ISGC 2019 May 13rd - 17th

N°1001 / PC
TOPIC(s) : Biomass conversion / Alternative technologies

Electrochemical conversion of a bio-derivable hydroxy-acid for the production of green diesel drop-in fuels

AUTHORS

Jérôme MEYERS / ITMC RWTH AACHEN UNIVERSITY, WORRINGER WEG 2, AACHEN
Joel B. MENSAH / ITMC RWTH AACHEN UNIVERSITY, WORRINGER WEG 2, AACHEN
F. Joschka HOLZHÄUSER / ITMC RWTH AACHEN UNIVERSITY, WORRINGER WEG 2, AACHEN
Stefan PALKOVITS / ITMC RWTH AACHEN UNIVERSITY, WORRINGER WEG 2, AACHEN
Regina PALKOVITS / ITMC RWTH AACHEN UNIVERSITY, WORRINGER WEG 2, AACHEN

PURPOSE OF THE ABSTRACT

The increasing share of renewable energy leads to a growing dependence on a fluctuating and more decentralized harvest of electrical energy. Therefore, the development of storage technologies for this energy form has attracted much attention in recent years. Moreover, the depletion of fossil resources and related CO2 emissions has become a global concern requiring new approaches e.g. the conversion of biomass wastes into liquid fuels. Here, electrochemistry shows strong potential to fill a technological gap through the production of biofuels from the intermittent electricity generation of renewables. [1]
3-(3-hydroxy-alkanoyloxy)alkanoates (HAAs) are hydroxy-fatty acid esters accessible through a bio-technological process starting from glucose. [2] The corresponding monomer 3-hydroxy decanoic acid (3-HDA) allows for a more facile handling and can be readily synthesized from HAAs through saponification in aqueous media at mild conditions.

In our electrochemical setup we have used a 3D-printed support to which the respective electrodes were attached. Electrochemical conversion was performed with a fittingly sliced graphite electrode as anode and titanium as cathode. High yields (over 70%) were accomplished after only 10 minutes of reaction time (1 Farad eq.), [3] overcoming the long existing lack of protocols for the efficient conversion of ?-hydroxy acids via non-Kolbe electrolysis. A thorough study of the reaction network revealed that 3-HDA is oxidatively decarboxylated into a radical species followed by an additional oxidation leading to the formation of a carbonium ion. Subsequently, the latter further reacts to various C9-based products. The afforded liquid C9-oxygenate product showed highly promising physical properties besides good combustion characteristics for a direct application as diesel fuel. The herein electrochemically synthesized C9-oxygenate fulfills the EN 590 diesel norm, forming the basis for the realization of high blending rates and thereby providing immediate CO2 reduction potential in a well-to-wheel perspective.
Lastly, the direct electrochemical conversion of 3-HDA in a diluted crude microbial fermentation broth (after saponification) was demonstrated leading to a substantial reduction of unit operations and energy for additional separation steps.

We gratefully acknowledge funding by the Federal Ministry of Food and Agriculture (BMEL) under the project number 22403415 (project executing body: Fachagentur Nachwachsende Rohstoffe). This work was performed as part of the Cluster of Excellence Tailor-Made Fuels from Biomass, funded by the German Excellence Initiative.

FIGURES

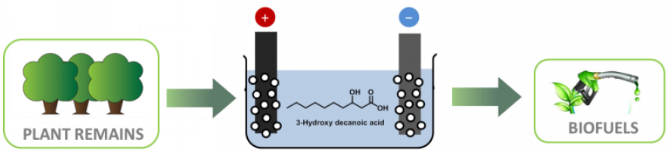

FIGURE 1

Figure 1

Biomass Valorization through Non-Kolbe Electrolysis

FIGURE 2

KEYWORDS

#Electrochemistry | #NonKolbeElectrolysis | #BiomassValorisation

---

BIBLIOGRAPHY

[1] F. Harnisch, C. Urban, Angew. Chem. Int. Ed. 2018, 57, 2–10.
[2] L. M. Blank, T. Tiso, A. Germer, 2015 Patent EP15175922.
[3] J. Meyers, et al., manuscript in preparation.