Polypyrrole functionalized carbon nanotubes as peculiar additives for high-performance thin-film nanocomposite reverse osmosis membranes

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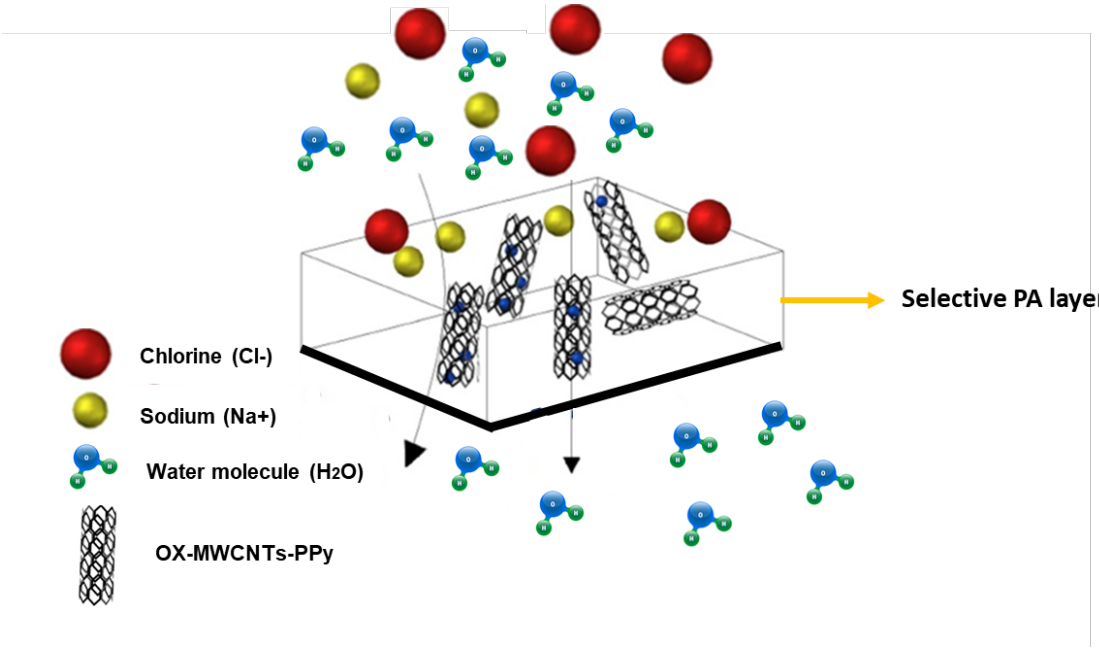
Graphical abstract



Abstract:

The introduction of functionalized multi-walled carbon nanotubes (MWCNTs) with hydrophilic structures to react with monomers in the active layer of thin film composite (TFC) membranes has shown promising results in different membrane applications. Modified MWCNTs can significantly improve the physicochemical, mechanical and performance (water flux and antifouling properties) of thin-film nanocomposite (TFN) membranes due to their hydrophilic moieties and tubular shape. In this study, the incorporation of polypyrrole-coated oxidized MWCNTs (OX-MWCNTs-PPy) in the RO-TFC membrane was investigated for the first time. The physicochemical properties of the developed membranes were characterized using FTIR, SEM, AFM, and contact angle analysis. The SEM images of modified MWCNTs and TFN membranes confirmed the unpackaged morphology of OX-MWCNTs-PPy and the smoother surfaces of the developed TFN membranes compared to the plain TFC membranes. Furthermore, the results indicated that the contact angle of membranes reduced from 68° for the plain TFC membranes to 58.1° for the fabricated RO OX-MWCNTs-PPy membranes. The SEM and contact angle results were in agreement with the AFM results confirming a smoother surface of the TFN membranes compared to the TFC membranes. Moreover, PPy and oxygen moieties increased the water flux of the TFN membranes compared to the pristine TFC membranes due to the new N—H bonds in their structure. That also reinforced the stability of

the membrane by creating a dense, cross-linked connection between the PA layer and OX-MWCNTs-PPy nanocomposites. This study can pave the pathway for developing modified MWCNTs-based membranes with superior antifouling properties.

Keywords: Water purification, RO membranes, Multi-walled carbon nanotubes, Surface modification, Antifouling properties