Bridge from Fossil Fuel to Sustainable Energy: Methane Pyrolysis for Zero Emission Hydrogen Production

Student Names

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Process Diagram

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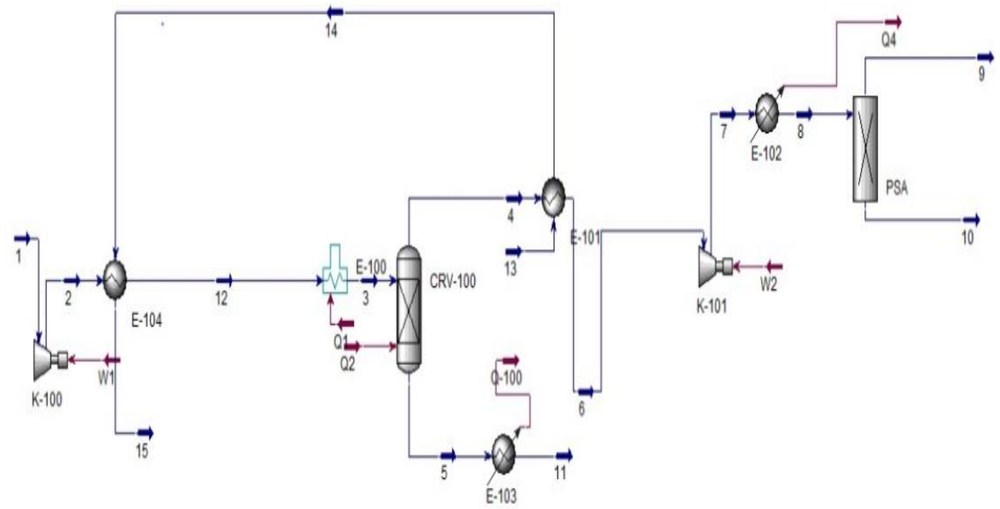
Chemical Engineering

Goals

- Design a methane pyrolysis plant in Saudi Arabia to produce 60 tons/day of hydrogen.
- Support Vision 2030 by creating a bridge to clean hydrogen production using natural gas.
- Eliminate CO2 emissions by converting methane into hydrogen and solid carbon.



Considerations

- Use of nickel-based catalyst in a fluidized bed reactor for better hydrogen yield.
- Operating at 750°C and 5 bar for optimal reaction conditions.
- Integration with existing natural gas infrastructure.
- Use of solid carbon byproduct in industrial applications.

Economical Analysis

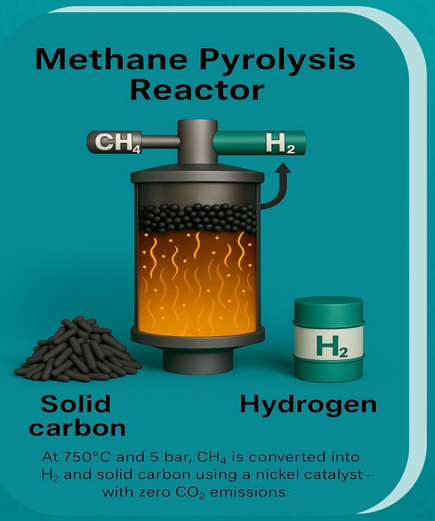
- Capital cost structure is competitive.
- Payback period within reasonable time frame.
- 20-year profit estimate: $1389.56 million.

Table 5.1: Capital cost

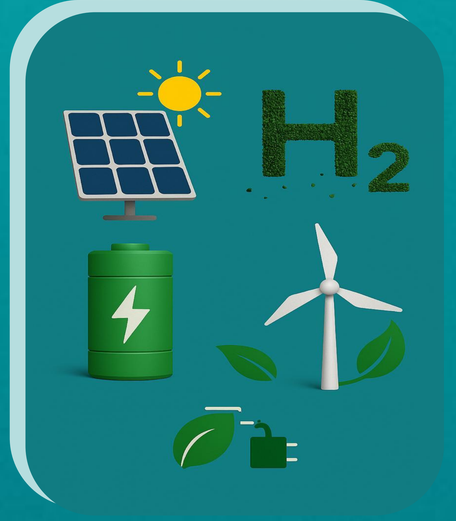
Equipment Type	Equipment Code	Purchasing Cost (in million dollars)
Compressor	K-100	2.13
Compressor	K-101	2.4
Reactor	R-100	0.105
Heat Exchanger	E-104	0.4
Heat Exchanger	E-101	0.4
Cooler	C-103	0.88
Cooler	C-102	0.88
PSA	P-100	0.6
Cyclone	S-100	0.15
Furnace	E-100	3.18
Total capital cost		**7.945**

Results

- Hydrogen Production: 2,500 kg/h
- Carbon Nanofiber Production: 9,048.8 kg/h
- Energy Integration: Internal fuel gas meets heating demand
- Hydrogen Recovery: 82.3% using PSA



Methane Pyrolysis for Clean Hydrogen Production



Sustainable energy from of products

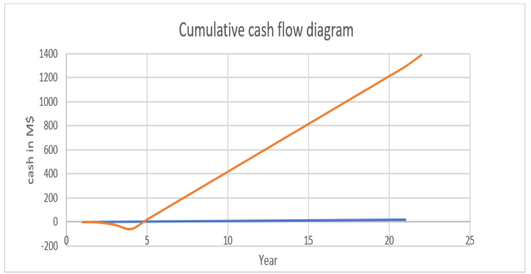


Figure 5.1: Cumulative cash flow diagram over 20 years.