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PERFORMANCE OF SINGLE THREAD HOLLOW FIBER MEMBRANE ON POLYMER SUSPENSIONS AND ACTIVATED SLUDGE

Wong Yen Kiat, Kazuo Yamamoto and Shinichiro Ohgaki

Department of Urban Engineering
The University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo 113

Introduction

Hollow fiber membrane consisting of hundreds of fiber threads are usually used for practical water and wastewater treatment purposes. Fouling and clogging are two serious and unavoidable problems in membrane processes. Clogging phenomenon due to the whole membrane module has been investigated [1,2], but the mutual influence of neighbour hollow fibers, perhaps, the accumulation of particles at some certain points, especially, at the hollow fiber effluent lead, and the air bubbles, were believed to be significant. For this reason, a single separated hollow fiber thread appears to be the most suitable choice in order to avoid the above mentioned facts. It was observed that intermittent release of the filtration pressure increased the effective filtration flux considerably[1], and, the detachment of particles from the membrane surface was used to explain this phenomenon, but what kind of mechanisms, and how effective the detachment of particles might give benefits to the filtration system? Furthermore, under what conditions, the release of pressure might give benefits to filtration flux? This doubtful points could be cleared easily by using only one hollow fiber membrane. The physical configuration of hollow fiber membrane (e.g. length of the membrane fiber) might become one important design criterion in wastewater treatment consideration.

Materials and Methods

The experiment set-up is shown in fig.1, with a detailed figure of the self-glued hollow fiber thread. The hollow fiber thread was the type produced by Mitsubisi Rayon Co., with a inner diameter 270 μ m, a wall thickness of 55 μ m, cut-off size of 0.1 μ m. The initial water flux was tested at about 24 m/d at a pressure of 1 kg/cm^2. The length used was 30 cm in loop, total effective filtration area was about 7.64×10^{-4} m^2. The membrane was glued to a 4mm diameter acrylic pipe, with epoxy resin, the end of the tube with excess resin was cut with a sharp razor blade 1 to 2 hours after curing started. The one thread hollow fiber membrane was fixed with some plastic pins to the flow channel wall of diameter 20 mm. The cross flow velocity was adjusted by valves. Before experiments with polymer suspensions and activated sludge, the whole pipeline circuit was cleaned by circulationg pure water, either filtrate from 200 thousand membrane unit or deionised water. The purpose of the MF cartridge was to trap the left over particles on the pipeline's wall, so that no particles, more than 0.1 μ m could influence the performance of the hollow fiber membrane. The pure water was tested until steady (lasted about 2 to 3 hours). Then, experiments with polymer suspensions and activated sludge were carried out.

Two types of polymer suspensions were used, namely MP1401 (0.7-0.9μm) and MP1451 (0.1-0.2 μm) Poly methyl meta acrylate (PMMA) suspensions and activated sludge MLSS concentration of about 5000-6500 mg/L were used. For Activated sludge, substrate was fed into the system continously, the sludge was discharged daily to maintain a retention time of about 10 days. pH was controlled at about neutral by adding either sodium hydroxide or hydrochloric acid by a pH controller. For PMMA solution, a pH of about 6.2-6.4 was adjusted.

Results and Discussion

Continous and intermittent operation (2 min on/2 min off etc.) experiments were carried out on MP 1401 (0.7-0.9 μm) and MP 1451 PMMA (0.1-0.2 μm) suspensions. For MP1401, effective size was much larger than the cut off size, thereotically , no particles can pass through the membrane, however, minimum amount of TOC (about 10-15 mg/L) was detected. This was due to the low molecular solvent originally present in the polymer suspensions. Figure 2 shows the relationship between filtration flux with time. Steady state was achieved after 3 to 4 days, lasted to about a week. Intermittent operations shows an increase in filtration flux (about 3 times of that obtained from continous operation). For operation 55 min on/ 5 min off, the same results was obtained. This can be used to explain that, the increment of the filtration flux was only due to the removal of gel layer by shearing force (circulation), under a velocity of 1.2 m/s, gel layer could not form on the membrane surface if there was not lateral(suction) force due to filtration. Basically, the pore sites were not seriously clogged by the polymer particles, but if the clogging happened inside the pore sites, like that shown in fig.3, intermittent operation shows little benefit.

Figure 4 shows the same relationship but activated sludge of MLSS concentration varied from 4500 to 6500 mg/L was used. The daily filtrate extracted from the one thread hollow fiber was about 600 to 700 mL/d. Intermittent run shows higher real time flux than that obtained from continous run, since thinner gel layer was observed. The sustrate was fed into the system continously (see fig.1) at about 800 to 900 ml per day. The MLSS was kept between 5000 to 6500 mg/L by desludging about 2.5 to 3 liters of sludge from the 25L reactor everyday. The COD_{Cr} of the effluent was observed between 150-280 mg/L.

References

1) Kazuo Yamamoto, Masami Hiasa, Talat Mahmood and Tomonori Matsuo, Water Science Tech, Vol. 21, Brighton, pp 43-54, 1989

2) Kazuo Yamamoto, Masami Hiasa and Tomonori Matsuo, 42nd Meeting of JSCE, 2, pp 824-825, 1987 (In Japanese)

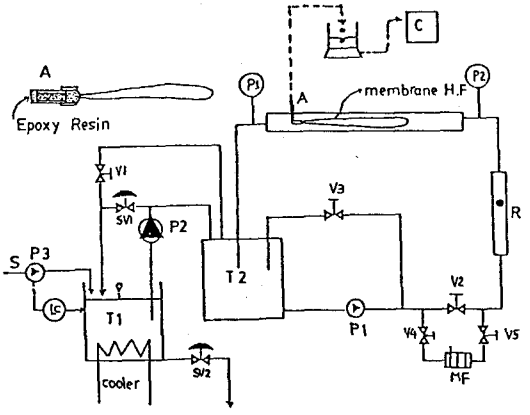

Fig. 1 Experimental Set-up

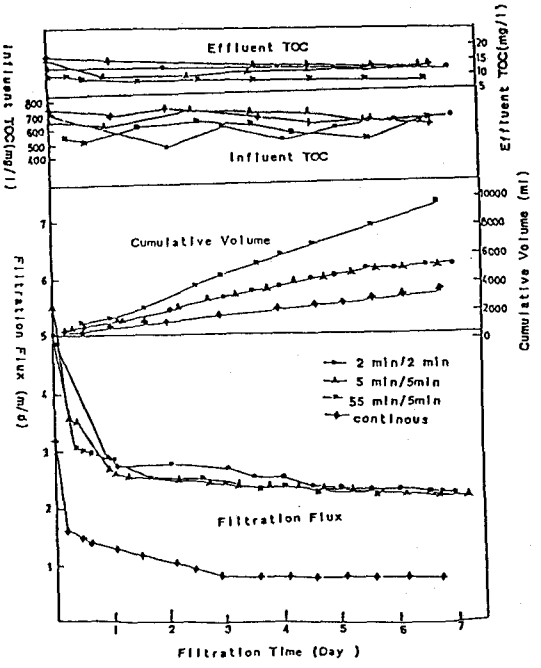

Fig. 2 Filtration Flux versus Filtration Time (MP 140) Effective Size 0.7-0.9μm, Pressure =0.6 Kg/cm² (44 cm Hg), Cross Flow Velocity = 1.2 m/s, T=25°C)

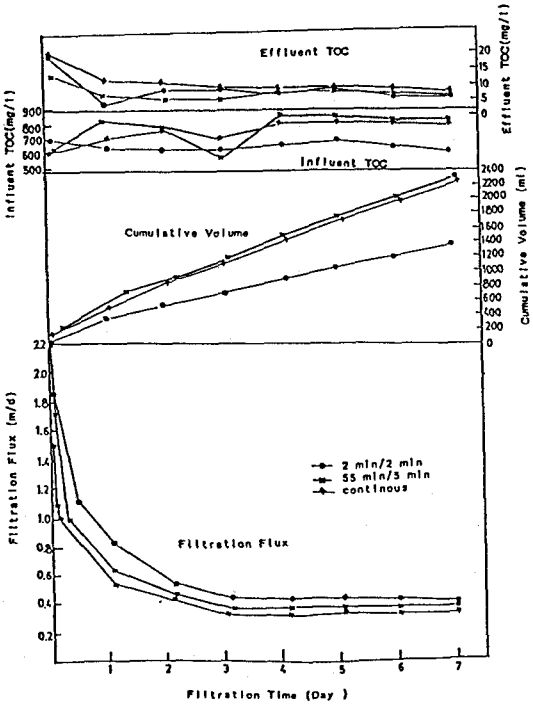

Fig.3 Filtration Flux versus Filtration Time (MP 145) Effective Size 0.1-0.2μm, Pressure =0.6 Kg/cm² (44 cm Hg), Cross Flow Velocity = 1.2 m/s, T=25°C)

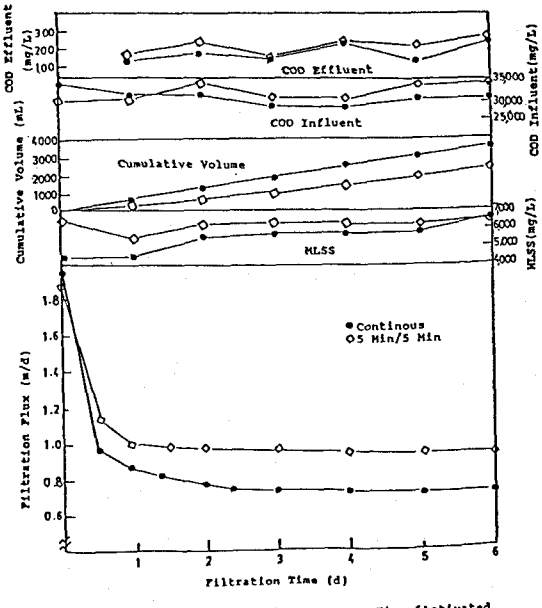

Fig. 4 Filtration Flux versus Filtration Time (Activated Sludge, Pressure=0.6 Kg/cm² (44 cm Hg), Cross Flow Velocity=1.2 M/s, T=25°C)