Speaker: Priyasha Fernando.

Advisor: Dr. Prathap Parameswaran.

SUSTAINABLE RECOVERY OF VOLATILE FATTY ACIDS FROM SWINE WASTEWATER

Abstract

Volatile fatty acids (VFAs) are short-chain organic acids naturally generated from complex organic compounds through intermediate fermentation reactions during anaerobic digestion. These organic acids are produced as byproducts of petrochemical reactions. VFAs serve as building blocks of many valuable chemical products. This study aims to develop a modified fermentation biotechnology platform from swine wastewater coupled with membrane filtration aided by microbial electrochemistry. Controlled swine wastewater fermentation experiments were conducted with two different inocula (wastewater sludge and cattle rumen fluid) with or without a microbial bioanode. The key variables were temperature, pH, Solid Retention Time (SRT)/Hydraulic Retention Time (HRT), and the anode potential. A series of experiments were performed at different SRT conditions. Performance was characterized by electric current production, VFA quantification through High-Performance Liquid Chromatography (HPLC), and gas composition through Gas Chromatography (GC).

At the 20-day SRT operation, sludge and rumen inocula showed distinctly different organic acid profiles predominated by propionate/acetate and butyrate/propionate, respectively. However, acetate was the primary organic acid at 15-day SRT operation, with washout occurring at 10-day SRT for swine wastewater fermentation with sludge inoculum. The rumen inoculum suffered a faster washout of the fermentative microbial communities starting at 15-day SRT due to either lower active biomass concentration or the sensitivity of fermentative rumen microbial communities to swine wastewater. The microbial biofilm anode with wastewater sludge enriched inoculum displayed a different fermentation product profile than either non-electrode fermenters, with caproic acid predominance at 20-d SRT. The anode area was observed as a rate-limiting step for kinetics and extent of swine wastewater fermentation. The recovery of VFAs from wastewater based on microbial reactions is becoming a promising research and development portfolio in the future due to its likely favorable life cycle and techno-economic footprint.

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