MICROBIAL FUEL CELLS: RESEARCH AROUND THE WORLD, PERSPECTIVES AND OPPORTUNITIES FOR MEXICO

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Introduction. Microbial fuel cells (MFCs) are devices that convert chemical energy from organic matter into electrical energy by the catalytic activity of microorganisms adhered onto electrodes. MFCs are made up of two electrodes joined by an external resistance allowing the circulation of electrons from the (bio)anode to the (bio)cathode, thus creating an electrical current. The anodic compartment, where the oxidation of organic matter occurs, is inoculated with bacteria capable of transfering electrons to the electrode, the so-called electrochemically active or exoelectrogenic bacteria. In most cases the cathodic compartment is saturated in oxygen, which is reduced by the electrons migrating from the anode and combines with hydrogen ions to produce water. In some instances, the cathode compartment is also inoculated, so reduction reactions are catalyzed by microorganism. With any configuration, MFCs enable removal pollution from effluents and generate clean energy.

Historical development of MFCs. Nowadays MFC systems are being developed around the world due to the broad diversity of fuels and inoculum sources that can be exploited using this technology. NASA issued the first reports on MFC applications in the 60s. For a long time these systems were fairly ignored, until the Lovley research group in the USA [1] evidenced the ability of *Geobacter* species to transfer electrons directly to electrodes in marine-MFCs. Since 2004, Logan's group has focused on wastewater treatment in MFC systems [2]. The USA has had the largest proportion of publications at 35% (2703 publications), followed by China at 21%, while Germany and France contribute with 4 and 3%, respectively.
The feasibility of implementing electrodes in diverse environments has led to the development of plant-MFC, solar-MFC, biosensor, and bioelectrochemical systems to recover other valuable products than electricity.
On the other hand, research on genetically modified microorganism, such as on mixed electroactive cultures, has been scarcely reported. MFC systems that produce valuable metabolites are also uncommon.
Real applications of MFCs are scale-up dependent; scaling has been limited by the low performance obtained in the laboratory. Until now, typical power densities have been in the range of 2-3 Wm^{-2}. Clearly multidisciplinary work is necessary, through real applications of MFC could be accelerated by the increased involvement of electrochemical engineering.

MFC research in Mexico. Mexican Institutions working on MFCs, to my knowledge, are located in Mexico City, Yucatan, Queretaro, San Luis Potosi, and Sonora. The first Mexican research on the issue was published in 2008. Around 20 publications have been registered by ISI Web Knowledge (April 2013). In these publications topics of interest include pollutants removal, inoculum sources, operational conditions, modification of electrodes, and MFC designs. Specifically, electricity and hydrogen production from fermentation effluents, carbon materials for bioanodes construction, and pharmaceutical wastewater treatment is being researched at the IPICYT in collaboration with the II-UNAM at the this moment. Despite all the above-mentioned works, statistics clearly indicate the need to enhance efforts to exploit and adapt this technology to Mexican needs.

Conclusion. MFC systems are a promising technology for supplying energy, removing pollutants, and generating valuable products. It seems urgent, as a first step, to create national research networks to accelerate the development of this technology in Mexico.

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References.

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