International Journal of Research and Review
www.gkpublication.in E-ISSN: 2349-9788; P-ISSN: 2454-2237

Review Article

A Review on Advanced Membrane Separation Methods for Water Treatment

Sunil J. Kulkarni, Pallavi M. Kherde

Datta Meghe College of Engineering, Airoli, Navi Mumbai, Maharashtra, India

Corresponding Author: Sunil J. Kulkarni

Received: 28/07/2015 *Revised: 04/08/2015* *Accepted: 21/08/2015*

ABSTRACT

Membrane separation methods are becoming more and more important in the era of rapid industrialization. The industrialization in inevitable for meeting the demand of rapid urbanization and increased living standard. The undesirable side effect of this industrial growth is water pollution. Many industries discharge effluents with high pollutant loading. Membrane separation methods give the product with uniform quality. Reverse osmosis, ultrafiltration, microfiltration and nanofiltration are few important membrane separation methods. Many modifications in these processes are also tried by various investigators to overcome the disadvantages. The current review summarizes the research carried out for water treatment by membrane technology.

Key words: Reverse osmosis, chemical oxygen demand, biofilm, disposal, organic matter.

INTRODUCTION

Wastewater treatment is important area of investigation in environmental science and engineering. The polluted water can cause various short term and long term diseases. Organic matter content of wastewater can affect the aquatic life if discharged without treatment. [1-5] the heavy metal content can cause various health effects on human beings and animals. [6-9] the removal of organic matter can be carried out by various methods such as activated sludge process, trickling filters and adsorption. [10-15]

Various membrane separation methods are also used with or without incorporating conventional techniques. [16,17] Heavy metals can also be removed by various biological and non biological methods. [18-20] Nowadays membrane separation techniques are becoming more and more important because of separation efficiency and purity of product effluent. The membrane separation technology can be coupled with other treatment technologies like membrane bioreactor for more effective treatment. The current review summarizes studies and research on advanced membrane separation methods for water treatment.

RESEARCH ON ADVANCED MEMBRANE TREATMENT FOR EFFLUENT: Esfahani et. al carried out investigation on membrane separation for industrial waste water treatment. [21] The membrane separation processes produce products with uniform and similar high purity, not related to the inlet wastewater.

They discussed membrane separation techniques such as reverse osmosis (RO), microfiltration (MF), ultrafiltration (UF), nanofiltration (NF) methods, Hybrid membrane systems and the membrane bio-reactor methods. According to these studies space requirement and cost are major disadvantages of membrane separation operations.

Al-Rekabi et.al, discussed advanced wastewater treatment techniques. [22] They discussed membrane treatment of effluents from secondary biological wastewater treatment plants, and integrated bio-membrane treatment of industrial and municipal wastewaters. Advances in polymer technology has, according to them led to membranes having improved contaminant rejection capabilities, lower pressure requirements, and greater durability. Bio-membrane processes are also important area of development in membrane separation. Three systems forms for bio-membrane are extractive, fixed film and filtration systems. According to studies carried out by Mojire et.al, membrane filtration is one of the major methods used in the leachate treatment. [23] According to their studies, it has found a place in the removal of recalcitrant organic compounds and heavy metals from landfill leachate.

Garud et.al, reviewed process and applications of reverse osmosis. [24] According to these studies, RO technology can be used to remove dissolved solids, colour, organic contaminants, and nitrate from feed stream. They discussed the application of reverse osmosis for the treatment of distillery spent wash, ground water treatment, recovery of phenol compounds, reclamation of wastewater and seawater reverse. Pramanik et.al carried out review on biological aerated filters (BAFs) for nitrogen removal. [25] The Biological aerated filters (BAFs) provide secondary treatment of municipal and industrial wastewaters. They explained operation of biological aerated filters. According to them, down flow systems with countercurrent air flow have the advantage of efficient mass transfer of oxygen to biofilm in the reactor. Higher influent flow rates can be handled better in upflow systems with co-current air and wastewater. According to the studies, BAF systems can be operated at a low HRT. Also it can be used as a compact system for small communities in treatment of their wastewater for carbon and nitrogen removal.

According to Calderon et.al, an advanced technology that combines conventional biological treatment with membrane filtration can be used to overcome disadvantages of biological wastewater treatment. [26] According to them, MBRs are characterized by a high soli retention time (SRT), which influences the biology of the system. This lowers the microbial metabolic activity and growth rates due to the limitation of substrates. Microfiltration (MF) and reverse osmosis (RO) can be incorporated with an advanced oxidation process (AOP) based on UV irradiation combined with hydrogen peroxide (UV/H_2O_2) for removal of micropollutants (MPs) from secondary municipal wastewater. An investigation on this topic was carried out by James et.al. [27] They compared three processes based on three unit process sequences, based on MF, RO, AOP and activated carbon (AC). According to their studies the combination of MF-RO-AOP was the most cost effective.

Shreesadh et.al, Carried out review on treatment of RO Reject for tannery industry. [28] According to them, the disposal of reverse osmosis reject became more severe problem because it contain high concentrations for TSS, TDS, BOD_5, COD, Cr^{3+}, TKN, Cl^- , Oil and Grease. The treatment methods like advance treatment processes which include Fenton oxidation, electro- coagulation, photo catalysis and

ozonation were suggested for further treatment of RO reject. During their investigation on widely used treatment technologies for hospital wastewater, Jafrudeen and Ahsan analysed MBR technology. [29] According to him, the use of Membrane Bio-Reactors (MBRs) in municipal wastewater treatment has grown widely in the past decades. The major advantage of MBR technology is that it eliminates the need for a clarifier or polishing filters. MBRs need cleaning once in 3 to 6 months. Another advantage of MBR is that it they yield 60-80% less sludge than conventional system and also they are 75 percent smaller than conventional systems. The major disadvantage of this technology is that it cannot tolerate abrasive and stringy materials, such as grit, hair and fibrous material. Also membrane fouling, high energy consumption and initial cost are limiting factors.

According to a comparative study carried out by Kumar et.al, membrane filtration is a promising alternative for treatment of textile dye effluents. [30] It is very promising if the effluent contains low concentrations of dyes. They also discussed ultrafiltration and nanofiltration as alternatives for textile effluent treatment. These methods are useful when high salt rejection of reverse osmosis is not necessary.

CONCLUSION

Wastewater treatment can be carried out by various conventional methods. These treatment methods can become more effective if combined with advanced treatment technologies. Membrane separation is one of these advanced treatment technology. The high purity of product effluent and uniform quality of the treated water are major advantages of membrane technology. The membrane technology can be combined with other biological and non biological treatment methods to obtain better results.

REFERENCES

1. M. Ahamaruzzaman, Role of flyash in Removal of organic pollutants from wastewater, Energy Fuels, 2009, 23(3), 1494-1511.
2. A. Matilainen, M. Vepsalainen, and M. Sillanpaa, Natural organic matter removal by coagulation during drinking water treatment: A Review, Adv. in Colloid and Interface Sci., 2010, 159(2), 189-197.
3. Sunil J. Kulkarni, Removal of Organic Matter from Domestic Waste Water by Adsorption, International Journal of Science, Engineering and Technology Research, 2013, 2(10), 1836-1839.
4. Sunil J. Kulkarni, Ajaygiri K. Goswami, Adsorption Studies for Organic Matter Removal from Wastewater by Using Bagasse Flyash in Batch and Column Operations, International Journal of Science and Research, 2013, 2(1), 180-183.
5. Sunil Jayant Kulkarni, Dr. Jayant Prabhakarrao Kaware, a Review on Health Effects of Phenol, 2015, 2(5), 968-972.
6. Musa B. and Abdullahi M.S., The toxicological effects of cadmium and some other heavy metals in plants and humans, Journal of Environmental Science and Water Resources, 2013, 2(8),245 - 249.
7. Rashmi Verma and Pratima Dwivedi, Heavy metal water pollution- A case study, Recent Research in Science and Technology, 2013, 5(5), 98-99.
8. Sunil J. Kulkarni, Sonali R. Dhokpande, Dr.Jayant P. Kaware, A Review on Studies on Effect of Heavy Metals on Man and Environment, International Journal for Research in Applied Science & Engineering Technology (IJRASET), 2014,2(10),227-230.
9. Laniyan, T. A; Kehinde Phillips, O. O andElesha, L, Hazards of heavy metal contamination on the groundwater

around a municipal dumpsite in Lagos, Southwestern Nigeria, International Journal of Engineering & Technology, 2011, 5 (11), 61-70.
10. Dinesh Mohan, Kunwar P. Singh, Vinod K. Singh, Wastewater treatment using low cost activated carbons derived from agricultural byproducts-A case study, Journal of Hazardous Materials, 2008, 152 (3), 1045-1053.
11. Sunil J. Kulkarni, Modeling for Adsorption Columns for Wastewater Treatment: a Review, International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences (IJIRMPS), 2014, 2 (2), 7-11.
12. Sonali R. Dhokpande, Sunil J. Kulkarni, Dr. Jayant P. Kaware, A Review On Research On Application Of Trickling Filters In Removal Of Various Pollutants From Effluent, International Journal Of Engineering Sciences & Research Technology, 2014, 3(7), 359-365.
13. Sunil J. Kulkarni, Suhas V Patil, and Y. P. Bhalerao, Flyash Adsorption Studies for Organic Matter Removal Accompanying Increase in Dissolved Oxygen, International Journal of Chemical Engineering and Applications, 2011, 2(6), 434-439.
14. Christian Drakides, Meiling Lay-Son, Model development for biological treatment of toxic industrial wastewaters: an easy tool for linking pilot results and field data, World Journal of Modeling and Simulation, 2010, 6(2), 122-133.
15. Sunil J. Kulkarni1, Sonali R. Dhokpande, Dr. Jayant P. Kaware, Modeling of Biological Wastewater Treatment Facilities: A Review, Int. Journal on Scientific Research in Engineering, Science and Technology, 2015, 1(2), 104-106.
16. Marcucci M, Ciabatti I, Matteucci A, Vernaglione G., Membrane technologies applied to textile wastewater treatment, Ann N Y Acad Sci., 2003,984, 53-64.
17. Sunil J. Kulkarni, Ajaygiri K. Goswami, Applications and Advancements in Treatment of Waste Water by Membrane Technology- A Review, International Journal Of Engineering Sciences & Research Technology, 2014, 3(9), 446-449.
18. Chettiyappan Visvanathan and Amila Abeynayaka, "developments and future potentials of anaerobic membrane bioreactors (AnMBRs)", Membrane Water Treatment, 2013, 3(1), 1-23, 2013.
19. Kulkarni Sunil J., Patil Suhas V., Tapre Ravi W., Goswami Ajaygiri K, Adsorption of Chromium from Wastewater on Different Adsorbents, International Journal of Research in Chemistry and Environment, 2013, 3(1), 231-236.
20. V. Vijayagopal and P. L. Sabarathinam, Kinetics of Biological Treatment Of Phenolic Wastewater In A Three Phase Draft Tube Fluidized Bed Bioreactor Containing Biofilm, African Journal of Biotechnology, 2008, 7(6), 834-837.
21. Bahareh Asadollahi Esfahani, Banafsheh Asadollahi Esfahani, Mina Shams Koupaei3, Seyyedeh, Zahra Ghasemi, Industrial Waste Water Treatment By Membrane Systems, 2014, 4 (S1), 1168-1177.
22. Wisaam S. Al-Rekabi, He Qiang and Wei Wu Qiang, Improvements in Wastewater Treatment Technology, Pakistan Journal of Nutrition, 2007, 6 (2), 104-110.
23. Amin Mojiri, Hamidi Abdul Aziz, Shuokr Qarani Aziz, Trends in Physical-Chemical Methods for Landfill Leachate Treatment, 2013, International Journal of Scientific Research in Environmental Sciences (IJSRES),2013, 1(2), 16-25.
24. Garud R. M., Kore S. V., Kore V. S., Kulkarni G. S., A Short Review on Process and Applications of Reverse Osmosis, Universal Journal of Environmental Research and Technology, 2011, 1(3), 233-238.

25. Biplob Kumar Pramanik, Suja Fatihah, Zain Shahrom, Elshafie Ahmed, Biological Aerated Filters (Bafs) For Carbon And Nitrogen Removal: A Review, Journal of Engineering Science and Technology,2012, 7(4), 428-446.
26. Kadiya Calderon, Alejandro González-Martínez, Cinta Gómez-Silván, Francisco Osorio, Belén Rodelas and Jesús González-López, Archaeal Diversity in Biofilm Technologies Applied to Treat Urban and Industrial Wastewater: Recent Advances and Future Prospects, Int. J. Mol. Sci., 2013, 14, 18572-18598.
27. Christopher P James, Eve Germain and Simon Judd, Micropollutant removal by advanced oxidation of microfiltered secondary effluent for water reuse, Separation and Purification Technology, 2014, 127, 30 , 77–83.
28. Shreesadh EC, Sandeep Thakur, M.S. Chauhan, Treatment of RO Reject for Tannery Industry-A Technical Review, Journal of Environmental Science and Sustainability (JESS), 2013, 1(4), 113 - 116.
29. Jafrudeen and Naved Ahsan, Study Of Widely Used Treatment Technologies For Hospital Wastewater And Their Comparative Analysis, International Journal Of Advances In Engineering & Technology, 2012, 5(1), 227-240.
30. Atul Kumar, Pratibha Choudhary and Poonam Verma, A Comparative Study on the Treatment Methods of Textile Dye Effluents, Journal of Chemical and Pharmaceutical Research, 2012, 4(1), 763-771.

How to cite this article: Kulkarni SJ, Kherde PM. A review on advanced membrane separation methods for water treatment. Int J Res Rev. 2015; 2(8):513-517.

****