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ORIGINAL PAPER

Clay-hyperbranched epoxy/polyphenylsulfone nanocomposite membranes

Mehdi Mahmoudian[1] · Peyman Gozali Balkanloo[1]

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Abstract Nanocomposite membranes containing polyphenylsulfone (PPSU) and a clay modified with a hyperbranched epoxy (HBE) were prepared by blending of modified montmorillonite (m-MMT) with a polymer solution using phase inversion method. The hyperbranched epoxy synthesized by polycondensation reaction of bisphenol A and triethanolamine with epichlorohydrin was grafted to amine-functionalized MMT by reaction between the epoxy groups of hyperbranched epoxy and the amine groups on the MMT surface. In this way, the m-MMT was exfoliated into single layers of nanoparticles in a solvent medium and the polymer chains were intercalated into m-MMT layers. The aim was to study the effect of this additive on the membrane separation efficiency. For this purpose, pure water flux, fouling, and pigment and heavy metal rejection were measured by a home-made dead end filtration cell and the performance of the prepared membranes was investigated. Hydrophilicity of the nanocomposite membranes was specified by water contact angle measurements. Degree of dispersion of additive into the polymer matrix and membrane morphology were studied by FESEM. Membrane surface area, pore size, and volume were evaluated by BET. The results indicated that the surface hydrophilicity increased after incorporation of m-MMT. Furthermore, the water permeability, salt rejection, and antifouling resistance of PPSU membranes were improved significantly. Membrane with 3 wt% m-MMT showed the best performance compared to other membranes.

✉ Mehdi Mahmoudian
m.mahmoudian@urmia.ac.ir

[1] Nanotechnology Research Institute, Urmia University, P.O. Box: 57159-404931 Urmia, Iran

Keyword Montmorillonite · Polyphenylsulfone · Nanocomposite membranes · Hyperbranched epoxy

Introduction

In recent years, due to the release of a variety of contaminants into the environment, great efforts have been made in removing them. Pollution of water resources by man has caused great concern over various toxic compounds such as organic compounds, dyes, heavy metals, and pesticides released in water. These compounds usually are water soluble and the separation processes associated with them have always been faced with complexity [1]. One of the common ways to assist environmental protection, improve human health and medical concerns, especially in water purification, is based on membrane technology which is very effective and low cost [2–4].

Polysulfone (PSf)-based membranes are used most extensively in membrane processes because of their high heat resistance, chemical, and mechanical strength and stability over a wide range of pH [5]. Generally, the membranes with antifouling performance have short service life. Low surface hydrophilicity and adsorption of soluble hydrophobic materials create fouling phenomenon and lower the permeability in membranes. The major drawback of polysulfone-based membranes is that they are hydrophobic in nature as well, which makes them susceptible to fouling [6, 7].

In the last few decades, nanocomposite membranes based on fillers such as carbon nanomaterials and inorganic clays have been highly regarded due to their unique characteristics. Compared to neat membranes, these novel nanomaterials, applied in the field of membranes, can largely improve properties such as the operating temperature and pressure, chemical stability, selectivity, permeability, and also can