Preparation of Sulfonated Poly(ethylene terephthalate) Submicron Fibrous Membranes for Removal of Basic Dyes

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ABSTRACT: In this investigation, a nanofibrous sulfonated poly(ethylene terephthalate) (SPET) membrane was prepared by electrospinning of the SPET solution in trifluoroaceticacid (TFA)/dichloromethane (DCM) mixture. The produced nanofibers had diameter ranging from 300 nm to 1 μm. The performance of this membrane's separation process was evaluated under different operating conditions. The influence of the electrospinning and filtration process parameters, such as concentration, applied voltage, deposition time, operating pressure, and filtration time on rejection of C.I. Basic Blue 3 were studied. The dead-end recirculation ultrafiltration set-up was employed. Under optimum conditions (concentration of 20% (w/v) of SPET, applied voltage of 20 kV and deposition time of 3 h) the removal of the aforementioned dye was 98%. Operating pressure has posed a significant influence on the membrane's separation performance, whereas the operating time had some effect on the separation performance. Two equilibrium adsorption isotherms: Langmuir and Freundlich were fitted to the dyes' equilibrium sorption data on SPET membrane at different feed concentrations. The Freundlich isotherm was found to well represent the measured adsorption data based on the higher coefficient of determination (r^2). © 2012 Wiley Periodicals, Inc. J Appl Polym Sci 124: E190–E198, 2012

Key words: nanofibrous membrane; electrospinning; filtration; cationic dye; adsorption isotherms

INTRODUCTION

Textile, paper, carpet, leather, and printing industries produce large volumes of wastewater polluted with dyes.[1–3] Among all dyeing processes, direct dyes on viscose and basic dyes on acrylic materials release the highest quantities of dye molecules in the wastewater.[4] Basic dye is a class of highly colored organic substances with positive charge delocalized throughout the chromophoric structure and has affinity towards textile materials which have negatively charged functional groups. Since these dyes are hardly degradable, also they resist to aerobic digestion and are stable to heat, light, and oxidizing agents; hence, wastewater containing basic dye is difficult to purify.[5]

There are various methods for removal of dye molecules from wastewater, such as ozonation,[6,7] biological treatment,[8,9] adsorption,[10–12] ion exchange,[13,14] coagulation,[15] membrane processes,[16–19] and, etc. Among all the mentioned methods, the membrane processes seem to be more effective than other methods.[20]

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A membrane in quintessence acts as a barrier separating two discrete phases. Its main function is to differentiate species which come into contact within one phase (feed) and transport them across to the other (permeate). This process has been frequently carried out under a driving force such as pressure or concentration gradient. Once a membrane is created, two key factors define its performance: flux and selectivity. Selectivity is controlled by the surface properties of membrane which discriminates the type of species passing through it. Whereas flux expresses the rate at which species are transported across the membrane. These two factors are affected by the structural and morphological possessions of the membrane such as porosity, pore size and distribution, wettability, pressure drop across the membrane (transmembrane pressure), and thickness.[21]

Recently, pressure-driven membrane processes, such as reverse osmosis, nanofiltration, and ultrafiltration have been investigated for the treatment of dye containing industrial wastewater. In spite of the fact that dyes are completely removed, the flux of reverse osmosis is very low and the process is not cost-effective. Although nanofiltration does not attain the retention behavior compared to reverse osmosis, but its flux is found to be more acceptable for water reuse. However, the major disadvantage of