일반강연 Ⅳ-i

A Study on Dynamic Separation of Silica Slurry Using a Rotating Membrane Filter: Transient State and Steady State

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회전막 여과기를 사용한 실리카 슬러리의 동역학적 분리에 대한 연구: 과도기와 정상 상태

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In this study characteristics of dynamic filters utilizing Taylor vortices were investigated both experimentally and theoretically. With fine silica slurry of 4.0 μm in average size experiments were conducted in Taylor vortices generated between the rotating inner cylinder consisting of microfiltration membrane of 1.2 μm in average pore size and the stationary outer cylinder. The diameter of the inner cylinder was 5.2 cm. Four outer cylinders having different diameters were manufactured and therefore four types of dynamic filters having the different ratio of the annular gap to the inner cylinder radius, i.e. 0.17, 0.33, 0.54, 0.65, were used as the experimental apparatus, as shown in Fig. 1.

The present experiments showed that with an increase in rotating speed of membrane the filtrate flux decreases slowly with times, and at steady state a higher filtrate flux is maintained in comparison with that in a conventional filter. However, the initial filtrate flux decreased at the high rotating speed by the pressure drop at the membrane surface. As the concentration of feed slurry increased, both the initial filtrate flux and the steady-state filtrate flux dropped, but the dimensionless filtrate flux was almost independent of slurry concentration. At turbulent flow regimes with Taylor vortices in the present experiments the axial velocity seems not to affect the filtrate flux in the region of the axial Reynolds numbers Re_a , $14.6 < Re_a < 36.5$.

From experimental results at transient state and steady state the following correlations were obtained respectively in terms of the initial filtrate flux J_{mo}, the steady-state filtrate flux J_{ms}, Taylor number Ta, the ratio of the annular gap to the inner cylinder radius d / r_i and the dimensionless cumulative throughput V / V_o:

(transient state)

$$J_{mo} / J_m = [-1.40x10^{-4}\ Ta + 5.16\ (d / r_i)^{1.33}]\ (V / V_o) + 1$$

(steady state)

$$J_{ms} / J_{mo} = 1.78x10^{-5}\ (d / r_i)^{-1.34}\ Ta + 8.39x10^{-2}$$

which represent the present measurements very well, as compared in Fig. 2.

The present studies on dynamic filters will be very useful in understanding dynamic filtration. Furthermore the related experimental and theoretical principles will be able to be applied to chemical processing and bioprocessing such as solid-liquid separation, concentration of expensive particles, biological cell harvest, membrane reactor and etc.

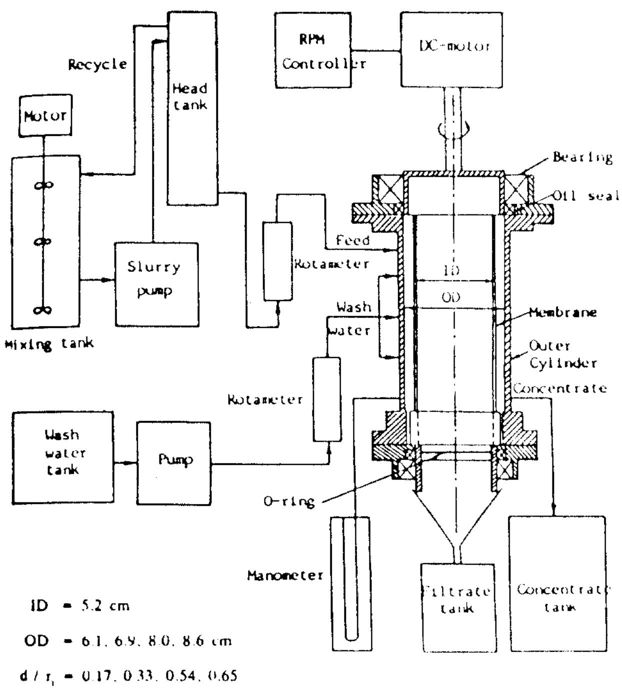

Fig. 1. Apparatus of dynamic microfiltration

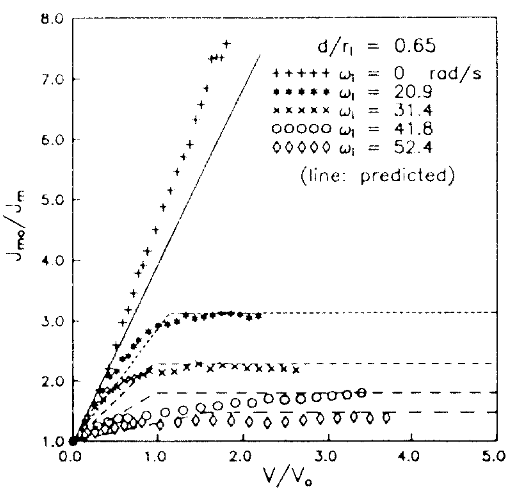

Fig. 2 Comparison of measured and predicted values of reciprocal of dimensionless filtrate flux (d / r_i = 0.65)