Recovery of ammonia and sulfate from waste streams and bioenergy production via bipolar bioelectrodialysis

Ammonia and sulfate, which are prevalent pollutants in agricultural and industrial wastewaters, can cause serious inhibition in several biological treatment processes, such as anaerobic digestion. In this study, a novel bioelectrochemical approach termed bipolar bioelectrodialysis was developed to recover ammonia and sulfate from waste streams and thereby counteracting their toxicity during anaerobic digestion. Furthermore, hydrogen production and wastewater treatment were also accomplished. At an applied voltage of 1.2 V, nitrogen and sulfate fluxes of 5.1 g NH4+-N/m2/d and 18.9 g SO42-/m2/d were obtained, resulting in a Coulombic and current efficiencies of 23.6% and 77.4%, respectively. Meanwhile, H2 production of 0.29 L/L/d was achieved. Gas recirculation at the cathode increased the nitrogen and sulfate fluxes by 2.3 times. The applied voltage, initial (NH4)2SO4 concentrations and coexistence of other ions were affecting the system performance. The energy balance revealed that net energy (≥16.8 kWh/kg-N recovered or ≥4.8 kWh/kg-H2SO4 recovered) was produced at all the applied voltages (0.8-1.4 V). Furthermore, the applicability of bipolar bioelectrodialysis was successfully demonstrated with cattle manure. The results provide new possibilities for development of cost-effective technologies, capable of waste resources recovery and renewable energy production.