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Application of a Submerged Anaerobic Osmotic Membrane Bioreactor Hybrid System for High-Strength Wastewater Treatment and Phosphorus Recovery

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Abstract : Recently, anaerobic membrane bioreactors (AnMBRs) has been widely utilized, which combines anaerobic biological treatment process and membrane filtration, that can be present an attractive option for wastewater treatment and water reuse. Conventional AnMBR is having several advantages, such as improving effluent quality, compact space usage, lower sludge yield, without aeration and production of energy. However, the removal of nitrogen and phosphorus in the AnMBR permeate was negligible which become the biggest disadvantage. In recent years, forward osmosis (FO) is an emerging technology that utilizes osmotic pressure as driving force to extract clean water without additional external pressure. The pore size of FO membrane is kindly mentioned the pore size, so nitrogen or phosphorus could effectively improve removal of nitrogen or phosphorus. Anaerobic bioreactor with FO membrane (AnOMBR) can retain the concentrate organic matters and nutrients. However, phosphorus is a non-renewable resource. Due to the high rejection property of FO membrane, the high amount of phosphorus could be recovered from the combination of AnMBR and FO. In this study, development of novel submerged anaerobic osmotic membrane bioreactor integrated with periodic microfiltration (MF) extraction for simultaneous phosphorus and clean water recovery from wastewater was evaluated. A laboratory-scale AnOMBR utilizes cellulose triacetate (CTA) membranes with effective membrane area of 130 cm^2 was fully submerged into a 5.5 L bioreactor at 30-35℃. Active layer-facing feed stream orientation was utilized, for minimizing fouling and scaling. Additionally, a peristaltic pump was used to circulate draw solution (DS) at a cross flow velocity of 0.7 cm/s. Magnesium sulphate ($MgSO_4$) solution was used as DS. Microfiltration membrane periodically extracted about 1 L solution when the TDS reaches to 5 g/L to recover phosphorus and simultaneous control the salt accumulation in the bioreactor. During experiment progressed, the average water flux was achieved around 1.6 LMH. The AnOMBR process show greater than 95% removal of soluble chemical oxygen demand (sCOD), nearly 100% of total phosphorous whereas only partial removal of ammonia, and finally average methane production of 0.22 L/g sCOD was obtained. Therefore, AnOMBR system periodically utilizes MF membrane extracted for phosphorus recovery with simultaneous pH adjustment. The overall performance demonstrates that a novel submerged AnOMBR system is having potential for simultaneous wastewater treatment and resource recovery from wastewater, and hence, the new concept of this system can be used to replace for conventional AnMBR in the future.

Keywords : anaerobic treatment, forward osmosis, phosphorus recovery, membrane bioreactor
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