Research on the Effects of Different Types of Materials on Micro-membrane

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Abstract. Four types of micro-membrane modules made of polyester621 (180 mesh), nylon6 (100mesh and 180 mesh) and polypropylene (180 mesh), which are available materials on the market, have been used as the membrane of Dynamic Membrane Bio-Reactor(DMBR) to treat simulated domestic sewage, and the results were compared. Under the same experimental conditions, the initial module flux of polyester and polypropylene were far less than that of nylon, and the downward trend of it were obvious over time. Nylon screen mesh had a relatively high initial module flux and there was a positive correlation between its aperture and module flux.

Introduction

Dynamic Membrane Bio-Reactor (DMBR), made of inexpensive nets as its filter material, is a new wastewater and sewage disposal technique that takes the advantage of newly-formed bio-membrane on the surface of material to perform the function of interception. In other words, a new membrane is added over the original one, which is termed dynamic membrane or secondary membrane. This technique keeps the merits that traditional bio-reactors have, while at the same time, has other advantages e.g., low energy consumption and low cost, etc. It is an extremely potential technique for wastewater and sewage disposal. A large number of domestic and overseas scholars have carried out further researches on this technique, for example, good results of control on preparation conditions and operation conditions have been obtained, which can reach the same level on treatment effects as Membrane Bio-Reactor (MBR) does[1-5].

How to Choose net

For dynamic membrane modules, net material fixed on the surface is vital for filter function. Thus, it is very important to take all the traits of net materials into account to select the proper one in practical application, namely water permeability, wear-resistance, acid and alkaline resistance, bio-attachment adhesion and other qualities like economy and easy to obtain.

In the experiment, four types of micro-membrane modules were made of polyester621 (180 mesh), nylon6 (100mesh and 180 mesh) and polypropylene (180 mesh) respectively, which are available materials for net on the market. The assembled dynamic membrane bio-reactors treated simulated sewage water for the purpose of making comparisons of their pre-films' lengths of time, the volumes of module flux and the abilities to regenerate, thus finally selecting the best material for net.

Experimental Materials and Method

Experimental Apparatus

Given is figure1 displaying the experiment apparatus of dynamic membrane bio-reactor. The length, width and height of the main reactor which is made of organic glass, are 50cm, 30cm and 45cm respectively. 10cm from the left side of the reactor is a baffle which divides the reactor into aeration zone and reaction zone. In the lower part of the aeration zone, several aerators are equipped. The operation of these aerators can create lateral aeration to provide plug flow power, as well as dissolved oxygen into mixture. The frame of the dynamic membrane module is made of PVC sheet with one net material fixed on its two sides. This is similar to flat membrane and the effective filtration area is 0.2m^2. Water will flow out of the apparatus due to the liquid pressure difference between standard liquid level and water outlet in the lower part of the apparatus. In order to maintain the balance of liquid levels, there are flowmeters both to the inlet and outlet.(During the experiment, each of the four modules were put into a reactor, with a flowmeter to its outlet to observe filtration flux changes.)

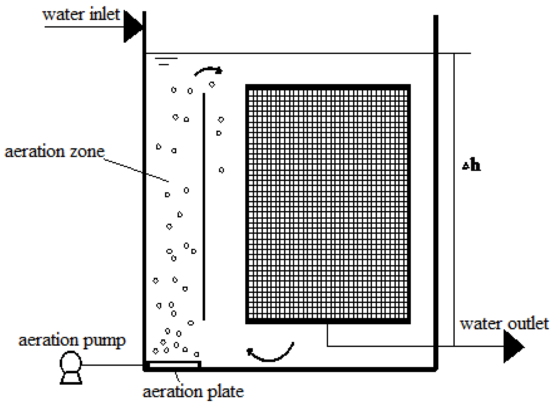

Fig. 1 The experimental apparatus diagram for the bio-reactor of dynamic membrane

Numbers of experimental materials for net are shown in Table1.

Tab. 1 The test's material for net

Number	Material and Type	Average Aperture(μm)	Remarks
1	Polyester 621	85.49 (nearly 175 mesh)	Monofil Plain Weave
2	Nylon 6	150 (100 mesh)	Monofil Plain Weave
3	Nylon 6	80 (180 mesh)	Monofil Plain Weave
4	Polypropylene 750	80 (180 mesh)	Monofil Plain Weave

It can be found from the above table that the physical and chemical properties of all three net materials are stable to some extent, among which nylon is most wear-resistant and it has some hygroscopicity; while polyester has relatively rough surface and poor hygroscopicity; polypropylene has light texture, smooth surface, good elasticity but poor ability to anti-age. Prices of the three chemical synthetic fibers are between 5 to 30 yuan/m^2 on the market. The price of nylon is the highest, approximately two to threefold of the other two materials, but still far cheaper than membrane materials in existing membrane bio-reactors.

The Quality of Inflow of Water and Testing Method

The laboratory inflow of water was simulated sewage that compounded by laboratory staff. Bases were glucose, ammonium chloride, potassium dihydrogen phosphate, with its COD at 210.9~328.4mg/L, ammonia nitrogen 15.7~23.5mg/L, TP 3.7~8.2mg/L and PH around 6.7. In the initial stage of experiment, some sludge from an aeration tank of a municipal effluent treatment plant was sieved. Then, the fully-sieved sludge was transferred to a reactor to aerate. A week later, the concentration of active sludge was measured to be about 5000mg/L, which could be seen as a sign of completion of domestication. At this time, four types of dynamic membrane modules were put into reactors to work. During the whole experiment, it is necessary to regularly observe changes of turbidity and flux of outlet in each module, and remain liquid level stable. In the experiment, COD was measured by potassium dichromate method (GB 11914—89) and turbidity by portable turbidimeter(Model HACH2100Q).

Comparison of Pre-film's Time Lengths

Figure 2 illustrates changes of turbidity of outlet on four micro-membrane modules over time.

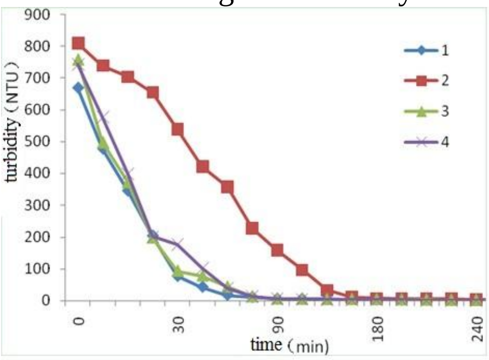

Fig. 2 The diagram for the change of module's outlet turbidity

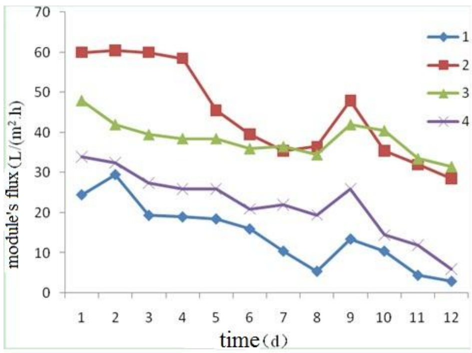

Fig. 3 The diagram for the change of module's flux

It can be seen clearly from the figure 2 that numbers of polyester, nylon and polypropylene were similar and outlets' turbidities were 670NTU, 759NTU and 743NTU respectively at the early stage of filtering. Then these turbidities saw a rapid decrease and their values of turbidity were close within same period of time for outflow. After 90minutes' filtration, the number of three outlets' turbidities were 5.59NTU, 5.94NTU and 6.77NTU separately. Following turbidity numbers basically remained lower that 5NTU and continued to decline over time, in the meantime, no obvious particulate matters were observed in the water. This means that the pre-films module 1,3 and 4 were basically finished after 90 minutes' normal outflow of water. Compared to the other three modules, module 2 got an outlet's turbidity much higher than 5NTU at 90^{th} minutes and it did not get close to this number until 180th minutes, which means nets with smaller aperture are conducive to form dynamic membrane quickly.

Comparisons on Changes of Module Flux and Regeneration

During the experiment, laboratory staff conducted a mechanical brushing on the modules' surfaces after reactors operated for 7 days. Figure 3 displays filtration flux changes measured by outlets' flowmeters. It can be known from the diagram that when mesh numbers were the same, the initial module flux of polyester and polypropylene were 24.5L/(m^2.h) and 34 L/(m^2.h) individually, less that that of nylon. By contrast, nylon(100 mesh) could get an initial module flux at 60 L/(m^2.h). This reveals that, under the same experimental conditions, different materials varied on their permeability and filtration effect, which is similar to Hong Junming and You Chaoyang's research findings. There is a positive correlation between aperture and initial module flux, that is, the bigger the aperture is, the higher the module flux values will be. It can also be found from the figure that all their initial module fluxes declined more or less over time, with polyester an2d polypropylene's downward trends most obvious. After carried out mechanical brushing on modules repeatedly, module fluxes increased back to some extent. However, after operating for one day, polyester and polypropylene modules experienced a remarkable drop on module flux; whereas nylon nets (both 100 mesh and 180 mesh) kept their average module flux above 30 L/(m^2.h). This was probably because polyester and polypropylene nets got relatively rough surface where sludge was prone to form a complete dynamic membrane, but it was easy to be blocked and difficult to be cleaned.

Conclusions

The aim to improve part of the structure of dynamic membrane module is to solve some problems, such as normal vibration , continuous backwashing and leaks on dynamic membranes which age and fall off; net materials of different mesh were compared on pre-films' lengths of time, the volumes of module flux and the abilities to regenerate, and finally to select the best material for net.

(1) Circular frame and damping plate were applied in the structure to keep dynamic membranes stable and uniform and reduce deformation.

(2) The improved structure of backwash can replace the traditional way of backwashing, which is low-energy consumed and less-water consumed. It can raise the normal efficiency of reactors to produce more water, at meanwhile, by backwashing in operation, it can promote dynamic membrane to update continuously to avoid leaks on the module due to aging and falling off irregularly.

(3) The design of double vector structure guarantees the stable operation of dynamic membrane bio-reactor and its high volume of module flux, also raises the quality of water flowing out of the reactor.

(4) The pre-film time length of polyester, nylon and polypropylene with same mesh are close to each other, but polyester's pre-film time length was shortest; the wider the aperture is, the longer the pre-film time will be.

Acknowledgment

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