

Application of Rotary Disc Membrane Module for NF Separation

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Introduction

Rotary disc modules(RDM)with UF membranes have been used for the treatment of wastewater containing fouling materials such as colloids and suspended solids at high concentrations. Compared to other modules, RDM equipped with NF membranes could significantly reduce the pretreatment steps which sometimes are major cost factors of the total treatment system. A NF/RO system was proposed to directly concentrate a pig farm wastewater which was generally treated by biological processes. The feed water consisting mainly pig urine was processed by NF membranes to separate most of low MW organic acids and salts from high MW organic constituents existing in the urine. The NF permeate was further processed by RO to produce permeate which has good quality for reuse or discharge. The NF and RO concentrates were found to have sufficient ingredients for cultivation of various vegetables. The main objective was to investigate the performance of NF RDM for the direct volume reduction of a pig farm wastewater.

Experiment

The NF RDM system consists of a rotating disk in pressure housing that can be operated at the pressure up to 30 atm. and at the operating speed up to 600 rpm. A schematic diagram of the RDM system was shown in figure 1.

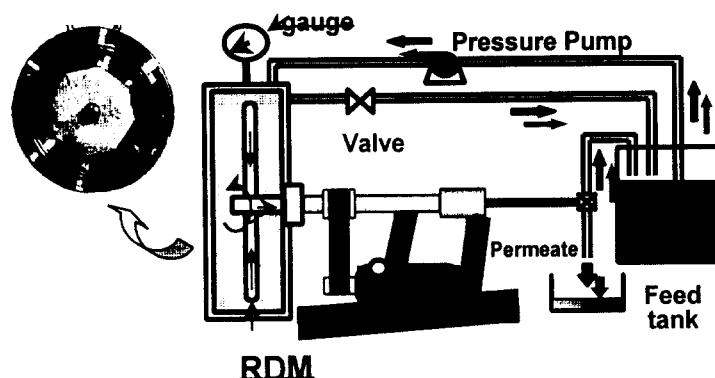


Figure 1. A Schematic diagram of RDM(Rotary disk membrane) system

Flat NF membrane(TS-40) was attached to both sides of the disk by using a ultrasonic welder. The feed water containing mainly pig urine and some suspended solids was obtained from a pig farm and prefiltered with 75 um sieve prior to the experiment. Separation of the feed was performed at 15 atm and 175 rpm. and the permeate was collected and measured by an electronic balance. TOC and conductivity of the permeate were measured for analyzing the rejection data. A long term test for the volume reduction of the feed up to 5 times was carried out. After each experiment, the membrane was cleaned at first by pure water flushing and then by acid or/and alkali with surfactants. The total nitrogen and the total phosphate of the permeate were also measured.

Results and Discussion

The pure water permeability of TS-40 membrane was 6.4 lmh/atm and the rejections of NaCl and MgSO₄ were 43% and 96%, respectively at 15 atm and 300rpm. Analyses of the feed water samples indicated a wide variation in concentrations as shown in table 1.

Table 1. Characteristics of pig farm wastewater

List	Value
- Suspended solids	990 - 3,000 mg/L
- Total organic carbons	2,583 - 4,561 mg/L
- Conductivity	16.25 - 26.8 mS/cm
- Total Nitrogen	928 - 3,918 mg/L
- Total Phosphorus	96 - 181 mg/L
- Viscosity	1.3 - 1.55 cP

The pig farm wastewater could be characterized by high concentration of suspended solids which are main causes of the membrane fouling. Various organic acids and salts in the urine resulted in the high concentration of dissolved solids shown as conductivity.

The volume reduction of the feed water was carried out in the RDM and the flux variation was shown in figure 2. When the initial feed of 20l was reduced to 4l the flux decreased from 30 lmh to 8 lmh. mainly because of the increase of osmotic pressure of the feed and the fouling. The initial conductivity rejection of 78% was also decreased to 50% as shown in figure 3 and the feed conductivity increased over 40 mS/cm.

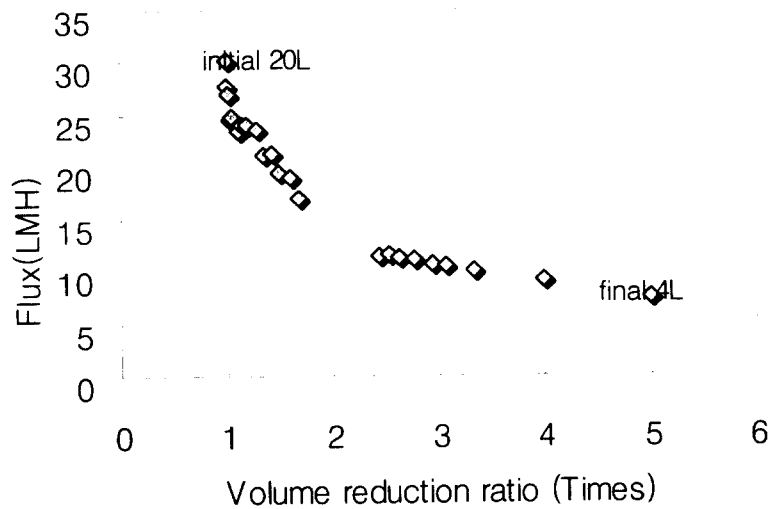


Figure 2. Variation of flux by the volume reduction ratio

Cleaning efficiency of the membrane was summarized in Table 2. % recovery of flux varied from 80% to 95% and the salt rejection tended to increase.

Table 2. Effects of Cleaning

	Flux (LMH/atm)	Recovery (%)	Salt rejection (%)
Virgin	6.4		43
First cleaning			
flushing with pure water	5.5	81	57
cleaning with surfactant	6.1	95	53
Second cleaning			
flushing with pure water	5.2	81	60
cleaning with surfactant and alkaly(pH10)	5.1	80	60
cleaning with acid (pH 4)	5.7	89	60

Rotary disk membrane module(RDM) appeared to minimize the fouling, especially induced by the suspended materials in the feed which caused main mass transfer resistance at the surface of membrane by forming cake layer. The economic analysis of NF/RO system for the treatment of the wastewater and the production of liquid fertilizer indicated a significant saving in land requirements and overall operating costs.

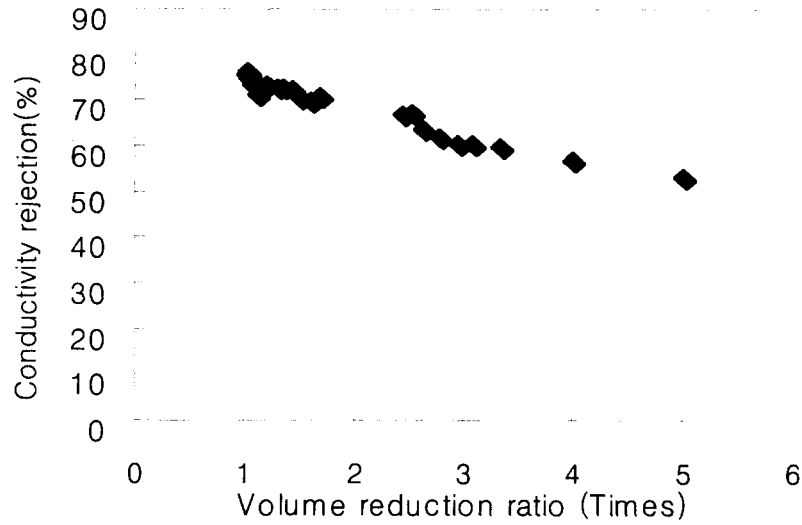


Figure 3. Variation of conductivity rejection by the volume reduction

Effect of the rotation speed on the permeate flux and salt rejection is shown in figure 4. The flux increased gradually at the rotation speed up to 500 rpm.

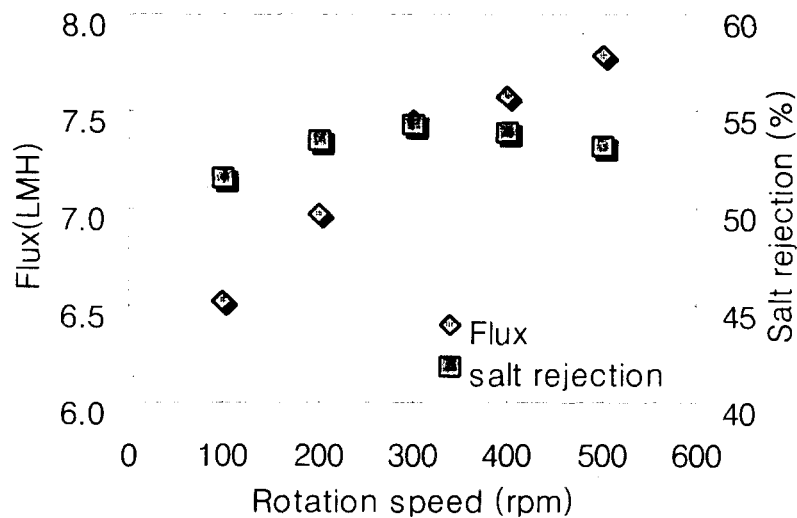


Figure 4. Effects of rotation speed.

Conclusion

NF RDM was successfully applied for the reduction of pig farm wastewaters. During the volume reduction the average flux was 15.4 LMH and the conductivity rejection was decreased from 73.4% to 48.5%. The rejections of TOC, T-N, T-P were as 82.4 - 90.0%, 69.9-71.2%, 96.8-98.9% , respectively. The flushing with D.W. and the cleaning with surfactant, alkali, acid were effective to recover membrane flux over 90%.