Future Energy Efficiency and CO_2 Reduction Potential

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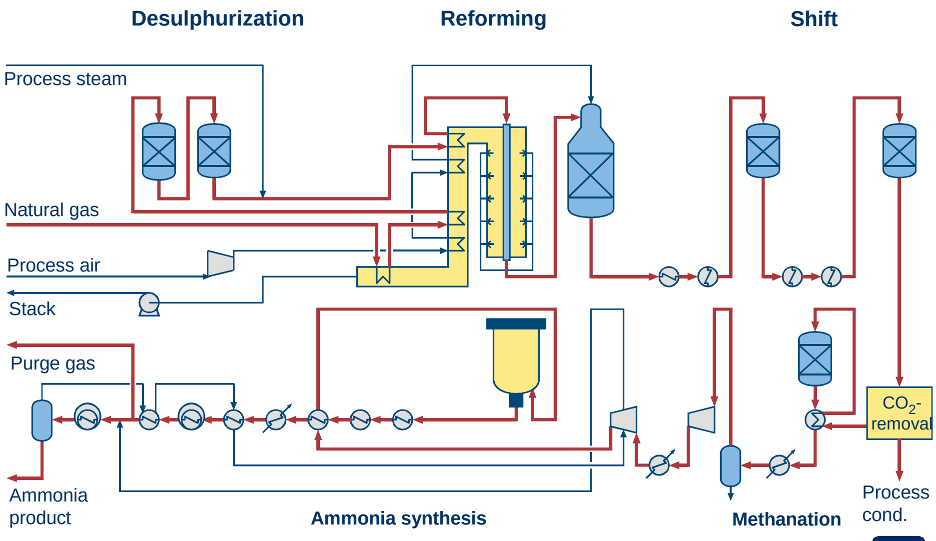
Outline

- Energy efficiency in ammonia plants
  - Current design
  - Historical development
  - Technology development
- Highlights of specific process features
  - Reforming section
  - Ammonia synthesis converter
- CO_2 reduction potential
- Integration with steam and power system
- Conclusion

Current scheme



Historical development - ammonia plants

- Plant energy consumption in the early 1980'ies was around 10.5 Gcal/MT NH_3
- In the late 1980'ies, this figure was around 7.75 Gcal/MT NH_3
- Many plants have been revamped, and best current plant is today around 7.1 Gcal/MT NH_3 after revamp
- For new plants, the current state-of-the-art consumption is around 6.6 Gcal/MT NH_3

Energy efficiency - ammonia plants

- A typical energy consumption figure based on the current scheme is today 6.8 Gcal/MT NH_3
- Two scenarios:
  - Stand-alone ammonia plant with no requirement for CO_2 production
  - Ammonia/urea complex
- Difference in climatic conditions (cooling water temperature and other site specific conditions)
- How much can the energy consumption figure be reduced in the (near) future ?

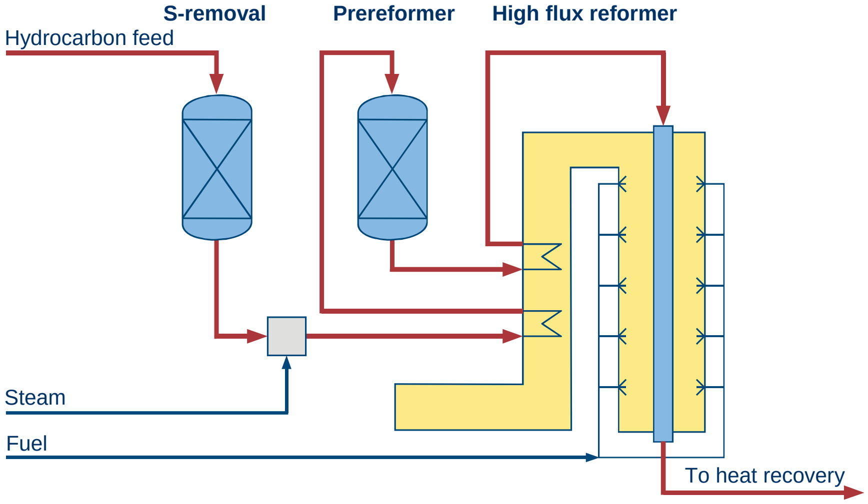
Energy reducing features

- High pressure in the front-end
- Low pressure in the ammonia synthesis loop (saving of power for synthesis gas compressor)
- aMDEA CO_2-removal
- Improved ammonia conversion in the loop
- Cryogenic purge gas recovery unit, returning the recovered hydrogen at high pressure compared to the membrane purge gas recovery unit
- Only major compressors on turbine drive (avoiding small inefficient steam turbines)
- Latest generation of rotating machinery

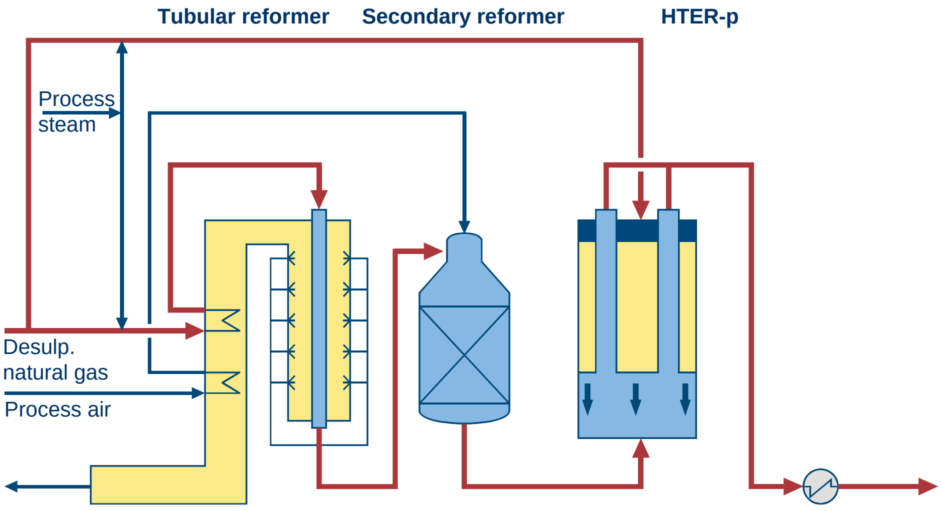
Technology development

- High flux primary reformer with prereformer
- HTER-p (Haldor Topsøe Exchange Reformer)
- S-300 converter
- Improved catalysts

Prereforming



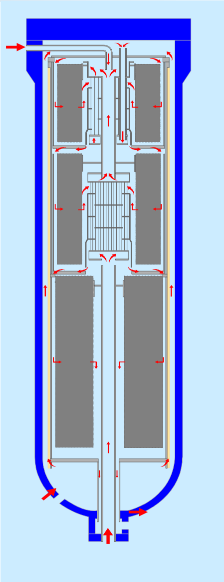
HTER-p flowsheet



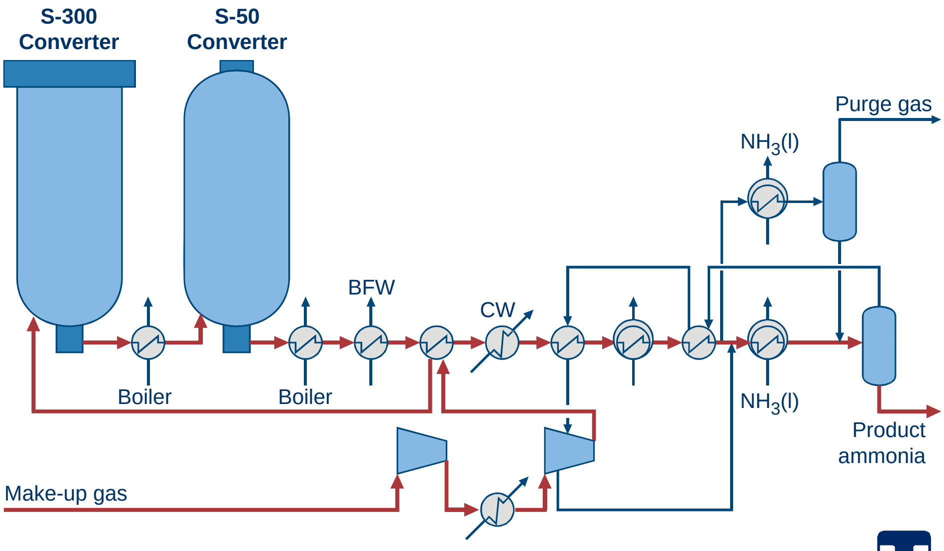
The HTER-p

- Compact
- Optimised utilisation of pressure vessel volume
- Allows for removal of internals
- No restriction of thermal movement

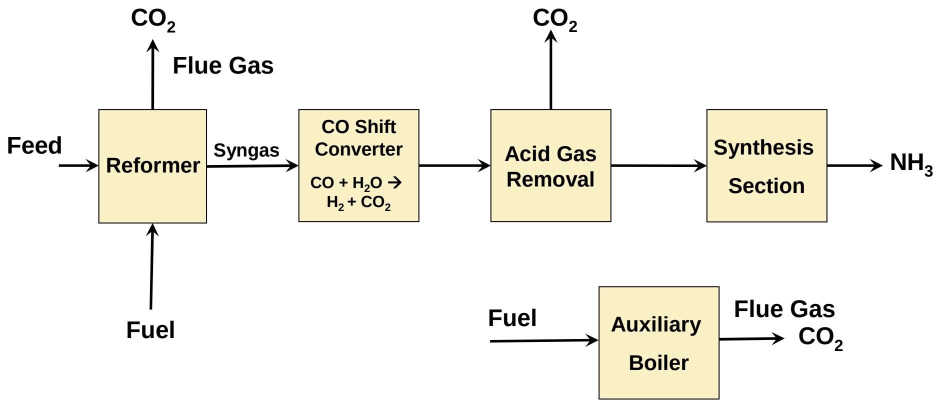
S-300 ammonia synthesis converter



S-350 ammonia synthesis loop



CO_2 emissions from ammonia plants



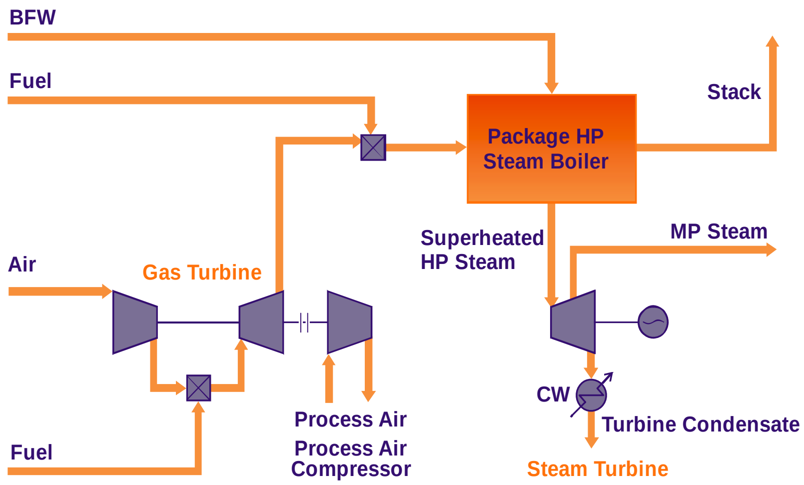
CO_2 reduction potential (1)

- About 75 % of the hydrocarbon is used as feed and 25 % as fuel in a steam reformer based ammonia plant
- In most plants, all the CO_2 generated from the feed is used in downstream plants (f. ex. urea)
- How much can the CO_2 emission be reduced in the (near) future in an ammonia plant ?

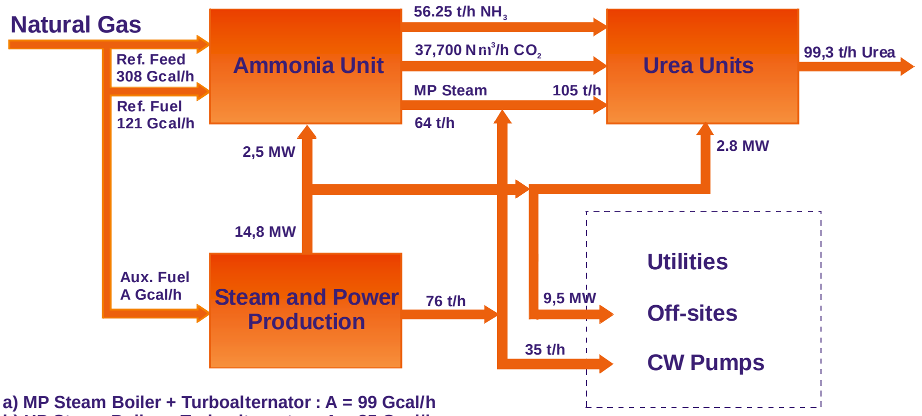
CO_2 reduction potential (2)

- Reduce fuel firing in plant (prereformer and HTER) – up to 20-25% reduction
- Remove CO_2 from flue gases (reformer and auxiliary boiler) – up to 90% can be removed
- Use combustion air preheat to reduce fuel firing
- Improve efficiency of steam and power generation unit in the complex

Integration of gas turbine driver in the ammonia process

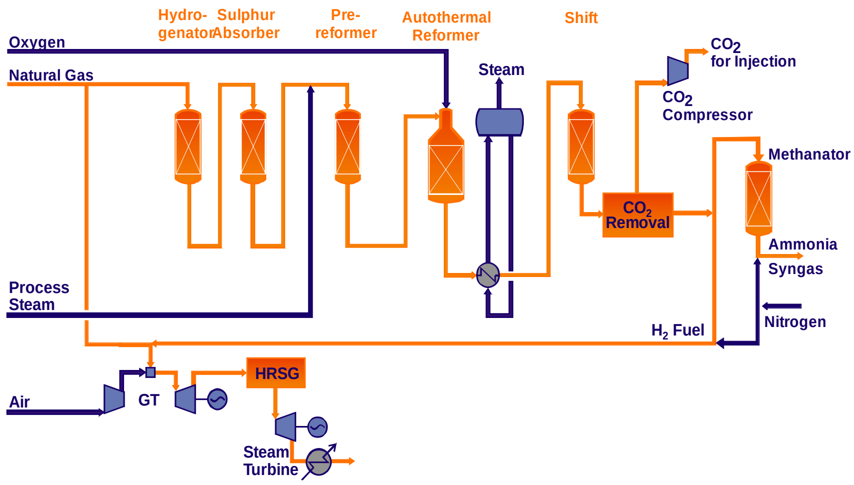


Integration with urea plant (1350 MTPD ammonia / 2385 MTPD urea)

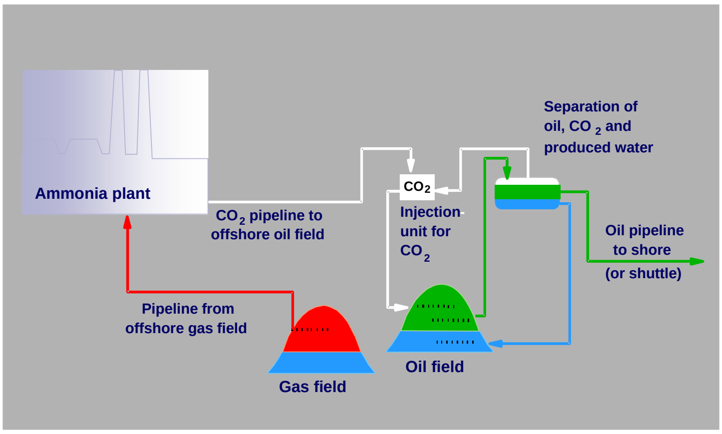


a) MP Steam Boiler + Turboalternator : A = 99 Gcal/h
b) HP Steam Boiler + Turboalternator : A = 85 Gcal/h
c) Gas Turbine + MP Steam Boiler : A = 73 Gcal/h
d) Gas Turbine + HP Steam Boiler : A = 67 Gcal/h

Integrated reforming and power cycle



Carbon effective ammonia production CO_2 for EOR



Conclusion

- Ammonia technology is continuously developed by introduction of new equipment designs and improved catalysts to suit the marked needs
- When the ammonia process is designed for low energy consumption it automatically results in low CO_2 emission as well
- Especially from ammonia/urea complexes the emissions are minimal
- Technology exists to integrate the plant with the off-sites to reduce the CO_2 emission to zero