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Removal of Chemical Organics and Chromaticity from Printing and Dyeing Wastewater Using Nanofiltration Membrane

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Composite nanofiltration membrane was applied to treat chromaticity and chemical oxygen demand (COD) from printing and dyeing wastewater. The results showed that nanofiltration membrane technology could effectively remove the chromaticity and chemical oxygen demand in the printing and dyeing wastewater, and the average removal rates were 100 and 98 %, respectively. Meanwhile, the process of recovery was up to 90 %. The water flux of the membrane was increased with the feed flow rate and the operating pressure and then decreased with the improvement of the process of recovery.

Keywords: Printing and dyeing wastewater, Decolour, Nanofiltration, Water flux.

INTRODUCTION

Nanofiltration membrane is the advent of the new separation membrane in the late 1980s. It had two notable features: one is the MWCO range between reverse osmosis and ultrafiltration membranes and an approximately 200 to 2000, another is a nanofiltration membrane for inorganic salt rejection rate[1-3]. Because it was separated from the surface of layer polyelectrolyte constitute. According to the first characteristic, the speculative nanofiltration membrane may have a microporous structure of about 1nm, so called "nano-filtration"[4,5]. From the structural point of view, most of the nanofiltration membrane is a composite membrane, *i.e.* separated from the surface of the film layer and the chemical composition of the support layer[6-8]. Nanofiltration membrane separation process without any chemical reaction, no heating, no phase transition, will not destroy the biological activity does not change the flavour, fragrance and thus more and more widely used in food, pharmaceutical industry in a variety of separation, purification and enrichment process[9-11]. Treatment of dyeing wastewater nanofiltration membrane technology pilot study in the separation performance of the membrane, the operating conditions (feed flow rate and operating pressure) and concentrated process on membrane performance impact are discussed in detail and analysis, to provide a basis and reference for nanofiltration membrane technology Dyeing wastewater treatment actual industrial applications.

EXPERIMENTAL

Wastewater for this study was fed from printing and dyeing mill in Tangshan, Hebei, China. It mainly contained a variety of organic compounds and inorganic salts, such as colored dyes, dyeing auxiliaries, surfactants, slurry, *etc*. After pretreated by flocculation, sedimentation and pre-filtration treatment, the chromaticity of wastewater was of 380 (X), the chemical oxygen demand of 520 mg/L, pH value of 6 to 8 and the inorganic salt content of 1065 mg/L. Then this wastewater was injected to the nanofiltration membrane system.

Experimental condition: Printing and dyeing wastewater treatment process is shown in Fig. 1. The membrane composite nanofiltration membranes were different pore sizes, the operating pressure is 0.5 to 1.5 MPa, the feed flow rate was 10 to 50 L/h, effective membrane area was 65 cm^2 and test temperature was 22-31 °C.

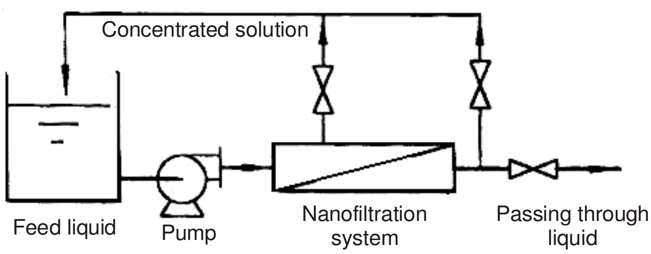

Fig. 1. Printing and dyeing wastewater treatment process

RESULTS AND DISCUSSION

Choice of nanofiltration membrane: Composition of dyeing wastewater was complex, containing macromer colored dye, other organic and inorganic salts of different molecular weights. Thus nanofiltration membrane technology for the treatment of dyeing wastewater for a variety of printing and dyeing wastewater selected suitable materials and pore size membrane material selection considering the pH of the wastewater and the type of dye, dyeing and printing of the test according to the characteristics of the wastewater, select aromatic polyamide nanofiltration membrane; choice of the membrane pore size must ensure that the membrane printing and dyeing wastewater color and removal of chemical oxygen demand in order to reach a certain processing requirements; nanofiltration membrane wastewater inorganic salt off. In addition to the rate compared to the reverse osmosis membrane is much lower, the lower osmotic pressure of the process, water through the membrane is correspondingly higher than the reverse osmosis process, at the same time also have a high removal rate of the nanofiltration membrane on the water hardness, the polyvalent metal ions such as, back to the standard and thus can be achieved by nanofiltration membrane technology treated waste water.

The pore size of membrane usually was characterized by the size of the salt rejection of nanofiltration membrane for 2000 mg/L NaCl aqueous solution, the greater the desalination rate, the smaller the pore size of the membrane. Table-1 showed the performance of different pore sizes nanofiltration membrane treatment of dyeing wastewater. Table-1 showed that the three nanofiltration membranes with different pore sizes could be 100 % removal of wastewater. The chroma of chemical oxygen demand removal performance of the pore size membrane of chemical oxygen demand increases as the membrane pore size decreases, the 3rd nanofiltration membrane was almost 100 % removal of chemical oxygen demand in the wastewater.

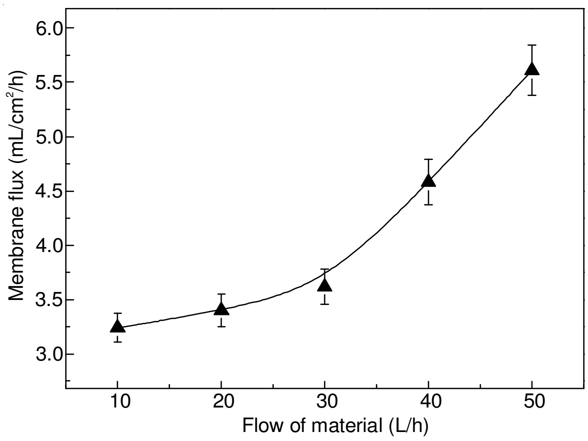

Fig. 2. Relationship between material flow and membrane performance

As shown in Fig. 2, nanofiltration membrane technology for the treatment of dyeing wastewater treatment efficiency directly depended on the cost of processing and was crucial to select the appropriate operating conditions. Under the premise of chemical oxygen demand and color removal, water flux, the higher the efficiency of processing, feed flow rate and operating pressure on water flux influence. As shown in Fig. 1, the water flux of the membrane increases with increasing feed flow rate and operating pressure. Feed flow mainly affect the current state of the waste on the membrane surface, the increased flow of material to liquid flow rate increases on the membrane surface, reducing the concentration polarization and contamination of the membrane surface, resulting in an increase in membrane water flux; operating pressure of the driving force of the pressure-driven membrane processes, overcome the osmotic pressure of the process and on both sides of the membrane to produce a net driving force for the process to reach a certain water flux, operating pressure increases, the net driving force of the process is increased, resulting in water flux increases.

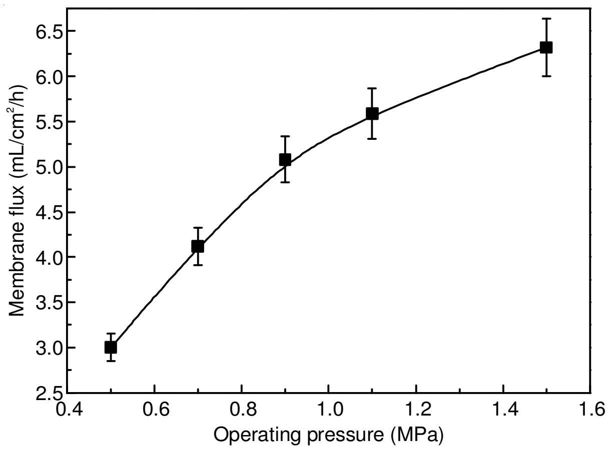

Fig. 3. Operating pressure membrane performance relationship enrichment process and membrane properties

As shown in Fig. 3, the treatment of dyeing wastewater with nanofiltration membrane, printing and dyeing wastewater enrichment process, the higher the membrane wastewater treatment rate, the higher the recovery process, the less concentrated wastewater, the concentrated wastewater also required for further processing, typically on the concentration of the wastewater for further biological or steam treatment. With the membrane of printing and dyeing wastewater concentrated wastewater organic content will continue to increase. The performance of the membrane will change. Table-2 showed the membrane performance under different process recovery with nanofiltration membrane treatment of dyeing wastewater.

As shown in Table-2, even if the process of recovery was of 90 %, remains at 100 % of the membrane on the chromaticity

TABLE-1
WASTEWATER TREATMENT PERFORMANCE OF NANOFILTRATION MEMBRANE

Number	Desalination rate (%)	Permeate COD (mg/L)	Permeate chromaticity (x)	Removal rates of COD (%)	Removal rates of chromaticity (%)
1	52	180	0	65. 4	100
2	68	82	0	84. 2	100
3	81	6	0	98. 8	100

Test conditions: 2000 mg/L NaCl aqueous solution, 1.0 MPa at 25 °C

TABLE-2
MEMBRANE PERFORMANCE UNDER DIFFERENT RECOVERY RATES

Fraction product recovery (%)	Membrane flux (mL/cm^2 h)	Concentrated solution COD (mg /L)	Permeate COD (mg/L)	Removal rates of COD (%)	Removal rates of chromaticity (%)
0	5. 8	520	6	98. 8	100
50	3. 2	1030	12	98. 8	100
66	2. 2	1570	20	98. 7	100
80	1. 5	2600	35	98. 7	100
90	1. 3	5100	75	98. 5	100

removal through the liquid chemical oxygen demand content is still small, only 10 % of the initial volume of wastewater and concentrated wastewater, greatly reducing the subsequent further processing of the pressure. So nanofiltration membrane technology behaved a good characteristic for the removal of chemical oxygen demand and chromaticity.

Conclusion

Nanofiltration membrane technology can effectively achieve the purpose of dyeing wastewater treatment. Nanofiltration membrane technology for printing and dyeing wastewater chemical oxygen demand removal rate was over 98 and then 100 chromaticity removal; permeate chemical oxygen demand content of the wastewater treatment rate (the process of recovery) up to 90 % still was less than 100 mg / L. The national emission standards had a high application value. With nanofiltration membrane dyeing wastewater treatment process, the water flux of the membrane operating conditions and process recovery. Membrane water flux increased with the increase of feed flow rate and operating pressure and then with the process improvement of recovery declined.

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