to initiate the reaction