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Study on the Feasibility of a Hybrid Wastewater Treatment Design for Achieving Carbon and Energy Neutrality

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Abstract

Aerobic digestion has been commonly applied in wastewater treatment; however, it consumes much electricity due to its aeration process. In this study, anaerobic digestion (AD) is used as an alternative to treat wastewater using non-aerated condition and also methane generated during the AD can be used as potential energy source, thus the overall energy requirement and carbon dioxide emission can be significantly reduced. Prior to AD, pre-concentration of organic content of wastewater like chemical oxygen demand (COD) using forward osmosis (FO) was attempted to improve the treatment efficiency of the AD process. Seawater is used for toilet flushing in coastal areas, e.g. Hong Kong, resulting in high salinity would be found in sewage, therefore, 28‰ sodium chloride (NaCl) solution was selected as draw solution to effectively extract water from sewage during the FO process. Synthetic domestic wastewater (SDW) containing 4‰ NaCl was tested by a small-scale FO chamber (3 cm x 7 cm membrane) with 250 mL/min flowrate using peristaltic pumps. Results showed that high water flux (>5 litres per m2 hour, LMH) and high-volume reduction of SDW (5X) can be achieved after 96 hours of FO operation. Besides, in the presence of salinity (~2.25‰), >80% COD removal was observed after 21 days of anaerobic digestion of SDW, using AD inoculum isolated from mangrove sediment. Further optimization study on methane generation and COD removal during the AD process would be conducted. This study demonstrates a promising direction to reduce energy consumption in wastewater treatment by using innovative hybrid system.

Keywords: Sewage treatment, Carbon dioxide, Methane generation, Anaerobic digestion, Forward osmosis