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ORIGINAL PAPER

Preparation, morphology and performance evaluation of polyvinylalcohol (PVA)/polyethersulfone (PES) composite nanofiltration membranes for pulp and paper wastewater treatment

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Abstract In this study, thin film composite PVA/PES nanofiltration membranes were fabricated for the treatment of pulp and paper industrial wastewater. Phase separation induced by immersion precipitation was used to prepare the PES support membrane. PVA/PES composite nanofiltration membranes were prepared by dipping the support PES membrane in the PVA and cross-linking solutions at different conditions. Maleic acid (MA) was used as cross-linking agent. PVA and MA have concentrations of 0.5–2 and 0.05–1 wt%, respectively. Morphological studies were carried out by means of scanning electron microscopy (SEM) as well as atomic force microscopy (AFM) techniques. In addition, the hydrophilicity of membranes was examined by contact angle measurements. Permeability and ability of PVA/PES composite nanofiltration membranes to reduce COD of the wastewater were evaluated by a cross flow filtration system. SEM images indicated that the PVA layer was uniformly formed on the PES support membrane. AFM images showed that the surface roughness, porosity and pore sizes of PES support membrane were reduced after formation of PVA layer on the support surface. Moreover, the hydrophilicity of the membranes was significantly increased. Experimental results demonstrated that the PVA/PES composite nanofiltration membranes were able to reduce the COD of wastewater. Optimum conditions for preparation of PVA/PES composite membrane are consisted of PVA concentration: 1 wt%, MA concentration: 0.5 wt%, cross-linking time: 3 min and curing time: 3 min.

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Introduction

Industrial wastewaters, especially those from pulp and paper units, are often rich in color, containing residual of reactive compounds and dissolved organic materials, which need proper treatment before releasing to the environment. Organic content of wastewater is commonly measured using lumped parameters such as biological oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), etc. COD is the measure of oxygen demand during the oxidation of oxidizable organic matters by a strong oxidizing agent.

Since there is an urgent need to find a compromising way to solve the environmental problems, membrane technology can play a major role in wastewater treatment to produce water from contaminated sources, nowadays [1–4]. Membrane processes are simple and easy to operate and need compact equipment. They also offer advantages in terms of less energy requirements. Hence, they have used in a wide range of application and have demonstrated a significant industrial role in terms of economical consideration [5, 6].

Nanofiltration (NF) process has been used in many applications such as wastewater reclamation industrial, water production, water softening, and separation of compounds having different molecular weights [7–12]. NF membrane is a pressure-driven membrane with properties between reverse osmosis (RO) and ultrafiltration (UF) membrane. Nanofiltration membranes usually include an ultra-thin separating barrier layer on the top of a reinforced porous ultrafiltration membrane.