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Performance of submerged membrane – Ion exchange hybrid system with Purolite A502PS in treating reverse osmosis feed

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ABSTRACT

The performance of ion exchanger Purolite A502PS in treating biologically treated sewage effluent (Reverse Osmosis feed) was evaluated in a submerged membrane ion exchange hybrid system (SMIHS). The experimental results showed that adding a small amount of Purolite A502PS of 0.5 g/L increased the organic removal of the submerged membrane reactor from less than 10% to above 40%. The homogeneous surface diffusion model (HSDM) could predict the adsorption kinetics of Purolite A502PS. A higher dose of Purolite A502PS in SMIHS led to better organic removal as well as reduced membrane resistance. After one hour of operation at a flux of 36 LMH, the amount of organic matter retained on the membrane surface decreased from 2.11E−9 kg/m^2 s to 8.25E−10 kg/m^2 s when 1 g/L of Purolite A502PS was added into the submerged membrane reactor. Although the increase of membrane flux from 36 L/m^2 h (LMH) to 60 LMH did not have much effect on organic removal, more organics were adsorbed onto the membrane surface. This led to a higher transmembrane pressure (TMP) of 12 kPa in the SMIHS after eight hours operation at a flux 60 LMH. The increase in TMP was approximately four times higher than that at a flux of 36 LMH.

1. Introduction

Having water of high quality in adequate quantities is an increasingly crucial issue for domestic supply and the manufacturing and agricultural industries. Although membrane filtration treatment for water reclamation is becoming more widespread, numerous challenges still prevail including the issue of membrane fouling. Membrane fouling including organic fouling is a significant problem in membrane application as it requires frequent chemical cleaning of membranes and thus more energy and a shorter membrane life.

Effluent organic matter (EfOM) which characteristically has a low DOC concentration, plays a major role in organic fouling of membranes [1–3]. Even a low concentration of organic compounds can lead to biofouling of RO as they gradually deposit on the membrane surface and form a conditioning film that not only assists microbial adhesion to the membrane but also provide the food for microorganism development [4]. Pre-treatment of feed water is considered to be the most promising solution to control the fouling due to its simple and easy implementation. Using porous membranes like microfiltration (MF) or ultrafiltration (UF) as a pre-treatment to dense membrane filtration is widespread. In recent years, many researchers have tried to incorporate supporting media into MF or UF in order to improve the treatment efficiency through scouring some of the foulant off the membrane surface and capturing some of the fouling-causing substances prior to their contact with the membrane surface.

Guo et al. [5] found that the addition of 5 g/L of powder activated carbon (PAC) in a hybrid membrane system operated at 24 L/m^2 h (LMH) could remove 89.8% of dissolved organic carbon (DOC). The DOC concentration of the wastewater in their study was 3.6–4.0 mg/L. A long-term study conducted by Vigneswaran et al. [6] indicated 84% DOC removal after 15 days operation. In their study, the initial PAC concentration was 5 g/L and the filtration flux was maintained at 12 LMH. It should be noted that PAC was added only at the beginning of the experiment. A few recent studies have shown the membrane adsorption hybrid system with a low dose of granular activated carbon (GAC) also led to high organic removal and reduced fouling [7,8]. Our recent study with seawater [9,10] shows that the submerged membrane coagulation–adsorption hybrid system (SMCAHS) can be used as pre-treatment for seawater reverse osmosis (the DOC of seawater was only 2.4 mg/L, less than DOC in the RO feed used in this study). Although this pre-treatment removed 48% of DOC from seawater, it

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