*Desalination and Water Treatment*
www.deswater.com

doi: 10.5004/dwt.2019.23431

142 (2019) 37–48
February

# Embedded high-hydrophobic CNMs prepared by CVD technique with PVDF-co-HFP membrane for application in water desalination by DCMD

Mustafa Mohammed Aljumaily[a], Mohammed Abdulhakim Alsaadi[a,b,*], N. Awanis Hashim[c,*], Qusay F. Alsalhy[d,*], Rasel Das[a], Farouq S. Mjalli[e]

[a]*Nanotechnology & Catalysis Research Centre (NANOCAT), University of Malaya, IPS Building, Kuala Lumpur 50603, Malaysia; email: mustafa.kh1989@gmail.com (M.M. Aljumaily), Tel. +60163630693; emails: mdsd68j@gmail.com (M.A. Alsaadi), raselgeneticist@gmail.com (R. Das)*
[b]*National Chair of Materials Science and Metallurgy, University of Nizwa, Nizwa, Sultanate of Oman*
[c]*Department of Chemical Engineering, University of Malaya, Kuala Lumpur 50603, Malaysia, Tel. +60196888638; email: awanis@um.edu.my*
[d]*Membrane Technology Research Unit, Chemical Engineering Department, University of Technology, Alsinaa Street No. 52, B.O. 35010, Baghdad, Iraq; email: qusay_alsalhy@yahoo.com, 80001@uotechnology.edu.iq*
[e]*Department of Petroleum and Chemical Engineering, Sultan Qaboos University, P.O. Box 33, Muscat 123, Oman; email: farouqsm@yahoo.com*

Received 8 May 2018; Accepted 7 November 2018

**ABSTRACT**

In this work, conditions for fabricating high-hydrophobic carbon nanomaterials (CNMs) by chemical vapor deposition technique on nickel-doped powder activated carbon such as reaction temperature, reaction time, and $H_2$:$CH_4$ gas ratio were optimized to achieve the optimum contact angle (CA). The results showed that the optimal reaction temperature, $H_2$:$CH_4$ gas ratio, and reaction time for the highest CA of 145° were 950°C, 1:1, and 20 min, respectively. The CNM with a CA of 145° was embedded with poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-co-HFP) membrane to improve its hydrophobicity and, in turn, its seawater desalination performance by direct contact membrane distillation (DCMD). Various CNM contents (i.e., 1.0, 3.0 and 5.0 wt.%) were embedded with 22:78 (wt.%) of PVDF-co-HFP/N-Methyl-2-pyrrolidone solution to prepare flat-sheet membranes via phase inversion. CNM content plays an important role in the membrane preparation and thus affected the DCMD performance. Particularly interesting was the membrane prepared from dope mixture with the 5 wt.% CNMs, which resulted in an increase in CA from 83° to 133°, and porosity from 45.3% to 96.94%, along with a decrease in the membrane thickness from 210 to 165 μm. However, CNM embedding into the casting mixture also affected the membrane's mechanical properties. Finally, DCMD permeation was enhanced from 10 to 16 L/hm$^2$ by embedding 5 wt.% of CNMs at the feed temperature of 45°C with salt rejection >99.9%.

*Keywords:* Chemical vapour deposition; Carbon nanomaterials; Hydrophobicity; PVDF-co-HFP; Direct contact membrane distillation; Desalination

* Corresponding authors.