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Membrane bioreactors in waste water treatment

Prof. Dhara Upadhyay,

Assistant Professor, Chemical Engg Department, VVP Engineering college, Rajkot

Abstract:

The research paper is a study showing applications of membrane bioreactors in waste water treatment and comparison between them. It reflects how the process is being carried out in membrane bioreactors. It discusses how the anaerobic process and membrane processes are being carried out. It also discusses the various variants of MBR and how are they advantageous. It also discusses the treatment of nitrate rich water in membrane bioreactor. It also discusses the applications of membrane bioreactor in better removal of micronutrients. It also throws a light on concept of reverse membrane bioreactor. It also shows the fouling control measure of membrane bioreactors. Anaerobic membrane bioreactor is used in wastewater treatment. Anaerobic membrane bioreactor technology goes through two stages. First, the wastewater enters the anaerobic bioreactor unit, where the organic load goes through the anaerobic process to be transformed into biogas. Subsequently, the remaining liquid, which still has small amounts of solids, goes into the membrane unit, to separate the remaining, smaller solid particles from the anaerobically treated wastewater. Overall, the study demonstrated that transverse membrane vibration is practical and beneficial for fouling control in the SMBR.

Anaerobic membrane bioreactor is used in wastewater treatment. AnMBR makes use of membrane bioreactor in a anaerobic environment. Anaerobic bacteria and archaea convert organic materials are converted into carbon dioxide (CO2) and methane (CH4) by anaerobic bacteria and archea. The sewage is filtered by membranes and the effluent and sludge are left apart. Combustion to biogas is done to generate heat and electricity. As the energy that can be generated by methane combustion can exceed the energy required for maintaining the process, a membrane bioreactor is considered to be a sustainable alternative for sewage treatment.

Process:

Anaerobic membrane bioreactor technology goes through two stages. First, the wastewater enters the anaerobic bioreactor unit, where the organic load goes through the anaerobic process to be transformed into biogas. Subsequently, the remaining liquid, which still has small amounts of solids, goes into the membrane unit, to separate the remaining, smaller solid particles from the anaerobically treated wastewater. This wastewater, otherwise known as effluent, can now either directly be recycled, or can further be treated by Reverse osmosis. The remaining solid particles are then cycled back to the anaerobic bioreactor unit where they can go through the biogas production process. Overall, this process removes 99% of the organic load contained within wastewater, and also produces biogas with a 70% purity.

1. **Anaerobic process:**

This process is carried out without oxygen, and is performed by anaerobic microorganisms. This is a four step process for the transformation of organic matter to biogases.

a. Hydrolysis: this is used to release proteins from micro organisms. This process breaksdown complex compounds such as lipids, proteins and polysaccharides.
b. Acidogenesis: products of hydrolysis are transformed into short chain fatty acids, ethanol, hydrogen gas and carbon dioxide by using acidogenetic bacteria.
c. Acetogenesis: it is used to convert the products of acidogenesis to acetic acid, hydrogen gas, carbon dioxide and small organic molecules.

d. Methanogenesis: methanogenic bacteria converts the products obtained in acetogenesis into biogas.

For this process a specific range of temperatures and pH is required. Mostly, if the temperature of the process is kept below 35 C, the anaerobic process slows down. Moreover, organic matter composition, nutrient concentration, and the presence of toxic substances also slows down.

2. **Membrane process:**
   The membrane process uses biofilm, which naturally occurs in substance found in lakes, rivers, rocks. They are utilized by causing the necessary biomass/organic matter to attach to the desired area. As the solid particles are very big to permeate the membrane, only pure liquid is able to get through. This allows for a high retention rate, therefore allowing the wastewater to be reusable.

   Variants of an MBR:

Crossflow/ External AnMBR

As the name suggests, this variant keeps the membrane unit outside of the main reactor unit. Here, the wastewater goes through the anaerobic process. After this step is complete, the remaining mixed liquor, flows into the external membrane unit. Keeping the same pressure, crossflow filtration is used to separate the permeate and retentate, effluent and organic load respectively. After this step, the effluent is released and the organic load cycles back to the main reactor unit where it can go through the anaerobic process to create more biogas.

Submerged AnMBR

This variant integrates the membrane unit directly into the bioreactor unit. In this configuration, the raw influent enters the membrane unit instead of first going through the anaerobic process. In the membrane unit, a low negative pressure separates the retentate and permeate. The permeate, otherwise known as the effluent, leaves the system while the retentate goes through the anaerobic process to become biogas.

Externally Submerged AnMBR

This variant of the AnMBR combines the previous two variants. First the anaerobic process takes place, and then it enters the membrane unit for filtration. Here, the influent(wastewater) is pumped into the externally submerged chamber where it is then filtered into the permeate and the retentate. This variant, similar to the submerged AnMBR, also utilizes low negative pressure to separate the permeate and retentate. After this process, the effluent leaves the system while the organic load recirculates into the bioreactor unit to then turn into biogas.

Advantages of each variants:

Cost: The submerged AnMBR variant is the most economical due to the low negative pressure requirements. Apart from this, the liquid does not need to be pumped into an external chamber to go through the filtration process. Due to both of these characteristics of the submerged AnMBR, it has a lower energy requirement, therefore costing less to operate than the external AnMBR variants.

Operability: The external AnMBR/ external submerged AnMBR variants are the most advantageous in terms of operability. In these variants, less membrane fouling occurs, and therefore these variants are functional for long periods of time. Additionally, due to the two units being separated, they are much simpler to clean when compared with the submerged AnMBR.

Size: While one of the main overall advantages of the AnMBR is its relatively compact size, the submerged AnMBR variant is the most compact of the three, keeping all of its operations within a single unit.

Srishti Rai et al also contributed to the study of applications of MBR for waste water treatment. A high influent quality is also one of the concept that contributes to its preference, an ecological footprint and lower sludge production. The freshwater is getting scarce rapidly in various parts of the world. Various problems like increase in salinity, heavy metal entry, eutrophication, etc. are harming the quality of fresh water. The MBR technology can resolve these problems due to recent developments in the technology. Severe wastewater can be easily treated by using MBRs, anaerobic condition.

Treatment of nitrate rich water in membrane bioreactor

Subhankar Basu et al presented the study of treatment of nitrage rich water in membrane bioreactor. Baffled membrane bioreactor (BMBR) for nitrate rich water treatment was studied in this research. They used ceramic membrane filter for sludge separation. External carbon source was used to maintaine C/N ratio. They obtained approximately 90% COD and 95% NO_3–N reduction. The bagasse ash filters that was free of suspended solids, produced clear permeat. They saw Sludge aggregates in the reactor. They also observed lower sludge volume index (40 mL/g compared to 150 mL/g for seed sludge), higher settling velocity (47 m/h compared to 10 m/h for seed sludge) and sludge aggregates (0.7 mm aggregates compared to <0.2 mm for seed sludge).

Yah Zhou et al reviewed reviewed the application of AnMBR for the treatment of high strength waste water. High COD removal (~95%) is obtained by anaerobic membrane bioreactor, offering advantages for efficient energy. This review gives study on AnMBRs application in various wastewater, which includes landfill leachate and waste activated sludge and the advantages it offers in degradation of complex contaminants. The performance of these strategies is checked in terms of membrane fouling control, and potential advantages compared with conventional methods. In addition to this, this study provides an in-depth study of innovative AnMBR configurations, which includes anaerobic electrochemical membrane bioreactor (AnEMBR), and anaerobic osmotic membrane bioreactor (AnOMBR). Evaluations of these configurations are conducted. More work is required to explore broader applications, achieve more efficient fouling control.

Membrane bioreactor for better removal of micropollutants:

Waste water treatment plants (WWTPs) partially degrades organic micropollutants. Here the ability to remove micropollutants and the development of the microbial community were checked together. Two stages of operation were observed in a period of 9 months, one with (S1) and one without (S2) the addition of exogenous OMPs. They observed that Ibuprofen and naproxen had the highest degradation rates, on the other hand, diclofenac was a more strong. *Hydrogenophaga*, p55-a5, *Propionicimonas*, *Fodinicola*, were the most popular groups in the polishing MBR.

Concept of reverse membrane bioreactor:

Amir Mahmoubi et al wrote a research paper on concept of reverse membrane bioreactor. The advanced concept of reverse membrane bioreactors (rMBR) introduced in this study is a new membrane-assisted cell retention technique that gives benefits other than the properties of conventional MBR. The rMBR works on the principles of membrane separation. Apart from this, this new membrane configuration works on the principles of concentration-driven diffusion. These new features brings ability of rMBRs in helping complex bioconversion, a variety of sugar sources and high suspended solid content. In this study, the similarities and differences between the rMBR and conventional MBRs, and regarding advantages, disadvantages, principles and applications for biofuel production are presented and compared.

Fouling control of submerged membrane bioreactor:

Tian Li et al wrote a research paper on fouling control of submerged membrane bioreactor. The present study shows the effectiveness of transverse vibration for the fouling control of hollow fibre membranes in a submerged membrane bioreactor (SMBR) with real mixed liquor. The investigation included short and long duration tests. The short duration tests involved both continuous and intermittent vibration in different concentrations of mixed liquor. The results concluded that continuous transverse vibration was very effective towards the fouling control. Intermittent vibration provided significant energy savings. With intermittent vibration, a short non-vibration time interval of less than 120 s was also found to be necessary to prevent irreversible fouling during this time interval when the permeated extraction continued. The long duration tests confirmed that transverse vibration could be effectively used in the SMBR to control the membrane fouling. Higher frequencies of transverse vibration produced larger shear stresses on the membrane surface. The characteristics of the biosolids in the reactor were monitored during the long duration tests. Overall, the study demonstrated that transverse membrane vibration is practical and beneficial for fouling control in the SMBR.

References:

1. Anaerobic membrane bioreactor for waste water treatment: present state of the art Rishi Pramodbabu [1], Srishti Rai [2], Soumya Pandit [3], Priti Patil [1], Srijoni Banerjee [4], Abhilasha Singh Mathuriya [2], Ram Prasad [5]
2. Evaluation of a membrane bioreactor system as post-treatment in waste water treatment for better removal of micropollutants Author Sonia Arriaga [a,b], Nadieh de Jonge [b], Marc Lund Nielsen [b], Henrik Rasmus Andersen [c], Vibeke Borregaard [d], Kevin Jewel [e], Thomas A. Ternes [e], Jeppe Lund Nielsen [b]
3. Anaerobic membrane bioreactor for the treatment of high-strength waste/wastewater: Zijing An [a], Junjie Zhu [a], Min Zhang [a], Yan Zhou [b,c], Xiaomei Su [a], Hongjun Lin [a], Faqian Sun [a]
4. Reverse membrane bioreactor: Introduction to a new technology for biofuel production Author links open overlay panelAmir Mahboubi [a,b], Päivi Ylitervo [a], Wim Doyen [b], Heleen De Wever [b], Mohammad J. Taherzadeh [a]