websites of note

by Zoltan Nagy

Bioelectrochemical systems (BES) for sustainable energy production and product recovery from organic wastes and industrial wastewaters

Bioelectrochemical systems (BESs) are unique systems capable of converting the chemical energy of organic waste including low-strength wastewaters and lignocellulosic biomass into electricity or hydrogen/chemical products in microbial fuel cells (MFCs) or microbial electrolysis cells (MECs) respectively, or other products formed at the cathode by an electrochemical reduction process. As compared to conventional fuel cells, BESs operate under relatively mild conditions, use a wide variety of organic substrates and mostly do not use expensive precious metals as catalysts. The recently discovered use of BESs for product synthesis via microbial electrosynthesis has greatly expanded the horizon for these systems. Newer concepts in application as well as development of alternative materials for electrodes, separators, and catalysts, along with innovative designs have made BESs very promising technologies. This article discusses the recent developments that have been made in BESs so far, with an emphasis on their various applications beyond electricity generation, resulting performances and current limitations.

- Deepak Pant, et al. (Separation & Conversion Technologies, VITO-Flemish Institute for Technological Research, Boeretang 200, 2400 Mol, Belgium)
  http://pubs.rsc.org/en/content/articlelanding/2012/ra/c1ra00839k/unauth#!divAbstract

Minimizing losses in bio-electrochemical systems: the road to applications

Bioelectrochemical systems (BESs) enable microbial catalysis of electrochemical reactions. Plain electrical power production combined with wastewater treatment by microbial fuel cells (MFCs) has been the primary application purpose for BESs. However, large-scale power production and a high chemical oxygen demand conversion rates must be achieved at a benchmark cost to make MFCs economically competitive in this context. Recently, a number of valuable oxidation or reduction reactions demonstrating the versatility of BESs have been described. Indeed, BESs can produce hydrogen, bring about denitrification, or reductive dehalogenation. Moreover, BESs also appear to be promising in the field of online biosensors. To effectively apply BESs in practice, both biological and electrochemical losses need to be further minimized. At present, the costs of reactor materials have to be decreased, and the volumetric biocatalyst activity in the systems has to be increased substantially. Furthermore, both the ohmic cell resistance and the pH gradients need to be minimized. In this review, these losses and constraints are discussed from an electrochemical viewpoint. Finally, an overview of potential applications and innovative research lines is given for BESs.

- Peter Clauwaert, et al.
  http://link.springer.com/article/10.1007/s00253-008-1522-2#page-1

Electrochemically assisted microbial production of hydrogen from acetate

Hydrogen production via bacterial fermentation is currently limited to a maximum of 4 moles of hydrogen per mole of glucose, and under these conditions results in a fermentation end product (acetate; 2 mol/mol glucose) that bacteria are unable to further convert to hydrogen. It is shown here that this biochemical barrier can be circumvented by generating hydrogen gas from acetate using a completely anaerobic microbial fuel cell (MFC). By augmenting the electrochemical potential achieved by bacteria in this MFC with an additional voltage of 250 mV or more, it was possible to produce hydrogen at the cathode directly from the oxidized organic matter. More than 90% of the protons and electrons produced by the bacteria from the oxidation of acetate were recovered as hydrogen gas, with an overall Coulombic efficiency (total recovery of electrons from acetate) of 60−78%. This is equivalent to an overall yield of 2.9 mol H_2/mol acetate (assuming 78% Coulombic efficiency and 92% recovery of electrons as hydrogen). This bioelectrochemically assisted microbial system, if combined with hydrogen fermentation that produces 2−3 mol H_2/mol glucose, has the potential to produce ca. 8−9 mol H_2/mol glucose at an energy cost equivalent to 1.2 mol H_2/mol glucose. Production of hydrogen by this anaerobic MFC process is not limited to carbohydrates, as in a fermentation process, as any biodegradable dissolved organic matter can theoretically be used in this process to generate hydrogen from the complete oxidation of organic matter.

- Hong Liu , Stephen Grot, and Bruce E. Logan (Penn State University, University Park, Pennsylvania 16802)
  http://pubs.acs.org/doi/abs/10.1021/es050244p

About the Author

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