To get a grip on the toxic hazard – onboard safety concepts for the use of ammonia as fuel

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Extended Summary

Due to the world wide efforts to stop the global warming also the marine industry is looking for alternative fuels or energy carriers for ships. The International Maritime Organization (IMO) set the target to reduce the total annual emissions of greenhouse gases (GHG) of ships by at least 50 % by 2050 compared to the amounts emitted in 2008.

This target cannot be reached by further improvements in the efficiency of the ships propulsion systems only. The usage of alternative energy sources is a need. The regenerative energy can be generated by wind turbines, solar cells or hydropower plants as electric power. Not only from GEAs standpoint, the most promising way is to convert the generated electrical power into hydrogen by an electrolysis plant.

Regarding todays available technologies for storing the hydrogen onboard ships, pressure vessels would be needed with pressure levels in the area of 350 bar and more. But due to the low density of hydrogen to much tank volume would be needed. The cooling down of hydrogen to about -253 °C would make it possible to store it in fluid form but this requires energy to cool it down and also requires energy to keep this low level as long as it is stored onboard. So one option is, to convert the hydrogen into ammonia.

Ammonia has to be cooled down to about -33 °C to store it in fluid form under atmospheric pressure. Of course also here permanent cooling energy is necessary, to keep the temperature down as well as a good thermal isolation of the tanks to minimize the heat entry from the ambient into the tank. But for this proven technologies are available: Liquified Natural Gas (LNG) is today already used onboard hundreds of vessels. Here the temperature has to be -162 °C to keep it liquid at ambient temperature. Handling and storing of a substance at -33 °C is much less demanding than a substance at -162 C. A growing community is convinced that the usage of ammonia as an energy carrier is an attractive option to bring the energy onboard.

The worldwide production of ammonia is estimated of more than 140 mio tons. This value shows that the handling of ammonia is worldwide well known. Today it is transported by truck, train and of course also by ships all over the world. So also the storage of ammonia in larger amounts onboard ships is a proven technology. The way ammonia is produced today

creates also CO2, that's why the above described way to create ammonia on basis of green energy is required for future use as an energy carrier.

The GEA Group wants to be one of the drivers in the further development of transport and conditioning system for ammonia between the storage tank and the combustion engine. The existing know how and long term experience based on the development and production of for fuel oil separators and fuel oil booster units, which are used in high numbers in the maritime industry. Furthermore GEA has decades of experience in using ammonia as a refrigerant onboard ships.

GEA produces the components like compressors, separators, packages, valves and filters in their own factories. GEA is well known in this specific part of the marine market. The fulfilment of requirements from classification authorities for design, Type Approval and on board integration is part of GEA´s daily business. That's why GEA is absolute convinced to push this technology ahead and support the worldwide efforts to reduce the greenhouse gas emissions.

The presentation starts with a short overview about the GEA Group. GEA is one of the largest manufacturer for mechanical equipment and provides sustainable solutions for sophisticated production processes in diverse end-user markets and offers a comprehensive service portfolio. The applications of ammonia cooling systems onboard different types of ships are presented.

The next part of the presentation is about the required safety measures. Safety precautions are necessary because ammonia is a flammable substance.

It is known that the risk of undesirable ignition or explosion is far lower as from liquified natural gas (LNG) or hydrogen (H2). For leakage detections a gas detection systems is shown. Humans are very sensitive to the smell of ammonia. We smell ammonia from a level of 5 ammonia molecules in 1 million air molecules on – means from a level of 5 parts per million (ppm). The maximum for spaces where people are continuously working is 20 ppm. This means it will be smelled, also without any detection system, far earlier as it becomes critical to the health. Also the ventilation systems, which are needed if ammonia leakages occur will be described in the presentation.

The presentation underlines also, that a training of the crew is necessary when ammonia systems have to be operated. If the safety measures are followed and the crew is trained then the use of ammonia onboard of ship is safe either for refrigeration systems, which is already shown over decades as well as for the new ammonia fuel systems. Ammonia onboard of ships can also be used as hydrogen carrier for hydrogen fuel cells or for direct use in ammonia fuel cells, which are currently under development.

GEA is convinced that ammonia will play a significant role as a future fuel in the marine industry.