Revolutionary energy fuel for yachts: Hydrogen in powder form shows promise

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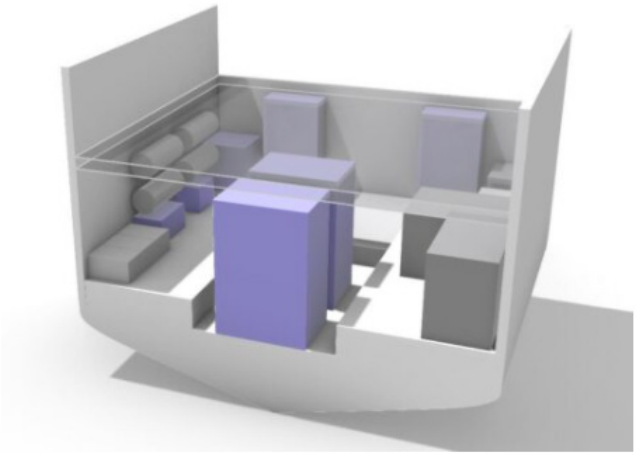
System setup H2Fuel reactor

THE HAGUE – Studio Delta, a technical design specialist that works on hulls, propulsion and stability of yachts, has explored the promise of hydrogen fuel. Jurn Henderiks, an intern studying marine engineering at Delft University of Technology, considered several fuels for – and their environmental impact on – a 37m superyacht, with a 6,000nm range.

He found hydrogen to hold much promise. His study's origin was a vocational high school project that led him to hydrogen in powder form, known as H2Fuel. It is a technology Studio Delta says Þts its innovation vision, hand in glove.

H2Fuel is hydrogen stored in powder form under normal atmospheric conditions. That makes it possible to make and store hydrogen onboard and release it using ultrapure water.

Henderiks' 'WtW GHG' analysis compared the efÞciency of different solutions to mitigate greenhouse gas emissions. His starting point were considerations associated with 20-year values that the IMO uses for its 2050 emission goals, not the 100-year values widely used in politics and business.



3D setup engine room

Marine Diesel Oil

MDO, by far the most widely used boat fuel, is much criticized but has more of a future than is often claimed. “Diesel has the potential to generate even cleaner energy than is now available,” says Henderiks. “Development seems to be at a standstill, under pressure from public opinion and politics.”

LNG

The marine and automotive sectors are keen on Liquid Natural Gas (LNG). It generates a signiÞcantly lower emission of harmful substances than MDO and that improves air quality. But LNG will generate ‘methane slip,’ the release of unburnt methane, a powerful greenhouse gas of which even a small quantity has a major climate impact. It is a greenhouse gas, 86 times stronger than CO2 in the Þrst 20 years.

If the amount of methane loss is expressed in the amount of CO2 and the emissions during production, transport and fuel used per nautical mile are included, LNG generates a lot more greenhouse gas emissions than diesel. How much more, depends on the LNG’s country of origin and engine type. A 4-stroke, dual-fuel Otto principle has 1.6 to 1.9 times more CO2 emissions than MDO. The Otto principle is a thermodynamic circuit process used in the comparison between internal combustion engines.

Ammonia

Henderiks also considered ammonia (NH3). It emits no CO2 when used, but in its production. “Only if ammonia is made with green energy can it be cleaner than MDO. However, in the current production form, the total emission of ammonia is higher per nautical mile than that of MDO. Even in small quantities, is liquid ammonia in the applied form extremely harmful to health and the environment”.

Hydrogen (H2) also has potential. Hydrogen has a high-density of energy, can be made cleanly and has no harmful emissions. The big disadvantage: it is highly volatile in both liquid and gaseous forms.

Powdered hydrogen

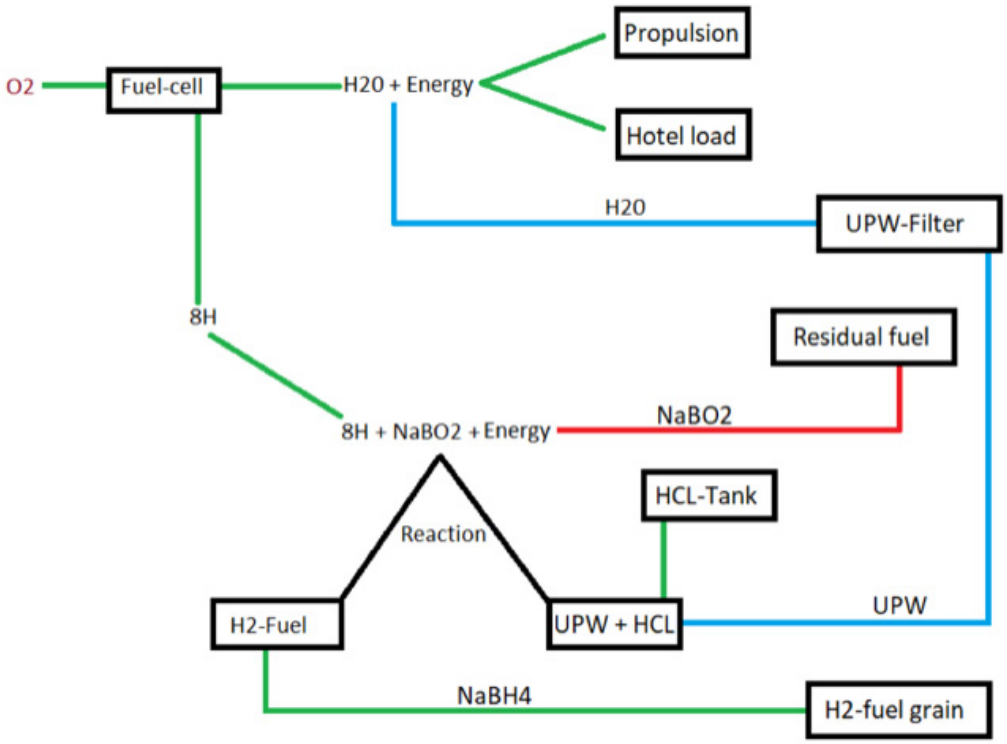
Much research has led to H2Fuel, i.e. hydrogen in bonded powder form. It can be transported and stored in this form and activated shortly prior to use as fuel for a fuel cell.

Metal hydrides, in which stored hydrogen is held in solid form, could be a safe alternative, says Henderiks. A long search for a good, weak metal hydride compound to be used in an efÞcient process led to H2Fuel. H2Fuel has 3 components: NaBH4, an inorganic substance equivalent to washing powder, ultra-pure water and an activator. The application is still nascent, but large companies, including in the automotive sector, follow developments closely.

How it works

H2Fuel powder is taken onboard and through reverse osmosis, a common onboard water maker technology, seawater is turned into ultra-pure water (UPW). The powder and the UPW are mixed and formic acid is added to activate the reaction. The hydrogen so produced is collected in a reactor and transported to the fuel cells to produce electricity. The risk of an explosion is virtually zero as relatively little pure hydrogen is present.

The residual fuel produced in the reaction process is stored onboard and that adds weight to the ship. However, this would also happen on a conventional ship if CO2 emissions were kept onboard. A deposit, paid when the fuel is bought, is refunded upon return of the residual fuel.



Unlike most fuels, H2Fuel can be completely emission-free in processing, transport and consumption. Its raw materials are extracted from the sea. The production process runs on the overcapacity of wind and solar energy. Transport can be completely clean and only water is emitted during use. Even though sufÞcient green energy must be provided in case of signiÞcant scaling up.

Practical matters

To achieve the 6,000nm range, Henderiks found that the superyacht must be lengthened by 2 meters (6.6ft.) to provide sufÞcient fuel capacity compared to the MDO version. Also, more onboard systems must be revisited. An electric Voith Schneider propeller was chosen instead of traditional shaft-line propulsion. A pod drive may also be considered. At the same time, residual heat can be used efÞciently. Much heat is released when the components are converted to hydrogen and can be re-used to keep the fresh water boilers warm.

H2Fuel Benefits

- Zero-emission in port (no running of generators)
- H2Fuel can safely end up in the sea as it is a natural substance. Extracting the raw material from seawater creates a circular process. The environment will be less burdened in case of major damage to a ship.
- Much safer than all the liquid and gaseous fuels onboard now used for propulsion.
- A quiet and low-vibration process on board. No running combustion engines.
- 100% ßexible energy supplier between propulsion and hotel mode
- Residual fuel is also a natural substance
- In a circular process, residual fuel can be reprocessed and is also a natural substance.

Disadvantages

- Land logistics don't yet exist and will be costly to develop
- Bound to generate skepticism and objections. The market tends to opt for known alternatives
- At this time expensive

Status of research

Henderiks describes the status of H2Fuel:

"The development of the technology is in a research phase, but the potential is there for automotive and, certainly, yacht building within a reasonable time span.

"The research was based on 37m boat which already shows the challenge of reaching a 6,000nm range without extending the craft. However, the fuel quantity for a 4,000nm range is achievable without a boat extension and offers a considerable degree of autonomy.

"A smaller ship, in combination with a reasonable range, will be tough to implement with H2Fuel, as the installation equals that of a 10ft sea container, surrounded by a number of other systems.

"On the other hand, what's needed on a much larger yacht merits investigation. The energy demand for propulsion rises signiÞcantly. And as the volume increases, the hotel side will require many times more energy.

"Without land logistics, any new fuel technology is pointless. A 'green deal' must be struck as happened once for LNG so that land logistics can be developed and expanded in parallel with the application in vehicles. This will possibly be different for the automotive sector than for the maritime industry.

"The system and process are still expensive. But as with many nascent processes, the large-scale application will be able to drive the price down to acceptable levels. There is a real chance of this if the application in the automotive industry gets off the ground."

www.studiodelta.nl

https://www.jachtbouwactueel.nl/revolutionary-energy-source-for-yachts-hydrogen-in-powder-form-shows-promise/