Optimizing fabrication of electrospinning nanofiber membranes for water filtration using response surface methodology

ABSTRACT

Nanofiber Polyethersulfone (PES) membrane fabrication using the electrospinning method incorporating dry/wet phase inversion was investigated. The electrospinning process is a straightforward and versatile method to produce onedimensional nanostructures, especially nanofibers. The electrospun's outcome can be affected by the various process parameters and solution parameters, making it an interesting study subject and an opportunity for customized nanofiber membrane. In this work, the analysis includes dope formulation and electrospinning parameter influence to membrane morphology dimensional structure based on Scanning Electron Microscopy (SEM) and filtration capability. Fibrous membranes were electrospun at 1 to 3 ml/h feeding rate and at 12 to 25kV voltage rate in a fixed 10 to 12 cm distance between the filter membrane and the syringe needle tip. The PES dope solution with N-methyl-2-pyrrolidone (NMP) as solvent electrospun onto a wet filter base membrane (5A 90 mm Advantec Filter Paper) to refine the fabricated fibrous membrane and to induce the dry-wet phase inversion process. The results indicate that the PES fiber dimension reduced at a lower feeding rate and higher voltage rate. In terms of liquid separation performance, experimental results showed that pure water permeation flux was reduced with the increased flow spinning rate of 1 to 3ml/hr but triple times higher than the increased concentration PES formulation, even at higher voltage spinning. The electrospun performance of polyethersulfone was also explained using Response Surface Methodology (RSM). It focused on the polymer content, tip-to-collector distance, and flow rate parameters toward fiber diameter and contact angle. Among these factors, the effect of PES content (f-value = 65.87) was the most significant, followed by tip-to-collector distance (f-value = 11.26) and flow rate (f-value = 2.59).