Inhibiting the growth of microbes on air cathode in microbial fuel cell by using antimicrobial agent

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Abstract

As a promising technology for renewable energy production and wastewater treatment, microbial fuel cell (MFC) is quite new and significantly important. The conventional two chamber MFC consisted of an anaerobic biological anode and aerobic biological/abiotic cathode separated by proton exchange membrane. On bio-anode, organic compounds were oxidized by microbes to produce proton (H+), electron and carbon dioxide. H+ diffused to cathode, electron travelled through outer circuit to cathode, where they combined with oxygen to form water. The cost of membrane and aeration device and the internal resistance were the main limitation of a conventional two chamber MFC. To eliminate the aeration device and reduce the internal resistance, air-cathode single chamber MFC (SCMFC) was introduced. SCMFC was simple in design and cost-effective. However, formation of aerobic biofilm on air-cathode fouled the attached Pt-catalysts on it and subsequently reduced the system performance. Therefore, a suitable mitigation measure was essential to suppress the growth of biofouling on cathode for cost-effective application of MFC in wastewater treatment and bio-energy recovery. The current study carried out to investigate the effectiveness of chloramphenicol as anti-biofouling agent on Pt-coated cathode to suppress the growth of aerobic biofilm in SCMFC operated in batch mode and compared the findings with a similar conventional SCMFC with Pt-coated air-cathode. The study was done by using two MFCs, i.e., one with conventional Pt-coated air-cathode (MFC-1) as control, and another with antibiotic mixed Pt-coated air-cathode (MFC-2). In the control MFC-1, the maximum generated cell potential of 0.82 V reduced to 0.62 V during three months operation

due to biofouling development on Pt-coated air-cathode. Besides, the control system achieved 95% COD removal by 5 days hydraulic retention time (HRT). However, with the newly developed antibiotic mixed Pt-coated cathode in MFC-2, the system achieved maximum cell potential of 0.85V with 95% COD removal by 10 days HRT. The higher HRT in MFC-2 demonstrated that there were no/less-aerobic biofilm grown on the cathode. Therefore, the rate of COD removal was slower compared to that in the control MFC-1 where two different groups of biofilm were involved in reducing the COD. The maximum columbic efficiency (CE) achieved in control MFC-1 was 8%, whereas, the maximum CE achieved in newly developed MFC-2 was 12.5%. A significantly high CE in MFC-2 explained that the major fraction of COD

was removed by the exo-electrogenic microbes on anode that were contributed to higher CE generation. The increment in CE by applying antibiotic on cathode indicated the absence of cathodic aerobic biofilm and the removal of COD was solely done by the anodic biofilm. Therefore, the application of antibiotic coating on cathode can suppress the growth of cathodic biofouling without interfering the other bio-electrochemical properties (COD removal, power recovery, pH change) of the system. However, the release of antibiotic chemicals from cathode to electrolyte could negatively affect the anodic biofilm performance in the long-term operation. Therefore, more studies were needed for long-term investigation with this antibiotic coated cathode or exploring the application of other antibiotics on cathode to make the system cost-effective and ecofriendly.