Performance prediction of microbial fuel cells for power generation and acid mine drainage treatment

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INTRODUCTION

One of the impacts of coal mining is the contamination by Acid Mine Drainage (AMD). This study proposes the development of Microbial Fuel Cells (MFCs) for energy generation and AMD treatment, as well as the application of a numerical model in order to predict the polarization curves of those systems in steady state.

EXPERIMENTAL/THEORETICAL STUDY

Experimental: Two MFCs operated in a fed batch mode. Anolyte: anaerobic sludge, coming from domestic effluent treatment plant and PBS medium. Membrane: Nafion 117. Catholyte: Real AMD and Postgate medium. Electrodes: Carbon felt. **Numerical:** Numerical adjustment of a model developed by Serra *et al.* 2020, experimentally validated against other studies, to predict Polarization Curves (PCs) in (MFCs) under steady-state conditions. Computer program written in the Python programming language.

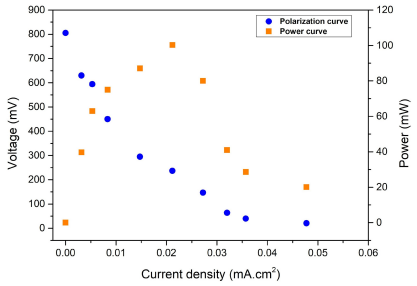
RESULTS AND DISCUSSION

Table 1. Experimental results of power generation and acid mine drainage treatment of two similar MFC.

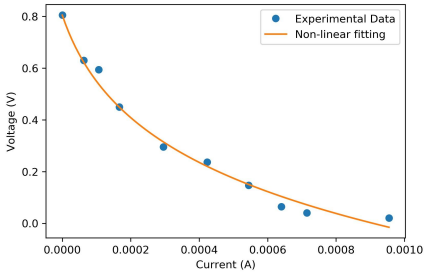
	Energy generation			AMD treatment	
	Max. Volatge (mV)	Max. Power Density (mW/m^2)	Coulumbic Efficiency	Sulfate removal (%)*	ΔCOD
MFC 1	418.7	87.65	32.6	63.0	40.69
MFC 2	390.4	76.21	17.7	41.0%	47.20

Figure 1 Polarization curves of MFC1. (a) Experimental results on day 57 of operation. (b) Comparison between the experimental polarization data of MFC 1 obtained at CP on day 57 and those obtained by non-linear fittings

a)



b)



CONCLUSION

The treatment of real AMD using MFCs yielded significant results in terms of energy generation, sulfate removal, and COD reduction, outperforming other studies. Additionally, the developed method for numerical prediction of the polarization curve proved effective (residuals 3.86×10^{-3}), enabling the identification of overpotential losses in MFC systems, which can be minimised, thus optimising their performance.

REFERENCES

Serra, P.M.D.; Espírito-Santo, A.; Magrinho, M. A Steady-State Electrical Model of a Microbial Fuel Cell through Multiple-Cycle Polarization Curves. Renew. Sustain. Energy Rev. 2020, 117, doi:10.1016/j.rser.2019.109439.

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