Theory of ion transport with fast acid-base equilibrations in bioelectrochemical systems

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Bio-electrochemical systems recover valuable components and energy in the form of hydrogen or electricity from aqueous organic streams. For a fundamental study of the performance of these bioelectrochemical systems, a detailed understanding of ion transport is of great interest. Therefore, we derive a one-dimensional steady-state model, which includes the transport of ionic species subject to diffusional and electrical forces in an aqueous environment. Since most of the ionic species included in our model can react as an acid as well as a base, ion transport is combined with infinitely fast ion acid-base equilibrations. The model is applied to describe the current-induced ammonia evaporation and recovery at the cathode of a bio-electrochemical system running on an organic stream containing ammonium. We identify that the capacity of the inert gas flow along the cathode is limiting the ammonia evaporation. Consequently, dissolved ammonia is transported from the cathode back into the anodic chamber through the ion exchange membrane, placed in between, and is therefore not recovered. Furthermore, we investigate the influence of the charge density of the ion-exchange membrane on the performance of the system.

Fig. 1. Schematic view of a bio-electrochemical system which recovers both energy (as H2) and ammonia from urine.

Reference
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