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Renewable Bioenergy Production from Wastes: Biohydrogen and Microbial Fuel Cells

Woo Hyoung Lee
Department of Civil, Environmental, and Construction Engineering
University of Central Florida, USA
WooHyoung.Lee@ucf.edu

As the human population increases and environmental requirements become more stringent, the need for sustainable water management treatment systems that meet regulatory standards and reduce energy consumption has become a top priority in the water industry. In addition, renewable energy production from waste is one of major components in futuristic cities. In this presentation, novel technologies and their applications for sustainable water and wastewater management and renewable energy productions is introduced. Particularly, renewable microalgal biohydrogen production from wastes and microbial (and microalgal) fuel cells (MFCs) technology for electricity production from wastewater is highlighted. Biohydrogen production from microalgae is possible by altering the sulfur (S) oxidizing transitions in photosystem II (PSII); however, this may not be practical in a wastewater environment. To counteract natural mechanisms of oxygen evolution in PSII, we utilized acetic acid and butyric acid, which are main volatile fatty acids (VFAs) found in anaerobic bacterial digestion in wastewater treatment, as oxygen regulators for photosynthetic biohydrogen production using Chlorella vulgaris and successfully produced maximum hydrogen yield of 65.4±0.3 mmoL H2 L-1 mM-1 acetate without artificial sulfur or chloride deprivation. This emerging understanding of the role of VFAs on oxygen regulation in PSII in natural environments is expected to lead algal-driven bioenergy production technologies to the next level. Next, sustainable electricity generation from oily wastes using microbial fuel cells (MFCs) technology will be presented. Among liquid oily wastes, bilge water (a shipboard oily liquid waste) was proposed for a possible substrate for MFCs using Pseudomonas putida ATCC 49128 in a single MFC chamber. Particularly, the effect of surfactant type and salinity on the oil biodegradation in an MFC was evaluated in terms of electricity production. With an anionic surfactant (sodium dodecyl sulfate), maximum power density from degrading 0.1% standard bilge mix was observed at 225.3 mW m-2. It was also found that green algae, Auxenochlorella sp., successfully produced electricity with maximum power density of 80 mW m-2 in a single MFC chamber. This study is first to demonstrate oily wastewater as a promising substrate for MFCs with simultaneous emulsion biodegradation and continuous power generation.