



Electrochemical ammonia accumulation and recovery from ammonia-rich livestock wastewater

Gwangtaek Lee ^a, Kwiyoung Kim ^b, Jane Chung ^a, Jong-In Han ^{a,*}

^a Department of Civil and Environmental Engineering, Korea Advanced Institute of Science and Technology (KAIST), 291 Daehak-ro, Yuseong-gu, Daejeon, 305-338, Republic of Korea

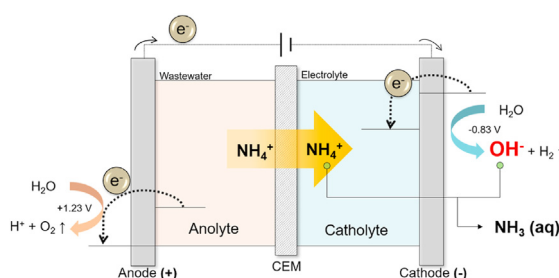
^b Department of Chemical & Biomolecular Engineering, University of Illinois at Urbana-Champaign, 600 South Mathews Avenue, Urbana, IL, 61801, USA



HIGHLIGHTS

- High nitrogen flux was obtained during the operation under intensive electric field.
- 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



ARTICLE INFO

Article history:

Received 26 June 2020

Received in revised form

25 September 2020

Accepted 12 October 2020

Available online 23 October 2020

Handling Editor: Dr. E. Brillas

Keywords:

Electrochemical system

Livestock wastewater

Nitrogen recovery

TAN accumulation

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 ($10,158 \text{ mg-N L}^{-1}$ for synthetic and $17,704 \text{ mg-N L}^{-1}$ 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 $5975 \text{ g-N m}^{-2} \text{ d}^{-1}$ with an energy input of $28.2 \text{ kWh (kg-N)}^{-1}$ 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.

© 2020 Elsevier Ltd. All rights reserved.

1. Introduction

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

* Corresponding author.
E-mail address: jihan@kaist.ac.kr (J.-I. Han).