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Chemical production in Germany

Soda Manufacturing with Double Climate Bonus

Fraunhofer researchers and their partners have developed an innovative and eco-friendly method of producing soda, essential for a wide range of industries, in the Green Soda project. The process is based on bipolar electro dialysis of brine. Ion exchange processes and the addition of CO₂ result in green soda. The technology will also help to strengthen manufacturing in Germany as an industrial location.

Sodium carbonate, also known as soda ash, is an essential material used in many different industrial sectors. It is used to make paper, preserve foods, manufacture glass and neutralize acids. It is also found in private households, where it is the main ingredient in baking powder and is used as a stain remover and drain cleaner. And the numbers reflect this: The German chemical industry association Verband der chemischen Industrie (VCI) indicates that some 2.1 million metric tons of soda ash and sodium bicarbonate were produced in Germany alone in 2023. The issue is that production of soda emits large amounts of carbon dioxide — 800 kilograms per metric ton. Salty wastewater is another byproduct, increasing the salinity of water bodies.

The solution is a sustainable new production process that generates no climate-damaging CO₂ emissions or saline wastewater. The method was developed at the Fraunhofer Institute for Ceramic Technologies and Systems IKTS in collaboration with partners working on the Green Soda joint research project, which is receiving funding from the German Federal Ministry for Economic Affairs and Climate Action (BMWK). The Helmholtz-Zentrum Dresden-Rossendorf and operators of geothermal facilities are involved as project partners, along with soda manufacturer QEMETICA Soda Deutschland.

Clean process: bipolar electro dialysis

Soda has been produced using the Solvay process since the 19th century. In this method, limestone is burned using coke or coal. This produces carbon dioxide, which reacts in further steps with brine, ammonia and lime, producing sodium carbonate — but also large amounts of calcium chloride wastewater. “Our method is an eco-friendly alternative without problematic basic materials,” explains Hans-Jürgen Friedrich, group manager for technical electrolysis, geothermal systems and the radionuclide lab at Fraunhofer IKTS.

The Green Soda method is based on an electrochemical process route. The centerpiece of the technology is bipolar electro dialysis, which involves ultra-thin membranes. The

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pores in these membranes are so tiny that only individual ions can pass through. The membranes function as an exchange medium by only allowing the negatively charged anions or positively charged cations to pass through. This means that during the process, a mixture of salt and water — brine — is split into sodium hydroxide and hydrochloric acid. Hydroxides are salt-like compounds that form sodium hydroxide on contact with water. Then, when CO₂ is added to the sodium hydroxide, the final product is soda.

“This lets us produce sodium carbonate without spewing greenhouse gases into the atmosphere and without harmful industrial wastewater increasing the salinity of rivers or other bodies of water,” Friedrich says. The Fraunhofer researchers are also planning to use geothermal heat energy for crystallization and drying processes to eliminate the use of fossil fuels.

A twofold carbon reduction

The researchers on the team are working with project partners on a system at the pilot plant scale that provides the CO₂ needed for the process from biogas systems or industrial combustion processes. This means the Green Soda project is preventing harmful greenhouse gas emissions in two ways at once: during the manufacturing process, and by using excess CO₂ from other industries.

Another advantage of the new method is that carbon-neutral production does not require expensive climate certificates. This is not only good for the environment, but also an important contribution to maintaining Germany’s high-quality industrial manufacturing base while also turning an economic profit.



Image 1: Production of soda previously produced large amounts of CO₂ and saline wastewater. The technology used in the Green Soda project solves both problems.

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Image 2: Clean production: the lab testing equipment for ecofriendly manufacturing of green soda through bipolar electro dialysis of brine. The process eliminates carbon emissions and salty wastewater.

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