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Offshore Hydrogen Production

Jack-Up And Ptalform Systems As Maritime Hydrogen Factories

 Case Study By Dipl.-Ing. Hans-Ulrich Baldes And Dipl.-Ing. Wolfgang Kiebert

Hydrogen as a green energy store, generated from pure water and renewable energy, is considered a future-oriented fuel and commodity in a climate neutral energy economy.

Maritime hydrogen factories produce green hydrogen sustainably from offshore wind energy and ocean water on large industrial scale.

Self-sufficient jack-up units and platforms equipped with power management, seawater desalination, pure water conditioning, electrolysers and compressing stations provide 100% green hydrogen via pipeline networks or filled in transportable standard containers for direct use in demand-driven circular economies.

- no land consumption
- mobile and flexible systems
- self-sufficient and carbon neutral energy supply
- pipeline independent solution
- directly applicable for better workload of offshore windfarms

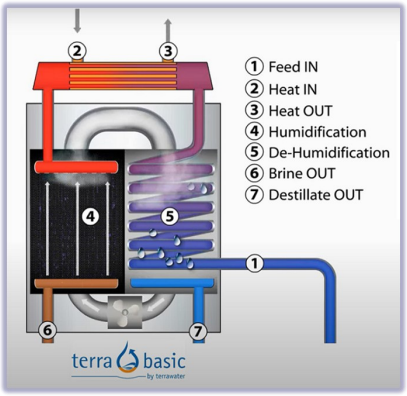
TOPICS

- Hydrogen Electrolysis
- Offshore Seawater Desalination
- Case Study Offshore Hydrogen Factory

Wind and seawater — Naturell source of green hydrogen

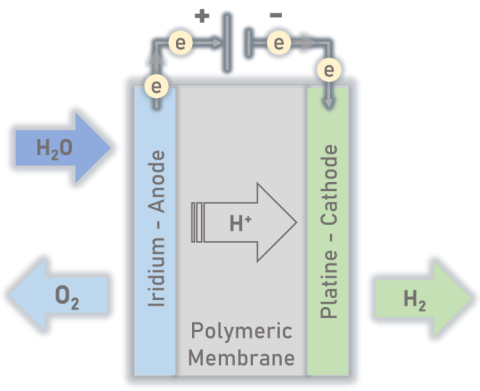
In an electricity driven process called electrolysis pure water can be split into its elements hydrogen H_2 and oxygen O_2 . If power from renewable resources is applied to the machine 100% green hydrogen is produced. However, electrolysers must only be feed with pure water to avoid scaling and corrosion of inner cell parts. Even drinking water still contains too many minerals that would negatively disrupt the process. Both tap water and desalinated sea or brackish water need to be conditioned on the required water qualities prior to use in the electrolysis process.

Proven technology for large scale sea and brackish water desalination is the reverse osmosis principle. In a multi-stage process membrane systems powered by high pressure separate salty water into a concentrated brine, which is feed back to the source, and a pure water fraction, which meets the required process water qualites.
Smaller amounts of ultra pure water as needed in building block design applications may be produced cost effectively in a single-stage chemical free humidification and condensation process using the electrolyser`s waste heat.

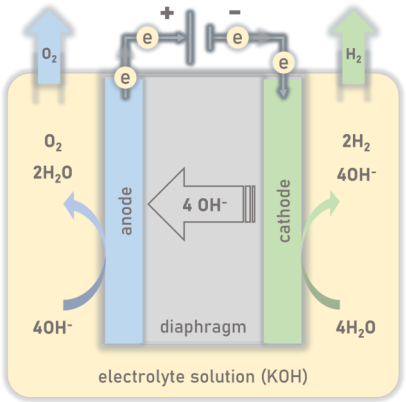


Hydrogen Electrolysis

The electrolysis process splits pure water into hydrogen H_2 and oxygen O_2 consuming electrical energy. Alkaline electrolyzers (AEL) or proton exchange membrane electrolyzers (PEM) are mostly used for green hydrogen production.



PEM Electrolysis Principle
Proton Exchange Membrane



principle alkaline electrolysis

Anode $4OH^- \leftrightarrow 2H_2O + O_2 + 4e^-$

Kathode $4H_2O + 4e^- \leftrightarrow 2H_2 + 4OH^-$

Offshore Hydrogen Factory

Renewable offshore wind power is most reliable and cost efficient energy source to operate electrolysers for green hydrogen production stable on high load rates.

Maritime hydrogen factories are tailored as scalable units with all equipment need to produce green hydrogen from wind energy and ocean water only. Systems are positioned close to an electricity hand-over point of an offshore windfarm for connecting to the wind power. Hydrogen can be feed into pipelines or gas bottled to be shipped containerised to harbours with hydrogen hubs for direct use in circular economies.

Concept offshore hydrogen factory

Jack-Up

Moving to the desired position, a jack-up fixes its legs on sea floor and lifts the platform up for operation. Jack-up is the ideal offshore system for 100% green hydrogen production in close vicinty to renewable recources like offshore windfarms.

The jack-up system provides modern accommodation layout for the operating crew and can be fully customized to the application's requirements.

A modular building-block design of all required components for green hydrogen production is redundant system. For maintenance or during times of lower output demands single trains can be taken out of operation without need to shut down the entire installation.

Such design guarantees high availability and reliability even in rough seas. Feeder vessels can moor at the jack-up, loading gas bottled hydrogen in containers from buffer stocks.

Prospects

MARITIME HYDROGEN SYSTEMS

Offshore hydrogen and drinking water projects are designed and calculated according to the requirements of the application. With our team of experienced technical experts, we advise interested parties and support them professionally in the development of promising projects.

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Offshore hydrogen factories are aimed to supply large quantities of 100% green hydrogen via pipeline connection or in tradable transport containers for direct use in circular economies.

Maritime Systems are addressed to public and industrial users with high need of green hydrogen.

Prospective Hydrogen Applications

- Hydrogen As Fuel
  - Transport And Mobility Sector
- Use of Hydrogen In Industries
  - Chemistry, Refinery, Glass, Cement, Steel, Others

Maritime offshore hydrogen factories are self-contained production sites with defined hand-over points. Systems are run and maintained by trained and experienced operation crews. Crew members provide all nautical skills and technical competences to manage offshore desalination and hydrogen electrolysis.

Design basis for offshore hydrogen factories and jack-up units is proven ship, plant and related machinery equipment which will be combined and adapted according to the project`s and owner`s requirements.

Driving factors for sustained increasing hydrogen demand is the common social resolution to decarbonize economies and changing consumption patterns in favour of climate neutral fuels and commodities.