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Electrochemical ammonia accumulation and recovery from ammonia-rich livestock wastewater

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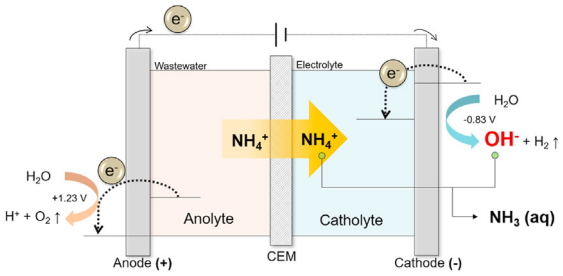
HIGHLIGHTS

- High nitrogen flux was obtained during the operation under intensive electric filed.
- High voltage operation suppressed back diffusion of NH_3, and minimized energy loss.
- NH_4^+ in real LW could be a primary charge carrier of total charge migration.
- Buffering capacity of LW prevented H^+ from dominating total charge migration.
- The rapid accumulation of NH_3 offered practicality of its continuous operation.

GRAPHICAL ABSTRACT



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ABSTRACT

High levels of ammonia inhibit microbial activities and lead to process instability of traditional wastewater treatment. Nitrogen recovery via ammonia stripping is the best developed method, but this approach requires large amounts of alkaline chemicals and substantial energy for stripping. In this study, we designed a simple electrochemical system that allows the facile accumulation of a neutral species of ammonia (NH_3), resulting in much lower overall stripping costs. In batch operation treatment of synthetic livestock wastewater (LW), the energy efficiency for total ammonia nitrogen (TAN) migration was found to be the best at a current density of 93.8 mA cm^{-2}. Fed-batch operation, using synthetic or real LW, resulted in very high degrees of TAN accumulation (10,158 mg-N L^{-1} for synthetic and 17,704 mg-N L^{-1} for real LW) in catholyte after 400 min. It was found that TAN migration was responsible for 0.221 and 0.492 of total charge migration for synthetic and real LW, respectively. The nitrogen flux across a cation exchange membrane was 5975 g-N m^{-2} d^{-1} with an energy input of 28.2 kWh (kg-N)$^{-1}$ when using real LW. All this supported the conclusion that an electrochemical approach such as this makes it possible to achieve highly desirable ammonia recovery from wastewater in a sustainable manner.

1. Introduction

Anaerobic digestion (AD) is a key biological process for stabilizing organic wastes with the distinctive advantages of good biogas

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