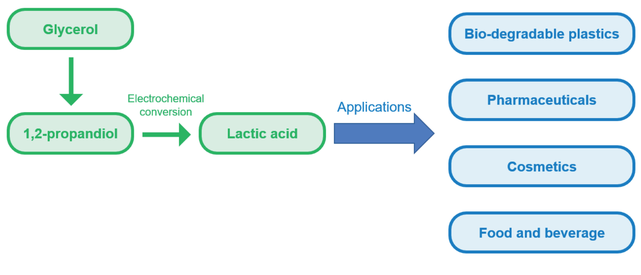
VOLTA CHEM

Electrification of the Chemical Industry

Electrochemical production of lactic acid

Introduction

Lactic acid (LA) is typically produced by bacterial fermentation of waste streams rich in carbohydrates. A novel and green route of obtaining lactic acid from bio-renewable sources such as glycerol is by electrochemical oxidation. First, the hydrogenolysis of glycerol leads to propanediol (PDO) which is further electrochemically oxidized to lactic acid.



Lactic acid is used in several industries. The annual production of lactic acid is estimated at 250kton at a price of 1600EUR/ton.

Electrochemical synthesis of lactic acid

First laboratory trials on the electrooxidation of propanediol in aqueous electrolytes show that lactic acid is produced with a high yield >75% and Faradaic efficiency of 70%, current density of 4-5 mA/cm^2. For the reaction, carbon based electrodes (graphite or carbon felt) are used.

At the surface of the working electrode, a mediator (M/M+) is oxidized. In such activated state, the mediator is used to oxidize 1,2-propanediol to lactic acid in the bulk of the electrolyte, the mediator itself get reduced and then is continuously regenerated on the electrode (see Figure 2, the anodic reaction). Direct electrochemical oxidation of PDO on Pt was also tested and resulted in 33% conversion and 93% selectivity towards lactic acid.

The preliminary results show a high selectivity and yield towards lactic acid formation with 100% conversion of propanediol.

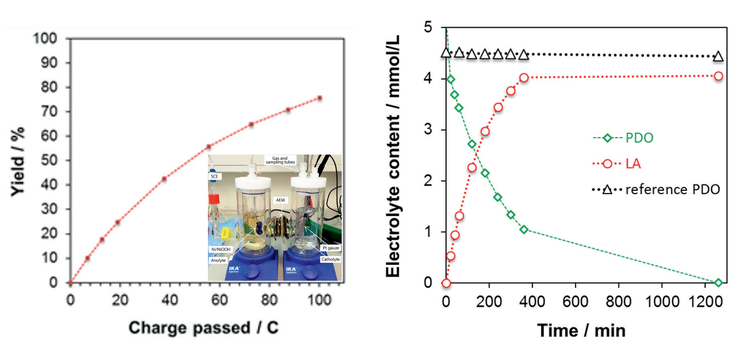


Figure 1. Preliminary results from the electrochemical oxidation of 1,2 propanediol (PDO) to lactic acid (LA)

Outlook

The production costs can be reduced by application of a paired electrolysis configuration. In this way, at the anode, a mediator is used to obtain the lactic acid. At the cathode, oxygen is reduced to peroxide/superoxide which is used to in situ oxidize 1,2-propanediol to lactic acid.

The reaction can further be upscaled to continuous production in the bench scale electrolyzer developed by TNO (Figure 3).

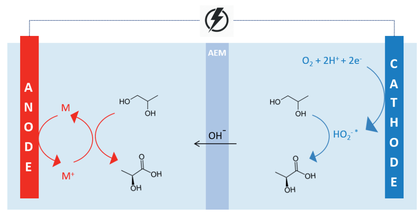


Figure 2. Proposed paired electrolysis configuration for the production of lactic acid

Figure 3. Electrolyzer developed at TNO for continuous synthesis process

R. Latsuzbaia[1] , R.J.M. Bisselink[2], M. Crockatt[1], C.P.M. Roelands[1], E.L.V. Goetheer[1]
[1] TNO, Dept. Sustainable Process and Energy Systems, Leeghwaterstraat 44, 2628 CA Delft, The Netherlands, tel. +31 88 866 2708, e-mail: roman.latsuzbaia@tno.nl
[2] TNO, Dept. of Functional Ingredients, Utrechtseweg 88, 3704 HE Zeist, The Netherlands

JOIN VOLTACHEM'S COMMUNITY: WWW.VOLTACHEM.COM/COMMUNITY

ACKNOWLEDGEMENT This project is funded by the topsector Chemie via the Dutch Ministry of Economic Affairs.

VoltaChem is powered by TNO innovation for life ECN Topsector Chemie