Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 4, Issue 3; April-June, 2017, pp. 208-211

http://www.krishisanskriti.org/Publication.html

Different Filtration Techniques for Water Treatment–A Review

Kapil Jangale, Kiran Bhuyar, Aniket. Zodape and Rashmi Nimbalkar

Priyadarshini Institute of Engineering & Technology Nagpur-19
E-mail: kapiljangale@rediffmail.com, kiranbhuyar@gmail.com, ronitzodape22@gmail.com

Abstract—*Water is most important resource for human survival and it is our responsibility to keep it clean and inexpensive. Further, increased amendment of drinking water standards globally is pushing the envelope for current water technologies. Thus the term "membrane filtration" describes a family of separation methods. The application of membrane technology in water and wastewater treatment is increasing due to stringent water quality standards. Nanofiltration (NF) is one of the widely used membrane processes for water and wastewater treatment in addition to other applications such as desalination. NF has replaced reverse osmosis (RO) membranes in many applications due to lower energy consumption and higher flux rate [1]. A competing membrane process to Reverse Osmosis (RO) for water treatment in the near future is Nanofiltration (NF). In this study, we tried to determine when apply of filtration process instead of other methods for water treatment is of a good relevance. The performance of the tested membranes was measured in terms of fluxes and rejection under different operating conditions (Feed solution composition, ionic strength, Hydrostatic pressure, recovery rate).*
This paper presents a detailed overview of the processes and technologies emerging in the field of filtration with specific application to water treatment systems. The paper highlights high effectiveness and high performance with studying parameters as per requirement.

Keywords*: Membrane Filtration, Recovery rate, Hydrostatic Pressure, Ionic strength, Feed solution composition.*

1. INTRODUCTION

Water, a limited finite resource, vital for the very existence of life on earth and a necessity for economic and social development and for environmental sustainability, is becoming a scarce commodity. Large amounts of water are being polluted because of industrial, domestic and farming activities. Where the availability of water cannot be increased by using conventional resources or by recycling or cannot be made available by demand management methods, the filtration of untreated water offers an alternative solution. New technological advances in the last 30 years tremendously reduced the capital cost and the energy consumption and also reduced the parameter as we need so that desalination can be considered as alternative solutions to water development. During the last three decades, membrane filtration has emerged as a separation technology for water treatment which is competitive in many ways with conventional separation techniques, especially in comparison to distillation. This section reviews the current status, practices, and advances that have been made in technologies and their contribution on current water supply needs. Additionally, it provides an overview of R&D activities and outlines future prospects for the state of the art water desalination technologies[1].Some conventional water treatment plants may have difficulties meeting the new regulations, whereas membranes are considered one of the most promising and capable technologies. Water quality from nano-filtration and reverse osmosis systems is excellent and is superior to conventional coagulation or softening processes [2-3].

Membrane act as selective barriers to restrict the passage of pollutants such as organics, nutrients, turbidity, microorganisms, inorganic metal ions and other oxygen depleting pollutants, and allows relatively clear water to pass through [4]. It is attractive solution for water quality and water reuse because of their advance technology.

Fundamentals of Membrane process: There are many types of membrane processes in use and they are Microfiltration, Ultrafiltration, Nanofiltration, Reverse Osmosis and etc.

Microfiltration (MF)

The pore size on microfiltration membranes ranges from 0.1 – 5 um, and has the largest pore size of the four main membrane types. Its pores are large enough to filter out such things as bacteria, blood cells, flour, talc and many other kinds of fine dust in solution. Because its pores are relatively large compared to other membranes, it can be operated under low pressures and therefore low energy.

Ultrafiltration (UF)

Ultrafiltration has a pore size range of 0.1um to 0.01um. UF membranes reject particles such as silica, viruses, endotoxins, proteins, plastics and smog/fumes such as ZnO. Due to the decrease in pore size, the osmotic pressure required is higher than that of MF.

Nanofiltration (NF)

Nanofiltration has a pore size range of 0.001-0.01um. NF membranes can filter particles up to and including some salts, synthetic dies and sugars, however it is unable to remove most aqueous salts and metallic ions, as such, NF is generally confined to specialist uses.

Reverse Osmosis (RO)

Reverse Osmosis has a pore size range of 0.0001 – 0.001. It is by far the finest separation material available to industry. It is used on a large scale for the desalination and purification of water as it filters out everything but water molecules, with pore sizes approaching the radius of some atoms in many cases. This pore size means it is the only membrane that can reliably filter out salt and metallic ions from water. The small pore size of RO membranes means that a significant amount of osmotic pressure is required to force filtration. [5]

Common methods for the Treatment of water:

Coagulation and flocculation

One of the first steps in a conventional water purification process is the addition of chemicals to assist in the removal of particles suspended in water. Particles can be inorganic such as clay and silt or organic such as algae, bacteria, viruses, protozoa and natural organic matter. Inorganic and organic particles contribute to the turbidity and color of water.

The addition of inorganic coagulants such as aluminum sulfate (or alum) or iron (III) salts such as iron (III) chloride cause several simultaneous chemical and physical interactions on and among the particles. Within seconds, negative charges on the particles are neutralized by inorganic coagulants. Also within seconds, metal hydroxide precipitates of the iron and aluminium ions begin to form. These precipitates combine into larger particles under natural processes such as Brownian motion and through induced mixing which is sometimes referred to as flocculation.

In water purification plants, there is usually a high energy, rapid mix unit process (detention time in seconds) where the coagulant chemicals are added followed by flocculation basins (detention times range from 15 to 45 minutes) where low energy inputs turn large paddles or other gentle mixing devices to enhance the formation of floc. In fact, coagulation and flocculation processes are ongoing once the metal salt coagulants are added.

Sedimentation: Waters exiting the flocculation basin may enter the sedimentation basin, also called a clarifier or settling basin. It is a large tank with low water velocities, allowing floc to settle to the bottom. Sedimentation tanks are typically designed within a range of overflow rates of 0.5 to 1.0 gallons per minute per square foot (or 1.25 to 2.5 meters per hour). In general, sedimentation basin efficiency is not a function of detention time or depth of the basin. Although, basin depth must be sufficient so that water currents do not disturb the sludge and settled particle interactions are promoted typical detention times for sedimentation vary from 1.5 to 4 hours and basin depths vary from 10 to 15 feet (3 to 4.5 meter).[6]

Review Past Study- In this paper, different authors' literature review papers are summarized on water analysis and their treatment processes in different region, which is helpful to know the different treatment processes and parameters used in the study which have mentioned in following table.

Type Of Water	Technique Use	Parameter	Result		Conclusion	REFERENCE
			Inffluent	Effluent		
Waste water	Nanofiltration, Reverse osmosis	Aldrich humic acid (AHA)	pH-7	pH-8.5 with dilute NaOH	Study the effect of crossflow velocity on permeate flux and AHA rejection with resistance of organic fouling. NF-83.8% RO-97.7%	[7]
Surface water	Nanofiltration	Organic & inorganic matter	pH-5 to 6 Hardness- 0.21 TOC-3.4	pH-6.8 80% recovery H-3.4 TOC-0.88	NF provides high & stable removal of organic matter & minimize environmental impact.	[8]
Waste water	Ultrathin Graphene nanofiltration	Salts, organic dye	Ca-46.3 Mg-12.6 Na-59.4 EC-601	Ca-0.88 Mg-0.2 Na-5.44 EC-39	It increases antifouling property by chemical modification.	[9]

Distillery water	Reverse osmosis	COD,TDS	COD- 30000 TDS- 25000 ppm	COD - <750 TDS- <1000	Membrane & membrane seperaion tech. with enzyme have very significant role in treatment.	[10]
Waste water	Coagultion Process	pH, COD, TOC,BOD,TS	pH-7.2 COD-1700 TOC-1200 BOD-940 TS-1940	pH-7 COD-70% TOC-60% BOD-44% TS-79%	Alum was better phermacuetical for water treatment plant with good efficiency.	[11]
Wash water	Reverse Osmosis	pH, TDS, COD, BOD1, CL	pH-9.88, TDS-2104, COD-586, BOD-190, CL-334	pH-5.67, TDS-196 COD-17 Bod-02 CL-34	This treatment plant is reduced the parameter as potable water & got treated water.	[12]
Waste water	Reverse Osmosis	pH, TDS, BOD, COD	pH-9.76 TDS-4280 BOD-80 COD-317	pH-7.52 TDS-474 BOD-10 COD-24	The removal efficiency of this plant with RO technique BOD: 88-98, COD: 91-97 with well treated water.	[13]
Waste water	Common treatment methods	BOD, COD, pH	BOD-114, TDS-443, pH-30	BOD-2, TDS-59 pH-0.1	It is concluded that, it remove the 97% of BOD and 90% of COD	[14]
Waste water	CETP methods	pH, suspended solids, COD, Chloride, sulphide,	pH-8.2 Suspended solids-5704 Cod-12857, Chloride-7091,	pH-6.0 Suspended solids-200, COD-120, Chloride-45,	It controls the characteristics of the discharged effluent caused a sensible reduction of the pollution entering the CETP.	[15]
Waste water	Ultrafiltration	Salt organic dye	Ca-46.3 Mg-12.6 Na-59.4 EC-601	Ca-45.8 Mg-12.4 Na-57.6 EC-622	It increases antifouling property by chemical modification	[9]

2. RESULT AND DISCUSSION-

Here we are going to discuss about different parameters & results obtained by various authors.

C.H.Koo, A.W.Mohmmad, and M.Z. Meortalib studied waste water by RO membrane & NF membrane process, and result of given parameter (AHA) is with input of pH-7 and output of pH-8.5 with dilute NaOH. Thus he concluded that Study the effect of cross flow velocity on permeate flux and AHA rejection with resistance of organic fouling. [7]

Rilina Linkenan studied surface water by NF process, and the result of given organic & inorganic parameter with input of pH-5 to 6, Hardness- 0.21 & TOC-3.4 and output of pH-6.8 of 80% recovery,Hardness-3.4 & TOC-0.88 and concluded that NF provides high & stable removal of organic matter & minimize environmental impact. [8]

Yi Han, Zhen Xu, & Chao Gao studied the waste water by nanofiltration and result of salt organic matter with input of Ca-46.3, Mg-12.6, Na-59.4, EC-601 and output of Ca-0.88, Mg-0.2, Na-5.44, EC-39 and they concluded that It increases antifouling property by chemical modification. [9]

Pawar Avinash Shivajirao, IJDWW using membrane techno studied the distillery water by reverse osmosis and the result of input COD- 30000,TDS-25000 ppm and output of COD - <750 and TDS- <1000, and he concluded that Membrane & membrane separation tech. with enzyme have very significant role in treatment.[10]

Yeddla, Gangadhar Reddy, Dr.T .Bala Narsaiah, B. Venkateswar Rao studied the waste water by coagulation process and result of input pH-7.2, COD-1700, TOC-1200, BOD-940, TS-1940 and output of pH-7, COD-70%,TOC-60%, BOD-44%, TS-79%, and concluded that Alum was better pharmaceutical for treatment plant. [11]

P.Schoeberl, M. Brik, R. Braun, W. Fuchs, studied the wash water by reverse osmosis process and result of input pH-9.88, TDS-2104, COD-586, BOD-190, Cl-334 and output of pH-5.67, TDS-196, COD-17, BOD-02, Cl-34 and concluded that This treatment plant is reduced the parameter as potable water. [12]

Ranganathan, K et al studied the waste water by reverse osmosis and result of input pH-9.76, TDS-4280, BOD-80, COD-317 & output of pH-7.52, TDS-474, BOD-10, COD-24, and concluded that the removal efficiency of this plant with BOD: 88-98, COD: 91-97. [13]

Federal Environmental Agency, Germany, 2002 done the common treatment methods with waste water and found result of given parameter with input of BOD-114, TDS-443, pH-30 and output of BOD-2, TDS-59, pH-0.1 and concluded that, it remove the 97% of BOD and 90% of COD. [14]

Chandra, R., Bhargava, R. N. 2011, studied the waste water by common effluent treatment plant method and result given of parameter with input of pH-8.2 Suspended solids-5704, COD-12857, Chloride-7091, and output of pH-6.0 Suspended solids-200, COD-120, Chloride-45 and found conclusion that this fact associated with more strict controls of the characteristics of the discharged effluent caused a sensible reduction of the pollution entering the CETP. [15]

Yi Han, Zhen Xu, & Chao Gao studied the waste water by ultrafiltration and result given of parameter with input of Ca-46.3, Mg-12.6, Na-59.4, EC-601 and output of Ca-45.8, Mg-12.4, Na-57.6, EC-622 and conclusion is that It increases antifouling property by chemical modification. [9]

3. CONCLUSION

As we studied the different results from all above references, it is stated that the various kind of water have treated by different techniques and got a treated water with high removal and better efficiency. But from whole study of all papers we concluded that NF and RO works more frequently with good removal efficiency than other techniques but NF has high flux rate and high consumption compared to RO. Thus the nanofiltration has high efficiency water filtration compared to all filtration techniques.

4. ACKNOWLEDGEMENT

We are thankful and acknowledge to Prof.D.T.Warade, Head, Central Library, PIET, Nagpur for providing digital library facilities for the completion of this work successfully.

REFERENCES

[1] Hanane Dach, Comparison of nanofiltration and reverse osmosis processes for a selective desalination of brackish water feeds, 19 Nov 2009

[2] Mulford, L.A., Taylor, J.S., Powell, R.M., Morris, K.E., Jones, P.S., and Reiss, C.R. DBP Precursor Removal by Reverse Osmosis, Proceedings of the Membrane Processes Conference, American Water Works Association, Orlando, Florida, 563-570. March 1991

[3] Taylor J. and Hong S. Potable water quality and membrane technology, Journal of Laboratory Medicine, 31 (10), 563-568. 2000.

[4] Mulder, M.: Basic principles in membrane technology, Kluwer Academic Publishers, 1997

[5] source- web (pore size of R.O. membrane- pore size memRe)

[6] Wikipedia-sedimentation and coagulation

[7] C.H. Koo, A.W. Mohammad, F. Suja', and M.Z. Meortalib Comparison of nanofiltration and reverse osmosis membranes performance subject to crossflow velocity effect during filtration of Humic acids, 5-7 Sept 2013

[8] Riina Liikanen- Nanofiltration as a refining phase in surface water treatment, 10th November 2006

[9] Jianping Zhou, Naiyun Gao, Guangyong Peng, Yang Deng, Pilot Study of Ultrafiltration-Nanofiltration Process for the Treatment of Raw Water from Huangpu River in China, accepted June 30, 2009

[10] Pawar Avinash Shivajirao, International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974, IJAERS/Vol. I/ Issue III/April-June, 2012/275-283, Treatment of Distillary Wastewater Using Membrane Technologies

[11] Yeddla. Gangadhar Reddy, Dr. T. Bala Narsaiah, B. Venkateswar Rao, International Journal of Engineering Research and Development e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com Volume 11, Issue 11 (November 2015), Treatment of pharmaceutical waste water using Coagulation method

[12] P.Schoeberl, M. Brik, R. Braun, W. Fuchs, Treatment and recycling of textile waste water, Desalination 171 (2004)

[13] Ranganathan, K et al; Recycling of wastewaters of textile dying industries using advanced treatment technology and cost analysis-Case studies, Conservation & Recycling vol. 50 issue 3 May, 2007. p. 306-318

[14] Global good practices in industrial wastewater treatment and disposal/reuse, with special reference to common effluent treatment plants, Central Pollution Control Board (Ministry of Environment & Forests, Govt. of India), Federal Environmental Agency, Germany, 2002)

[15] Chandra, R., Bhargava, R. N. 2011, Bacterial diversity, organic pollutants and their metabolites in two aeration lagoons of common effluent treatment plant (CETP) during the degradation and detoxification of tannery wastewater, Bio resource Technology.