Scientific Journal of Impact Factor

e-ISSN (O): 2348-4470

International Journal of Advance Engineering and Research Development

Volume 4, Issue 12, December -2017

Study on Ultrafiltration and Reverse Osmosis Performance to Remove Pollutant from Textile Industry Waste Water

[1]Pawan Chouhan,[2]Paranita Samariya,[3]Mayank Vyas, [4]Dr. S. K. Singh

[1]Post Graduate Scholar, Civil Engineering, MBM Engineering College, Jodhpur, India
[2]Assistant Engineer, Department of Local Body, Rajasthan, India
[3]Post Graduate Scholar, Civil Engineering, MBM Engineering College, Jodhpur, India
[4]Professor, Civil Engineering, MBM Engineering College, Jodhpur, India

ABSTRACT :- *Treated waste water from secondary treatment unit of textile industry has high TDS. Therefore, it required to install RO plant to reduce high TDS from waste water. A pilot plant study was done to assess the effectiveness of RO plant.*

The membrane technology was used with associated modern technologies to make sure that the entire system would produce pure water. The end water should pass the quality set by the governing bodies. In the reverse osmosis method, need to understand that the feed water should be preconditioned first so as the membranes will be protected. Ultrafiltration is a pretreatment of Reverse Osmosis method. The reverse osmosis method starts with the pre filtration of water. Through pre filtration, the large particulates as well as the contaminants will be sorted out before it will reach the membrane. It is also referred as pre filtering wherein the semi permeable membrane will be free from clogging.If the pressure is reduced during the process, it is an indicator that the water is not filtered enough before it will reach the unit. The reverse osmosis is a reliable and proven to be effective method of producing excellent quality water. It reduce the TDS upto 70%. The performance study in respect of various parameters have been carried out in this case study.

The case study was for analysis and design for reuse of waste water from textile industrial unit. It is observed that in final outlet, all parameters except Total Dissolved Solid for some samples were meeting the standards of reuse. . After number of trials, it was found that with Reverse Osmosis, the TDS was reduced to less than 57.22 mg/lit, which is acceptable for reuse of waste water for agricultural purpose and other industrial purposes.

Key words: *RO, UF, Textile industry waste water, BOD, COD, TDS.*

1. INTRODUCTION

Textile industries transform fibers into yarn; convert the yarn into woven fabrics or knitted fabrics, dyeing, printing and finish these materials at various stages of production. In textile dyeing, three major processes are involved, namely preparation process, coloration process and post treatment process. The preparation process includes singeing, desizing, scouring, mercerization and bleaching. The coloration process involves dyeing and the post treatment process deals with printing and finishing. The textile industry consumes a large quantity of water and generates an equal amount of wastewater, as known as effluent. The nature of the generated waste depends on the type of the process, the technology involved, types of raw materials and chemicals used. In the processing of textiles, the industry uses a number of dyes, chemicals, auxiliary chemicals and sizing materials. As a result, the contaminated wastewater generated causes.

Acute environmental problems, unless it is properly treated before its disposal. Textile effluents are generally intensely colored, which contain both suspended and soluble organic and inorganic impurities and they possess high Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). They are of highly polluting nature and their disposal, without proper treatment affects the environment. In particular, the water courses are affected by the addition of color, suspended impurities, pH values, and dissolved minerals, depletion of oxygen, toxic substances, oil and grease. The harm is equally done on the land. The environmental problems associated with this process are typically related to water pollution, caused by the discharge of untreated water.

The Total Dissolved Solids (TDS) in the effluent is not taken care of by the conventional process. Hence an alternative method using the membrane process is employed to treat the wastewater from those industries which contain a high amount of TDS. In particular, the Reverse Osmosis (RO) membrane technology is used to treat and remove the level of TDS in wastewater.

1.1 EffluentfromTextile Processing Industry

Textile fabrics contain impurities which need to be removed prior to the preparatory process or dying process or printing process in order to impart the fabric with maximum absorbency and uniform dye uptake properties. During these processes, the textile fabrics are added with chemicals like auxiliaries, dyes and pigments. Table 1 delineates the different stages the chemicals used in each stage and their corresponding nature in effluent characteristics of textile processing industry.

Table1: Originof textileeffluentsandtheircharacteristics

Origin	Characteristics/Chemicals	Nature
Sizing	Starch,Waxes,SuspendedSolids,CarboxymethylCellulose(CMC), PolyvinylAlcohol(PVA),BadOdour, SoftenerAndOilFats	HighInBOD,COD
Desizing	Starch,HydrolyzedStarch,BadOdour,Enzymes,Salt,AcidicPh,CMC,PVA,Fats,Waxes AndPectins	HighInBOD,SuspendedSolids(SS),DissolvedSolids (DS)
Scouring	Alkalies,Surfactants,SaponifiedOils,HydrolyzedPectins, Proteins,SuspendedSolidsAndOil	HighInBOD,COD, HighPh
Mercerizing	SodiumHydroxide,CottonWax	HighPh,LowBOD,HighDS
Bleaching	SodiumHypochlorite,Cl_2,Naoh, H_2O_2,AcidsSurfactants,$Nasio_3$, SodiumPhosphateAndShortCotton Fibers	HighAlkalinity,High SS
Dyeing	Dyestuffs,Urea,Salt, ReducingAgents,OxidizingAgents, AceticAcid,DetergentsAndWetting Agents	StronglyColored,High BOD,DS,LowSS, HeavyMetals

2. TREATMENT OF TEXTILE INDUSTRY WASTE WATER

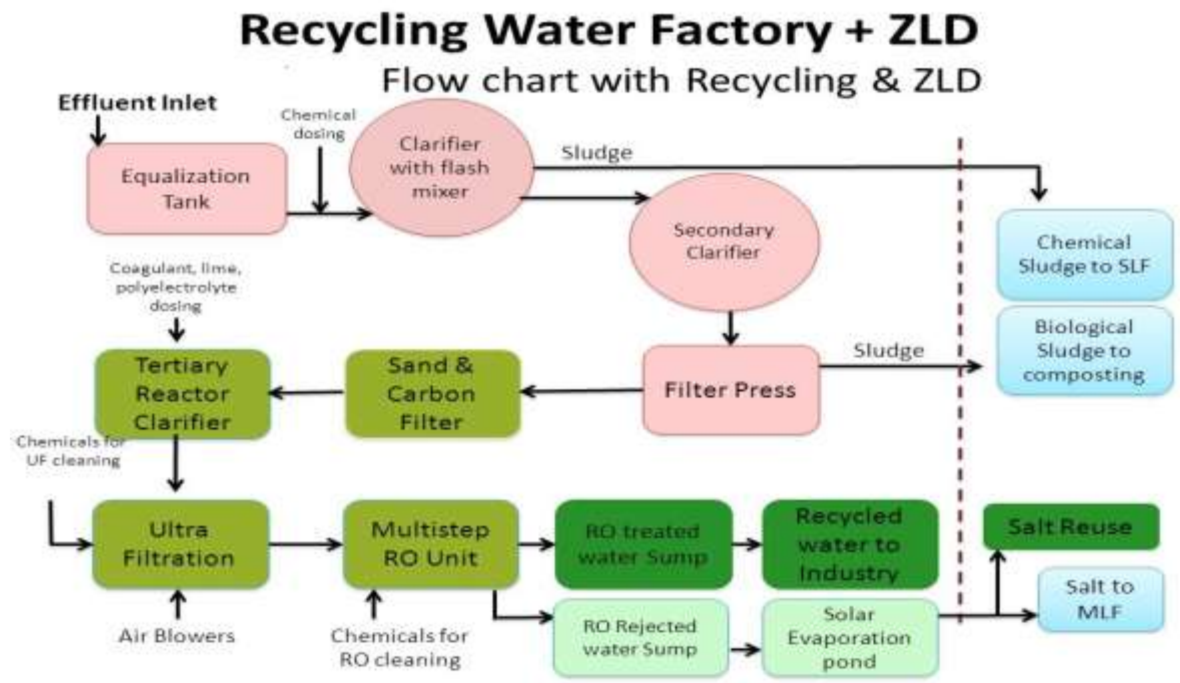


Figure.1: Flow sheet of conventional ETP of textile industry

2.1 Reverse Osmosis

Besides the phase change, the separation of fresh water from saline water can also be accomplished by pressure-driven membrane processes. Among these processes, Reverse osmosis is the most widely used, which occupies more than 70% market share for seawater and brackish water desalination in Europe. By pressurizing saline water through a semi-permeable membrane that only allows the permeation of water molecules but not ions or any other dissolved matter, a stream of pure water can be produced as well as a brine stream. Feed pressure is required to overcome the osmotic pressure on the feed side of the membrane. For seawater desalination, the feed pressure commonly ranges from 60-80 bars , while for brackish water, the figure is much lower (~20 bar).

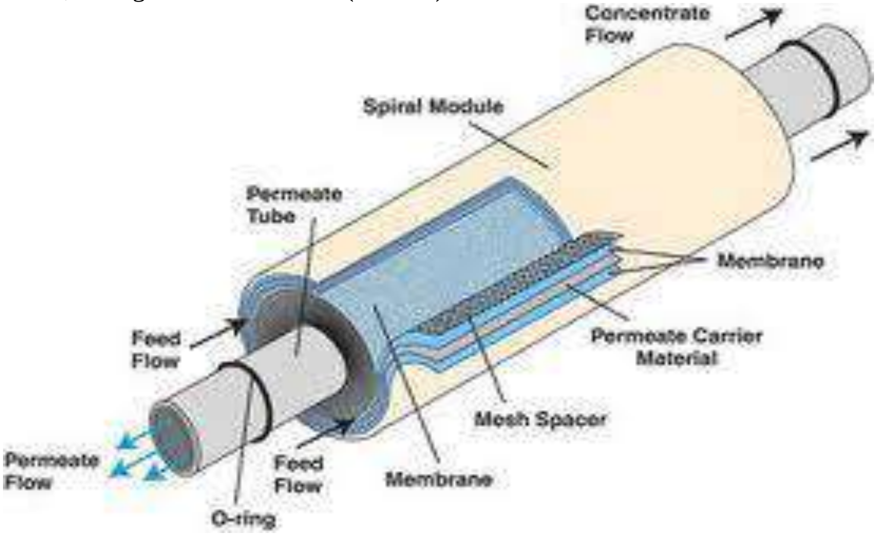


Figure 3: Reverse Osmosis Membrane

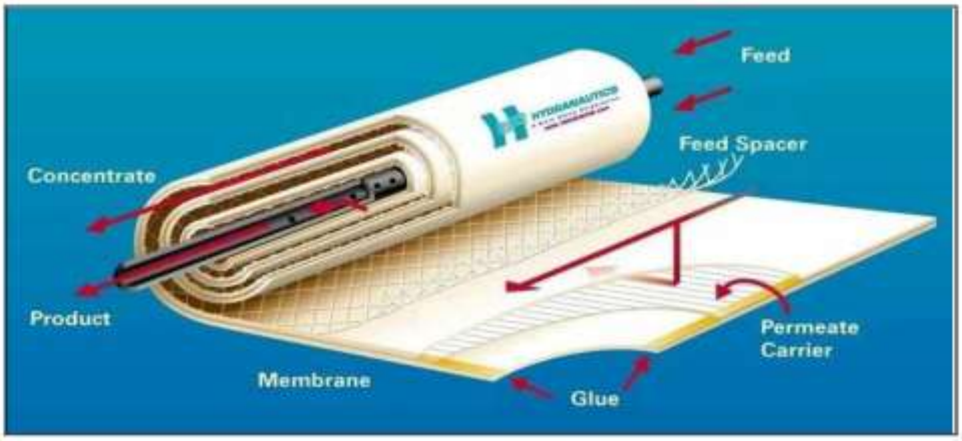


Figure 4: Process of Treatment Inside

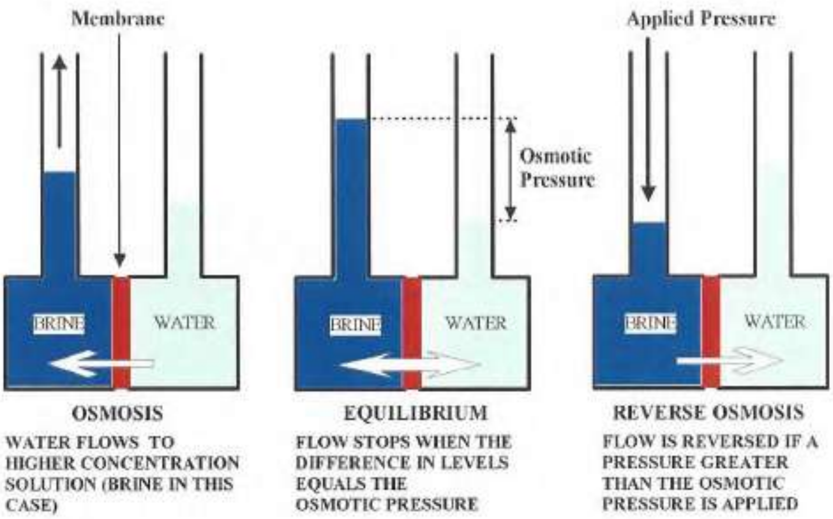


Figure 5 : Diagram showing principle of Osmosis and Reverse Osmosis (Semi Permeable Membrane shown in red

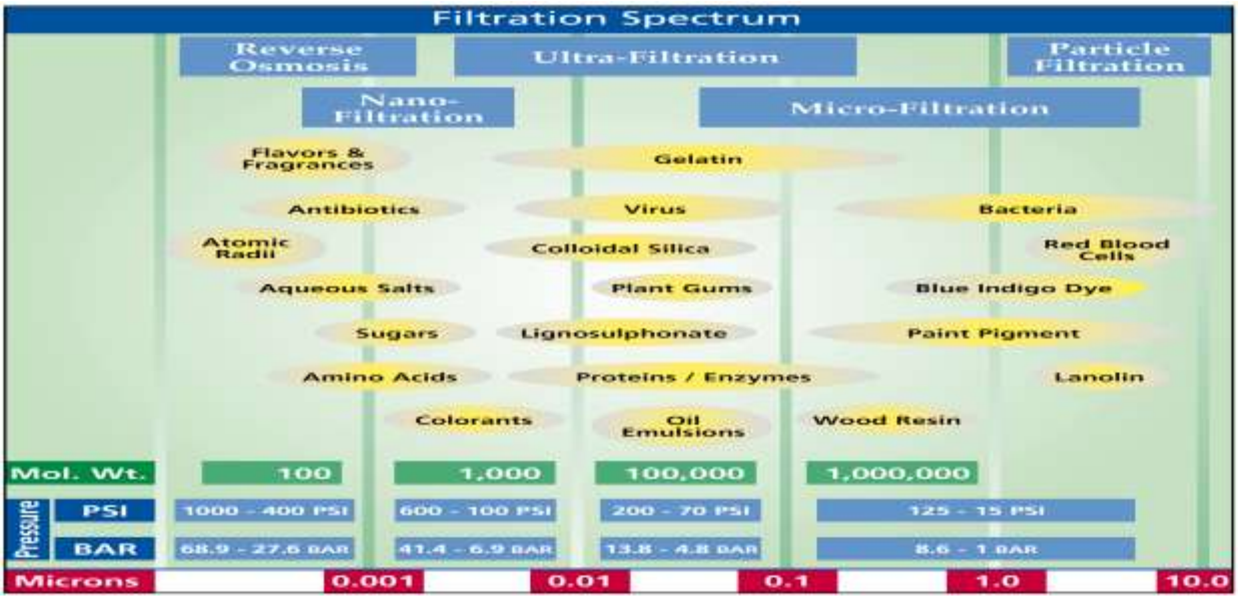


Figure 6: size of materials that are removed by various separation processes

The treated influent from ETP of textile industry will be having higher TDS concentration (up to 6000 mg/l) , therefore, thus a RO plant is recommended on ETP of textile industry to reduce TDS concentration in treated water. This RO filtration process, further, produces high TDS water so called RO reject, which is again a environmental concern, other than low TDS treated water. Therefore, to reduce predicted environmental adverse impact due to RO rejects an effective SPLASH system, high rate evaporation process, to be installed on generated RO reject is recommended, by product, i.e. concentrated salts, of SPLASH system will be, finally, sent to TSDF site.

Textile industry generate huge amount of industrial waste water.to overcome this problem of waste water a ETP plant is established and tertiary treatment facility (pressure filter and activated carbon) is installed to enhance the quality of treated industrial waste water and for reuse of high TDS treated waste water coming out from tertiary treatment RO plant is installed to reduce TDS.

2.2Process of Treatment of Textile Industry Waste Water through UF & RO.

Secondary effluent was collected from ETP of textile industry which have high COD so we add fresh water for decreasing amount of COD, called blended water. Effluent blended feed water enter into flash mixture by pump and add the chemicals like polyaluminiumchloide and polyelectrolyte for sludge is settle down and feed is enter to clarifloculator and dual sand media filter. The feed water is hereby pressed into the UF module by a pump, and permeates through the membrane due to transmembrane pressure (TMP) difference. Depending on the membrane's pore size, water contaminates are being rejected by the membrane and remain in the feed water.in order to avoid a too high concentration of rejected contaminates, which can consists of colloid as well as molecules, atoms or ions, a part of the feed is taken out from the system as concentrate. Too high concentration of contaminants in a membrane system can lead to mineral scaling on the membrane or fouling of colloids, building up a cake layer on the membrane, changing filtration properties and necessary filtration pressure.

Ultra filtration water passed into RO module by pump and flow is adjusted by Rota- meter when rejected valve is opened & flow is adjusted to create pressure upto 5.8kgf/cm2 in the system by using booster pump. Flow rate of purified water and reject water is measured by Rota- meter.at a certain pressure water to flow in different stages of membrane. Purified water and reject water are collected in respective tank.

Proper pre-treatment using both mechanical and chemical treatments is critical for an RO system to prevent fouling, scaling and costly premature RO membrane failure and frequent cleaning requirements.

2.3 RO membrane cleaning

RO membrane will inevitably require periodic cleaning, anywhere from 1 to 4 times year depending on the feed water quality.as a general rule, if the normalized pressure drop or the normalized salt passage has increased by 15%, then it is time to clean the RO membrane in place or have them removed from the RO system and cleaned off site by a service company that specialized in this service.it has been proven that offsite membrane cleaning is more effectively at providing a better cleaning than onsite cleaning skids. RO membrane cleaning involve low and high pH cleaners to remove contaminates from the membrane. Scaling is addressed with low pH cleaners and organics, colloidal and biofouling are treated with a high pH cleaner. Cleaning RO membranes is not only about using the appropriate chemical. There are many other factors involve such as flows, water temperature and quality, properly designed and sized cleaning skids and many other factors that an experienced service group must address in order to properly clean RO membrane.

Typesof ROMembranes

There are different types of RO membranes like spiral wound membrane, tubular membrane, plate and frame membrane, capillary membrane and hollow fiber membrane.

3. OBSERVATION& ANALYSIS

As the objective of the project is to study the performance of RO plant, hence variable for unlet of RO plant is taken into consideration are:-

1. pH
2. COD
3. TDS
4. Turbidity
5. Alkalinity

The various observation taken from different parameter have different range:

Table 2: Percentage change in pH from UF unit

S. No.	Range of pH	pH inlet (average)	pH outlet (average)	% reduction in pH
1.	6 to 7	6.92	6.9	0.29
2.	7 to 8	7.50	7.46	0.53
3.	8 to 9	8.15	8.05	1.23

Table 3: Percentage removal of COD (mg/l) from UF unit

S. No.	Range of COD (mg/l)	COD inlet (average) (mg/l)	COD outlet (average) (mg/l)	% reduction in COD
1.	80-100	92.4	82.50	10.71
2.	100-150	126.34	108.09	14.44
3.	150-200	177.39	161.29	9.08
4.	200-250	219.64	207.44	5.55

Table 4: Percentage removal in TDS from UF unit

S. No.	Range of TDS(mg/l)	TDS inlet (average) (mg/l)	TDS outlet (average) (mg/l)	% reduction in TDS
1.	9000-12000	10700.00	10570.00	1.21
2.	12001-15000	13021.43	12827.86	1.49
3.	15001-18000	16350.00	16000.00	2.14
4.	18001-21000	22416.67	21916.67	2.23

Table 5:Percentage reduction in Turbidity from UF unit

S. No.	Range of Turbidity(mg/l)	Turbidity inlet (average) (mg/l)	Turbidity outlet (average) (mg/l)	% reduction in Turbidity
1.	2-3	2.68	0.00	100.00
2.	4-6	4.31	0.00	100.00

Table 6: Percentage change in pH from RO unit

S. No.	Range of pH	pH inlet (average)	pH outlet (average)	% reduction in pH
1.	6 to 7	6.70	5.46	18.51
2.	7 to 8	7.48	6.32	15.56
3.	8 to 9	8.05	6.94	13.79

Table 7: Percentage removal of COD (mg/l) from RO unit

S. No.	Range of COD (mg/l)	COD inlet (average) (mg/l)	COD outlet (average) (mg/l)	% reduction in COD
1.	80-100	88.95	6.60	92.58
2.	100-150	116.16	8.36	92.80
3.	150-200	180.63	16.54	90.84
4.	200-250	232.72	16.93	92.73

Table 8: Percentage removal in TDS from RO unit

S. No.	Range of TDS(mg/l)	TDS inlet (average) (mg/l)	TDS outlet (average) (mg/l)	% reduction in TDS
1.	9000-12000	10570.00	57.22	99.46
2.	12001-15000	12827.86	83.49	99.35
3.	15001-18000	17475.00	121.60	99.30
4.	18001-21000	23400.00	375.25	98.40

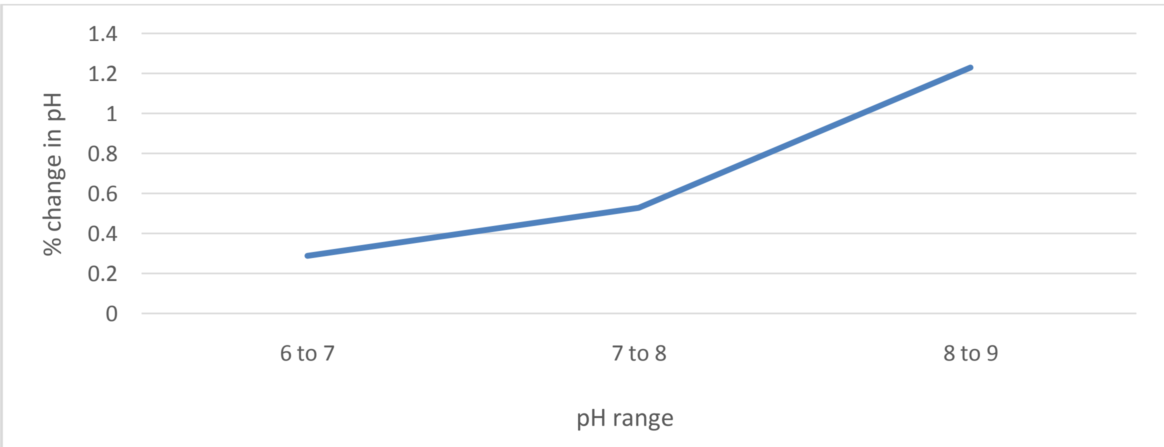
Table 9: Percentage reduction in Alkalinity from RO unit

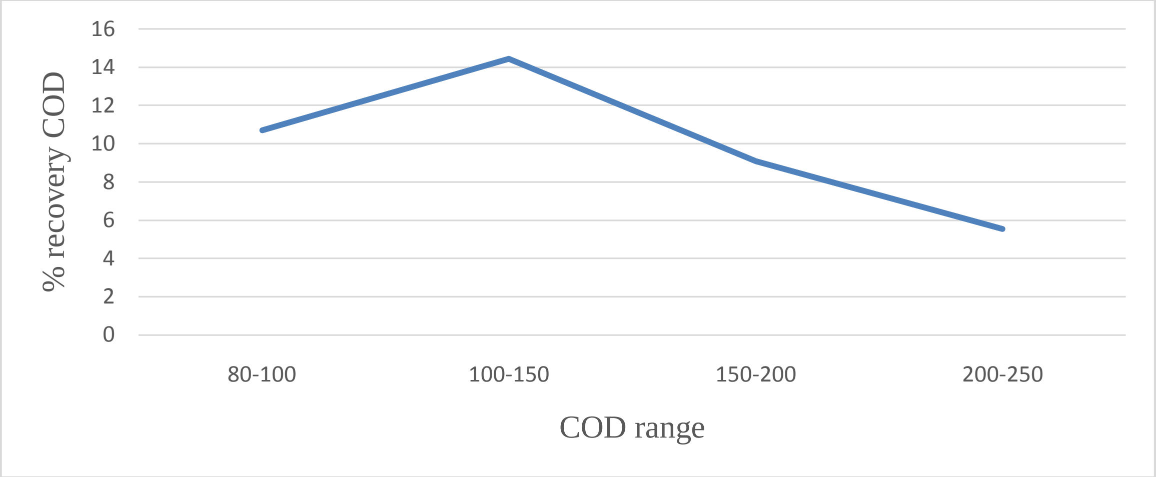
S. No.	Range of Alkalinity (mg/l)	Alkalinity inlet (average) (mg/l)	Alkalinity outlet (average) (mg/l)	% reduction in Alkalinity
1.	7-14	7.43	0.00	100.00
2.	14-21	14.72	0.00	100.00
3.	21-30	24.47	0.00	100.00

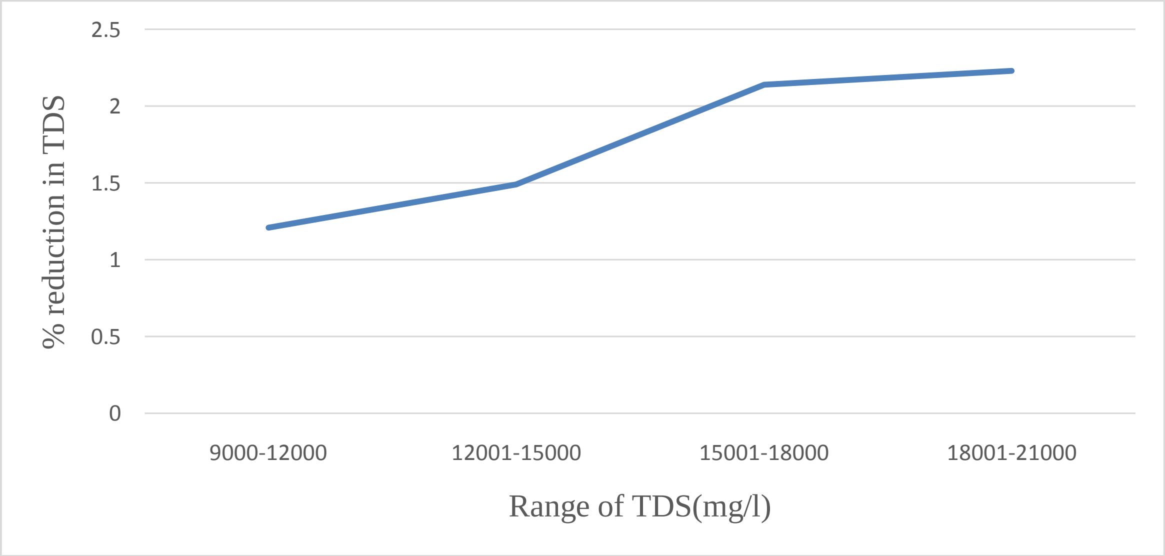
Table 10: Percentage recovery of water for RO plant with 6 elements (outlet TDS < 500 ppm)

S. No.	TDS(mg/l)	Pressure kg/cm^2	% water recovery
1.	12000-15001	25	50
		30	50
		33	50
2.	15000-20000	33	50
		35	50
		39	50
3.	>20000	25	30
		30	30
		39	50

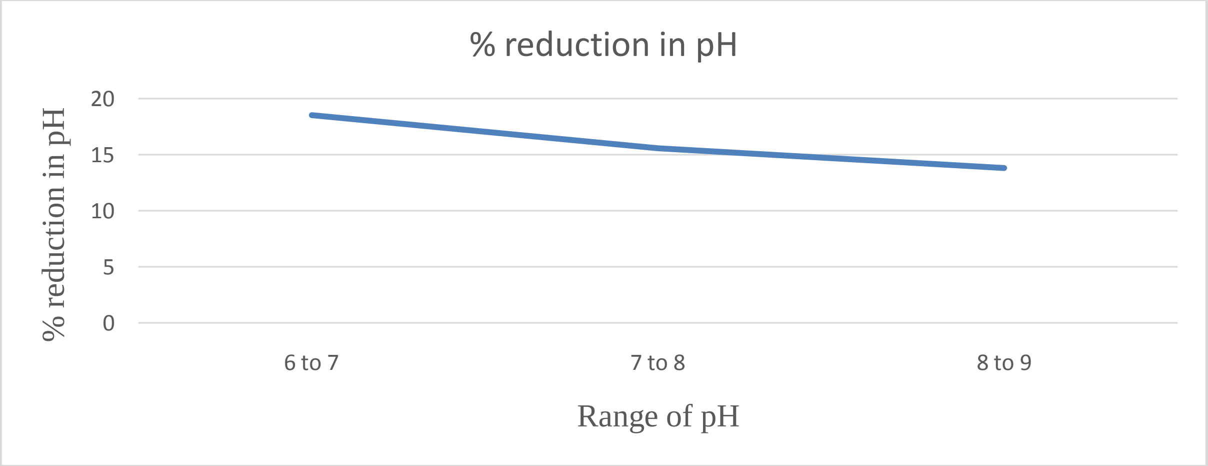
Graphical representation of different parameter removal by UF Unit

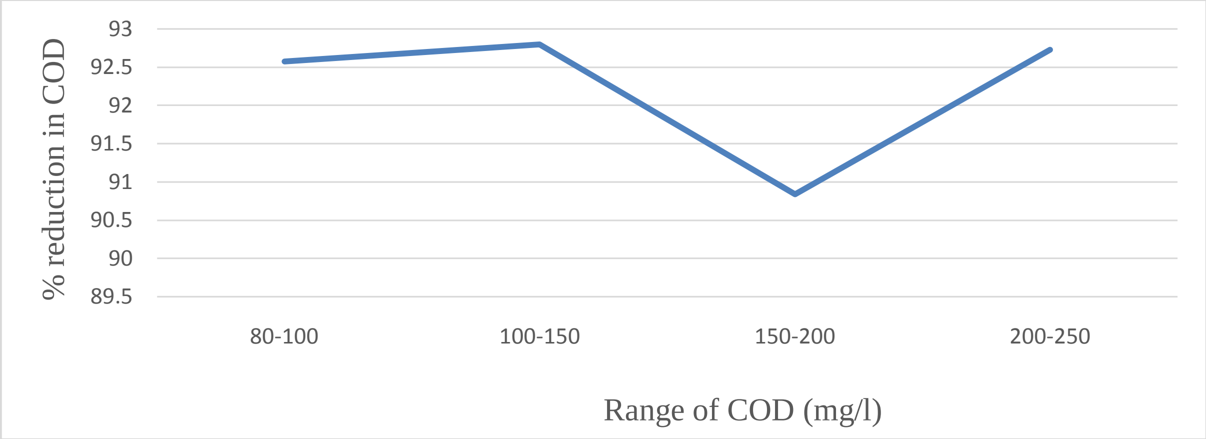


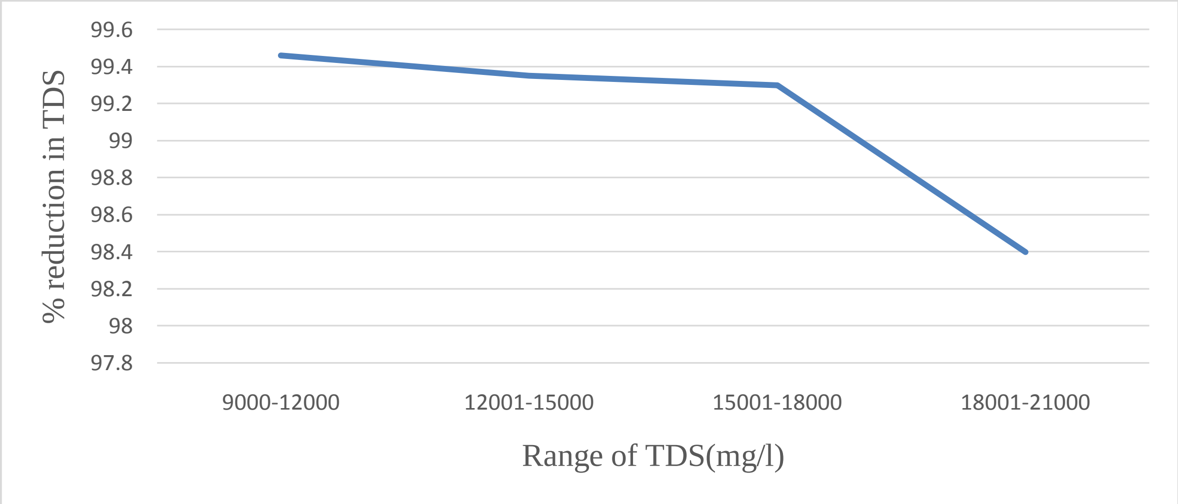


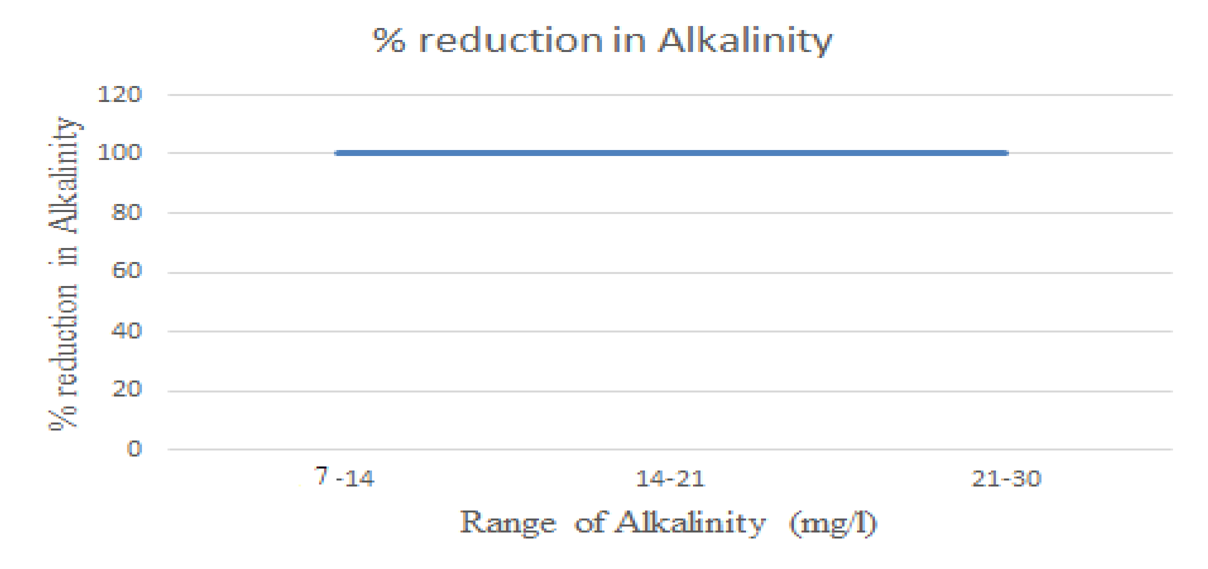


Graphical representation of different parameter removal by RO Unit









Analysis
Parameter analyzed for UF and RO treatments unit are pH, COD, TDS, and Turbidity, alkalinity.
Ultrafiltration treatment unit

- Percentage change in pH is compare with different pH ranges 6-7,7-8 & 8-9 and the corresponding % change are 0.29%,0.53% & 1.23 respectively.

- Percentage removal in COD is compared with different COD ranges 80-100,100-150,150-200 & 200-250 and the corresponding % removal are 10.71%, 14.44%, 9.08% & 5.55% respectively.
- Percentage removal in TDS is compared with different TDS range 9000-12000, 12001-15000, 15001-18000 & 18001-21000 and the corresponding % recovery are 1.21%, 1.49%, 2.14% & 2.23% respectively.
- Percentage removal in Turbidity is compared with different Turbidity range 2-3,4-6 and the corresponding % recovery are 100% & 100% respectively.

Reverse osmosis treatment unit

- Percentage change in pH is compared with different pH range 6-7, 7-8, &8-9 and the corresponding % change are 18.51%, 15.56% & 13.79% respectively.
- Percentage removal in COD is compared with different COD range 80-100,100-150,150-200 & 200-250 and the corresponding % recovery are 92.58%,92.80%,90.84% & 92.73% respectively.
- Percentage removal in TDS is compared with different TDS range 9000-12000, 12001-15000, 15001-20000 & 20000-27000 and the corresponding % recovery are 99.46%, 99.35%, 99.30% & 98.40% respectively.
- Percentage removal in alkalinity is compared with different alkalinity range 7-14, 14-21 & 21-30 and the corresponding % recovery are 100%, 100% & 100% respectively.

Recovery & reject handling:

The following are the method used for reject recovery and handling:ion

- Solar evaporation
- Mechanical evaporation
- Treatment storage & disposal facility

4. CONCLUSION

Reverse osmosis membrane separation technology is proven and reliable. The ease of operation, low operating costs, and consistent and high quality filtrate places membrane technology as a leading waste water process technology in the worldwide effort to improve environmental water quality. Water demand is increasing and quantity of available water is limited. Although regulation and supply vary between areas and country, overall the need for advance waste water treatment method to reduce water consumption and preserve the environment has become apparent. Cross flow membrane processes such as ultrafiltration and reverse osmosis are providing cost-effective methods to treat waste water and recover water.

The average pH of secondary effluent is obtained as 8.16.the pH value of 6.92 to 8.5 is obtained after treating the secondary effluent. Percentage change in pH is compare with different pH ranges 6-7, 7-8 & 8-9 and the corresponding % change are 0.29%, 0.53% & 1.23 respectively from UF. Percentage change in pH is compared with different pH range 6-7, 7-8, &8-9 and the corresponding % change are 18.51%, 15.56% & 13.79% respectively from RO.That is percent change in pH is maximum from reverse osmosis as compared to ultrafiltration.

In ultrafiltration percentage removal in Turbidity is compared with different Turbidity ranges 2-3, 4-6 and the corresponding % recovery are 100% & 100%.

Percentage removal in COD is compared with different COD ranges 80-100,100-150,150-200 & 200-250 and the corresponding % removal are 10.71%, 14.44%, 9.08% & 5.55% respectively from UF unit. Percentage removal in COD is compared with different COD range 80-100,100-150,150-200 & 200-250 and the corresponding % recovery are 92.58%, 92.80%, 90.84% & 92.73% respectively from RO unit. Percent removal COD is maximum from reverse osmosis as compared to ultrafiltration.

High TDS water treated at high pressure in RO unit to increase the water recovery upto 50%.

Percentage removal in Alkalinity is compared with different Alkalinity range 7-14, 14-21, 21-30, and the corresponding % recovery are 100% & 100% respectively.

Reference

1. Anderson, M.A., A.L. Cudero, and J. Palma. Capacitive deionization as an electrochemical means of saving energy and delivering clean water. Comparison to present desalination practices: Will it compete? Electrochimica Acta, 55, 3845 (2010).
2. Fritzmann, C., J. Löwenberg, T. Wintgens, and T. Melin. State-of-the-art of reverse osmosis desalination. Desalination, 216, 1 (2007).
3. Avlonitis, S.A., K. Kouroumbas, and N. Vlachakis. Energy consumption and membrane replacement cost for seawater RO desalination plants. Desalination, 157, 151 (2003).
4. Wilson, J.R., Demineralization by electrodialysis. 1960: Butterworths Scientific Publications
5. Sonin, A.A. and R.F. Probstein. A hydrodynamic theory of desalination by electrodialysis. Desalination, 5, 293 (1968).
6. AWWA (1999) Reverse Osmosis and Nanofiltration, Manual of Practice M46, American Water Works

Association
7. https://en.wikipedia.org/wiki/Reverse_osmosis
8. Ramesh Kumar, M. and Saravanan, K. "Application of Reverse Osmosis to textile industrial wastewater treatment", Journal of The Technology World, Vol. 5, No.1, pp. 300 – 305, 2009.
9. Anderson, J., Hoffman, S. and Peters, C. "Factors influencing Reverse Osmosis rejection of organic solutes from aqueous solution", The Journal of Physical Chemistry, Vol. 76, pp.4006, 1972.
10. APHA, "Standard methods for the examination of water and wastewater", 20th Ed., American Public Health Association, Washington DC, USA, India, 1998.
11. Gomez, M., Plaza, F., Garralon, G., Perez, J. and Gomez, M.A. "A comparative study of tertiary wastewater treatment by physicochemical – UV process and macrofiltration – ultrafiltration technologies", Desalination, Vol. 202, pp. 369 – 376, 2007.
12. Tinghui, T., Matsuura, T., Sourirajan, S, 1983. Effect of membrane materials and average pore size on reverse osmosis separation of dyes, Industrial engineering chemical production research division, 22, 77 – 85.
13. Ciardelli, G., Ranieri, N, 2001. "The treatment and reuse of wastewater in the textile industry by means of ozonation and electroflocculation", Water research, 35, 567 – 572.

