FLUX DECLINE DURING THE ULTRA-FILTRATION OF DILUTE Si COLLOIDAL SOLUTION WITH HOLLOW FIBER MEMBRANE

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ABSTRACT

The ultrafiltration behavior of dilute colloidal solution containing Si particles has been investigated. The experiments in cross flow mode have been performed at different operating condition by using the membrane with 20 kDa cut-off. The flux decline was due to the development of membrane fouling which was a dynamic process of two distinctive stages. For the high trans-membrane pressure, the pore blocking resistance was dominant at the initial period of filtration and was followed by the cake resistance. And for the low cross flow velocity, the membrane fouling was governed by the cake filtration model at the initial stage of filtration process. Flux jump was observed temporally during the membrane filtration of mixed feed solution.

INTRODUCTION

One of the major bottlenecks in ultrafiltration of colloidal solution such as that of Si is fouling, which exhibits sudden flux decline. Membrane fouling reduces productivity and shortens membrane life. Fouling is a complex phenomena depending on interaction of membrane - solution and also other parameters. Fouling can be classified into two types according to its location; one is the surface fouling which occurs on the surface of membrane (the build up of cake layer) and the other is the internal fouling which occurs on the surface of membrane pores (pore plugging and adsorption). The objective of this work is to investigate the permeation behavior of Si colloidal solution with using the hollow fiber membrane and to analyze the fouling mechanism.

EXPERIMENTAL

The experiment was carried out with the holloe fiber membrane(MWCO : 20000) The experiment was operated at 25℃ atmosphere, the feed flow rate of 0-4L/min and the applied pressure of 0-3kg_f/cm^2. Si concentration was determined by both atomic absorption spectrophotometer(Shimadzu 6701) and turbidimeter(Oberco 965).

RESULTS

As shown in Fig. 1, flux decline with time was observed for both the cross flow for the hollow fiber membrane. And the type of flux decline was similar, but the rate of decline is more significant at the case of high applied pressure. This decline is due to accumulation of the colloid particles both rejected on the membrane surface and adsorbed in membrane pores. In case of high trans membrane pressure, the initial deviation from

linearity suggests an initial pore plugging. The pores that are larger than the Si particles can be blocked by small Si particles. Fig. 2 presents the results of an fouling model. From the Hermia's equation, a plot of dR/dt against time will readily reveals the resistance mechanism. A positive gradient is indicative n>1 and therefore pore blocking. While a negative gradient suggest cake filtration. In Fig. 2, both lines which reveal the fouling mechanism, show the same trend. It can be seen that after 3min of operation the gradient of dR/dt becomes negative, therefore the pore blocking becomes insignificant and the cake filtration predominates in each case. And the effect of pore blocking at high pressure is more severe than that of the low pressure case. Flux jump was observed temporally during the membrane filtration of mixed feed solution in Fig. 3. Cake layer of mixed feed solution was composed of two different layers. The initial upper layer was consist of large particle and the other was made up of small particle. The upper fouling layer peeled off from the lower layer by shear and the resistance of permeation decreased.

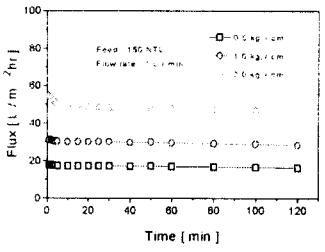

Fig. 1. Effect of TMP on the permeate flux.

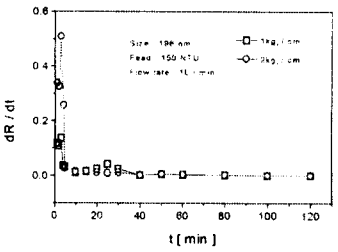

Fig. 2. dR/dt analysis for the different TMP.

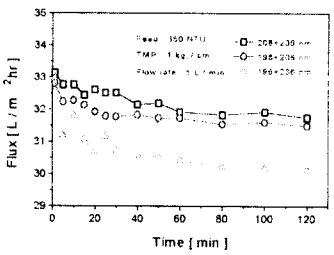

Fig. 3. Effect of particle size in mixture on the permeate flux

CONCLUSION

In the ultrafiltration process of the Si-colloid solution, the flux decline with time was induced by both the growth of Si cake on the membrane surface and the pore plugging by Si particles. Rapid flux decline in the early stage due to the pore blocking of membrane pores followed by cake deposition at high trans membrane pressure. Flux jump was observed temporally during the membrane filtration of mixed feed solution

REFERENCES

1. J.G. Wijmans, S. Nakao, and C.A. Smolders, *J. Membrane Sci.*, 20, 115(1984).
2. E. Iritani, Y. Mukai and T. Murase, *Trans IChemE*, 73,Part A, 551(1995).
3. A.B. Koltuniewicz, R.W. Field and T.C. Arnot, *J. Membrane Sci.*, **102**, 193(1995).
4. R. Jiraratananon, D. Uttapap, and C. Tangamornsuksun, *J. Membrane Sci.*, **129**, 135 (1997).