Bioelectrochemical systems: application and scale-up

Apr 2012 - 2016

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Motivation

With increasing worldwide energy demands and raised concerns about the environmental impacts of burning fossil fuels, renewable energy sources are slowly but steadily winning terrain. Apart from the intrinsic demand this puts on the development of new forms of renewable energy, this also requires additional energy storage facilities to cope with the often intermittent character of renewable energy generation. Moreover, along with the growth in energy demand is the need for efficient recycling of nutrients, valuable metals and potential energy in waste streams. For all these challenges, bioelectro-chemical systems (BESs) offer new perspectives.

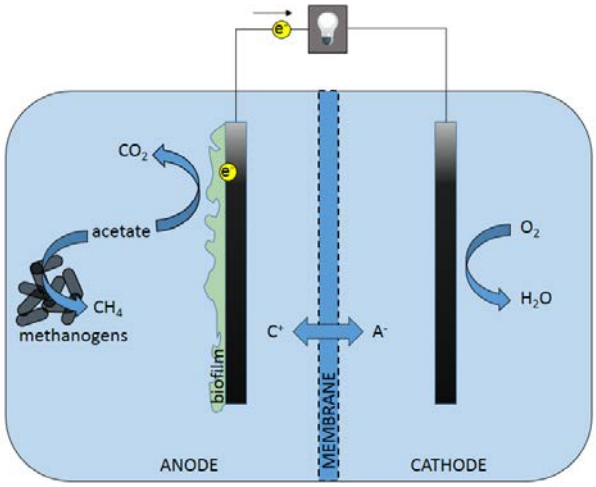
Technological challenge

BESs are bioreactors in which the reduction and oxidation reactions are spatially separated. The electrons pass through an electrical circuit in order to complete the full reaction, comparable to fuel cells and batteries (Fig. 1). However, the reduction and/or oxidation in BES are catalyzed by micro-organisms (MO). These MO are able to either accept or donate electrons from/to an electrode. The principles of BES are currently under study for clean and energy efficient conversions, e.g. for energy recovery from a broad range of waste waters, metal recovery from acid mine drainages and formation of organic components from CO2.

Commercial application of BESs is currently hindered by several bottlenecks. For example, part of the substrate is converted into other than the desired products, decreasing the coulombic efficiency. Also, the reaction at the electrode suffers from energy losses. More knowledge of the biological dynamics in these systems as well as advancements in material sciences are required to overcome these difficulties. The aim of this project is to target these bottlenecks, so that BES application becomes commercially attractive.

Research objectives

- increase electricity production by investigating the effect of anode potential and substrate concentrations, and determine how these affect the coulombic efficiency
- testing different cathode materials and designs for suitability in a microbial fuel cell configuration
- operating the Microbial Fuel Cell on wastewaters that contain a mixture of organic components



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