Alternative Fuels for Marine Transportation: do cryogenics offer a solution with respect to environmental protection?

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Why alternative cryogenic fuels?

- Fossil fuels have been at the heart of mobility all of the 20th and at the dawn of the 21st century constantly affecting climate change.
- There is a call for a gradual transition away from fossil fuels, with clean and renewable sources of energy to climb high at the hierarchy of motion options (EU's plan for the green transition: the "Green Deal“ and the "FitFor55" package)
- Energy security, the cost of energy for the citizen and business, and the need for a strong industrial and transportation base, had been sidelined from the political agenda or taken for granted in the recent years.
- Limits on the most important air pollutants such as: sulphur oxide, nitrogen oxide, ozone depleting substances, and volatile organic compounds are already set (IMO, 1997).
- H2 or/and NH3 stored in cryogenic conditions, can decarbonize the transport industry.
- Their hazardous properties (fire and explosion potential) both in their production and storage, but also in their transportation modes need to be studied.

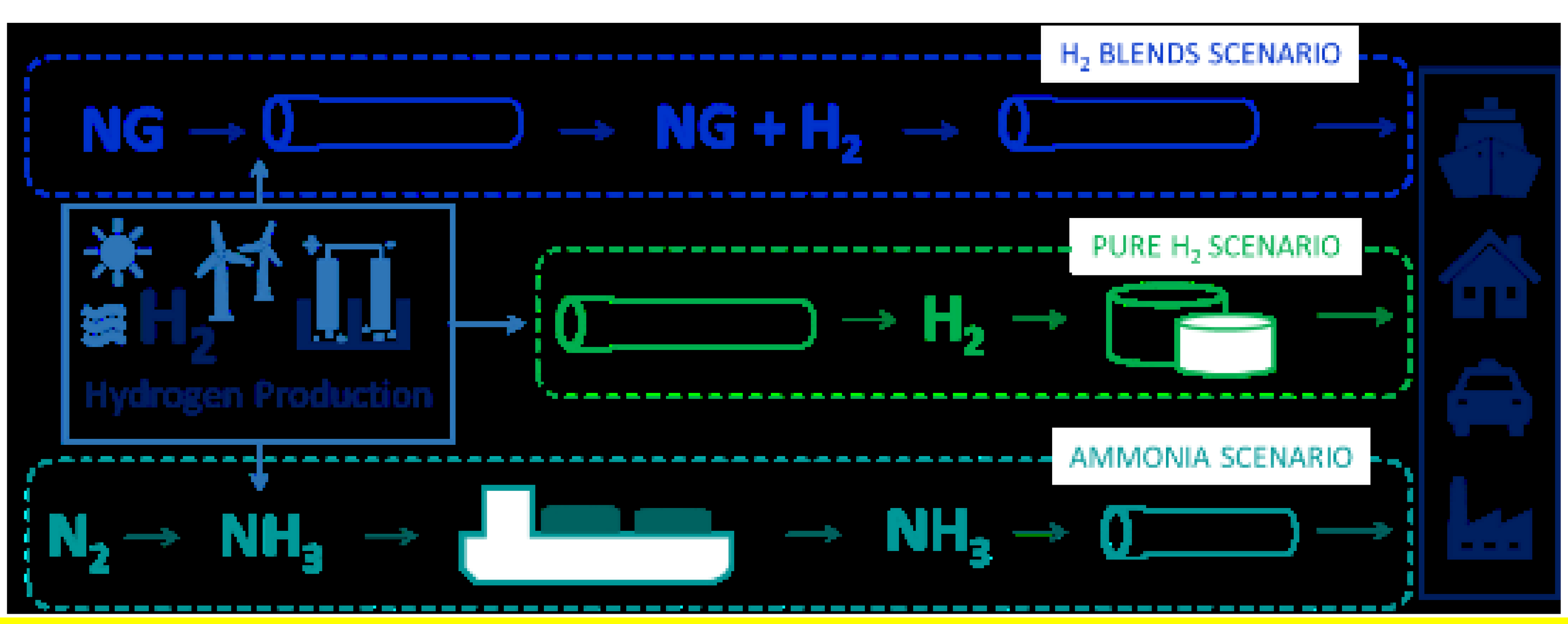

Fig. 1 Different scenarios for the distribution/storage of H2

Fig. 2 NR678 Hydrogen-Fuelled Ships (https://marine-offshore.bureauveritas.com/nr678-hydrogen-fuelled-ships)

Table 1: Ammonia fuelled ships, basic facts

- **Fuel type**: The only fuel considered for deep-sea vessels which don’t contain a carbon molecule.
- **Properties**: Liquefies at -33°c. At ambient pressure. **Energy density** c.30% of conventional marine fuel.
- **Uptake by industry**: At this time, ammonia remains at a conceptual stage. First, “ammonia-ready” engines will likely be available around 2024.
- **Green credentials**: Ammonia can be produced via two different carbon-neutral avenues: from natural gas with carbon capture and sequestration through electrolysis from renewable electricity. Both types have the potential to reduce CO2 emissions by close to 100.
- **Negatives**: Ammonia fuelled engines may require significant pilot fuel. Ammonia has the potential for emissions of N2O. The resolution of this problem is crucial for the environmental credibility of ammonia.
- **CO2 saving**: Both types can potentially reduce CO2 emissions by nearly 100.
- **Safety considerations**: Ammonia is highly toxic and highly corrosive. Exposure to even small quantities of ammonia can result in life-changing injuries or even death
- **Availability**: Green and Blue ammonia are virtually non-existent products today. However, both fuels’ supplies will likely develop in the coming years in USGC, NW Europe, the Middle East, and Oceania within the next decade.
- **Price**: Green ammonia is likely to price at a significant premium to conventional fuels for some time (c.1.5-2x).

Discussion

NH3 has been used as fertilizer for decades, with accidents leading to severe injuries and deaths, due to flammability and/or toxicity; on the other hand, H2 is highly explosive in certain concentrations. Large-scale implementation in the maritime environment raises additional concerns on effects of spills on and into water.

The feasibility of emerging NH3/H2 technologies must be checked through the production of experimental data and models for NH3/H2 releases on and into water and the development or risk trends and input to standardization.

Last, but not least the “green” production of these fuels themselves remains a big riddle along with their renewable character.

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