Integrated wastewater treatment process using MESH filter modules for direct activated sludge separation

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INTRODUCTION

Membrane bioreactors (MBR) combine conventional wastewater treatment and membrane filtration to create a highly efficient wastewater treatment process. MBR are generally acknowledged for their low floor space requirement and the high quality effluent. However, there are certain disadvantages associated with the MBR technique which are mainly cost related. The innovation used in this approach, is the substitution of membranes by cost effective mesh filters offering higher flux rates at very low filter pressures. To investigate, pre-screening tests were performed with different mesh materials and subsequently a laboratory test plant was set up at the laboratories of IFA-UT.

In summary, it was demonstrated that the big advantages of mesh filtration are :

- High filtration rates up to 150 L/[m².h] at a filter pressure below 20 mbar can be realized.
- The suspended solids concentration in the effluent was in the range of 5 to 10 mg/L compared to well working standard activated sludge systems with 20 mg/L.

SCREENING TESTS

Goal of the test::

to pre-select a mesh material for the later investigations

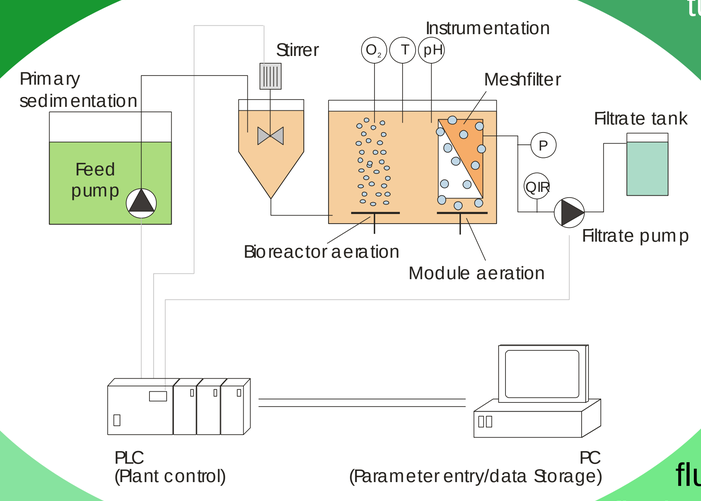
in the laboratory bioreactor by using a self-made experimental set-up.

Selection criteria were:

- small mesh opening [mm] and big open area [%]
- the smallest possible turbidity in the permeate
- a high flux rate

Mesh opening [mm]	Open area [%]	Mesh count [-]	Thread diameter [mm]	Weight [g/m²]	Thickness [mm]	Air Perm. 20 mm WG [L/m²s]
25	17	165	31	38	49	1600
27	14	140	40	50	70	1500
29	16	140	34	40	56	1970
29	20	150	31	32	49	2475
38	28	140	31	31	48	4550
47	31	120	34	33	64	4800
55	31	100	40	37	65	5190
70	28	77	55	55	90	3750
90	32	62	64	57	106	4800
120	35	49	80	70	135	5740
120	41	55	64	51	105	6300

Figure: Tested mesh materials



PILOT PLANT DATA

The test plant with a total working volume of 500 liter incorporated a denitrification and a nitrification process. Sludge recirculation was done by a spiral pump. The nitrification tank contained a flat sheet type filter module made from a woven nylon fabric of 30 µm mesh width which was stretched over a rectangular frame. The active filter area had a dimension of 700 x 250 at a distance of 15 mm. The resulting effective filter area was 375 cm² or roughly 0.375 m². An aeration unit was placed below the filter module serving both for aeration of the activated sludge and to generate turbulence to minimize the filter layer on the mesh filter. The aeration unit for the activated sludge tank was a standard membrane diffuser of 320 mm length.

Figure: Pilot plant

FILTER PERFORMANCE

The suction head was only about 10 - 20 mbar and raised very slowly. Depending on the operation conditions after a filtration period between a few days and up to 2 - 3 weeks, the suction head increased suddenly, often within minutes, and almost complete blocking of the filter occurred. In general, there was no obvious indication of impending filter blocking. Full filter performance could be re-established by intensive flushing of the blocked filter on air.

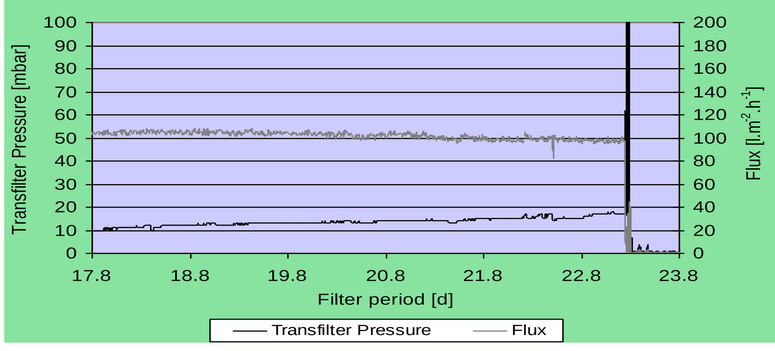


Figure: Example of the general behavior of the mesh filter in the start up phase. Data: Flux 100 L/[m².h], MLSS 3.5 g/L, and the blocking effect

EXPERIMENTS

All air sparing experiments were carried out automatically by computer control. The parameters that were changed were on the one hand the time period for air flushes in seconds and on the other hand the interval of air flushes. Under normal conditions the air amount was 6 L/min and during the air flushes it raised up to more than 26 L/min. The amount of air was controlled by a rotameter. After the filter got blocked a mechanical cleaning with water was done and a new experiment was started with different air flush conditions.

Experiment [-]	Time period normal air [min]	Air flushes status "high" [sec]	Air flushes status "low" [sec]	Amount flush cycles [-]
1	1	5	5	0
2	1	5	5	5
3	1	5	5	5

Figure: Overview starting conditions for the different air sparging experiments

Discussion and Conclusion

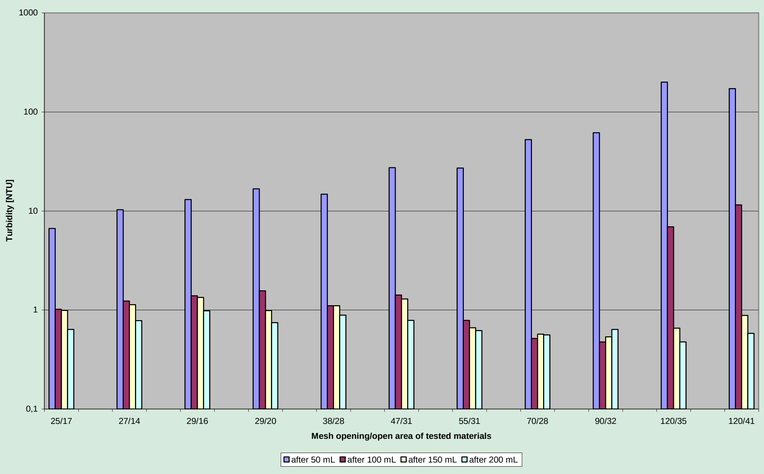


Figure: Results of screening tests mesh opening versus turbidity after each 50 mL filtration

The suitability of a mesh filter as a sludge separation device in wastewater treatment was investigated. Using a filter of 29 µm mesh size, it was observed that the appropriate development of a secondary filter layer is of critical importance to the effluent quality. High flux rates from 50 up to 150 L/(m².h) can be achieved. At the same time the pressure loss was very low. Screening tests with different materials showed that filter material with a wide range of mesh sizes can be used. Only above a certain mesh size there is a significant influences on the turbidity of the permeate. In particular, this applies for the initial period before a stable sludge layer on the filters surface is established.

Figure: Experimental set- up for screening tests

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