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COUPLING WASTEWATER TREATMENT TO METHANE GENERATION IN BIOELECTROCHEMICAL SYSTEMS

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Abstract

Bioelectrochemical systems (BESs) are an innovative and attractive technology that combines bacterial metabolism with electrochemistry for wastewater treatment. In a BES, 'electro-active' bacteria engage in extracellular electron transfer reactions with solid-state electrodes, which serve as electron acceptors or donors in their energy metabolism. So far, the most studied BES is the microbial fuel cell (MFC), in which microorganisms use an anode as terminal electron acceptor for the oxidation of waste organic substrates, thereby generating electrical power.

The more recent discovery that cathodes can also serve as electron donors to drive microbial reductions of oxidized compounds, has opened new perspectives for application of BESs (besides electricity generation) in the field of bioremediation and in the production of fuels and chemicals. These latter systems are typically regarded as microbial electrolysis cells (MECs) since, differently from MFCs, require the voltage generated from substrate oxidation (at the anode) to be boosted with a power supply in order to drive the target cathodic reaction, otherwise energetically unfeasible.

Here, a fully biological MEC coupling acetate (as model substrate) oxidation to biomethane generation has been developed. The MEC consisted of an anodic and cathodic compartment separated by a proton exchange membrane and filled with graphite granules, which functioned as both electrodic material and support for microbial biofilm formation. An activated sludge and an anaerobic sludge from a wastewater treatment plant were used as the anode and cathode inoculum, respectively. The MEC performance, in terms of methane production, acetate removal, and coulombic and energy efficiency, has been evaluated as a function of different operating parameters, including the organic load to the anode compartment and electrodic potentials. Overall, the obtained results pinpoint a remarkable potential of BESs for electricity-driven production of biofuels from wastewater.