PRESS RELEASE

Hydrogen technology

Electrolyzers set to become mass products

If you want to use hydrogen as a sustainable source of energy, you need electrolyzers. However, they are rare and expensive because they are still largely manufactured by hand. To enable them to be produced on an industrial scale in the future, a research team at Fraunhofer IPA is currently developing a fully automated electrolyzer factory.

Hydrogen is available on the earth in abundance. However, it is highly reactive and is therefore bound in molecules such as water (H_2O). If you want to use this gaseous element as an emissions-free energy source, you first need to spilt the hydrogen from the water molecule. This is what electrolyzers are used for. They split water into its components hydrogen (H_2) and oxygen (O). Fuel cells are then able to convert the hydrogen back into electricity, which in turn powers engines, or the hydrogen is simply burnt in blast furnaces.

As hydrogen has an important part to play in the energy and transportation transition, the world will soon need an enormous number of electrolyzers. However, so far, these have been produced largely by hand, an immensely time-consuming, expensive and error-prone process. This is why scientists at the Fraunhofer Institute for Manufacturing Engineering and Automation IPA along with partners from research and industry are aiming to fully automate the manufacture of electrolyzers. Friedrich-Wilhelm Speckmann from the Center for Digital Battery-Cell Manufacturing (ZDB) at Fraunhofer IPA says: "The goal is to develop an automated electrolyzer factory on a gigawatt scale. This means that the electrolyzers manufactured here over the course of the year ahead should have a total nominal capacity of at least one gigawatt."

Robots set to take over stacking in the future

An electrolyzer consists of two electrodes – the positively charged anode and the negatively charged cathode – and a separator, in this case a proton-exchange membrane (PEM). To increase performance, many electrolytic cells are stacked together. So far, this stacking has largely taken place by hand but in future, it could be carried out by robots.

However, because it is not just the stacking but also the entire production line that is to be automated, the researchers also have to take into account all the upstream and downstream processes, which means overhauling the entire system. This involves factory and production planning as well as component testing, all the way through to

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end of line testing. The consortium is also developing cutting-edge stack designs, which will simplify future manufacturing procedures, allowing them to be completed more quickly as a result.

Manufacturing system planning, robots and sensors for electrolyzer factory

In order to make the automated electrolyzer factory a reality, the project partners are initially building a state-of-the-art production line. Every section will then be modularly adjusted and expanded so that the individual processes are better interlinked and automated than before. In the process, the scientists will have to clarify a whole series of unanswered questions, such as: Which robot topology is best suited to stacking? How should a robot pick up the components and what is the maximum speed at which it can be accelerated without damaging the sensitive components? Which optical sensors should be integrated into the system for quality assurance? Which manufacturing technologies will enable electrolyzer production to be scaled up? What should a fully automated electrolyzer factory look like and how should it be built?

The research team aims to have the answers to these and many more questions by March 31, 2025. This is the end date for the research project "Industrialization of PEM Electrolyzer Production" (PEP.IN), which has received more than EUR 20 million of funding from the German Ministry of Education and Research (BMBF). In addition to Fraunhofer IPA, the following organizations are also involved in the joint project: the Fraunhofer Institute for Solar Energy Systems ISE, the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT, MAN Energy Solutions SE, H-TEC Systems GmbH, Audi AG, VAF GmbH, the hydrogen and fuel cell center ZBT GmbH and the Jülich GmbH research center. PEP.IN is part of the "H2Giga" lead project, one of three hydrogen lead projects of the BMBF making a key contribution to the implementation of the National Hydrogen Strategy.

Electrolyzer in Haurup near Flensburg.
Source: H-TEC SYSTEMS GmbH

Fraunhofer IPA involved in further H_2Giga projects

Degrad-EL3-Q	As part of the "Degrad-EL3-Q" research project, a research team from the Center for Cyber Cognitive Intelligence (CCI) at Fraunhofer IPA is investigating to what extent degradation analyses carried out using a quantum computer offer clear advantages over traditional computer technologies. To find out more, please visit: *https://www.ipa.fraunhofer.de/en/reference_projects/Degrad-EL3-Q.html*
FRHY	As part of the H_2Giga project "Reference factory for high-rate electrolyzer manufacture" (FRHY), a research team from the competence center DigITools is mapping out the individual manufacturing modules for the reference factory as digital twins and connects these virtually to make a complete production line. The team is also developing a multi-site, service-oriented manufacturing IT platform. For more information, please visit: *www.ipa.fraunhofer.de/H2Giga_FRHY*
IREKA	As part of the research project "Iridium-reduced anode catalysts for PEM hydrogen electrolyzers" (IREKA), a research team from the Department of Electroplating at Fraunhofer IPA and from the Leibniz Institute for Catalysis is working toward reducing requirements for the rare element iridium for PEM electrolyzers. In order to achieve this, the team is investigating three possible approaches. For more information, please visit: *https://www.ipa.fraunhofer.de/de/referenzprojekte/IREKA.html*
ReNaRe	As part of the H_2Giga project "Recycling – sustainable use of resources" (ReNaRe), a research team from the Department for Robot and Assistive Systems at Fraunhofer IPA works on automated disassembly of electrolyzers. In order to achieve this, the team is gathering available systems and defining the requirements for modular robot tools and necessary AI algorithms for the robot programing. A digital twin assists with disassembly in order to optimize the individual steps virtually. For more information, please visit: *https://www.ipa.fraunhofer.de/en/reference_projects/ReNaRe.html*

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