Preparation and characterization of polysulfone/organoclay adsorptive nanocomposite membrane for arsenic removal from contaminated water

E. Shokri [a,b], R. Yegani [a,b*], B. Pourabbas [b,c], N. Kazemian [d]

[a] Faculty of Chemical Engineering, Sahand University of Technology, Tabriz, Iran
[b] Membrane Technology Research Center, Sahand University of Technology, Tabriz, Iran
[c] Faculty of Polymer Engineering, Sahand University of Technology, Tabriz, Iran
[d] East Azarbaijan Water and Wastewater Company Laboratory, Tabriz, Iran

Abstract

Organoclay embedded polysulfone (PSf) nanocomposite membranes were prepared for arsenate removal from contaminated surface water. Prepared membranes consisted of different weight ratios of organoclay to polymer, ranging from 0 to 2.0 wt% and were characterized by FE-SEM, XRD, AFM, pure water flux, mechanical strength, contact angle measurement and adsorption experiments. Obtained results showed that pure water flux, surface hydrophilicity, roughness and mechanical strength of the membranes increased as organoclay content increased from 0 to 2.0 wt%. XRD analysis confirmed the exfoliated structure of organoclay in membrane when its content increased from 0.5-1.5 wt%. Further increase in organoclay content; up to 2.0 wt%, resulted in the intercalated structure of dispersed organoclays in membrane matrix. Adsorption kinetic of arsenate was found to follow pseudo-second-order kinetic model and equilibrium data showed good correlation with the Langmuir model. The obtained results also revealed that the arsenate adsorption was most favorable in the neutral pH. Moreover, membrane reusability of the 1.5 wt % and 2.0 wt% organoclay embedded PSf membranes was assessed by conducting five cycles of adsorption experiments and membrane regeneration in dead-end filtration. Obtained results confirmed the applicability of the prepared membrane for multiple cycles.

Keywords: Organoclay, Nanocomposite membrane, Arsenate, Adsorptive removal, Contaminated water

Introduction

Arsenic is one of the most toxic elements in the environment and has negative impact on human health when presented at elevated levels in surface water. It is usually found in an inorganic form like oxyanions of arsenite (As(III)) and arsenate (As(V)) (Camacho et al., 2011). Arsenate is the dominant species in surface water due to high redox potential while arsenite is found in anaerobic groundwater conditions (Sun et al., 2014). Arsenic exposure in drinking water has been proven to leave serious negative impacts on human health, causing skin, lung, liver, bladder, kidney and lymphatic cancer (Giles et al., 2011; Wu et al., 2012). Due to these health hazards associated with arsenic contaminated water, the World Health Organization (WHO) has decreased the maximum contaminant level (MCL) of arsenic in drinking water from 50 ppb to 10 ppb (Chandra et al.,