Nitrogen recovery using Microbial Electrolysis Cell

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Bioelectrochemical systems (BES), are an emerging technology with a wide range of potential applications that can generate different products as electricity or hydrogen. Moreover, BES can be used to recovery ammonium when ammonia from the anolyte cross to the catholyte through the membrane by two process: diffusion and migration. If nitrogen content in manure could be feasibly and efficiently recovered in BES, it would become an additional source of revenue that would help to palliate its managing costs. Therefore, it would also reduce environmental impact of fertilizers manufacturing process, which are energy intensive

In this research, laboratory scale MECs (~60 mL) were used with the objective of studying the nitrogen diffusion through a cation exchange membrane firstly in abiotic conditions, and then using microorganisms in the anode compartment. Furthermore, the effect of different catholytes (phosphate buffer and sodium chloride) and different applied potentials were studied. Afterwards, the results obtained at laboratory scale were validated in two bigger reactors of 250 and 500 mL and nitrogen recovery efficiency was calculated.

In lab scale MECs, the maximum recovery efficiency obtained was 61%, with synthetic medium as anolythe, PBS as catholyte and a applied voltage of 1.4 V, which corresponds to a concentration of 540 mg $N\text{-}NH_4^+$/L in the cathode (Fig. 1). However, the maximum concentrations of nitrogen in the cathode (~1000 mg $N\text{-}NH_4^+$/L) occur when the real medium was used due to a higher initial concentration in the anode.

In semi-pilot MEC, the amount of ammonium remaining in the anode was between 1040 and 1610 mg NT/L, which means that ~35 % of ammonia has passed from the anode to the cathode and can be recovered. Current density reaches values of about ~0.4 A/m^2 for both cells, which is similar to that usually found in lab scale studies with MEC fed with pig slurry. The concentration of TOC has an average value of 2.8 g/L, with low amount of biodegradable organic matter.

To conclude pig slurry was considered as a proper substrate due to its high nitrogen concentration, however for future works, the possibility of using other substrates with higher biodegradable organic matter or use it in codigestion should be studied.

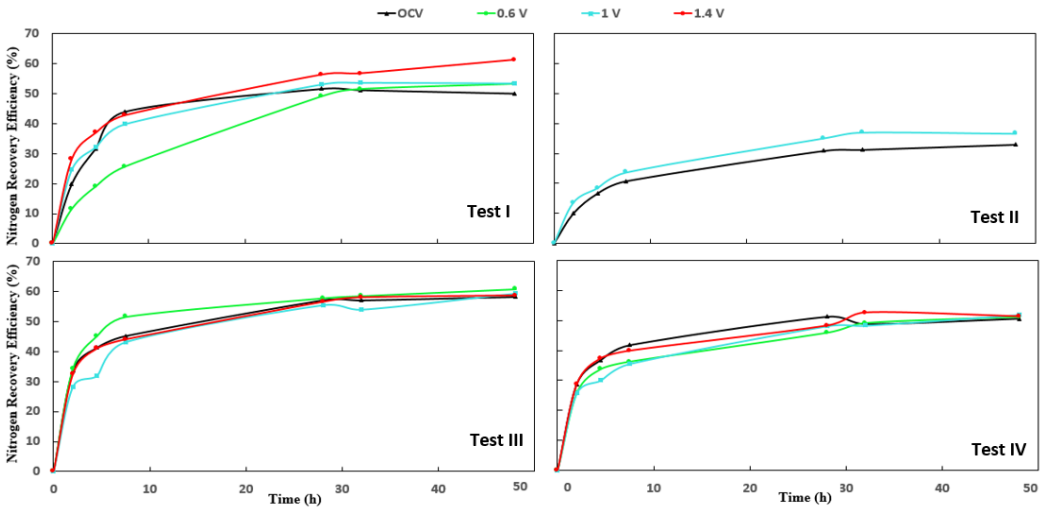

Figure 1. Nitrogen Removal efficiency at different voltage applied in four different situations: a) synthetic medium as anolyte and PBS as catholyte (Test I), b) synthetic medium as anolyte and NaCl as catholyte (Test II), c) pig slurry as anolyte and PBS as catholyte (Test III), d) pig slurry as anolyte and NaCl as catholyte (Test IV).