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ELECTRICITY PRODUCTION AND NITROGEN REMOVAL FROM DIGESTATE BY MICROBIAL FUEL CELLS

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Abstract

The final product (digestate) from biogas power plant is a nutrient-rich sludge produced by anaerobic digestion and commonly used as a fertiliser. According to the EU Directive 91/676/CE, treatment of digestate may be mandatory prior its sparging over soil in order to reduce the impact that nitrogen has on the natural environment. Biological nitrogen removal can be achieved in two steps: nitrification (aerobic oxidation of ammonia to nitrite and nitrate) and denitrification (reduction of nitrate to nitrogen gas). More recently, the concept of nitrogen removal has been changed since the confirmation of the anaerobic ammonium oxidation (anammox), where autotrophic oxidation process converts ammonia to N_2 using nitrite as the electron acceptor. It has been shown that nitrification and denitrification can occur into the microbial fuel cell (MFC) cathodic compartment leading to simultaneous nitrogen and organic carbon removal.
The goal of our study was the simultaneous removal of carbon and nitrogen in MFC reactors fed with digestate produced in the anaerobic codigestion of an undefined mixture of agricultural wastes and cow manure (Azienda Agrozootecnica Bruni Sutri - VT). We assembled two-chamber reactors separated by cation exchange membrane; the anodic chamber was fed with the liquid phase of the digestate whereas catholite was inoculated in the cathodic compartment. Two reactors have been assembled: I) pre-conditioned MFC, containing a *Geobacter sulfurreducens* bioanode; II) un-conditioned MFC, containing a sterile anode. The anodic and cathodic electrodes were connected through an external resistor. The reactors have been operated under batch feeding for two months during which they were monitored daily. Following feeding of the anodic chamber of the pre-conditioned reactor, there was a rapid increase of electricity production (up to a maximum power transfer of 0.6 mW–240.2 mW/m^2-at 346.8 mV). At the same time, the unconditioned reactor did not show appreciable electrical activity. Nonetheless, following a 28 days lag phase (most probably the time required for electrode colonization by anode-respiring bacteria) the un-conditioned reactor showed electricity generation as well (the maximum power transfer reached 0.4 mW–172.2 mW/m^2-at 359.4 mV).
The electrochemical activity of the anodic biofilms and the redox potentials were established by cyclic voltammetry. Additionally, chemical oxygen demand and nitrogen removal efficiencies in both reactors were also determined.