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Efficiency of Photosynthetic Microbial Fuel Cell (Pmfc) Depending On Microalgae Species Inhabiting the Cathode Chamber

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Extended Abstract

Photosynthetic microbial fuel cells (pMFC) combine the processes of anaerobic wastewater treatment and the cultivation of photosynthetic microorganisms and enable the generation of electricity by the potential difference between these processes. In the studies carried out, the influence of the cultivated microalgae species on the efficiency of electricity generation was determined. The species tested in the experiments were *Arthrospira platensis* and *Chlorella vulgaris*.

Dual-chamber MFCs fed in batch mode was used for the experiment, in which each chamber had a volume of 1 L and the anode and cathode chambers were separated by a Nafion™ 117 membrane. The anode and cathode were made of carbon cloth and carbon rods, respectively. The cathode chamber was filled with *Arthrospira platensis* and a suitable medium (modified Aiba and Ogawa medium) [1]. The cathode chamber was filled with *Chlorella vulgaris* and 3N-BBM+V (Bold Basal Medium with 3-fold Nitrogen and Vitamins, modified) medium [2]. Dairy wastewater with a concentration of 2000 mg COD/L flowed into the anode. While the microalgae were growing, the microalgae culture medium in the cathode chamber replaced by the effluent from the anode chamber. The algae were grown in 16:8 light mode.

As a result of the experiments, it was found that the key influence on the amount of current produced was the availability of the substrate in the anode chamber, which determines the production of electrons as a result of the decomposition of organic substances flowing into the anode chamber. The next decisive factor was the amount of oxygen produced by the microalgae in the cathode chamber, which created a potential difference and allowed the free flow of electrons. *Arthrospira platensis* produced a higher amount of electric current because there was a higher amount of dissolved oxygen in the cathode chamber during the dark phase than in the case of *Chlorella vulgaris*. The decrease in photosynthetic activity and thus oxygen production in the dark phase significantly reduced the voltage generation, but during the light phase it increased again to maximum values. In the case of *Arthrospira platensis*, the highest current density generated in the MFC was 91 mW/m2. Most of the COD was removed in the anode chamber and the removal efficiency was 87%, while nitrogen was mainly removed by microalgae in the cathode chamber. The nitrogen removal efficiency of *Arthrospira platensis* and *Chlorella vulgaris* was 58% and 43%, respectively. The above results indicate that it is more advantageous to cultivate *Arthrospira platensis* in the cathode chamber for higher efficiency of wastewater treatment and generation of higher value of electrical energy.

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References

[1] S. Aiba, T. Ogawa. Assessment of growth yield of a blue-green alga: Spirulina platensis in axenic and continuous culture. *J. Gener. Microbiol*, 102, 179–182, 1977.
[2] Z. Guo, W.B.A. Phooi, Z.J. Lim, Y.W. Tong. Control of CO2 input conditions during outdoor culture of Chlorella vulgaris in bubble column photobioreactors. *Bioresour. Technol*. 2015, 186, 238–245, 2015.