Hydrogen-powered ferries: unlocking the potential

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Q&A Summary

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Do electrolysers work with salt water?

JP | Technically yes, but commercially available electrolysers work with purified water. If salt water is available, it can be purified to be used. There is research into electrolysers that can use salt water directly to overcome problems with degradation and lifetime.

How do you see the location optimality of HRS for vessels combined with that for road-based transport?

JP | It's much simpler for vessels because there is much more predictable volume, and the location is fixed. The comparable situation on land would be a fueling station that supports a fleet.

Do you envisage that electrolysers will be able to act as a means of load levelling for renewable sources of power.

JP | Yes, electrolysers are instant and dynamic load sinks that can be turned off and on by the grid operator to manage load.

What is the efficiency of H2 including the complete chain of delivery?

JP | There is no general answer to this question, it depends on the method of production, distribution, and use.

What is the cost competitiveness when talking of hydrogen ferries and battery powered ferries....and for how much kilometer the hydrogen would power the engines?

JP | There's no general answer, it depends on the vessel and its usage.

In your opinion, is an Energy Management System in a fuel cell & battery hybrid power train, focusing on maximizing fuel cell lifetime, an essential element enabling the adoption of the technology in maritime and other sectors?

JP | No, it's not an essential element, but is a way to incrementally improve performance or lower cost.

Hydrogen is blasting agent, how the hazardous mitigation controls are implemented?

JP | Hydrogen is a fuel, and like all chemical fuels contains energy. It has been used for decades as an industrial commodity and the safety practices developed in industry are successful and are what is used today.

What's about fuel cells using other fuels rather than H2, as, f.e. methanol (LNG)?

JP | They are possible but do not have zero emissions.

Why is cost of H2 expected to be more stable than other fuels?

JP | Renewable H2 depends on renewable electricity. The cost of renewable electricity depends on the capital cost of the system; the fuel is free. This makes renewable electricity, and thus renewably hydrogen, have a very predictiable cost for the lifetime of the renewable electricity generation system.

Does your lifetime costs factor in establishing infrastructure?

JP | No

Do you need batteries as Li-ion in pair with fuel cells to absorb electric inrush ?

JP | No

Which fuel options is more cost effective Hydrogen, Ammonia or LNG? Thank you.

JP | There is no general answer to this question, it depends on the method of production, distribution, and use.

What H2 prices did you consider to compare with e.g. Diesel fueled vessel? As far as I know H2 especially from green sources is much more expensive?

JP | $5-$10/kg

I have heard that fuel cells are an ignition source itself. If true, how do you guarantee a safe environment all the time, even during leakage?

JP | It has been used for decades as an industrial commodity and the safety practices developed in industry are successful and are what is used today.

So you think financial support is needed to lead to a breakthrough of the Technology?

JP | Technical breakthroughs will require R&D funding, like in all technical development work.

The volumetric storage density of hydrogen seems to be a limiting factor in the marine environment for both compressed gas and liquid hydrogen. Do you feel that LOHCs such as Ammonia are necessary for the implementation of Hydrogen in larger vessels.

JP | They are not necessary. Ammonia is 0.5x the size of LH2 but 5-6x heavier. On displacement-limited vessels this can actually reduce cargo-carrying capacity. There are many other pros and cons of H2 carriers vs LH2.

Can Hydrogen system be carried safely onboard vessels?

JP | It has been used for decades as an industrial commodity and the safety practices developed in industry are successful and are what is used today.

Are the locations overlapping such that you could use the same fueling station for both applications?

JP | With regards to combining marine and land-vehicles fueling, you could gain some advantages in terms of reducing deliveries but if the marine vessel is using LH2 and the land vehicle using GH2 then there isn't as much overlap in other equipment.

If we have a vessel using 2000 kW to have a speed of e.g. 25 knots 4 hours a day, how large size of "fuel" tanks is needed? Size and weight?

JP | 2000 kW * 4 hr = 8,000 kWh. 33 kWh/kg-H2 and fuel cell efficiency of 50% gives 485 kg. Typical storage densities of a compressed hydrogen array is 18 kg-tank/kg-fuel and 94 L-tank/kg-fuel. Typical for LH2 is 8.7 kg-tank/kg-fuel and 25 L-tank/kg-fuel.

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why do the IMO/IGF codes treat Hydrogen as if it is poisonous, when it is not? i.e. Why gas tight enclosure? Why double block and bleed valves?

JP | Because it is flammable.

Why does the panel believe Hydrogen is a more plausible fuel over LNG, Ammonia, Short trade EV?

JP | If there is a need for zero emission then there are only two ways, batteries or hydrogen fuel cells. If there is not a need for zero emission, then fossil fuel solutions will be cheaper in the short term.

With a consumption of 2000 kW for maintaining a speed of 15 knots for 8 hours a day, which shall be the dimensions and weight of fuel tanks?

JP | See above.

So what is the efficiency also including the production of H2?

JP | See above.

Looking at OPEX for the Fuel cells, what is the life length and cost for replacing/refurbishing the fuel cells when due?

JP | There is a wide variance depending on the fuel cell type and manufacturer.

Will hydrogen storage take more space than the normal fuels

JP | Yes. LH2 is about 4x larger than diesel. Gaseous H2 is about 10-15x.

Do you think that high temperature fuel cells such as SOFCs are a better long term solution then PEMFC for the marine environment given the improved efficiency they offer (if waste heat recovery can be utilised).

JP | SOFCs need a lot of development to be robust enough for maritime. If there is a situation with constant baseload they may be able to be considered.

What price of the hydrogen fuel is needed in order to render to TCO to be cheaper for fuel cell vessels than diesel vessels in most applications?

JP | Lots of factors here but $3-$6/kg is a range to consider.

How much of an impact does transient behaviour have on a fuel cells lifetime

JP | Different manufacturers have different requirements and impacts.
