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Joint press release by CreativeQuantum, INERATEC, Leibniz-Institut für Katalyse, Ruhr- Universität Bochum and Chemiepark Bitterfeld-Wolfen

Efficient process for green methanol demonstrated in container plant

Goals achieved: E4MeWi research network tests and validates sustainable and scalable processes for methanol production

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The E4MeWi research association is currently demonstrating how effectively green methanol can be produced in the future in a container plant at the Bitterfeld-Wolfen Chemical Park. Methanol is regarded as a key technology for defossilizing shipping and aviation and also for freeing the chemical industry from its dependence on crude oil. The project compares two different promising process approaches in a container plant: INERATEC is starting with the established heterogeneous-catalyzed direct synthesis of e-methanol from green hydrogen and carbon dioxide (CO₂). CreativeQuantum and the Leibniz Institute for Catalysis (LIKAT) are using a comparatively new, homogeneously catalyzed process. The synthesis gas required for this is to come from a new type of co-electrolysis developed by the Ruhr University Bochum. The homogeneously catalyzed process works at significantly lower temperatures and pressures. The project has been funded by the Federal Ministry for Economic Affairs and Energy with a total of around two million euros since November 1, 2020.

The aim of the project is to test the two processes for producing e-methanol in a container in an industrial environment at the Bitterfeld-Wolfen Chemical Park and to demonstrate their performance. Load flexibility and raw material efficiency are crucial due to the use of renewable sources for green hydrogen.

The homogeneously catalyzed process takes a completely new approach. "By developing the highly specialized homogeneous catalysts on the computer, we were able to reduce the reaction temperature from 260 °C to 130 °C with significant production rates and high selectivities. The required pressure of 80 bar was also more than halved. In addition, unlike the conventional process, 15% water is not produced as a by-product, which eliminates the need for energy-intensive separation," says Dr. Marek Checinski, Managing Director of CreativeQuantum GmbH and initiator of the consortium.

The next major task now is to reduce production costs by using larger plants and larger catalyst quantities.

After laying the foundations for the technology in 2017 and filing a patent application for the new process in 2018, the collaboration within the research project between CreativeQuantum and LIKAT, with the team led by Dr. Ralf Jackstell, focused on improving the catalytic system and the process conditions. The process was also scaled up further. This iterative process was significantly accelerated through the intensive exchange of quantum mechanical simulations and experiments. "In line with Leibniz's motto "Theoria cum Praxi", we accompanied the process from the development of the catalyst synthesis on a laboratory scale to solvent optimization and upscaling," says Dr. Ralf Jackstell, group leader for "Applied Carbonylations" at the Leibniz Institute for Catalysis.

The working group of Prof. Dr. Ulf-Peter Apfel from the Ruhr University Bochum has been working with CreativeQuantum on the question of how green synthesis gas can be produced. This requires green electricity, water and carbon dioxide. Through systematic virtual screenings and selected experiments in the laboratory, the team was able to find new materials for catalysis that process CO₂ and water simultaneously by means of co-electrolysis. The process was investigated from individual atoms to complex surface compositions. Prof. Apfel's team also drove reactor development through to the first high-performance cell. "Thanks to the close collaboration with CreativeQuantum, we were quickly able to develop new, robust catalyst systems and determine the reaction conditions with which we can now selectively convert CO₂ to synthesis gas," says Prof. Ulf-Peter Apfel.

The heterogeneously catalyzed process in this project was contributed by INERATEC. INERATEC's challenge was to scale down the solid-state catalyzed methanol production by means of direct hydrogenation of CO₂ in this pilot plant. In this process, CO₂ and green hydrogen are converted into the target product methanol in a further step. Managing Director Dr.-Ing. Tim Boeltken says: "In addition to e-Fuels, we see synthetic methanol as an indispensable building block for a sustainable future where fossil resources are no longer needed. The successful production of sustainable methanol on this demonstration scale is a crucial step forward on our mission. It lays a solid foundation for scaling up our pioneering technology. In accordance with thermodynamics, the next scaling stage of the reactor technology has been demonstrated, laying a solid foundation for the global scaling of our methanol technology."

After successful test operation, the respective advantages of both processes in terms of potential production costs of green methanol will be presented.

Thanks to the active support of local partners such as Miltitz Aromatics and the Bitterfeld-Wolfen Chemical Park, it was possible to set up and successfully operate an integrated system in the chemical park within a short period of time. The integrated plant was designed and built by INERATEC with input from the project partners. The project was also supported by the economic advisory board of representatives from Linde, ThyssenKrupp and Clariant.

E⁴MeWi stands for Energy-Efficient Renewable Energy-based Methanol Economy. The shift towards an E⁴MeWi can currently be observed particularly well in the shipping industry. Large shipping companies are already investing heavily in sustainable methanol mobility. The project partners are continuing to develop the E⁴MeWi technology in order to get it ready for the market as quickly as possible.

Contact:

Further information on the project and photographic material can be found on the website <https://www.e4mewi.de>.

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Fotomaterial:

The E4MeWi team with the members of the advisory board in front of the demonstration plant for the innovative process for the production of green methanol. From left: Dr. Ralf Jackstell and Dr. Rauf Razzaq (both LIKAT), Max Fuhr (Chemiepark Bitterfeld-Wolfen), Prof. Dr. Ulf-Peter Apfel (Ruhr University Bochum), Dr. Matthias Krüger (thyssenkrupp Uhde), Dr. Marek Checinski (CreativeQuantum), Dr. Normen Szesni (Clariant), Dr. Nicole Schödel (Linde), Dr. Lars Esmezjan (INERATEC), Dr. Alexander Janz and Dr. Kenta Stier (both CreativeQuantum), Copyright: CreativeQuantum GmbH