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XPS study of the composition and structure nanofiltration (NF) and reverse osmosis (RO) membranes

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Introduction

Nanofiltration membranes have properties that combine size and electrical effects, as those present in ultrafiltration membranes, with solution diffusion mechanisms, as those typically ruling transport in non-porous reverse osmosis membranes [1,2]. This process streams are mainly composed by ions and organic matter. At present, one of the filtration process challenge is to know the mechanisms of transport of this material through the NF and RO membranes and to relate it with the structure and composition of the active separation layer [3-5]. In particular, the X-ray photoelectron spectroscopy (XPS) is a surface chemical analysis of the material under study has allowed to accurately determining the electronic state of polymeric materials which are composed of NF membranes [6].

Methods

Three commercial nanofiltration membranes (NF-30, NF-40 and NF-80) and one commercial osmosis reverse membrane (RO-99) were characterized by X-ray photoelectron spectroscopy. XPS spectra were recorded with an Omicron spectrometer equipped with an EA-125 hemispherical electron multichannel analyzer and an unmonochromatized Mg Kα, X-ray source at 150W and a pass energy of 20 eV. The samples were pressed into a small pellet of 15mm diameter and then mounted on the sample holder and introduced into the chamber where they were degassed for 6–8 h, in order to achieve a dynamic vacuum below 10−8 Pa prior to analysis. Resulting spectral data were analyzed using CASAXPS software and RSF database by peak fitting after Shirley background correction.

Results and discussion

The chemical composition of the NF and RO membrane surface was investigated by XPS (Table 1). The observed atomic concentration of C, O, and N are typical of aromatic polyamide film [6,7]. The NF-30 and RO-99 membranes surface shows a different chemical composition, with a low relative amount of nitrogen. Moreover, the deconvolution of N1s peaks reveals that these samples have the higher concentration of protonated amine ($-NH_3^{2+}$) [8] On the other hand, NF-30 shows the higher relative content COOH groups.

Table 1 XPS results of the membranes surface

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	%at C	%at O	%at N	O/C	N/C	N/O
NF-30	65.83	32.27	1.90	0.490	0.029	0.059
NF-40	69.11	23.70	7.19	0.343	0.104	0.304
NF-80	67.92	25.48	6.60	0.375	0.097	0.259
RO-99	66.55	32.75	0.30	0.492	0.005	0.009

Conclusions

The differences observed in NF and RO membranes related to its atomic concentration can help us to explain the different behavior on the separation process.

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