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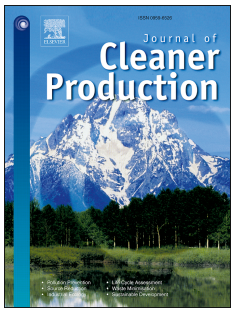

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Optimization of Process Variables by the Application of Response Surface Methodology for Naphthol Blue Black Dye Removal in Vacuum Membrane Distillation

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Abstract

This study focuses on the determination of optimum conditions for different operating variables for removal of dye from wastewater in the vacuum membrane distillation process. Response surface methodology was applied to develop a regression model for analysis of permeate flux, specific energy consumption, and percentage removal. A set of experimental runs for VMD setup was developed using the central composite design of experiment method. Three regression correlations models were developed to predict the permeate flux, specific energy consumption and percentage removal using experimental conditions. The developed models were further used to optimize the operating parameters for desired conditions of responses. The optimum conditions for operating parameters were found as 85^{o}C, 5lpm, 30ppm and 750mmHg for feed temperature, feed flow rate, initial dye concentration, and vacuum degree for maximum permeate flux and percentage removal and for minimum specific energy conditions. The developed model was verified with experimental conditions and found as best fitted. The fouling on membrane surface was analyzed using scanning electron microscopy (SEM) and EDS.

Keywords: Central composite design, Naphthol Blue Black Dye, Optimization, VMD, SEM

1 Introduction

Treatment of dye-containing wastewater is a major problem for many industries like paint, pigment, textile, pulp and paper industries. A large amount of water is required for the production of textile and discharged as wastewater which contains a high concentration of azo dyes, reactive dyes, other chemical residue and non-biodegradable compounds with high BOD and COD(Dasgupta et al., 2015; Tang and Chen, 2002). The discharge of colored wastewater into fresh water sources caused the problem of non-aesthetic, eutrophication, due to their high solubility. The degradation of dye can form toxic and carcinogenic products even at a lower concentration. Azo dyes are characterized by the presence of azo bonds $(-N=N-)$ with aromatic rings and auxochromes such as $-OH$, $-NH_2$, $-COOH$, $-SO_3H$ etc. Due to high solubility in water, the removal of azo dyes from wastewater is very difficult using conventional techniques coagulation, sedimentation, activated sludge process, etc.. Biological methods and physicochemical methods cannot remove dye from wastewater to the desired limit that has a great impact on the environment and human health. These