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Polysulfone nanocomposite membrane embedded by silanized nanodiamond for removal of humic acid from water

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ABSTRACT

In this study, polysulfone (PSf) nanocomposite membranes embedded with functionalized nanodiamond (ND) were prepared via Non-Solvent Induced Phase Separation (NIPS) method. ND nanoparticles were silanized by using the esterification reaction of hydrolyzed vinyltrimethoxysilane (VTS) in alcoholic solution in order to enhance the compatibility between ND and PSf. Fourier Transform Infrared Spectroscopy (FTIR) analysis revealed that ND nanoparticles were successfully functionalized by silane groups. Nanocomposite membranes were then prepared with different percentages of silanized NDs (SNDs). The membranes were characterized using a set of analyses and the results showed that the addition of SNDs up to 1.0 wt.% resulted in an increase in hydrophilicity, water content, porosity and water flux of membranes. Moreover, Scanning Electron Microscopy (SEM) images indicated that the membrane with 1.0 wt. % nanoparticles had more pores on the membrane surface with smaller average pore size in comparison to other membranes. Antifouling properties of the membrane was also investigated in filtration of humic acid solution and the results showed that reversible fouling and flux recovery of membranes increased at the presence of SNDs.

Keywords: *Polysulfone, Functionalization, Nanodiamond, Fouling, Nanocomposite.*

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Table S1. Solution to Eq. (11) for different values.

Fouling Model	m	Linear form of flux expression	Flux expression
Cake filtration	0	$\frac{1}{J^2} = \frac{1}{{J_0}^2} + kt$	$J = \frac{J_0}{(1 + {J_0}^2 kt)^{1/2}}$
Intermediate blockage	1	$\frac{1}{J} = \frac{1}{J_0} + kt$	$J = \frac{J_0}{1 + J_0 kt}$
Standard blockage	1.5	$\frac{1}{\sqrt{J}} = \frac{1}{\sqrt{J_0}} + kt$	$J = \frac{J_0}{(1 + {J_0}^{1/2} kt)^2}$
Complete blockage	2	$ln(\frac{1}{J}) = ln(\frac{1}{J_0}) + kt$	$J = J_0 \, exp(-kt)$

Table S2. Combined fouling models at constant pressure.

Model	Equation	Fitted parameters
Cake filtration and complete blocking mechanism (CFCBM)	$V = \frac{J0}{Kb}(1 - exp(\frac{-Kb}{KcJ0^2}(\sqrt{1 + 2KcJ0^2 t} - 1)))$	K_c (s/m^2), K_b (s^{-1})
Cake filtration and intermediate blocking (CFIBM)	$V = \frac{1}{Ki} ln(1 + \frac{Ki}{KcJ0}((1 + 2KcJ0^2 t)^{1/2} - 1))$	K_c (s/m^2), K_i (m^{-1})
Complete blocking and standard blocking mechanism (CBSBM)	$V = \frac{J0}{Kb}(1 - exp(\frac{-2Kbt}{2 + KsJ0t}))$	K_b (s^{-1}), K_s (m^{-1})
Intermediate blocking and standard blocking mechanism (IBSBM)	$V = \frac{1}{Ki} ln(1 + \frac{2KiJ0t}{2 + KsJ0t})$	K_i (m^{-1}), K_s (m^{-1})
Cake filtration and standard blocking mechanism (CFSBM)	$V = \frac{2}{Ks}(\beta \, cos(\frac{2\pi}{3} - \frac{1}{3} arccos(\alpha)) + \frac{1}{3})$, $\alpha = \frac{8}{27\beta^3} + \frac{4Ks}{3\beta^3 KcJ0} - \frac{4Ks^2 t}{3\beta^3 Kc}$ $\beta = \sqrt{\frac{4}{9} + \frac{4Ks}{3KcJ0} + \frac{2Ks^2 t}{3Kc}}$	K_c (s/m^2), K_s (m^{-1})