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Effect of N_2-back-flushing in multichannels ceramic microfiltration system for paper wastewater treatment

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Abstract

The ceramic microfiltration system with periodic N_2-back-flushing was operated for treating paper wastewater discharged from a company making toilet papers by recycling milk or juice cartons. Two kinds of alumina membranes with 7 channels used here for recycling paper wastewater. The optimal N_2 filtration time for HC04 membrane with 0.4μm pore size was lower value of 4min than 16min for HC10 with 1.0μm pore size at fixed back-flushing time 40s, trans-membrane pressure 1.0kg_f/cm^2 and back-flushing pressure 5.0kg_f/cm^2. From the results of TMP effect at fixed filtration time and back-flushing time, the lower TMP was better on membrane fouling because high TMP could make easily membrane cake and fouling inside membrane structure. However, we could acquire the highest volume of total permeate for the reason that TMP was driving force in our filtration system to treat paper wastewater. Then the permeate water of low turbidity was acquired in our microfiltration system using multichannels ceramic membranes, and the treated water could be reused in paper process.

Keywords: Ceramic membrane; Multichannel; Back-flushing; Microfiltration; Paper wastewater

1. Introduction

Nowadays the recycling rates of industrial wastewater should be increased, and the dual water system extended to solve the shortage of water source and water pollution by dramatic economic development of developing countries. Various technologies for advanced wastewater treatment have been developed to satisfy such a demand, and one of them was membrane separation. Recently the membrane separation has been applied to wastewater treatment for reuse.

Many researchers have published the results of wastewater treatment by membrane separation. Tchobanoglous et al. [16] treated highly the domestic wastewater by ultrafiltration (UF), and

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Cheryan and Rajagopalan [2] studied the economic efficiency of oil–water emulsion treatment by combining method of the traditional chemical treatment and membrane separation. Roorda and van der Graaf [13] investigated the characteristics of ultrafiltration for effluents of two wastewater treatment plants. As an example of applications of ceramic membranes used in this study Li et al. [9] used ceramic microfiltration (MF) membranes to separate cells from *E. coli*-containing fermentation broth. Then, Nazzal and Wiesner [10] reported the effect of pH and ionic strength in water treatment by ceramic microfiltration membranes.

However, the economic efficiency of membrane separation for wastewater treatment should depend on the power cost of operation, the permeate flux, and the membrane lifetime. The lifetime of membranes has a deep relation with membrane fouling during the operation. It was well known that the membrane fouling was made by concentration polarization and gel layer formation on the surface of membranes, and adsorption and pore blockage in the pores inside membranes. Therefore, a lot of researches have been accomplished for solving the membrane fouling in the world. For an example, Taylor vortex was applied to microfiltration to reduce the membrane fouling by Park et al. [11] and Choi et al. [3]. Then, the membrane back-flushing is a new technology to minimize the membrane fouling, and to maintain a high permeate flux during membrane separation. Many papers related with membrane back-flushing have been published nowadays. Davis et al. [4] built up a modeling of concentration and depolarization with high frequency backpulsing. Srijaroonrat et al. [15] applied the back-flushing to ultrafiltration of oil/water emulsion. And Sondhi et al. [14] researched that the membrane fouling could be minimized by backpulsing in the cross-flow filtration of chromium hydroxide suspension using ceramic membranes. And Kuberkar and Davis [8] could reduce the fouling resistance of pollutant layer on the membrane by back-flushing in the microfiltration of protein cell mixture (BSA, yeast). Heran and Elmaleh [5] showed that highly frequent back-flushing could be effective on the microfiltration of three kinds of suspended solids through inorganic tubular membranes. Then, we published membrane fouling control effects of periodic water-back-flushing period, TMP, and flow rate using tubular carbon ceramic UF and MF membranes for recycling paper wastewater [7]. Also, we recently reported effects of periodic N_2-back-flushing in paper wastewater treatment using carbon UF and MF membranes [6].

The high chemical resistance of ceramic membranes used here made it possible to treat the paper wastewater including various chemicals and pollutants. And the ceramic membranes were washable by strong acid or steam with high pressure because of their high mechanical strength, and had a long lifetime. We tried to find the optimal conditions of 7 channels ceramic microfiltration system with periodic N_2-back-flushing for the wastewater discharged from a company making toilet papers, and to reuse in paper process.

2. Theory

The resistance-in-series filtration equation shown in Eq. (1) was applied to analyze the experimental data of this research. The equation was known well in the application field of membrane separation. Carrene et al. [1] investigated the resistance of membrane, cake of bacterial cell, adsorption, and concentration polarization of solution by using Eq. (1).

$$J = \Delta P/(R_m + R_b + R_f) \quad (1)$$

where J was the permeate flux through membrane, ΔP was TMP (trans-membrane pressure), R_m the resistance of membrane, R_b the resistance of