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Applications and Advancements in Treatment of Waste Water by Membrane Technology- A Review

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Abstract

Removal of various pollutants from waste water can be facilitiated by various methods. Conventional treatment methods include physical treatment followed by biological treatments , either attached growth or suspended growth. These methods have their own disadvantages like large land area requirements, disposal of the sludge produced in the treatments, operating problems under various conditions of temperature. Membrane technology is very promising and widely studied alternative. The current review aims at studying the research carried out for application of membrane technology for the wastewater treatment. During the review it was found that the membrane technologies such as electro dialysis, membrane bioreactors, anaerobic membrane bioreactors, reverse osmosis, ultrafiltration, microfiltration, nanofiltration etc. can be used effectively for wastewater treatment. High efficiency and low area requirement, compactness are key features of this technology. This technology can be combined with conventional aerobic and anaerobic treatment facilities to increase the effectiveness. Membrane technology is the most important method in achieving the objective of reuse of wastewater in an era of water scarcity in many parts of the world.

Keywords: bioreactor, anaerobic treatment, effluent, organic matter.

Introduction

Wastewater treatment in modern days has become very important because of the scarcity of water in many parts of the world and the health effect because of the polluted water. This calls for the effective, economical and feasible alternative for treatment. The new technology containing membranes is very attractive alternative. This paper aims at reviewing the research carried out in this area for removal of various pollutants in effluent with respect to the methods used, affecting parameters and the effectiveness. It was found during this review that the use of membrane technology is widely studied and explored. Many researchers have used the membrane bioreactors, electrodialysis, osmosis, anaerobic membrane treatment effectively for wastewater treatment. It was also observed that use of combined treatment with other methods like activated sludge process and other conventional purification systems can be very effective.

Membrane separation for waste water treatment

Al-Saed et.al. analyzed the research carried out in wastewater treatment using membrane technology in North African countries (1). It was found that more research was necessary in view of sustainability and viability. Marcucci et. al used membrane technology for wastewater treatment in textile industries (2). Their treatment system consisted of sand filter, microfiltration and ultrafiltration. Final purification was done by nanofiltration. They concluded that it is possible to use this technology on industrial scale. Membrane bioreactors (MBR) are promising option for wastewater treatment. An overview of the membrane bioreactor for waste water treatment and reuse was carried out by Melin et.al (3). It was observed that MBRs were more efficient for municipal wastewater treatment because of low organics, nutrient to microorganism ratio and effluent quality. Possibility of reuse of wastewater is increased because of MBR technology. Franks et.al. discussed the evolution of the design of large scale

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wastewater reclamation plants using energy saving Reverse Osmosis (RO) membranes(4).It was concluded that energy saving membrane are as good as low fouling membranes, in fact more cost effective .Also low feed pressure is required. Proper chemical dosing and proper operation of membrane pretreatment ensures stable and effective treatment.Awaleh et.al. highlighted the various industrial wastewater treatment technologies currently available (5).Their study indicated that application of activated carbon was effective for direct removal of dyes. Combination of aerobic and anaerobic biological treatment was efficient in for removal of soluble biodegradable organic pollutants. The use of membrane is increasing for waste treatment. Membrane technology is important aspect if we look at reuse of wastewater. Principle, operation and performance of various types of MBRs were discussed by Jyot et.al. (6). Membrane bioreactor (MBR), is the combination of two processes viz. activated sludge treatment together with a separation of the biological sludge by micro or ultra-filtration membranes. It was observed that, in MBRs the traditional secondary clarifier is replaced by the membrane separation. Slow growing bacteria can be easily maintained in MBR.The external membrane MBR configuration was preferred versus the internal membrane configuration. According to their study, external membrane MBRs are less susceptible to changing effluent quality, loading and also independent of the reactor operation, require less area.

Visvanathan and Abeynayaka discussed the potential of anaerobic membrane bioreactors (An MBRs). (7).Hydrolysis and methanogenesis are two important steps in this. Rate limiting step depends on complexity of the waste. This technology is especially very advantageous where high particulate matter and temperatures are involved. In these conditions conventional anaerobic reactors are difficult to maintain. It was observed that these reactors can be used for high strength wastewater also. Treatment with reuse of wastewater on coastal areas in Croatia was done with membrane technology by Vlasic and Cupic (8).According to their study the role of social and economical factors like policy makers, planners, funding agencies educators, implementing agencies, and technology providers is very important, in adopting new approach and technology and carrying out research for more and more economical method for treatment.Stoller et. al. carried out an investigation on treatment of tannery waste water by using membrane technologies in a conventional purification process (9). They adopted integrated approach for the same. They adopted nanofiltration and reverse osmosis as a substitute for biological reactors. It was observed that there is the need of overdesign because of fouling issues. It was estimated that use of membrane .The treatment of domestic wastewater by electrolysis and membrane technology was carried out by Son et.al (10). They used copper electrodes with ceramic membranes for the treatment. Their system consisted of two main parts. One electrolysis reactor and second ceramic membrane reactor. Electro-oxidation and electro-coagulation was carried out in the first one and suspended matters and solids can be removed in second. It was observed that most of the kjeldahl nitrogen was removed by electrolysis. Organic nitrogen in the form of solid can be removed by electro-coagulation. Phosphorous was also removed successfully. The increase in the solids and turbidity during electrolysis can be overcome in the second step of membrane treatment. A study on adoptability of membrane technology for dairy waste water was carried by Khojare et.al. (11). Their study indicated that the membrane technology results in plant footprints up to 4 times smaller than conventional systems. The sludge production deceases by 70%. Development of high throughput ‘zeolite’ membranes is important aspect in the improvement of this technology. Hybrid treatments like solar evaporation and reverse osmosis are also interesting option being explored by researchers.Wu et.al reported results of nanofiltration (NF) for treatment of Bamboo industry waste (12).They studied the removal of chemical oxygen demand (COD, ammonia and colour from the wastewater. 90, 84, and 83% rejection of COD, ammonium and conductivity was obtained by them during experimentation.Hajdukova et.al. presented a study on the membrane technology (electrodialysis) for industrial wastewater treatment (13). It was observed that the pretreatment is very important for effective use of the membrane technology. The pretreatment by alum was most effective with 98% solid and 53% COD removal. The removal of heavy metals by membrane technology was tried by Moslehi et.al. (14). They compared the activated sludge (ASP) system with membrane technology. Chromium, zinc and lead were major heavy metal pollutants in the research of the authors. It was observed that for chromium concentrations below 50%, the removal was 95% and more. For zinc, satisfactory removal was achieved when membrane and ASP were combined. Lead removal was 60% by membrane.

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Sayadi carried out research on the effluent treatment by using advanced anaerobic membrane bioreactor technology (15). Their study focused on treatment of low strength wastewater like municipal wastewater. They tried to transform the municipal wastewater into biogas (energy) and water for irrigation containing large amounts of fertilizers. Their results indicated that this technology was very effective for bioconversion into methane and also the COD removal of 90% was achieved.Gaulke carried out review on site water treatment facilities in Japan (16). High quality treatment was possible because of technology available. Cost, footprint, desired level of treatment, availability of water and opportunities for beneficial reuse are few factors which affect the treatment technology.Frenkel has provided a brief history of membranes, types of membranes and installations(17). He also discussed application of membranes for water treatment. Brady studied three different membrane configurations for heavy industry wastewater (18). Spiral elements, hollow fiber cartridges, and tubular modules were used in combination with aerobic treatment. He concluded that membrane filtration; in combination with biological treatment was an economically viable and accepted technology for recovering water for reuse in heavy industry facilities. A review on membrane separation for water treatment and desalination was carried out by Palit(19) .According to him the use of membranes for water treatment and desalination is growing and ever increasing.Yao-bo et.al. described the treatment of wastewater from petroleum complex by membrane bioreactor (20). They studied effect of mixed liquor suspended solids (MLSS) and hydraulic retention time (HRT) on COD removal by hollow fiber membrane. The average COD, oil, solid and turbidity removal was 91, 86, 92 and 99 % respectively. Anisotropic Cellulose Acetate Membrane was studied for wastewater treatment by Kumar et.al. (21).Pawar discussed the use of membrane technology for distillery wastewater treatment (22).According to him membranes and membrane separation techniques with immobilized microorganisms or enzyme are important methods in modern day treatment of wastewater.

Conclusion

The review summarizes the research and studies carried out for the application of membrane technology for wastewater treatment. The membrane technology is promising method for removal of various pollutants such as organic matter, solids, turbidity and various heavy metals. The membrane technologies used for the wastewater treatment includes electrolysis, reverse osmosis, anaerobic membrane bioreactors. Membrane technology has many advantages such as less area requirement and high removal efficiency. Membrane technology can be combined with conventional treatments as per requirement for more effective treatment of waste water.

References

[1]Rashed Al-Saeda, Sami Sayadi, Adnan Ghata, Hussein Abdel-Shafy, Gerhard Schories,Marisol Oropeza, Antonia Lorenzo, Enrico Drioli,"Advancing membrane technologies for wastewater treatment and reclamation in selected Arab MENA countries", Desalination and Water Treatment ,Vol.4 ,pp287–293, 2009.

[2]Marcucci M, Ciabatti I, Matteucci A, Vernaglione G., "Membrane technologies applied to textile wastewater treatment", Ann N Y Acad Sci., Vol..984,pp.53-64.2003.

[3]T. Melin, B. Jefferson, D. Bixio, C. Thoeye, W. De Wilde, J. De Koning, J. van, "der Graaf and T. Wintgens,"Membrane bioreactor technology for wastewater treatment and reuse", Integrated Concepts in Water Recycling ,2005.

[4]Rich Franks, Craig R. Bartels, Keith Andes – Hydranautics, Mehul Patel, "Implementing energy saving RO technology in large Scale wastewater treatment plants", IDA World Congress-Maspalomas, Gran Canaria-Spain October 21-26, 2007.

[5]Mohamed Osman Awaleh and Youssouf Djibril Soubaneh, "Waste water treatment in chemical industries: the concept and current technologies", Hydrol Current Res ,2014,Vol. 5, No.1,pp. 1-12,2014.

[6]Jain Jyoti, Dubey Alka and Singh Jitendra Kumar , "application of membrane-bio-reactor in waste-water treatment: a review", International Journal of Chemistry and Chemical Engineering. ,Vol.3, No.2 pp. 115-122,2013.

[7]Chettiyappan Visvanathan and Amila Abeynayaka,"developments and future potentials of anaerobic membrane bioreactors (AnMBRs)", Membrane Water Treatment, Vol. 3, No. 1 ,pp 1-23,2013.

[8] A. Vlasic and D. Cupic, "Applying the mbr technology in wastewater treatment with reuse of wastewater on coastal areas in croatia",thirteenth international water

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(ISRA), Impact Factor: 1.852

technology conference, iwtc 13 , hurghada, egypt pp.,727-736,2009.

[9]Marco Stoller, Olga Sacco , Diana Sannino and Angelo Chianese, "successful integration of membrane technologies in a conventional purification process of tannery wastewater streams",Membranes Vol.3, pp.126-135,2013.

[10]Dong-Jin Son, Woo-Yeol Kim, Chan-Young Yun, Duk Chang, Dae-Gun Kim, Sung-Oun Chang, Jin-Ho Kim, Young Sunwoo, Yoon-Sun Bae, Ki-Ho Hong,"combination of electrolysis technology with membrane for wastewater treatment in rural communities",Int. J. Electrochem.Sci.Vol.9 , pp.4548 - 4557 ,2014.

[11]A.S. Khojare, A.B. Kadu,P.G.Wasnik,M.R. Patil and Mrs. B.A.Khojare,"adaptability of membranes for dairy waste management", Asian J. Exp. Sci.,Vol. 19, No. 2,pp.105-112,2005.

[12]Donglei Wu, Wei Wang, Shaojun Chen, Zhizhong Yang, Guangming Tian, Shams Ali Baig & Qaisar Mahmood,"Advanced bamboo industry wastewater treatment through nanofiltration membrane technology",Desalination and Water Treatment,Vol.51,No.16-18,pp.3454-3462, 2012.

[13]Jitka Hajdukova, Jan Thomas, Petra Maliková, Veronika Matúšková, "Membrane processes for industrial wastewater treatment – demineralization station", GeoScience Engineering ,Vol.111, No.4, pp.. 11-16, 2013.

[14]P.Moslehi,J.SH.Ayegan,S.Bahrampayma, "Performance of membrane bioreactor in removal of heavy metals from industrial wastewater",Int. J. of Chemical Engg.,Vol.5,No.4,pp.33-37,2008.

[15]Sami Sayadi,"Advanced anaerobic membrane bioreactor technology for wastewater treatment and effluent reclamation in Tunisia",The 3rd International Conference on Water Resources and Arid Environments and the 1st Arab Water Forum,2008.

[16]L.S.Gaulke, "On-site wastewater treatment and reuses in Japan",Water Management,Vol.159,No.WM2,pp.103-109,2006.

[17]Val S. Frenkel "Membranes in water and wastewater treatment", World Environmental and Water Resources Congress,pp. 1-10.Honolulu, Hawaii, United States,2008.

[18]Francis J. Brady,"Heavy industry plant wastewater treatment, recovery and recycle using three membrane configurations in combination with aerobic treatment– A Case Study",WaterEnvi.Foundation,WEFTEC,pp. 3256-3262,2006.

[19]Sukanchan Palit, "wastewater treatment and desalination with the help of membrane separation processes-a short and far-reaching review", International Journal of Chemical Sciences and Applications , Vol.3, No. 3, pp 352-355,2012.

[20]Fan Yao Bo,Wang Ju Si,Jiang Zhao-Chun, "Test of membrane bioreactor for wastewater treatment of petroleum complex",J.Env.Sciences,Vol.10,No.3.,pp.269-275,1998.

[21]Mukesh Kumar, Amit Kumar Sharma And Meena Sharma, "A study of anisotropic cellulose acetate membrane: an application to wastewater treatment ",Chemical Science Transactions, Vol.3,No.2,pp. 833-839,2014.

[22]Pawar Avinash Shivajirao, "treatment of distillery wastewater using membrane technologies",International Journal Of Advanced Engineering Research And Studies , Vol.1, No.3,pp.275-283,2012.

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