Research article

polymers advanced technologies

Received: 25 May 2012, Revised: 26 August 2012, Accepted: 1 November 2012, Published online in Wiley Online Library: 5 December 2012

(wileyonlinelibrary.com) DOI: 10.1002/pat.3092

Polysulfone/Brij-58 blend nanofiltration membranes: preparation, morphology and performance

E. Saljoughi[a,b], S. M. Mousavi[a]* and S. A. Hosseini[a,b]

In present research, novel asymmetric polysulfone (PSF) membranes with high hydrophilicity and noticeable rejection of arsenic, as one of the major environmental problems, were prepared from PSF/Brij-58/NMP (1-methyl-2-pyrrolidone) system via immersion precipitation. Pure water was used as gelation media. The variation effect of coagulation bath temperature (CBT) and addition of Brij-58 on morphology, wettabiliy, pure water permeation flux and rejection of As (III) and As (V), as two dominant states of arsenic in the nature, were studied by scanning electron microscopy, contact angle measuring instrument and experimental setup. The results demonstrated that both hydrophilicity and rejection properties of the prepared membranes were significantly enhanced by small addition of Brij-58 surfactant in the casting solution along with using the lowest level of CBT. Addition of 4 wt. % of Brij-58 and using cold coagulation bath resulted in the highest rejection of As (V). Initial increase in Brij-58 concentration, from 0 wt. % to 2 wt. %, resulted in higher rejection of As (III). However, higher Brij-58 concentrations than 2 wt. % (increase from 2 wt. % to 6 wt. %) led to lower rejection of As (III). Also, it was found out that addition of Brij-58 in the casting solution along with increasing the CBT resulted in formation of membranes with high permeability and sub-layer porosity and thin top layer. Copyright © 2012 John Wiley & Sons, Ltd.

Keywords: membrane; phase inversion; arsenic removal; polysulfone; hydrophilicity

INTRODUCTION

The contamination of groundwater aquifers by arsenic has generated severe problems in many countries.[1] Nowadays, many people are exposed to excessive arsenic amounts through contaminated drinking water. In nature, arsenic occurs in several chemical forms and oxidation states. The two states prevalent in water environment are trivalent (As (III)) and pentavalent (As (V)).[2] Quantity of arsenic in nature is shown in Table 1.

Drinking water, after food, represents a secondary source of inorganic arsenic in the human system. In humans, accumulation of arsenic results in a wide range of health effects including cancers of skin, kidney, lung and bladder. Consequently, in recent years, authorities have taken a more stringent attitude to arsenic in the environment; in particular, World Health Organization guideline fixed the new standard limit for arsenic in drinking water to 10 ppb.[2,3]

Membranes are broadly applied in many chemical engineering fields such as the production of high-quality water, removal or recovery of toxic or valuable components from various industrial effluents and applications in the food and pharmaceutical industries.[4,5] Nanofiltration (NF), as an important portion of membrane separation processes, along with other methods such as using adsorbents, is a conventional method for arsenic removal. Several researchers have studied removal of arsenic by commercial NF or reverse osmosis (RO) membranes that their results are summarized in Table 2.[6–8]

Polymers are the most widely used materials for membrane fabrication because of their desired mechanical properties, flexibility to be formed into different modules, intrinsic transport property and low cost.[9]

Polysulfone (PSF) has been adopted as the membrane material for important separation processes, because it is reliably available in well-defined qualities such as[10,11]:

1- High chemical and hydrolytic stability as well as good mechanical and film-forming properties
2- Proper flexibility, as a result of amorphous phase of the PSF
3- Excellent thermal and electrical properties over a wide temperature range
4- Non noxious property along with durability to hot water, steam and alcohol

As a result of above advantages, PSF has been adopted as the membrane material for manufacture of medical devices and use in important separation processes such as hemodialysis, extraction, purification and concentration.[10–12]

Despite of above advantages, PSF membrane has a tendency to be contaminated for its low hydrophilicity, which can result in declining of flux and life of the membrane as well as

* *Correspondence to: S. M. Mousavi, Department of Chemical Engineering, Faculty of Engineering, Ferdowsi University of Mashhad, Mashhad, Iran. E-mail: mmousavi@um.ac.ir*

a *E. Saljoughi, S. M. Mousavi, S. A. Hosseini*
Department of Chemical Engineering, Faculty of Engineering, Ferdowsi University of Mashhad, Mashhad, Iran

b *E. Saljoughi, S. A. Hosseini*
Research Center of Membrane Processes and Membrane, Faculty of Engineering, Ferdowsi University of Mashhad, Mashhad, Iran