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Poster-E35: Hydrogen production in Microbial Electrolysis Cells using stainless steel and nickel foam as cathode materials

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Hydrogen is the energy vector that can support the energy transition to replace fossil fuels and mitigate the effects of climate change. Agroindustrial wastewaters containing carbohydrates can be used as feedstock to obtain biohydrogen through dark fermentation. However, at the end of fermentation, between 60% and 70% of the initial organic matter is transformed into volatile fatty acids (VFAs). VFAs can be used in a subsequent step using Microbial Electrolysis Cells (MECs) to produce hydrogen, increasing the overall hydrogen yield that can be obtained from the initial substrate. MECs consist of an anode and a cathode in two chambers separated by an ion-exchange membrane. At the anodic chamber an electroactive biofilm with exoelectrogenic bacteria metabolize the VFAs and transfers electrons to the anode. At the cathode water is reduced to produce high-purity molecular hydrogen. Unlike a conventional electrolysis cell (2-3 V), MECs require less power (1-1.5 V). However, the bottleneck for MECs implementation lies in incorporating low-cost materials that provide long-term operation. In this work we evaluate hydrogen production in MECs using an acetate(1.5g/L) in a first phase and acidogenic effluent from dark fermentation of brewery wastewater in a second phase. The brewery wastewater had a COD of 3.24g/L, 0,17 ± 0,02 g/L of carbohydrates, 662 mg/L of ethanol, 978 mg/L of acetic acid, 762mg/L of propionic acid and 66 mg/L of butyric acid. Anaerobic granular sludge was used as inoculum. Two cathode materials were tested, nickel foam and stainless steel and the catholyte was NaCl 125mM. MECs were operated at 30°C at a missing rate of 120rpm. Gas volume produced in both chambers was collected and measured in an inverted graduated cylinder. In the first phase (with acetate) H_2 yield was not significantly different between both cathode materials (1011 ± 85 mL/L for stainless steel and 990 ± 94 mL/L for nickel foam. However, the applied potential was higher for stainless steel than for nickel foam (1.29 ± 0.17 vs 1.12 ± 0.03 respectively) which could indicate that a more active electrogenic biofilms were formed in the MEC with nickel foam cathode. Coulombic efficiency (81-84%) was not significantly different between MECs however electric efficiency was higher using nickel foam as cathode (92 ± 5% vs 84 ± 3%). In the first 10 operation cycles, COD removal was less of 60% for both cathode materials. This was due to a decrease of pH in the anodic chamber which affected the electroactive biofilm. In the following cycles, pH was adjusted every day and the COD removal increased to 90% and hydrogen production up to 1600 mL/L for both cathodes evaluate. After 25 cycles operated with acetate the substrate was changed to real brewery wastewater. Hydrogen production was higher using stainless steel (621 ± 178 mL/L) than nickel foam (546 ± 112 mL/L). Electrical efficiency was around 84 % in both cases. However, for both configurations, the organic matter removal was lower than 50 %, and coulombic efficiency was lower than 75 %. At the same time, both cathode materials have a limit for recovering electrons and transforming them into hydrogen (cathodic efficiency) less than 80%. Microbial communities of the anodes are being analyzed by 16S amplicon sequencing.