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Improving the performance of polyamide Nano-filtration membrane in acidic media by incorporation of modified multi-walled carbon nanotubes

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Short Introduction

Thin Film Composite (TFC) NF membranes are prepared by interfacial polymerization (IP) between amine and acyl chemical groups. The biofouling is significant drawback for the NF membranes that could be decreased with variety of acidification process. After a while, active PA layer will not be stable in high acidic media, which lead to lower performance of membranes [Tang (2012) Nyström (2004)]. This efficiency reduction can appear in experimental results. For making the acidic resistance membrane, the nano-particle embedding in PA-layer is economical and effective [Hoek (2011)]. Multi-walled carbon nanotubes (MWCNTs) have been employed due to their well water transport and functionality properties. In this study new nanocomposite membranes that were prepared of polysulfone/TFN-PA by incorporating of aromatic amine functionalized-MWCNT (AAF-MWCNTs). The effect of AAF-MWCNTs on the salinity removal efficiency and the acid resistance of NF membranes is presented.

Material and Methods

All of the reagents were purchased from Sigma-Aldrich Co. First, the raw MWCNTs by clear and similar method were functionalized, then the AAF-MWCNTs were embedded in PA-layer during the Interfacial Polymerization, as described elsewhere [Vatanpour (2017), Blotny (2002)]. To evaluate the acid-resistance of membrane, those were aged in hydrochloric acid solutions. The X-ray photoelectron spectroscopy (XPS) has been applied to confirm influence on acidic-resistance improvement of the modified NF-membrane.

Results and Discussion

XPS results showed the presence of carbon, oxygen, and nitrogen in the bare and AAF-NF membrane. More Oxygen and Nitrogen elements in AAF-Membrane has been confirmed the AAF-MWCNTs existence into thin film layer. Table 1 summarizes the elemental composition and the percentage of the synthesized membranes. The aged membrane showed the presence of new peaks at about 291 eV associated to π- π bonds. For the N atoms, two peaks at about 399.4-399.7 and 400.18

- 401.3 eV have been assigned. After acid aging decreased and increased respectively indicating the increase of the percentage of NH_3^+ groups. Also for Oxygen two peaks at about 530.8 and 532.6 eV appeared which decreased down and increased respectively as a consequence of the increase of the carboxylic acid groups. The reduction and increase of the mentioned oxygen peaks decreased to a lesser extent in modified membranes which is a reason to achieve the acid-resistance membrane.

Table 1. Binding energies and relatively amount of elements for bare and modified membranes before and after acidification, pH: 1.5, HCl, shaking for 24 h, ambient situation, rinsed with desalinated water, 24 h for drying at room temperature.

Elements	Bare Membrane		Aged Bare Membrane		AAF Membrane		Aged AAF Membrane	
	E_b (eV)	%	E_b (eV)	%	E_b (eV)	%	E_b (eV)	%
C (1S)	78.541		78.867		78.278		76.904	
C-C,C-H	284.8	63.2	284.8	60.8	284.8	63.2	284.8	60.4
C-N , C-O	286.7	13.1	286.1	10.9	286.7	13.1	286.1	10.2
C=O-N , N=C , C=O	287.8	6.1	287.6	10.7	287.8	6.1	287.7	9.1
C=C	283.8	12.4	284.1	16.9	283.8	12.4	283.9	17.2
Saturated,π bond	-	-	291.3	0.78	-	-	291.1	0.28
N (1S)	9.888		7.868		9.665		8.497	
C-N, C=N, O=C-N	399.7	98.2	399.6	95.3	399.4	94.8	399.5	94
$-NH_3^+$, $-NH_2R^+$	400.2	1.8	401.4	4.7	401.2	5.2	401.4	6.1
O (1S)	14.901		15.167		15.160		15.439	
O=C-N, C=O, C-O	530.9	85.1	530.8	63.9	530.7	77.0	530.8	74
HO-C-N, O-C-O	532.8	28.2	532.6	41.8	532.7	11.8	532.7	18.8

Conclusions

Acid-resistance NF membranes were successfully prepared by the embedding of AAF-MWCNTs into the PA-layer of NF membrane. Influence of AAF-MWCNTs in NF membranes has been confirmed by results of aging tests and XPS analyses.

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