Bio-Electrochemical Systems [BESs]: An Advanced and Renewable Bio-energy Technology

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Abstract

Bio-Electrochemical Systems [BESs], also known as Microbial Electrochemical Systems [MESs], constitute a unique category of innovative, promising and "green" electrochemical technologies for (waste)water treatment, which has attracted the interest of the scientific community the last 15 years. More specifically, BESs is a hybrid technology that combines physical-chemical, biological and electro-chemical reactions, towards the conversion of the biodegradable fraction of organic compounds in water and wastewater streams (chemical energy) into renewable (electrical) energy and by-products (e.g. hydrogen, methane, carbon dioxide, nutrients, metals etc.) in a sustainable way, utilizing certain electro-active microorganisms as biocatalysts in order to catalyze the redox reactions at electrode–electrolyte interfaces of MESs. Based on the field of their applications, BESs can be broadly categorized into Microbial Fuel Cells [MFCs] for producing bio-electricity, Microbial Electrolysis Cells [MECs] for bio-hydrogen production, Microbial ElectroSynthesis Cells [MESs] for high-value products generation and Microbial Desalination Cells [MDCs] for water desalination, with MFCs and MECs being the main representatives of BESs that are rapidly developed towards environmental sustainability. Hence, MESs could be considered as the appropriate "future tool" which could produce both clean water and "green" energy at the same time, addressing two of the most important issues facing humanity–clean water and energy demand–shaping the future of world society. However, the understanding of the multidisciplinary approaches involved in MES technology (development of new BESs configurations, new cathode/anode materials, new and different membranes, different substrates and electrolytes, type of microbial community, optimization of the operational parameters, limitations and economic feasibility) is still challenging, and intensive investigations are necessary in future research works toward further development of MESs, in view of potential practical applications.

Keywords: Microbial Electrochemical Systems, bio-electricity, environmental sustainability

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