

Microbially charged redox flow battery: coupling a bioelectrochemical cell with a redox flow battery

M. S. S. Santos^{1,2,3}, L. Peixoto², C. Dias-Ferreira³, A. Mendes¹, M. M. Alves²

¹LEPABE, Chemical Engineering Dpt., Faculty of Engineering University of Porto, Porto, Portugal;

²Centre of Biological Engineering, University of Minho, Braga, Portugal

³Research Centre for Natural Resources, Environment and Society (CERNAS) / College of Agriculture, Polytechnic Institute of Coimbra, Bencanta 3045-601 Coimbra, Portugal

Email: marciasofiasantos@hotmail.com

Redox flow batteries (RFB) are electrochemical systems applied in the conversion and storage of chemical energy in electricity. Redox chemical species (in soluble form) are the main responsible for the energy storage. Quinones are electroactive molecules applied in RFB because of their chemical and physical properties.

The aim of this work is to develop an innovative technology to generate and storage the energy resultant from Bioelectrochemical system (BES). The strategy outlined was coupling a BES with a RFB that present potential to combine bioenergy production and storage in a microbially charged redox flow battery.

Firstly, a BES system was studied with *Geobacter sulfurreducens* as biocatalyst to convert a quinone (2,6-anthraquinone) in its respective reduced form, acetate being the carbon source used. The BES presented current intensities around 500 mA.m⁻² and power densities around 2 Wm⁻². The reduction was assessed visually by a typical colour change (from yellow to dark red) and by cyclic voltammetry. Simultaneously, as a control, the 2,6-anthraquinone was electrochemically reduced applying and controlling the cathode potential where the reduction was also observed by colour change and by cyclic voltammetry.

In an RFB, the quinone bio-reduced in the BES and electrochemically reduced in the electrochemical cell were studied using potassium hexacyanoferrate as the second redox chemical species for discharging/charging cycles in the RFB as the proof of concept of the microbially charged redox flow battery. The study was performed in a 25 cm² single redox flow cell (RF) with a constant current density of 0.2 mA.cm⁻² where coulombic efficiency, voltage efficiency and energy efficiency were observed for 10 cycles.