

Electrons and CO₂ to fatty acids through electrolysis and fermentation (EFA)

Publieke samenvatting / Public summary

Aanleiding

Currently, the chemical industry relies heavily on fossil based feedstock and energy, being responsible in the Netherlands alone to up to 40% emission of greenhouse gases. In the EFA project, we put forward a technology suitable for a post fossil era based on renewable electricity and carbon feedstock. Energy from sustainable sources, e.g. wind turbines or solar cells, will in near future be available in excess, especially when weather conditions are optimal. The intermittency of the renewable electricity sources brings forward the need for energy storage. At large scale, energy storage can be done in chemicals. Electrochemical conversion of the energy and carbon dioxide into formic acid or other organic acids is a very efficient way to tackle this issue of energy storage. In order to produce larger chain value-added organic molecules from renewable energy and carbon dioxide, electrolysis is combined with microbial. To this end, EFA concentrates on maximal utilization of renewable power and feedstock, to produce fatty acids and microbial proteins via integration of electrochemical conversion and fermentation routes.

Doelstelling

The goal of EFA is to develop a post-fossil era innovative, sustainable and economically competitive process for direct CO₂ utilization using energy from sustainable resources, via combination of electrochemistry and fermentation for the formation of fatty acids and microbial protein. The

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products targeted are intermediate compounds with an outlook to be used on a short term in high value applications such as personal care products, detergents and other. Especially, home & personal care industries use long chain fatty acids and there is a clear need to replace the nowadays mainly used palm oil with sustainable alternatives. In EFA, industrial end users are represented in the consortium and will test and validate the products against commercial alternatives. In the long term, the microbial oils and fatty acids can also be used for applications in fuels and probably even food products. Furthermore, from the same fermentation process, the biomass can be valorized as proteins for food. The project is going to assess both application routes: personal care as well as food against the rapid market implementation targeted to contribute to the 2030 climate objectives.

Korte omschrijving

Main activities of EFA will involve:

- Development of continuous formic acid production via electrolysis of CO₂ for use in fermentation (TNO):
 - Design, construction and testing of stack electrochemical reactor electrochemical reactor with in situ product separation functionality
 - Demonstration of continuous production of formic acid/formate suitable for fermentation at a scale of ~1kg/h formic acid.
- Development of a yeast fermentation process using formic acid as feedstock (WFBR)
 - Strain engineering to enable carbon assimilation from formic acid by oleaginous yeast
 - Adaptation and improved formic acid utilization of oleaginous yeast strains by adaptive laboratory evolution (ALE)
- Integration of electrolysis and fermentation steps by conditioning the sample size, concentration as well as the effect of the impurities on the process (TNO,WFBR)
- Isolation of microbial oils and fatty acids from biomass (WFBR, KLK Kolb)
- Application testing (KLK Kolb, ECOVER, Corbion) of:
 - Fatty acids for use in laundry products as surfactants by in-situ saponification

Resultaat

The activities in the EFA project will lead to the following results:

- Electrolysis and fermentation

technology demonstration at TRL 5-6 using already existing infrastructure at the project partners (e.g. Field lab industrial electrification Rotterdam) - Full chain experimental showcase of the utilization of CO₂ to formic acid and subsequent utilization in fermentation to produce fatty acids and valuable co-products - Relevant product samples validated by industrial partners for several application areas (personal care products, detergents and food) - Technoeconomic assessment and market introduction plan with a horizon towards 2030 climate goals

De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.

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