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RO-NF MEMBRANE PROCESS FOR PHARMACEUTICAL WASTEWATER TREATMENT AND SEPARATION OF ANTIBIOTICS

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Abstract

Experiments were carried out on a nanofiltration (NF) and reverse osmosis (RO) membranes separation system for recovery of antibiotics from pharmaceutical wastewater. For this purpose a membrane system including reverse osmosis (Saehan RE4040-BE) and nanofiltration (FilmTec Spiral NF4040) membranes was proposed and evaluated for the treatment of amoxicillin wastewater. The effects of operating pressure and the concentration of the feed on the efficiency of the membrane were evaluated. The separation performance of the nanofiltration membrane is encouraging. The best operating pressure for the NF membrane is 8-10 bar. The rejection of amoxicillin by the selected NF membrane is adequate and in most cases exceeds 98% whereas COD reaches a maximum rejection of 40%. The rejection of COD and amoxicillin by the selected RO membrane exceeds 97%. This study also illustrates that the nanofiltration membrane process is a promising technique for the concentration of antibiotic extracts and for the recovery of organic solvents.

Introduction

Increased quantities of organics such as pharmaceuticals, antibiotics and other organic micropollutants can be found today in the aquatic environment and are of great concern in wastewater, and water reuse applications.

Nanofiltration (NF) membranes have attracted much attention lately for their distinctive separation performance. They have nominal nano-scale pores with estimated pore sizes of around 0.5-2 nm in diameter on their active surface and may be either negatively or positively charged by the dissociation of surface functional groups.

In the present study membranes of reverse osmosis (RO) and nanofiltration (NF) were proposed for antibiotic wastewater. Amoxicillin waste liquor was used as the working medium for the experimental study. The RO process was employed to reduce the organic content in the RO permeate and to concentrate amoxicillin in the retentate.

Materials & Methods

A spiral NF membrane (FilmTec NF4040) and a RO membrane (Saehan RE4040-BE) were used in this study.

The experimental set-up used to study the separation performance of the membranes is shown in Fig.1.

Fig.1 Membrane Unit

The membrane unit is mainly comprised of a membrane module, a pump, a micro filter and a GAC filter for pre-disposing the wastewater to remove big particles or suspended materials that may damage membranes.

The concentration of amoxicillin in feedstock and permeate was measured by a UV-Vis spectrophotometer. The method is based on the reaction of amoxicillin with N,N-dimethyl-p-phenylenediamine in the presence of potassium hexacyanoferrate(III) in alkaline medium. The water soluble blue color product was measured at λ_{max} 660 nm.

Results & Discussion

The separation performance of membranes depends on the operating conditions. The operating parameters such as pressure and concentration of feedstock have an important influence on the separation performance.

Effect of pressure:

Experiments demonstrate that the operating pressure has great effect on the efficiency of the membranes by increasing the flux of permeate and antibiotic rejection. In Figs. 2 and 3 the relationship between operating pressure and separation performance for the NF and RO membranes is shown for amoxicillin wastewater.

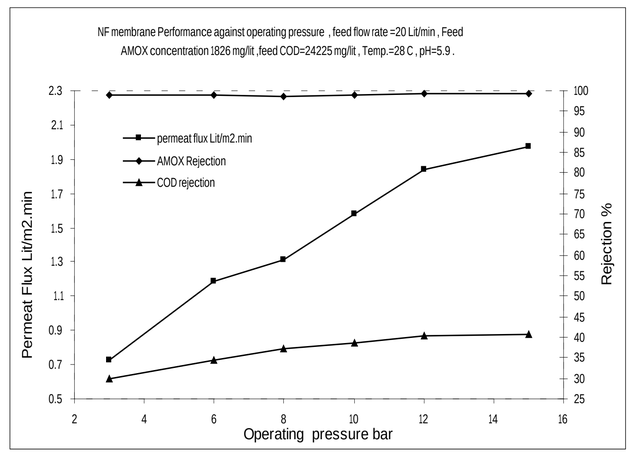

Fig.2 Effect of pressure on NF performance for wastewater

Effect of concentration of feed:

There often exists a concentration polarization problem in many membrane transport processes when the concentration of solute is high.

As shown in Fig. 5 the amoxicillin and COD rejection is high (over 97%) for RO membrane and is scarcely affected by the concentration of amoxicillin.

Fig.3 Effect of pressure on RO performance for wastewater

For the NF membrane, as shown in Fig. 4, amoxicillin rejection exceeds 97% whereas COD reaches a maximum rejection of 40%.

In this work the polyimide NF membrane for the concentration of amoxicillin extract showed a suitable separation performance under the test conditions.

Fig.4 Effect of feed concentration on NF performance for wastewater

Fig.5 Effect of feed concentration on RO performance for wastewater

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