MICROFILTRATION OF EFFLUENT PRODUCED BY A MOVING BED BIOFILM REACTOR BY AN IMMERSED HOLLOW FIBER MEMBRANE MODULE.

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Introduction.

The objective of this research was to investigate the efficiency of polymeric hollow fiber membranes for clarification of the effluent produced by a moving bed biofilm reactor (MBBR). The effluent from such a process consists of small, poorly settleable flocs resulting in a clarification problem using conventional methods.

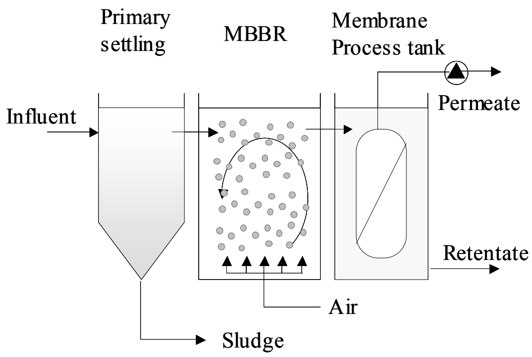

Figure 1: Schematic of pilot plant and experimental configuration.

Experimental configuration and procedure.

The pilot plant used in this investigation is shown in figure 1 and consisted of a primary settling tank, the MBBR and a process tank with a submerged hollow fiber membrane module. Raw sewage was fed to the pilot plant without any pretreatment. Operation and loading rate of the MBBR was defined to maintain only BOD removal without nitrification and denitrification, and an average load of 3 kg $COD/m^3 \cdot d$ was applied. Effluent from the MBBR was then collected in the membrane process tank operating at a 50-60% recovery.

A control panel was used to operate the submerged membrane module. A suction pump was set to maintain a constant flux and the performance of the unit was determined by monitoring the transmembrane pressure. The control panel also enabled periodic backwashing of the hollow fibers and air scouring of the unit if necessary. The overall performance of the pilot plant was determined by analyzing the following parameters; suspended solids, COD and SCOD, turbidity, particle size and distribution, pH, dissolved oxygen (DO), temperature and ammonia nitrogen. Samples were collected from the influent to the MBBR, the MBBR, the membrane process tank and in the permeate respectively.

Results and discussion.

The overall temperature of the wastewater remained consistently around 14°C for the duration of this study. An average of approximately 20 mg/l NH_4-N was measured throughout the pilot plant and no nitrification was observed in the process. DO concentrations varied in each section of the pilot plant as a function of the aeration in the MBBR and the air scouring in the membrane process tank. On average the influent DO was 2 mg/l, 6 mg/l in the MBBR and between 8-10 mg/l in the membrane process tank and permeate. Representative results from the analysis of suspended solids, turbidity and COD, SCOD for a given operating condition are shown in figure 2. COD removal is achieved in the MBBR reactor and there is no detectable biological activity within the membrane process tank. Practically all particulate COD is removed from the permeate in that the COD measured in the permeate is soluble COD. Results are consistent with SS and turbidity measurements for the permeate in that no particulate matter is found (SS < 5mg/l and turbidity < 1 NTU). The effluent from the pilot plant showed a consistent high quality irrespective of operating conditions with average treatment efficiencies reported in table 1.

Quality Parameter	SS mg/l	Turbidity NTU	COD mg/l	SCOD mg/l
Treatment efficiency. %	99,5	99,5	84,0	24,6

Table 1. Average treatment efficiencies of measured parameters.

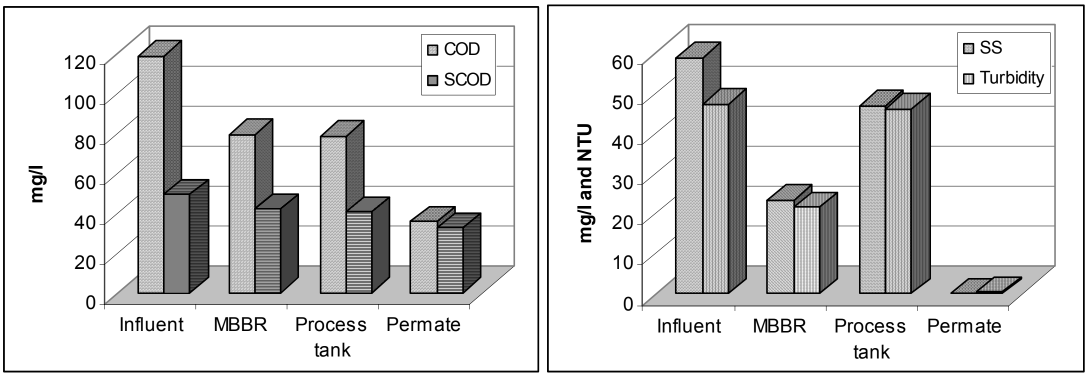

Figure 2. Representative analysis results of COD/SCOD, SS and turbidity.

The membrane performance was investigated by varying operating conditions for the membrane unit. An average permeate flux of 58 $l/m^2 \cdot h$ was maintained for all tests and a transmembrane pressure (TMP) range of 0-0,7 bar. Fouling of the membrane module was controlled by operating the unit with 10 minute cycles (9min 30sec suction and 30sec backwash) and continuous air scouring, air scouring in pulses (2 minutes on/off) and no air scouring respectively. Results are shown in figure 3. A cleaning procedure using an extended backwash and low concentrations of NaOCl was applied when the limiting TMP of 0,7 bar was reached. Initial TMP values (≈ 0,1 bar) were recovered by the cleaning procedure applied. A major contributor to the operating costs of the pilot plant is the need for air scouring to minimizing membrane fouling. Without air scouring the system had run cycles between 1,5-2 hours before cleaning was required. With continuous air scouring, cycles of approximately 80 hours were achieved before extended cleaning was required. Air scouring in pulses resulted in approximately 10 hours of operation before cleaning was required, however, an optimization of the system was not investigated.

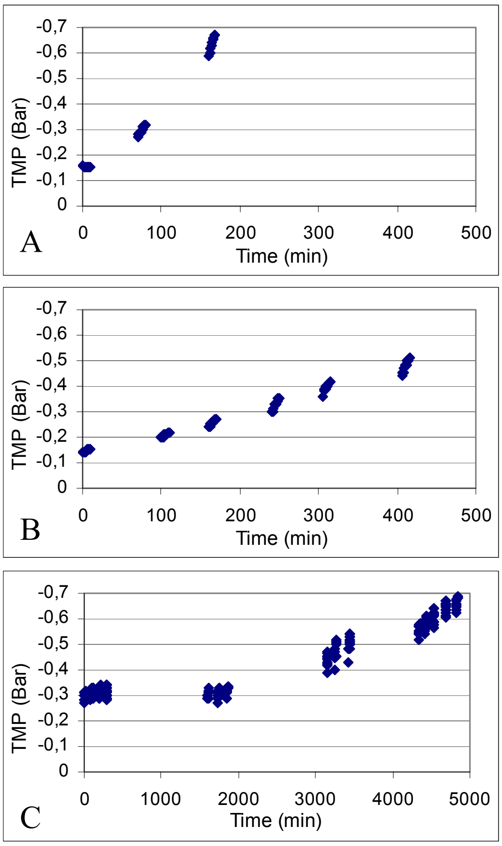

Figure 3.
Transmembrane pressure development for operating conditions investigated:
A - no air scouring
B - air scouring in pulses
C - continuous air scouring

Conclusions

Separation of the biomass and particulate matter from the MBBR was achieved with an average of 99,5% removal efficiency. Even though operation of the MBBR was not optimized, a very high quality effluent was produced with the MBBR-membrane hybrid process. A permeate flux around 60 $l/m^2 \cdot h$ was maintained with operation cycles varying between 10-80 hours depending on the application of continuous air scouring or in pulses. Backwashing of the membrane through a backpulse cycle was not sufficient on it's own to minimize membrane fouling and air scouring is the most important factor in reducing fouling. The results indicate, however, there is a great potential to reduce operating costs by optimizing a backpulse/air scouring cycle. Results indicate that application of microfiltration for the clarification of effluent from a MBBR in a hybrid process has potential as an alternative for treatment of municipal wastewater.

Acknowledgements

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