



Next Generation Ammonia Synthesis

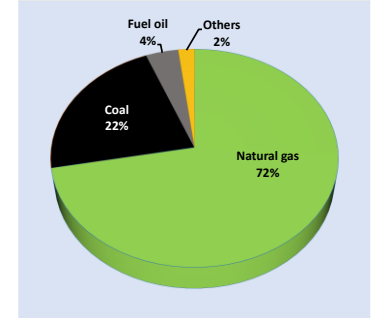
AEA 2020 Conference – Panel discussion
19th Nov. 2020 9:00 – 10:30 AM (AEDT)

Australia's National Science Agency

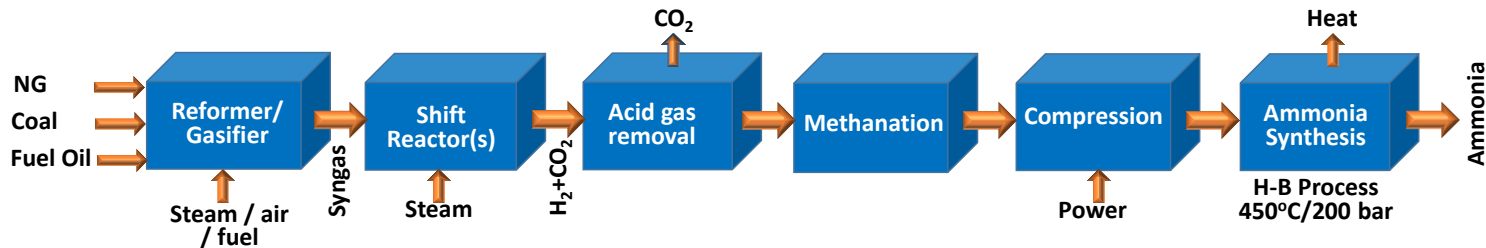


Ammonia synthesis

- Global ammonia production: ~ 200Mt per annum.
- Coal, NG and fuel oil as the feedstocks.
- Multiple processing stages makes the plant highly capital intensive.
- Synthesis process requires 8-15 MWh energy input per ton of ammonia.
- Process produces over 420 Mt of CO₂ emissions annually.

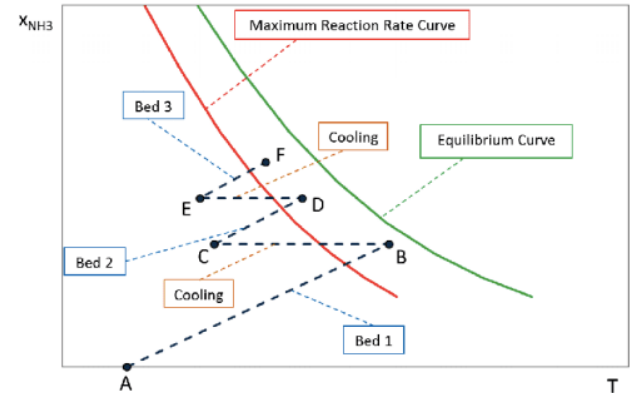


Feedstock for global ammonia production



H-B Process – Typical performance

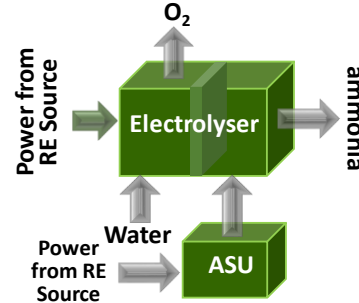
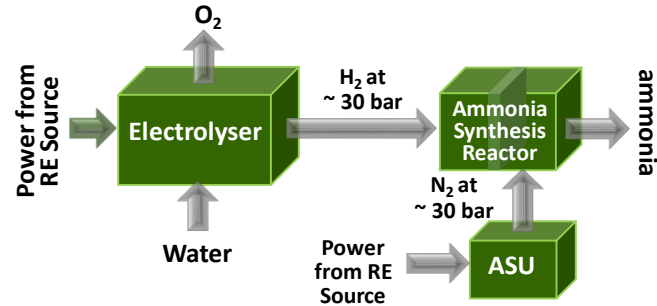
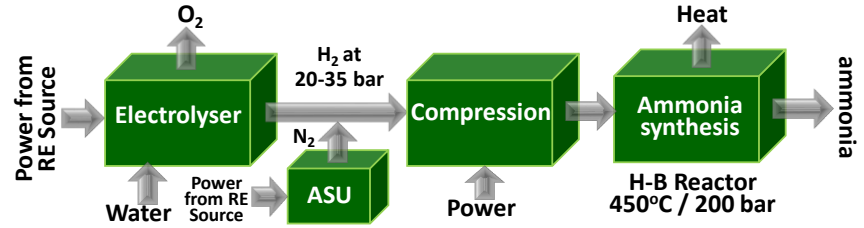
- H-B reactor operates at $\sim 450^{\circ}\text{C}$ / 150-200 bar and uses iron-based catalyst.
- Multiple catalyst beds in the reactor to achieve 15-20 mol% ammonia in the product stream.
- Ammonia separated by lowering the temperature, and unreacted gases recycled.
- High ammonia yield with HGSV in excess of 10,000/h.



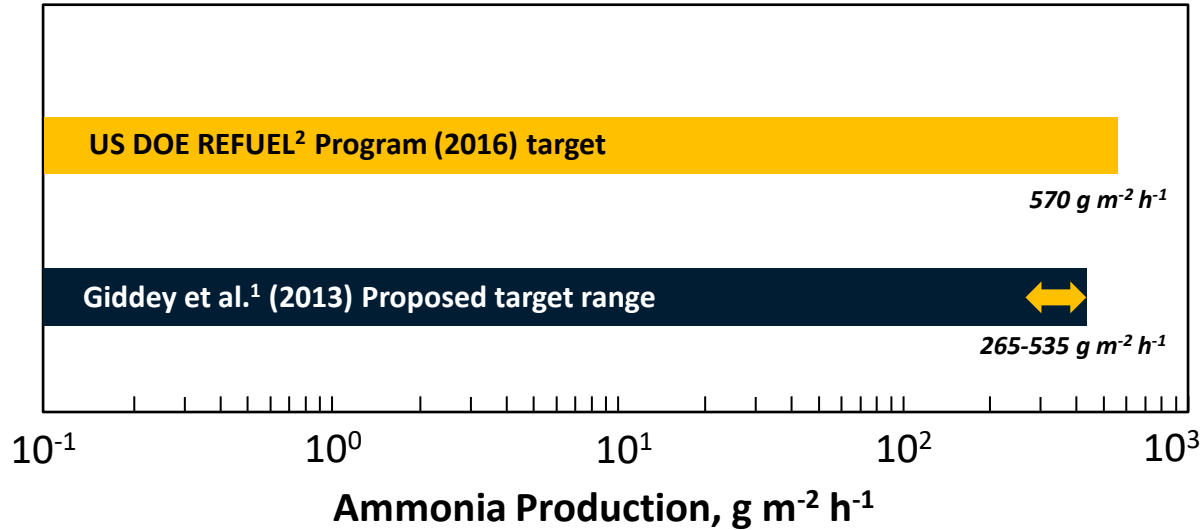
Temperature and reactants conversion trajectories
Courtesy of F. Ermanno, Casale SA and ARPA-E

Global effort to find alternative ways of synthesis

- Improvements to H-B process – catalyst and absorbents development.
- Hydrogen from Electrolyser as a feedstock for H-B process.
- Metal membrane process.
- Electrochemical synthesis of ammonia (Aqueous, polymer and ceramic electrolytes).



Proposed targets for ammonia synthesis rates



¹ Int J Hydrogen Energy, 38 (2013) P14576

² ARPA-E (2016) REFUEL Program

Thank you



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