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INTERMITTENT AND CONTINUOUS FILTRATION OF ACTIVATED SLUDGE WITH VARIOUS NUMBERS OF HOLLOW FIBER LOOPS

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1 Introduction

Hollow fiber membrane consisting of hundreds of fiber threads are usually used for practical water and wastewater treatment purposes. Clogging due to the accumulation of particles at hollow fiber effluent lead and inter fiber clogging have not yet been investigated and were believed to be significant. It is necessary to examine the treatment capability of a single thread hollow fiber compared with that of bundle type hollow fiber membrane module. The filtration characteristics of the mentioned hollow fiber membrane (with various fiber thread numbers and different length) were examined. Activated sludge of mixed liquor suspended solids (MLSS) between 4000 to 8000 mg/L was used.

2 Material and Methods

The experiments were carried out under laboratory scale apparatus with 20 mm circular flow channel as shown in Fig. 1. Two pumps were used, P1 for circulation (maximum flow rate of about 3000 L/h, corresponding to a flow velocity of 2.5 m/s) and the other, P2, for creating filtration pressure up to 150 KPa of pressure. The transmembrane pressure was negligible when P2 was off because the applied pressure by P1 was very low compared with that obtained from P2. Intermittent filtration pressure release was achieved by switching on and off of P2 which was controlled by a sequential timer; 5 minutes on and 5 minutes off time was used. Hollow fiber membrane used was made of polyethylene and manufactured by Mitsubishi Rayon Company (Japan), with a cut off size of 0.1 μ m, inner and outer diameter of 270 μ m and 380 μ m respectively. The length of loop hollow fiber membrane used was 30 cm. The pipelines of the apparatus were cleaned by circulating pure water on line with a 0.05 μ m filter cartridge before pure water flux was measured. Alcohol was injected to initiate the flow because of hydrophobic nature of the membrane. For the case of used membrane, attached particles were removed before measurement of pure water flux was made.

3 Results and Discussion

Fig.2 shows the filtration flux, MLSS and percentage COD removal with filtration time for number of hollow fiber loops varied from 1 to 16. The fluxes reached steady states on the 5th day of filtration. Longer time was necessary since accumulation of particles was slow. MLSS varied from about 4 g/L to 8.5 g/L. COD removal was observed to be more than 95%. Flux decreased exponentially with numbers of hollow fiber loops. Hollow fiber of single loop gave maximum flux since the accumulation of particles was minimum. Fig. 3 shows the same results as Fig.2, but intermittent filtration of 5 minutes on and 5 minutes off was employed. Flux decreased at a slower rate with respect to the numbers of hollow fibers. The COD removal was observed to be higher than 93%. Fig.4 summarizes the steady state fluxes obtained after 6 days of filtration for every experiment conducted. In case of lower cross flow velocity was employed, since thicker gel layer was formed, the fluxes were low. For hollow fibers under high cross flow velocity, equal fluxes were obtained. The fibers were dispersed completely by turbulence, so that every thread acted independently. No accumulation of sludge particles was observed. For intermittent operation, the fibers were scattered incompletely. Less influence by number of hollow fibers was observed. The filtration rate obtained from intermittent operation was higher than that obtained from continuous counterpart. The dispersion of hollow fibers could be used to explain this increment.

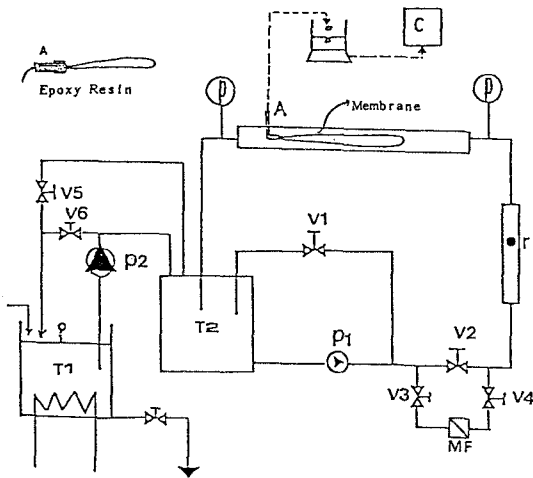


Fig. 1 Experimental Set-up

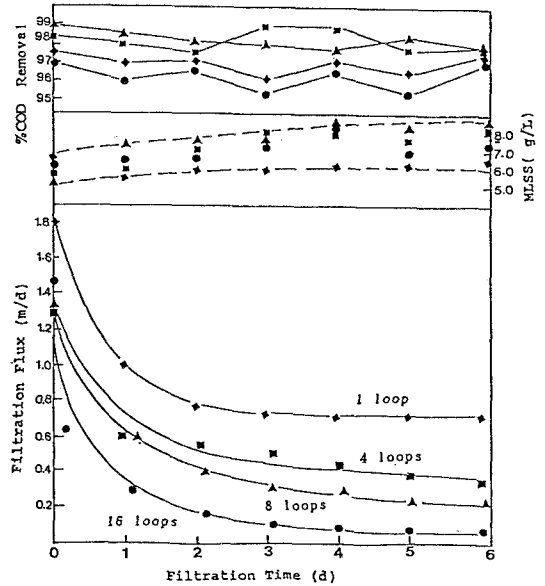


Fig. 2 Filtration Flux versus Filtration Time (Activated Sludge, Pressure = 59 KPa, Continuous Filtration, Cross Flow Velocity = 1.3 m/s, T = 25 °C)

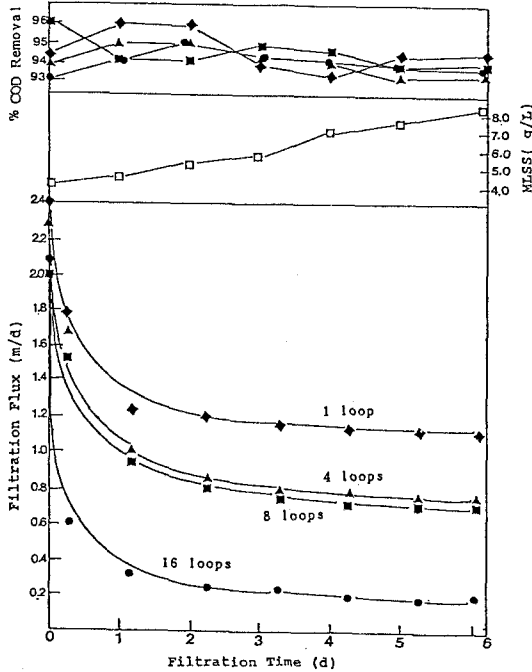


Fig. 3 Filtration Flux versus Filtration Time (Activated Sludge, Pressure = 59 KPa, Intermittent Filtration, 5 Min/5 Min, Cross Flow Velocity = 1.3 m/s, T = 25 °C)

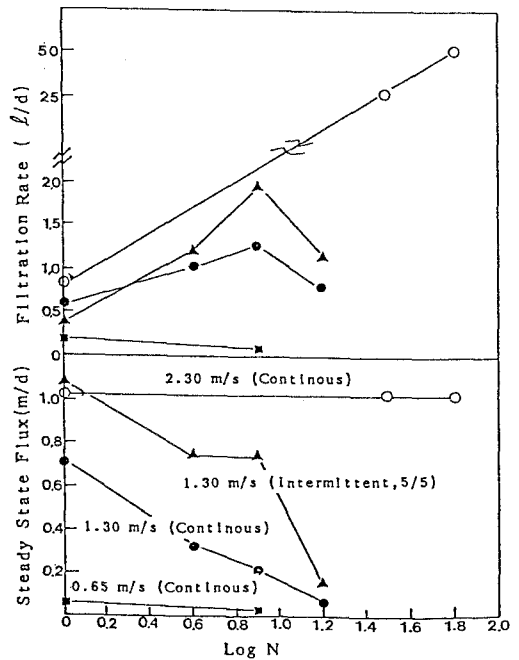


Fig. 4 Steady State Flux and Flow Rate versus No. of Hollow Fibers (Activated Sludge, MLSS=4.0 g/L to 8.5 g/L, Pressure = 59 KPa, Cross Flow Velocity as shown, T = 25 °C)