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CO_2 to Ethylene via Electroreduction

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Abstract

The global economy's dependence on fossil-fuel-derived products is a major obstacle in achieving the carbon-neutral future. The chemical industry substantially contributes to industrial carbon dioxide (CO_2) emissions. Till the continued reliance on fossil fuels persists, these emissions will remain a negative consequence.

Carbon capture and utilization (CCU) technologies can effectively mitigate these emissions by utilizing CO_2 emissions as a production feedstock and converting them into necessary chemical products. This approach not only allows for the reuse of CO_2, instead of its deep storage, but also reduces the demand for fossil fuel extraction. However, unfavorable process economics and the need to develop a new supply chain for CO_2-based production have hindered the large-scale deployment of CCU.

The electrocatalytic conversion of CO_2 to value-added chemicals, i.e., electrochemical CO_2 reduction (CO2R) offers a promising solution for storing intermittent renewable electricity and addressing the carbon emissions problem. As renewable electricity costs continue to decrease, this technology will provide a competitive means of producing chemical feedstocks like carbon monoxide, formic acid, methane and multicarbon (C2+) products like ethylene and ethanol.

This review presents an alternative approach to CO2R — waste CO_2 is recycled on-site, and an electroreduction unit is retrofitted into an existing chemical production process. On-site CO_2 can be immediately converted into raw materials and recycled back into the production unit, generating synergies between the new CO2R technology and the established chemicals sector. This approach reduces the number of separation steps required and minimizes logistical efforts.

The review provides a techno-economic evaluation of retrofitting an ethylene oxide (EO) plant with CO2R conversion and discusses recent developments in catalysts, performance and separations in CO2R processes. Additionally, an iPEP module with a user-friendly interface covering multiple geographic locations is included, as the economics of this process is highly dependent on the location.

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