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Monosodium glutamate as a draw solute for sewage thickening by forward osmosis–nanofiltration

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Abstract. Monosodium glutamate (MSG) was evaluated as a draw solute (DS) of forward osmosis–nanofiltration (FO-NF) process for sewage thickening. Water flux (J_w) and reverse draw solute flux (J_s) through FO membrane with MSG were compared to those with NaCl as the reference DS. In addition, the influence of MSG to anaerobic digestion of concentrated sewage for methane gas production was investigated. The J_s/J_w for MSG was 0.0015mol/L at 1M of initial concentration with a CTA(HTI) membrane, which was 6 % of that for NaCl, while the water flux (J_w) for MSG (ca. 10 L/m^{2}h) was comparable to that for NaCl in FO processes. MSG recovered up to 98% by NF process, which changed with applied membrane and MSG concentration. The collected primary effluent from the full-scale wastewater treatment plant was thickened up to nine times in terms of volumetric concentration factor. The physical membrane flushing by a water could effectively recover the flux. The inhibitory effects of MSG on anaerobic methane production could be negligible and the gas production potential increased.

Keywords: anaerobic toxicity assay; forward osmosis; monosodium glutamate; nanofiltration; reverse solute flux; sewage thickening

1. Introduction

The severe worldwide water shortage has been raised a critical issue owing to climate changes, population growth, industrialization, and urbanization. In order to overcome the water shortage in urbanized areas, the water reuse technology has been suggested (Batstone *et al*. 2015, Jiang *et al*. 2018). However, the energy requirement for the additional treatment for water reuse in the conventional wastewater treatment plant is high. In order to overcome these problems, several recent studies have proposed the use of alternative wastewater treatment plant (AWWTP) systems, which can simultaneously produce high quality reusable water and energy (Holloway *et al*. 2007, Cath *et al*. 2006). The typical AWWTP systems use membrane separation and anaerobic digestion (AD). The membrane separation in the AWWTP system thickens feed wastewater, which can facilitate the AD operation. A highly thickened wastewater allows the use of smaller anaerobic digesters, increases the volumetric biogas (methane) production, and decreases the heating energy (Liu *et al*. 2016).

Conventional membrane processes such as nanofiltration (NF) and reverse osmosis (RO) have been applied in the AWWTP. However, these membrane processes are faced to severe membrane fouling and required frequent membrane cleaning. In order to overcome these disadvantages, forward osmosis (FO) membrane processes have recently been suggested for thickening of wastewaters (Chen *et al*. 2014, Xue *et al*. 2015). FO uses the osmotic pressure of a highly concentrated solution with a chemical potential to draw water across a semipermeable membrane from a low-concentration solution with a low water chemical potential (Ghadiri *et al*. 2019). The FO process has several advantages including a 1) smaller fouling owing to the absence of hydraulic pressure across the membrane, 2) low energy requirement, and 3) high removal for ions.

The FO process has been applied to wastewater treatment. Chen *et al*. (2014) studied the performance of a submerged membrane bioreactor with FO separation over 22 days; the removal rates of organic carbon, NH_4^+-N, and total phosphate (TP) reached 96, 60, and 100%, respectively. Xue *et al*. (2015) reported an FO process for a municipal wastewater treatment using seawater as the draw solute and achieved a 2.3-times-thickened wastewater.

Several previous studies have been carried out for regeneration of draw solution and water production in the FO process and hybrid processes linking the FO process. The draw solutes were classified into five types (Ge *et al*. 2013), 1) volatile compounds such as ammonium bicarbonate (McCutcheon *et al*. 2006), 2) nutrient compounds such as glucose and fructose (Kravath *et al*. 1975, Yong *et al*. 2012, Lutchmiah *et al*. 2014), 3) inorganic salts such as sodium chloride (Achilli *et al*. 2010), 4) organic salts such as sodium formate, sodium acetate, sodium propionate, and magnesium acetate (Bowden *et al*.

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