



Optimization of a microbial fuel cell for wastewater treatment using recycled scrap metals as a cost-effective cathode material

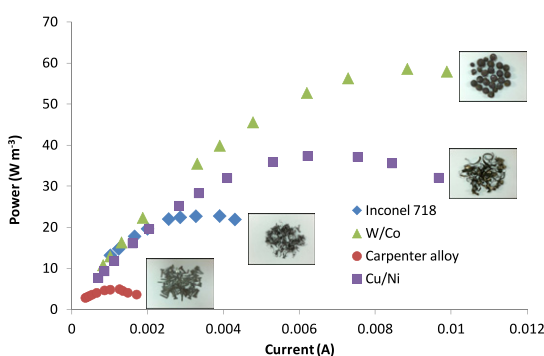
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HIGHLIGHTS

- ▶ Scrap metals can be used as the cathode of an MFC.
- ▶ W/Co > Cu/Ni > Inconel 718 > carpenter alloy.
- ▶ Inconel 718 was the most stable.
- ▶ Maximum acetate removal = 99.7% in full loop.
- ▶ Energy recovery = 0.1 kW h m⁻³.

GRAPHICAL ABSTRACT



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ABSTRACT

Microbial fuel cell (MFC) for wastewater treatment is still hindered by the prohibitive cost of cathode material, especially when platinum is used to catalyze oxygen reduction. In this study, recycled scrap metals could be used efficiently as cathode material in a specially-designed MFC. In terms of raw power, the scrap metals ranked as follows: W/Co > Cu/Ni > Inconel 718 > carpenter alloy; however, in terms of cost and long term stability, Inconel 718 was the preferred choice. Treatment performance – assessed on real and synthetic wastewater – was considerably improved either by filling the anode compartment with carbon granules or by operating the MFC in full-loop mode. The latter option allowed reaching 99.7% acetate removal while generating a maximum power of 36 W m⁻³ at an acetate concentration of 2535 mg L⁻¹. Under these conditions, the energy produced by the system averaged 0.1 kWh m⁻³ of wastewater treated.

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1. Introduction

Water and energy are intricately linked as water is needed to produce energy, while energy is required to extract, treat and

distribute water in what has been increasingly referred to as the water-energy nexus (Desai and Klanecky, 2011; Kenway et al., 2011; Novotny, 2011). Wastewater treatment requires enormous amounts of energy because of its reliance on the activated sludge process where the organic pollutants are converted into biomass (the sludge) and carbon dioxide by an energy intensive aerobic process. The energetic cost of conventional activated sludge (CAS) alone can be estimated between 0.3 and 0.6 kWh m⁻³ of wastewater treated (Tchobanoglous et al., 2004). In fact, wastewater is normally enriched with degradable organic constituents and, according to Heidrich et al. (2011), the average calorific heat value of domestic wastewater determined by freeze-drying of samples

Abbreviations: AD, anaerobic digestion; CAS, conventional activated sludge; CE, Coulombic efficiency; HRT, hydraulic retention time; ICP-OES, inductively coupled plasma-optical emission spectroscopy; MFC, microbial fuel cell; ORR, oxygen reduction reaction; PBS, phosphate buffer solution; PEM, proton exchange membrane; TSS, total suspended solids; VSS, volatile suspended solids.

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