Abstract

Microbial fuel cell (MFC) is an emerging technology, which holds promise towards sustainable wastewater treatment along with direct electricity generation. Performance of dual chambered MFCs (dMFCs) was evaluated using Ralex^{TM} anion exchange membrane (AEM) under batch mode with *Shewanella putrefaciens*. A three parameter optimization was performed and the results suggested that surface area of cathode had significant effect on the current generation. Performance of single chambered MFCs (sMFC) was compared with dMFC. The maximum volumetric power density obtained for dMFC was 1.9 W/m^3 whereas that of sMFC was 2.74 W/m^3. Conductive carbon ink coated membrane cathode assembly (MCA) along with current collector was found promising for long term application in sMFC. Manganese cobaltite nanorods were found suitable as cathode catalyst to replace platinum. Higher volumetric power density was achieved with inexpensive polyvinyl alcohol/ Polydiallyldimethylammonium chloride (PVA-PDDA) composite AEM as compared to PVA based cation exchange membrane and Ralex AEM mainly due to low internal resistance and less biofouling. An optimized quantity of PVA solution was found to be effective for cathode binder. Anode half cell performance was found to improve in *Shewanella* mediated MFC by supplementing optimized amount of $CaCl_2$ and riboflavin to anolyte; the anode surface modified with nano-hematite increases the capacitance of the bioanode. Further, the sMFC was used for VFA rich wastewater treatment using anaerobic mixed consortia. Inoculum pretreatment with mild sulphuric acid procedure enabled maximum power generation. Microbial community of acid pretreated inoculum showed the dominance of sulphate reducing bacteria at anode. Multi parameter optimization was performed considering three parameters; substrate concentration, anode surface area and anolyte pH on power generation. The initial anolyte pH was found most significant on current output. The spent media after dark fermentation was then used as a substrate in a litre scale MFC. Maximum power output of 3.02 W/m^3 was obtained with an anolyte pH of 7.5 using alkali pre-treated spent media. *Pseudomonas aeruginosa* IIT BT SS1 was isolated and used for 'bioaugmentation' technique to reduce start-up time. The augmented system produced slightly higher power output compared to both the mixed culture and the pure culture of *Pseudomonas*. Thus, efforts were made in this research to find suitable MFC configuration, suggest suitable membrane cathode assembly and strategy for start-up to maximize power production of MFC while treating wastewater.

Keywords: microbial fuel cell; power density; polyvinyl alcohol; spinel; oxygen reduction; *Shewanella putrefaciens*; Sulphate reducing bacteria; multiparameter optimization; *Pseudomonas aeruginosa, ion exchange membrane*; biocapacitance