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Thin-film nanocomposite membrane with CNT positioning in support layer for energy harvesting from saline water

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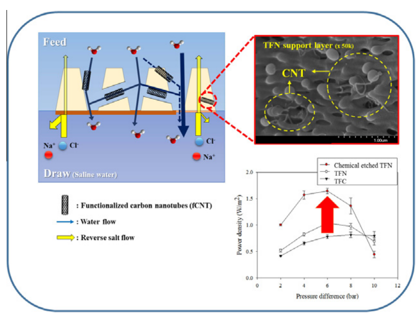
HIGHLIGHTS

- The TFN with CNT positioning in support layer was successfully synthesized.
- The porosity and hydrophilicity of support layer were increased.
- Membrane permeability induced by CNT and active layer etching was improved.
- The TFN exhibited significantly enhanced water flux and power density.
- This method is easy to upscale with minimum additional cost.

GRAPHICAL ABSTRACT



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ABSTRACT

The pressure retarded osmosis (PRO) process has been considered as an alternative and renewable technology to generate electricity from mixing two solutions of different salinities. However, improving the osmotic performance of semi-permeable membrane is still a major challenge in the PRO system. Therefore, thin-film nanocomposite (TFN) membrane was synthesized by using carbon nanotubes (CNT)-embedded-polyethersulfone (PES) supporting layer and polyamide active layer in this study. The prepared membranes were further employed in the PRO process to harvest energy from saline water. The water flux increase of the TFN membrane was promoted by CNT-induced porosity and the hydrophilicity of the support layer as well as by the chemical etching of the active layer. The water flux and maximum power density of the developed TFN membrane was found to be 87% (averaged from 2 bar to 10 bar) and 110% greater than for bare thin-film composite (TFC) membranes, respectively. Furthermore, the TFN membrane preparation could easily be scaled up using conventional fabrication methods with less than 2% additional material cost. Therefore, this finding could contribute to the commercialization of sustainable energy generation by utilizing the tremendous potential of fresh- and salt-water mixing.

1. Introduction

In recent years, there has been an increase in research into sustainable energy generation with the aim of overcoming energy shortages. According to the International Renewable Energy Agency (IRENA), the total technical potential for salinity gradient energy is estimated to be around 647 gigawatts (GW) globally, which is equivalent to 23% of the electricity consumption in 2011 [1]. Thus, various processes have been developed to harvest salinity gradient energy, including pressure retarded osmosis (PRO), reverse electrodialysis (RED), capacitive mixing, osmotically induced nanofluidic

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