Electrochemical treatment of industrial bio liquids is technically feasible reducing the cost of sustainable renewable energy

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After just eighteen months of research, experimental studies have identified suitable electrode materials as well as established an operational window. This lays the ground works for paired electrochemical tests combining anodic oxidation and cathodic reduction processes.

Tobias Graßl of CONDIAS speaks out about the exciting research *"Sustainable electrochemistry requires innovative concepts covering smart chemistry, new high-performance electrodes, and a reliable cell design. CONDIAS was able to optimize and adapt its BDD electrodes to the special needs of the EBIO project. Extensive work has been done with regards to cell technology as electrode and cell have to work hand in hand to gain maximum chemical output. Additive manufacturing of cell parts was used to optimize electrical and hydrodynamic properties.*

Electrochemical pyrolysis liquid conversion requires an initial fractionation process separating oil and aqueous phase. Hydrogenation of saccharides and depolymerization of heavier lignin fractions requires the usage of recycled side streams, such as methanol and acids, to improve the electrolyte properties.

Bastian Mei Professor at Twente University recounts some breakthroughs in the project *"We established a correlation between solution composition, particularly cations, and Kolbe activity and determined the actual potential required to obtain transformation of acetic acid/acetate to Kolbe/non-Kolbe products. By trying to disentangle the complexity of pyrolysis oil using 2D-NMR we understand its transformation during oxidative treatments in an electrochemical environment, which has revealed the impact of electrode structure and precisely doping concentration on the process (Kolbe) selectivity."*

Image: Nanostructured Boron doped diamond electrodes on silicon pillars.
Credit: University Twente and Condias

Furthermore, EBIO can boast that an electrochemical black liquor conversion has been achieved. By feeding black liquor directly into an electrochemical cell, polymeric lignin is depolymerised, and the monomeric intermediates can be reduced. Separation of oxidised intermediates of higher value, such as vanillin, is technically feasible by either adsorption onto ion exchange materials, or extraction. For fuels production most feasible seems the consecutive electrochemical or catalytic reduction.

Preliminary results from the EBIO Projects societal impacts consist of pre-selection of a set of impact categories, criteria, and indicators for this analysis. These findings that form the basis of the research are essential building blocks for further development to discover the final set of factors that will make electrochemical treatment of black liquor feasible.

The concepts proven in EBIO contribute to accelerating and reducing the cost of the next generation of sustainable renewable energy generation. EBIO will develop a novel generation of electrochemical conversion technology targeting more costs effective approaches. Costs will be reduced by valorising residual streams in existing refineries (pyrolysis liquid, black liquor), and enabling valorisation of products that have a significantly higher value than just combustion value. This project will not only contribute to cost savings but also a valuable understanding of technological, economic, and environmental parameters required for the conversion of different types of low value crude bio liquids into energy dense hydrocarbon using electrochemistry.

About EBIO:

EBIO – *Turning low value crude bio liquids into sustainable road transport fuels* started on the 7th of December 2020 and runs for 48 months.

The consortium, coordinated by Sintef AS (Norway), counts **9 beneficiaries** from **7 countries:** B.T.G. Biomass Technology Group BV – BTG (The Netherlands), Johannes Gutenberg-Universitat Mains – JGU (Germany), Universiteit Twente - UT (The Netherlands), Condias GMBH (Germany), Turkiye Petrol Rafinerileri Anonim Sirketi – TUPRAS (Turkey), Poyry Sweden AB – AFRY (Sweden), ETA – Florence Renewable Energies (Italy), Agencia Estatal Consejo Superior Deinvestigaciones Cientificas – CSIC (Spain).

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