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COMBINATION OF MOVING BED BIOFILM REACTOR AND MEMBRANE BIOREACTOR FOR WASTEWATER TREATMENT

1. Abstract

Water is the essence of life and we need to protect it if we want to protect our lives. It's not a problem of recent years, but a problem of centuries, when people only contaminated everything around them without thinking about the lives of future generation.

It is easy to understand that water scarcity is not problem just for the human health, but also for economic and financial development. It could highly effect on business, so nature-based solutions provide public and ecosystem benefits [1].Due to water scarcity, water should be treated not only for discharging, but also for water reuse. Therefore, it should be emphasized that wastewater have to serve as alternative water source. One of the best technologies, which can replace conventional treatment system is the combination of MBBR (moving bed biofilm reactor) &MBR (membrane bioreactor), which is based on biological treatment followed by membrane filtration.

2. Materials and methods

1.1 Membrane

Three membrane modules made of SiC with flat sheet MFmembranes (manufactured by Cembrane A/S) were placed into the MBR. Maximum backwash and suction pressure are –700 mbar and 2 bar respectively. An active membrane surface of 1 module is 0.276 m^2.

2.3 Cleaning agent for membranes

Wastewater contains a lot of pollutants with organic and inorganic nature. Hence two types of chemicals should be used (table 1). Also, NaOH should be used for adjustment up to pH 10-11.

Table 1

Chemicals for CIP (clean in place)

Reagent	Concentration	Purpose
NaOCl + NaOH to pH 10-11	100–1000 ppm (active chlorine)	Remove organic matter
Citric acid	0.2%	Remove inorganic matter

2.2 Study set-up

The investigation was conducted in the laboratory, which belongs to Norwegian University of Life Sciences. The object of investigations is Pilot

plant (PP) of MBR & MBBR combination. As a source of wastewater served sewage from campus in Ås, Norway. The studies were conducted with co-financing by the European Union's ERASMUS+ program.

3. Pilot Plant of combination MBBR & MBR

Combination of MBR & MBBR technology was made as an alternative system to replace or upgrade existing overloaded activated sludge plants. Main advantages of using MBR are [2]: lower footprint;better permeate quality;less complex operating;higher reliability and resistance to overload and toxic compounds (Lee, Kang, & Lee, 2006).

MBBR systems have been provided as reliable source of biomass for a stable work of system. In MBBR systems, biofilm attached to plastic media, which constantly is moving inside the bioreactor by bubbles generated by aerator; also, here present part of the suspended growth. In addition, MBBR serve as a biological pretreatment for reducing the load on the membrane surface and hence decreasing fouling layer growth.

Pilot plant (PP) of MBR & MBBR combination shown on figure 1. As a source of wastewater was used sewage from campus in Ås, Norway. Wastewater come in storage separately as gray and black water. This opportunity could be used for regulation necessary biomass load on system.

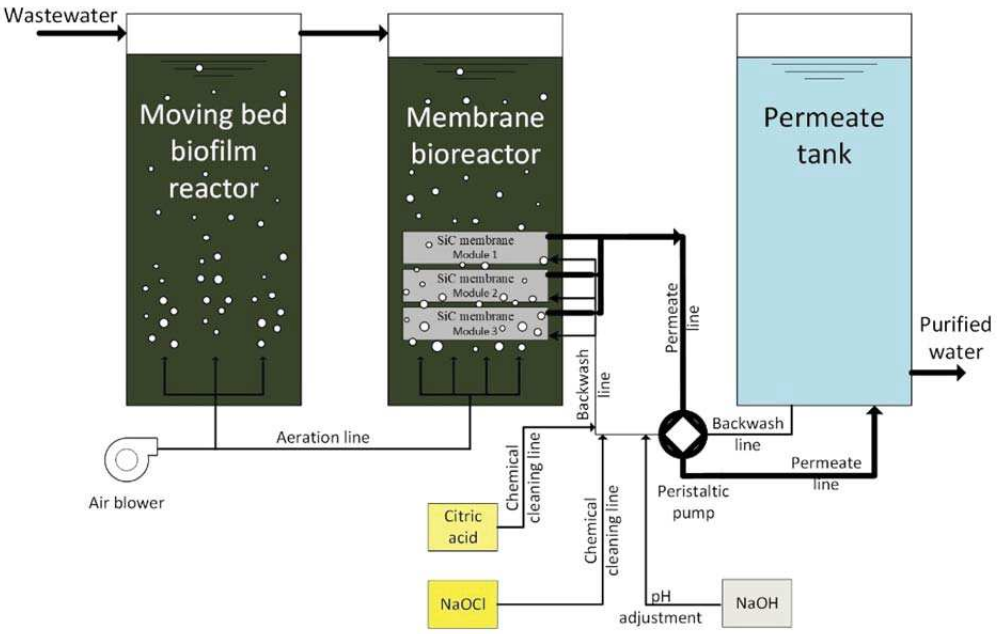

Figure 1. Filtration mode

The PP consists of 3 main parts. MBBR treatment (there was used two tanks of MBBR to reduce the workload for separational part. After MMBR

part water comes for followed separation in membrane tank and permeate directed to the permeate tank. All system works automatically.

Operational time of PP could be divided on the filtration cycles, where each cycle as well splits on the filtration and backwash time. Backwash is necessary to maintain optimal conditions for filtration, that includes low transmembrane pressure (TMP) and high permeability (P), subsequently low fouling rate. To conduct backwash cleaning, system automatically stops filtration mode and starts backwash mode according to the table 2, and shown on the figure 2. As a backwash liquid was used small amount of permeate.

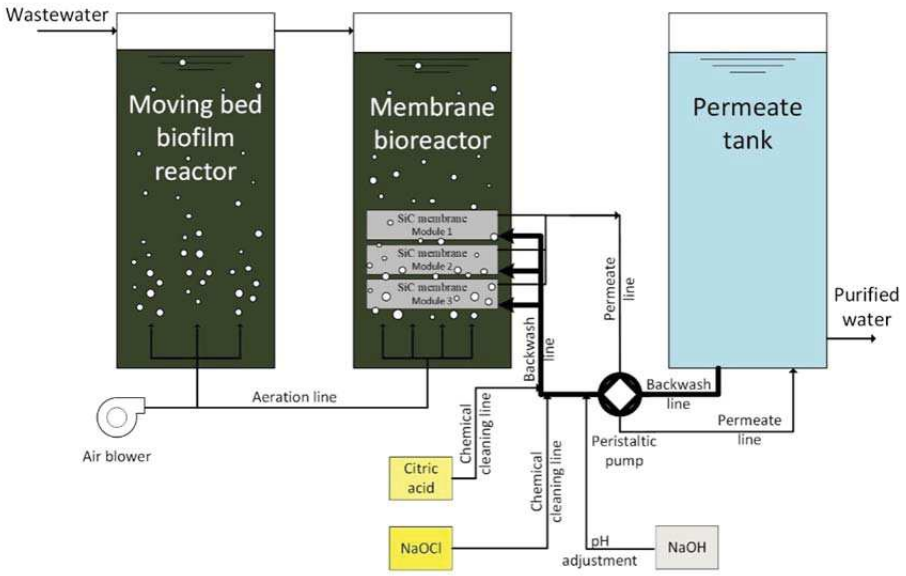

Figure 2. Backwash mode

Table 2

Filtration modes

Filtration	300 sec
Relaxation I	60 sec
Backwash	20 sec
Relaxation II	120 sec

But after some period of time TMP reaches too high values that could not be changed by simple backwash, therefore chemical cleaning should be provided (figure 3). For performance of chemical cleaning, filtration process should be stopped. Dosing pump directs NaOCl to the backwash line and membrane remains in the backwash mode until membrane will be covered with this solution.

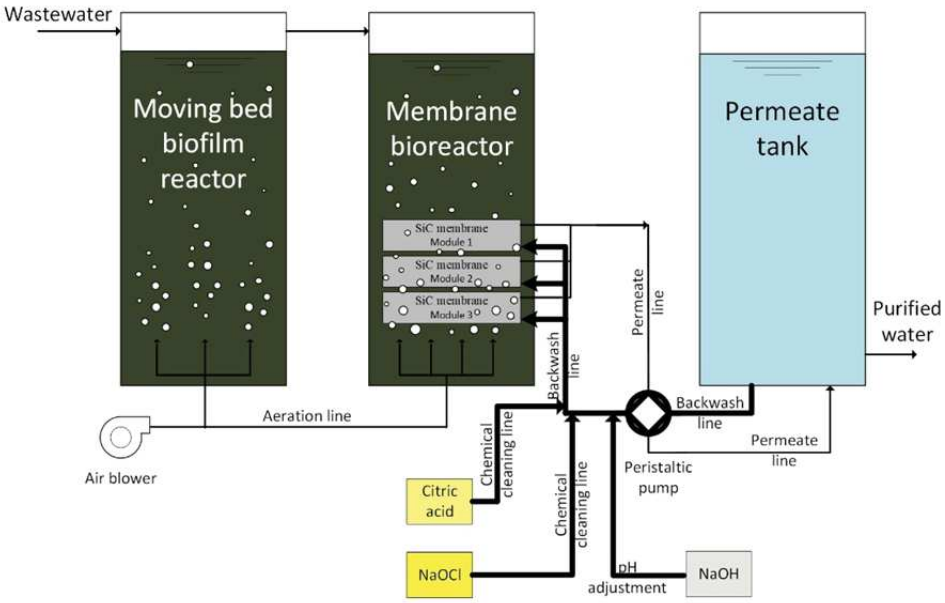

Figure 3. CIP mode

4. Conclusion

Due to water scarcity, development of novel treatment methods such as using of the MBR & MBBR combination. MBBR tanks organized as two sequence chambers, allows to decrease load on membrane separational chamber. In addition, MBBR makes system reliable, stable and independent to raw wastewater quality. At the same time MBR with ceramic membranes allows to receive in the end high quality effluent, that could serve as a alternative water source. The MBR & MBBR combination is the most perspective wastewater treatment system, which should be developed as option for decentralized and centralized system as well.

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