

Research News

October 1, 2026 Page 1 | 3

Green hydrogen from seawater

Electrolysis with Untreated Seawater: Fraunhofer Tests Materials and Membranes

Seawater and brackish water could serve as alternative water sources for hydrogen production. The challenge is that conventional electrolyzers require high-purity water that needs extensive treatment. In the SeaEly project, the Fraunhofer Institute for Wind Energy Systems IWES and the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM investigated how suitable seawater and brackish water are for hydrogen production and what testing and evaluation infrastructure is needed.

The direct use of seawater or brackish water is particularly promising for coastal and offshore applications. Converting electricity from wind turbines directly into hydrogen creates a storable and transportable energy carrier that can then be used as a chemical feedstock, for energy supply or for the production of ammonia and synthetic fuels. Coordinated by Fraunhofer IWES, the joint research project SeaEly investigated the direct electrolysis of seawater and brackish water to produce hydrogen and oxygen from October 2022 through March 2026 as part of the Hydrogen Republic of Germany ideas competition. In addition to Fraunhofer IWES and Fraunhofer IFAM, participants included Technische Universität Berlin, Whitecell Eisenhuth GmbH & Co. KG and the Institute of Shipping Economics and Logistics. The project was funded by the German Federal Ministry of Research, Technology and Space (BMFTR).

Less processing, lower costs?

“The idea was to determine how pure seawater needs to be before it can be used directly in electrolysis without overtaxing the equipment,” says Nadine Menzel, Group Leader of Electrochemistry and Analytics at the Fraunhofer IWES Hydrogen Lab Leuna. SeaEly was designed to determine to what extent seawater could replace drinking water and process water in electrolysis. “At Fraunhofer IFAM, we developed new membranes for electrolyzing untreated seawater and tested them on a modular electrochemical test bench,” says Andreas Brinkmann, a research scientist in the Adhesion and Interfacial Research department at Fraunhofer IFAM.

The test bench allows materials to be exposed to a range of operating conditions and subsequently analyzed in detail. This makes it possible to identify deposits, surface changes, corrosion and aging processes. Combining materials development with testing thus provides a sound basis for systematically assessing how well components withstand different types of stress.

What happens during electrolysis

In water electrolysis, an electric current splits water into hydrogen and oxygen. The membrane plays a key role in this process: It separates the two reaction chambers while enabling the ion transport required for the electrochemical reaction. Put simply, it acts like an extremely fine sieve, allowing certain ions to pass through while keeping the resulting gases as separate as possible.

This becomes particularly challenging when seawater is used. Chlorides and other constituents can trigger side reactions, accumulate on surfaces or cause corrosion and aging. Brinkmann: "The more impurities our electrolyte contains, the more pressing the question becomes: How long will each of our components last?"

Fraunhofer IFAM can investigate this question using various electrolytes and cell configurations. In addition to electrochemical measurements, scanning electron microscopy, EDX, XPS and TOF-SIMS provide detailed analyses of the materials after testing. "This allows us to assess the rate of wear," says Brinkmann.

"At the same time, Fraunhofer IWES developed a larger, multipurpose test bench," explains Menzel. "It can be used to study and compare different electrolysis technologies and newly developed components using brackish water or salt water, including PEM, alkaline and AEM electrolysis." Promising materials can then advance from small test cells to larger setups. This makes it possible to assess both material behavior and interactions among multiple cells and other system components.

Outlook: from feasibility to long-term stability

The project developed test benches and components for studying electrolysis using seawater and brackish water and conducted initial feasibility studies. The resulting infrastructure now supports systematic long-term testing focused on aging, corrosion, deposits and the effects of electrolyte composition on component service life. Fraunhofer IFAM and Fraunhofer IWES are already using the test benches beyond the project, e.g., to investigate alternative water sources and assess the suitability of electrolysis components. The test benches are also available for industry projects and external applications.

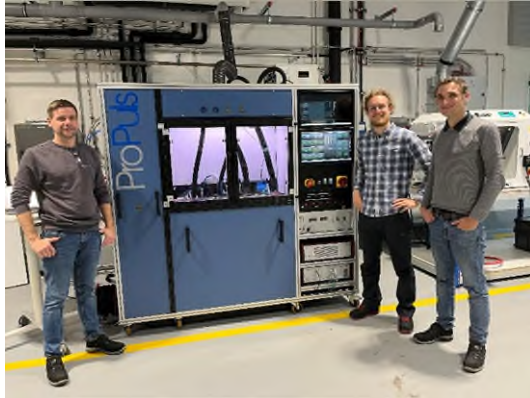


Fig. 1 Pilot test bench for analyzing electrolysis stacks using various electrolytes at Fraunhofer IWES © Fraunhofer IWES

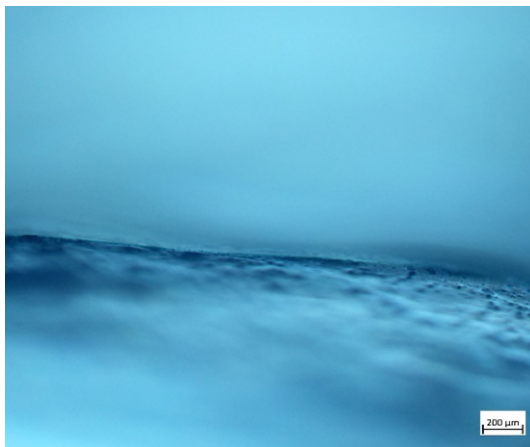


Fig. 2 Microscopic image of a newly developed anion-exchange membrane that was used to electrolyze synthetic seawater, with promising results for applications in saline environments © Fraunhofer IFAM

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