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Lowering the applied potential during successive scratching/re-inoculation improves the performance of microbial anodes for microbial fuel cells

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HIGHLIGHTS

- ▶ Lowering imposed potential with re-inoculations allow efficient bioanodes.
- ▶ Alkaline pH up to 9.6 does not affect the efficiency of the anodes.
- ▶ *Desulfuromonas acetexigens* was detected as dominant species.

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ABSTRACT

Microbial anodes were formed under polarisation at −0.2 V/SCE on smooth graphite plate electrodes with paper mill effluents. Primary, secondary and tertiary biofilms were formed by a successive scratching and re-inoculation procedure. The secondary and tertiary biofilms formed while decreasing the polarisation potential allowed the anodes to provide current density of 6 A/m^2 at −0.4 V/SCE. In contrast, applying −0.4 V/SCE initially to form the primary biofilms did not lead to the production of current. Consequently, the scratching/re-inoculation procedure combined with progressive lowering of the applied potential revealed an efficient new procedure that gave efficient microbial anodes able to work at low potential. The observed progressive pH drift to alkaline values above 9 explained the open circuit potentials as low as −0.6 V/SCE. The remarkable performance of the electrode at alkaline pH was attributed to the presence of *Desulfuromonas acetexigens* as the single dominant species in the tertiary microbial anodes.

1. Introduction

Strengthened environmental requirements and regulations have forced the pulp and paper industries to reduce the consumption of fresh water in papermaking processes. This trend has led to process waters that are highly concentrated in organic matter, requiring stronger treatment before the effluents can be rejected or recycled (Mathuriya and Sharma, 2009). Paper industries have consequently been searching for new effluent treatment technologies and, in this framework, microbial fuel cells (MFCs) might be a promising technology (Huang and Logan, 2008a). MFCs produce electrical energy from the oxidation of the organic matter contained in wastes. They could thus reduce the amount of sludge produced by biological treatment (Kim et al., 2007) and help to supply some of the energy needed by the treatment plant. At laboratory scale, MFCs have been shown to be able to treat effluents from various origins (Pant et al., 2009).

The objective of the present work was to design an optimal protocol for forming microbial anodes using an effluent coming from the pulp and paper industry. It has been shown that inoculating a reactor with a scraped-off biofilm collected from a running MFC (Rabaey et al., 2004; Kim et al., 2005; Wang et al., 2010; Harnisch et al., 2011; Cheng et al., 2011) or with the effluent from a previous reactor (Huang and Logan, 2008b) improves the electrochemical performance of the new biofilms with respect to the biofilms that were used as inoculum. Similarly, clean electrodes inserted in a running MFC in the vicinity of an already active biofilm anode have been shown to benefit from the presence of the already formed microbial anode (Liu et al., 2008).

Our protocol consisted of forming a primary biofilm from an inoculum source and then scratching the biofilm from the anode

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