

Response to Comment on "Sustainable Power Generation in Microbial Fuel Cells Using Bicarbonate Buffer and Proton Transfer Mechanisms"

We appreciate that Ahn further emphasized the potential importance of the self-produced CO₂ from the degradation of carbon sources in facilitating proton transfer (1). However, Ahn overestimated the possible CO₂ (bicarbonate) concentration in our experiments. The claims "If the MFC had been operated under a continuous steady state condition, CO₂ partial pressure in the headspace of MFC would be maintained at almost 1 atm." and "if the MFC had well behaved under a steady state for a long-term period. The CO₂ partial pressure of the MFC must be maintained to considerably high level, approximately 1 atm." in the comment are not correct.

Under steady state conditions, equilibrium is established between the dissolved CO₂ in liquid phase and the CO₂ gas in headspace. The concentrations of CO₂ in the liquid and in the headspace remain constant since all the produced CO₂ is carried away by the effluent. Based on the equation for calculating Columbic efficiency of MFCs under continuous flow mode (3), the maximum produced CO₂ concentration (ΔC_{CO_2}) can be calculated as:

$$\Delta C_{\text{CO}_2} = \frac{I}{FbqE_c} \quad (1)$$

where F is Faraday's constant, $b = 4$ is the number of electrons exchanged per mole of CO₂ produced, q is the volumetric influent flow rate (0.6 mL/min in this study), I is the current, and E_c is the Coulombic efficiency.

The maximum current density in the MFC tests using 50–200 mM phosphate buffer was 0.6–0.9 mA/cm², corresponding to a maximum current (I) of 8–13 mA (anode surface area 14 cm²). Assuming the Coulombic efficiency (E_c) was 70% based on the result of a similar experiment (4), the maximum produced CO₂ (bicarbonate) concentration was only 3–5 mM according to eq 1. Considering the

bicarbonate in the influent was negligible, the balanced CO₂ partial pressure in headspace should be only about 0.01–0.02 atm even assuming there was no gas diffusion through the gas permeable air-cathode. The diffusion might further reduce the concentration of CO₂ in the liquid and headspace of the cell. Compared with 50–200 mM phosphate buffer in the influent, the role of the produced bicarbonate with a maximum concentration of 3–5 mM is negligible. Therefore, we did not consider the self-produced CO₂ as the major pH buffer or proton transfer carrier in the reported experiment. Under certain circumstances, however, the self-produced bicarbonate may serve as an effective pH buffer and proton transfer carrier, as stated in our paper (2). In the *Introduction* section, we wrote "CO₂ generated from the degradation of carbon sources may serve as a low cost and effective pH buffer". In the *Implications in MFC Applications* section, we stated "Another great advantage of bicarbonate buffer is that it can be converted from the self-produced CO₂ in an MFC." And "the accumulation of CO₂ in a half-closed or closed MFC system may reduce or eliminate the need for the addition of buffers, making such an MFC system simpler and more economically viable."

Literature Cited

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