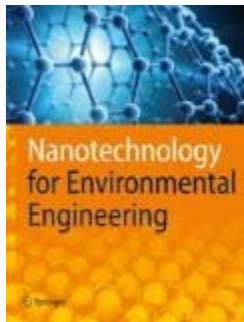


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### Estimation of critical fluxes, thermal stabilities and failure criteria of cellulose-based membranes and modelling of salt diffusivity during pervaporative desalination

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#### Abstract

The consequences of highly saline freshwater on the ecosystem and humans are quite alarming and have gained little attention in recent times. Progressive advances in pervaporation have helped to unlock its potentials in the desalination of salty streams. In this study, desalination of lagoon-water using cellulose acetate membrane (CAM) and its copper-doped nanocomposite (CA-CuNP) membrane was investigated. A newly developed model was used in estimating salt diffusion coefficients in steady and unsteady state situations. At the experimental phase, permeate fluxes increased with temperature but dropped when the critical fluxes (5.11–6.01 L/m<sup>2</sup>h and 5.29–7.56 L/m<sup>2</sup>h) were exceeded for the CAM and CA-CuNP membranes respectively. At steady state, the critical permeate volumes for the pristine

and nanocomposite membranes were 0.2273 and 0.1826 L with corresponding fluxes of 0.034 and 0.031 L/m<sup>2</sup>h after 10 and 9 h, respectively. The estimated steady and unsteady diffusivities for the membranes are:  $1.46 * 10^{-4}$ – $8.43 * 10^{-3}$  m<sup>2</sup>/h ( $4.06 * 10^{-7}$ – $2.34 * 10^{-6}$  m<sup>2</sup>/s) and  $2.44 * 10^{-4}$ – $0.17 * 10^{-4}$  ( $6.78 * 10^{-8}$ – $4.72 * 10^{-9}$  m<sup>2</sup>/s), respectively. The nanocomposite membrane gave slightly higher salt rejection with fluxes mimicking the power law model. Thermal resistance of the pristine membrane improved from 219.36 to 221.18 °C after doping it with copper nanoparticles. Furthermore, the estimated critical permeate fluxes are indicative of saturation conditions for the CAM and CA-CuMP membranes and hence are signals for membrane plugging which then implies that proactive measures can then be taken to abate such situations.

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### Availability of data and materials

All relevant data generated from this research have been included in the submission.

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### Contributions

SES conceptualized this research idea, prepared the manuscript, developed the model for estimating solute diffusivity at steady and unsteady states, provided the required supervision during experimentation, and carried out the data analyses; MH was involved with experimentation and data curation; PA was involved with project administration, equipment acquisition and the experimental set-up; EO, AA and BO made useful observations and contributions during the laboratory work.

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#### **Ethics declarations**

#### **Conflict of interest**

The authors declare that there is no conflict of interest as regards this publication.

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