Continuous wastewater treatment contaminated with heavy metals by coupling a microbial fuel cell and a microbial electrolysis cell

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The main objective of this study was to find the feasibility of continuous removal of mixed heavy metal ions from wastewater by coupling a microbial fuel cell (MFC) and a microbial electrolysis cell (MEC) in a continuous mode (Fig. 1). This research focused on a mixture of chromium (VI) ions, zinc (II) ions, copper (II) ions, and nickel (II) ions, as a typical plating solution, to be removed using the MFC-MEC coupled system. The electrode material was graphite felt. To compare parameters the system was also run in a batch. In the batch mode, the effects of Cr (VI) initial concentration on removal efficiency of Zn (II) and Ni (II) in MEC has been first studied. The initial concentrations of Cr (VI), Cu (II), Ni (II), and Zn (II) were all 10 ppm in MFC, and the concentrations of Ni (II) and Zn (II) were 10 ppm in MEC. As Cr (VI) concentration increased from 10 ppm to 100 ppm, the voltage supply to MEC was increased, and Ni (II) and Zn (II) reduction rate was also increased. EIS has been applied to investigate the effect of experimental conditions on electrochemical reactions. The impedance of different Cr (VI) concentrations from 10 ppm to 100 ppm in MFCs showed that, compared with low initial Cr (VI) concentrations, higher initial Cr (VI) concentrations exhibited much lower resistance (Ohmic resistance; 19.3~13.4 ohms, charge transfer resistance; 28.2~21.5 ohms), and thus the MFCs were able to deliver more power toward MEC. The initial Cr(VI) concentration increased power generation by both increasing the cathode potential and decreasing the resistance of MFC. A typical current density and power density at the maximum power point were 1.08 Am-2 and 863 mWm-2 respectively. The typical removal efficiency for chromium ion by reduction of Cr (VI) in the MFC was in the range of 96.9%~100% for 10 ppm after 8 hours. That of Cu (II) in MFC was only in the range of 29.0%~29.7% for 10 ppm. On the other hand, the removal efficiencies of Ni (II) and Zn (II) in the MEC were in the range of 55.0%~59.9% and 76.2%~77.6% for 10 ppm, respectively. The removal efficiencies of Zn (II) and Ni (II) in the MEC were slowly increased with the initial concentration of Cr (VI) in the MFC increased. In the continuous mode, effects of the hydraulic retention time (HRT from 2h to 12h) on the removal efficiency of 10 ppm solution have been studied. HRT had a little impact on removal efficiency of each ion. The removal efficiencies were 55.0%~78.5% for Cr (VI), 30.6%~32.4% for Cu (II), 55.0%~59.0 for Ni (II), and 75.3%~75.8% for Zn (II), respectively. Even if the initial concentration of Cr (VI) significantly changed, the other three ions showed only a little change as HRT increased because (1) the concentrations of Ni (II) and Zn (II) in MEC were as low as ppm range, and (2) remaining un-reacted Cr (VI) and Cu (II) flew into MEC, interrupting the Ni (II) and Zn (II) reduction in MEC. With one train the remaining concentrations of Ni (II) and Zn (II) were 4.5 ppm and 2.5 ppm, respectively for HRT of 2h.

Speaker Biography

Chansoo Choi has his expertise and passion in development of microbial fuel cells. He approaches this method for removal and/or recovery of heavy metals from wastewaters, simultaneously generating electrical energy. He also has been developing storage batteries for use to store alternative energy sources, such as solar cells. He developed gold, copper, and silver recovery models, and mercury, cadmium and lead removal models after years of experience in research and teaching in universities.

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