TERTIARY WASTE WATER TREATMENT: A REVIEW

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***ABSTRACT*: Tertiary treatment is the final stage of waste water purification. It raise the effluent quality before it is discharged to the receiving environment such as sea, river, lake, ground etc. Tertiary treatment removes different types of pollutants such as organic matter, suspended solids, nutrients, pathogens and heavy meals that secondary treatment is not able to remove. It includes sedimentation, coagulation, membrane processes, filtration, ion exchange, activated carbon adsorption, electrodialysis, nitrification and denitrification, ozonation, ultraviolet radiation etc. Effluent becomes cleaner by tertiary treatment through the use of stronger and more advanced treatment systems. This paper reviews the different tertiary treatment technologies available. Recent innovations for achieving clean and clearer water suitable for reuse or discharge to the surface water sources are discussed.**

***Keywords*: Advanced wastewater treatment, membrane processes, nitrification and Denitrification, tertiary treatment, waste water treatment.**

1. INTRODUCTION

Tertiary treatment is the next wastewater treatment process after secondary treatment. This treatment is sometimes called as the final or advanced treatment and consists of removing the organic load left after secondary treatment for removal of nutrients from sewage and particularly to kill the pathogenic bacteria. The effluents from secondary sewage treatment plants contain both nitrogen (N) and phosphorus (P). N and P are ingredients in all fertilizers. When excess amounts of N and P are discharged, plant growth in the receiving waters may be accelerated which results in eutrophication in the water body receiving such waste. Algae growth may be stimulated causing blooms which are toxic to fish life as well as aesthetically unpleasing. Secondary treated effluent also contains suspended, dissolved, and colloidal constituents which may be required to be removed for stipulated reuse or disposal of the treated effluent. The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality before it is discharged to the receiving environment such as sea, river, lake, ground, etc., or to raise the treated water quality to such a level to make it suitable for intended reuse. This step removes different types of pollutants such as organic matter, SS, nutrients, pathogens, and heavy metals that secondary treatment is not able to remove. Wastewater effluent becomes even cleaner in this treatment process through the use of stronger and more advanced treatment systems. It includes ion exchange, reverse osmosis, membrane processes, ultra violet, electro dialysis, nitrification and denitrification etc. Tertiary treatment is costly as compared to primary and secondary treatment methods. Tertiary treatment may be provided to the secondary effluent for one or more of the following contaminant further. To remove total suspended solids and organic matter those are present in effluents after secondary treatment. To remove specific organic and inorganic constituents from industrial effluent to make it suitable for reuse .To make treated wastewater suitable for land application purpose or directly discharge it into the water bodies like rivers, lakes, etc .To remove residual nutrients beyond what can be accomplished by earlier treatment methods. To remove pathogens from the secondary treated effluents. To reduce total dissolved solids (TDS) from the secondary treated effluent to meet reuse quality standards (*Tertiary water treatment by NPTELl IIT Kharagpur).*

2. GENERAL OVERVIEW

2.1*Electrodialysis:*

Mohammadi et.al. (2002) carried out investigation on electrodialysis for zinc ion removal from wastewater. They explained a robust design method for separation of zinc ions from a solution. They determined the optimum configuration of factors for the best performance. They determined optimum values of influential parameters such as concentration 1000 ppm, temperature 60°C, flow rate 0.07 mL/s and voltage 30 V. They found that membrane paired with higher ion exchange capacity (IEC) improves the performance.

Schoeman et.al. (1996) used electro-dialysis for treatment of a hazardous leachat.They evaluated electro-dialysis as an alternative method to desalinate/concentrate the leachate for effluent volume reduction and pollution control. Their studies indicated that the leachate could be effectively desalinated/concentrated with electrodialysis (ED). They observed that the TDS of the ED feed was reduced from approximately 100g/l to less than 2g/l with 5 stage ED.

Dermentzis et.al.(1994) carried out an investigation on ammonia removal from fertilizer plant effluents by a coupled electrostatic shielding based electro-dialysis. In this investigation, they interposed electrically and ionically conducting graphite powder beds between the anode and cathode inside an electrolytic setup. These electrodes were used as intermediate bipolar electrodes. Their findings were novel and first of the kind effort. The applied electric field locally inside the mass was eliminated by graphite powder bed electrodes. According to them, thin electrostatic shielding zones - ionic current sinks can be used to enhance current density.

Valero et.al.(2008) studied the conditions for the treatment of a wastewater. They treated wastewater from almond industry. In their work they developed a simple and useful method for measuring voltages between different points inside the reactor. An investigation was carried out on removal of cadmium and cyanide from aqueous solutions by using electrodialysis by *Marder et.al.* According to them, one of the largest problems for environmentalists is the discharge of galvanic industry wastewaters containing heavy metals and cyanide. In their investigation they used a five-compartment electro-dialysis cell. They found that the removal of cadmium and cyanide depends on the applied current density. It was limited by the precipitation of cadmium on the cation-exchange membrane in the dilute central cell compartment.

*Benvenuti et.al.(1998)*studied electro-dialysis as an alternative for treatment of nickel electroplating effluent. According to them, one of the main contributors of metal discharges into the environment is galvanic process. They evaluated nickel extraction, pH and conductivity for all four compartments. They used flame atomic absorption spectrophotometer for nickel determination. They observed that the ED treatment showed a reasonable extraction for all ions in the solution, making good quality water for reuse.

*Viader et.al.(2001)*carried out an investigation on recovery of phosphorus from chemically precipitated sewage sludge ashes by using electrolytic method. According to them, additional steps are required to separate phosphorous (P) from heavy metals. It is also important to ensure its bioavailability in the resulting ashes. They were able to recover P at a rate of 70%. Choi and Jeoung used electro-dialysis for removal of zinc ions in wastewater.They obtained useful data for treatment of the wastewater discharged from zinc electroplating processes. They investigated effect of parameters like the initial concentration of dilute solution, the flow velocity and the applied voltage on zinc removal. They observed that, with an increase in the initial concentration of dilute solution, the flow velocity and the applied voltage the removal ratio also increased. Also it was found that the initial concentration of dilute solution and the applied voltage caused increase in The energy consumption. The effect of flow velocity on energy consumption was negligible.

Nowak et.al (2009) carried out batch electro-dialysis for removal of fluoride from wastewater. They studied effect of initial fluoride and salt (NaCl) concentration. Also the presence of organic matter on fluoride removal was investigated by them. They observed that the separation efficiency increased upon decrease of initial fluoride content in model solutions. They also observed that humic acids in fluoride solutions subjected to electro-dialysis treatment have no adverse effect on the process.

Heidekamp studied desalination of cooling tower blow down (CTBD). He used electro-dialysis and membrane capacitive deionization (MCDI) for this purpose. In capacitive deionization, ions are collected at carbon electrodes which have ion-selective membranes placed in front. He carried out comparative studies between ED and MCDI for the treatment of cooling tower blow down water. He observed that energy requirement of MCDI for the treatment of CTBD water was 5 times higher than desalination with ED. He found that the energy requirement for MCDI becomes less with decrease in salt concentrations. *Baraka* discussed new trends in removing heavy metals from industrial wastewater. In his review, the recent developments and technical applicability of various treatments were discussed. He focused on innovative physico-chemical removal processes such as; adsorption on new adsorbents, membrane filtration, electro-dialysis and photocatalysis. According to his review, important disadvantage of electro-dialysis is high operational cost due to membrane fouling and energy consumption. High separation selectivity drives the researchers to the process. Chemical precipitation and electro-dialysis methods were used for Electroplating wastewater treatment. They treated wastewater containing a high chromium concentration through chemical precipitation (CP) and electro-dialysis (ED). They found that that chemical precipitation or electro dialysis alone could not produce qualified water for recycle. They observed that the combined CP-ED process was able to greatly eliminate about 95% Cr (VI) chromium from the wastewater. A large saving at reagent cost and operation cost, and less environmental concern were salient features of combined process. Allison carried out studies on electro-dialysis for surface water treatment. According to him, membrane separation process is tolerant to turbidity values that can International Journal of Scientific Research in Science and Technology (www.ijsrst.com) 508 be routinely achieved using clarification and media filtration processes. The membranes used in the process can bear continuous exposure to effective levels of oxidizing disinfectants. Also according to him, the membranes are extremely resistant to irreversible fouling by dissolved organic material.

*Oztekin and Altin (1992)*carried out studies on fouling problems in wastewater treatment by electro-dialysis system. According to them, factors such as the operating conditions and device structures such as ion content of raw water, current density, flow rate, membrane properties, feed concentration, and geometry of cell compartments affect the performance of the process. Precipitation of foulants such as organics, colloids and biomass on the membrane surface or inside the membrane is major cause of fouling. These fouling problems results in increase in membrane resistance, loss in selectivity of the membranes and affect negatively to membrane performance. This results in high energy consumption and poor separation efficiency. For reduction of fouling in ED process, they studied the factors such as pre-treatment of the feed solution, turbulence in the compartments, zeta potential control, pH and flow rate optimization, modification of the membrane properties and pulsed voltage. They concluded that decreasing flow velocity, increasing current density and colloid concentration can cause increase in fouling. Electro-dialysis of tannery and metal-finishing effluents was studied by *Moura et.al.* These studies were focused on removal of Chromium. They obtained blends of polystyrene and polyanilineto produce membranes for electro-dialysis. They found that synthesized membranes presented similar chromium transport to that observed in the Nafion 450 membrane.

2.2***Reverse Osmosis:***

Lonsdale (1987); Baker, (1990) and Strathmann, (1990) reported Most currently available RO membranes fall into two categories: asymmetric membranes containing one polymer, and thin-film, composite membranes consisting of two or more polymer layers. Asymmetric RO membranes have a very thin, permselective skin layer supported on a more porous sublayer of the same polymer the dense skin layer determines the fluxes and selectivities of these membranes while the porous sublayer serves only as a mechanical support for the skin layer and has little effect on the membrane separation properties. Since the skin layer is very thin (from 0.1 to 1 µm), the membrane resistance to water transport (which is proportional to the dense skin thickness) is much lower and, as a result, water fluxes much higher than those through comparable symmetric membranes.

Maiet. al. (2005) carried out study of on reverse osmosis membrane. RO membranes are dense membranes that do not have distinct pores. It is a pressure-driven process (between 20 and 80 MPa) that rejects smallest contaminants and monovalent ions (<350 Da) from solution. The mass transfer in RO is due to solution-diffusion mechanism, size exclusion, charge exclusion and physical-chemicalinteractions between solute, solvent and the membrane .RO is most commonly known forits use in drinking water purification from seawater, removing the salt and other substances from water. This technology has been demonstrated to be useful and could provide high removal efficiencies in the treatment of a wide variety of effluents from chemical, textile pulp and paper, petroleum and petrochemical, food, tanning and metal finishing industries although it has very strict feed water requirements as regards the concentration of suspendedsolids, fibres and oily constituents . RO process can als o be combined with UF, pervaporation, distillation, and other separation techniques to produce hybrid processes that result in highly efficient and selective separations. The expansion of RO membrane applications promoted the design of suitable membrane material to take into considerate on chemical structure, membrane configuration, chemical stability and ease of fabrication.

*Vigneswaran et al, (1991)*worked on the RO membrane process to be widely commercialize. Reverse osmosis is reversal of the natural process of osmosis in which water from dilute solution passes through the semi-permeable membrane into a more concentrated solution due to osmotic pressure . In the reverse osmosis, an external pressure greater than osmotic pressure is applied so that water from concentrated solution passes into dilute solution. Thus it can be separate salt and low MV pollutants from water and waste water.

2.3***Membrane Technology:***

Mulder, (1996); Bodzek et al. (1999); Chaufer and Deratani (1988); Chmielewski et al. (1999); carriedout work on membrane technology, which is a rapidly emerging technology. It was considered as a technically important separation process only over 30-40 years ago. Membrane processes are currently used in a wide range of applications. Owing to its multidisciplinary character and many advantages, many researchers have been interested in membrane technology and tried to improve the performance of membrane processes using membrane processes, separation can be carried out continuously with low energy requirement and under mild conditions such as pressure, temperature and pH. Up-scaling from bench scale to large scale is easy. Membrane properties are variable and can be adjusted. Membrane processes are more compact and technically simpler to operate than other processes. High efficiency and material recovery are very attractive advantages to use membrane processes. Additionally, membrane processes can be combined with other separation processes (hybrid processing). The major membrane processes are reverse osmosis (RO), nanofiltration (NF), ultrafiltration (UF), microfiltration (MF), dialysis, electro dialysis (ED) and pervaporation (PV). Among these membrane processes, nanofiltration and reverse osmosis can be used for the removal of heavy metals. However, their high operation and maintenance costs due to high pressure are unfavorable. Ultrafiltration membranes are known to have pore sizes in the range of 1-100 nm and be able to retain species in the molecular weight range of 300 to 500,000 Daltons. They are usually used for the separation of fairly large molecules and applied in fields such as the food and dairy industry (for example: concentration of milk and cheese making), pharmaceutical industry, textile industry, chemical industry, metallurgy, paper industry, and leather industry. Generally, ultrafiltration membrane process alone cannot be used for heavy metal removal because of their small ionic size. However, using polyelectrolyte for complexation with heavy metal ion can enhance theperformance of ultrafiltration membrane process. This hybrid process is called polyelectrolyte-enhanced- ultrafiltration (PEUF) (also known as complexation-UF or binding-UF). PEUF process is applied not only for the removal of heavy metal ions but also for several purposes such as the treatment of waste effluents, groundwater, and seawater, and the separation of radionuclides.

Microfiltration (MF) membranes are gaining interest in this part of the world for their ability to produce high quality water at relatively low operating pressures. Membranes of this type are principally made of either organic polymers or ceramic materials (*Cermades et al., 2007*). Polymeric membranes are more commonly used for water treatment applications because they are cheaper to manufacture. However, it is only recently that ceramic membranes for drinking water treatment have gained popularity; mainly because of their numerous advantages over polymeric membranes. According to Lehman et al. (2007), ceramic membranes are superior to polymeric membranes and more resistant to severe chemical and thermal environments, allowing them to perform more efficiently under extreme operating conditions. In addition, ceramic membranes can operate at higher fluxes, produce higher feed water recoveries, withstand high pressure backwash operations, operate at extended backwash intervals, and have a longer life without breakage (*Lehman et al., 2007*).

2.4***Ultraviolet (UV Rays):***

Kano et al. (2007) worked on the UV technologies are being increasingly used in water purification systems, taking advantage of the germicidal properties of UV and also its effect in reducing organic contaminants. This paper discusses the effectiveness of using UV technologies along a water purification chain and the parameters and configurations to be considered when selecting UV lamps for water purification systems. Also described are the effects of UV exposure on various types of bacteria and the effect of different UV wavelengths on organic molecules. Results are given on the germicidal effect of a 254 nm UV lamp, used for biofilm prevention in a pure water storage reservoir and on the effect of a dual-wavelength UV lamp (185 nm and 254 nm) in Milli-Q® ultrapure water systems for the reduction of organic contaminants.

White (1992) and DeMars and Renner (1992), the energy released by the Ultraviolet (UV) rays reacts with nuclei acids and other vital cell components, resulting in injury or death of the exposed cells. Ultraviolet (UV) dosage, which is the most critical function of ultraviolet (UV) disinfection, was computed as afunction of the contact time. Contact time, which is the time the raw water is within the sterilization chamber, was defined by *Clancy et al. (1997*), as directly proportional to dosage. It is the amount of energy per unit area (calculated by dividing the output in watts by the surface area of the lamp), and thus the overall effectiveness of microbial destruction in the lamp. The product of intensity and time, known as the Dose, is expressed in microwatt seconds per square centimeter (uWsec/cm^2). With a contact time per litre of 4 seconds, cross-sectional area of ultraviolet lamp of 5.31cm^2 , and a disinfected volume of 25 litres, the ultraviolet dosage was computed as: 40 x 80/6.31 = 22600µwsec/cm

3 PROCESS DESCRIPTIONS

3.1***MEMBRANE PROCESS:***

Membrane separation processes commercially developed include:

Microfiltration:

It is a filtration process in which porous membranes are used for the separation of suspension particles with diameters between 0.9-90 microns from the flow of gases and fluids. Therefore, the scope of application of microfiltration membranes occurs between ultrafiltration membranes and common filtration *(Manali Desai and Mehali Mehta, 2014)*

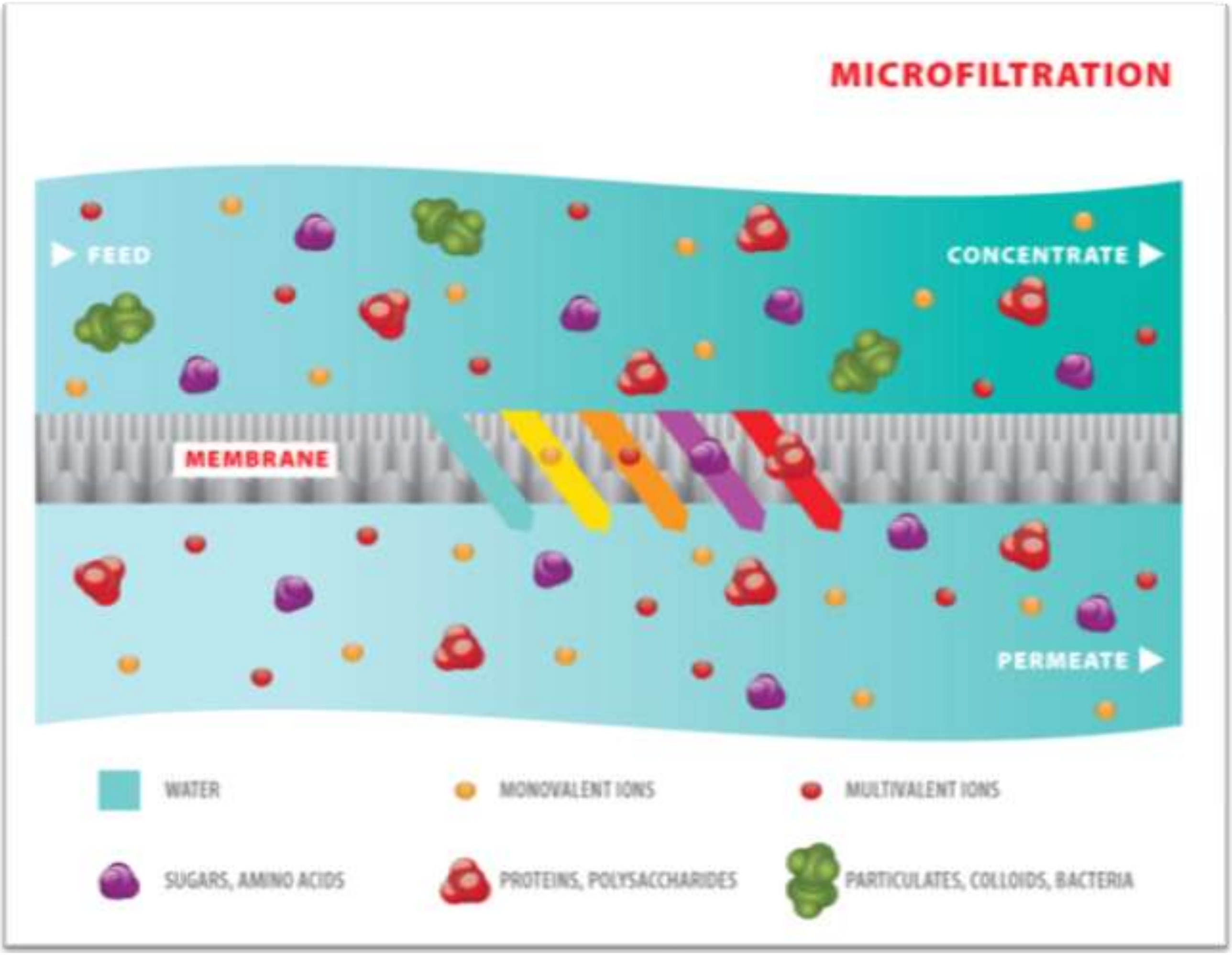

Fig. 3.1(a):(Microfiltrationhttp://synderfiltration.com/learningcenter/articles/membranes/degreesof-membrane-separation/)

Ultrafiltration:

Ultrafiltration is known as a process between microfiltration and nanofiltration. Ultrafiltration membranes usually have pores in the range of 10 to 1000 Å. With smaller pores size, the larger particles pass less through the membrane. Accordingly, the rate of fluid filtration is determined according to the pores size of the membrane. These membranes are also capable of disposing particles in the molecular weight range of 300 to 500000. Materials and particles normally excreted by these membranes include sucrose, biomolecules and polymers and colloidal particles *(Manali Desai and Mehali Mehta, 2014).*

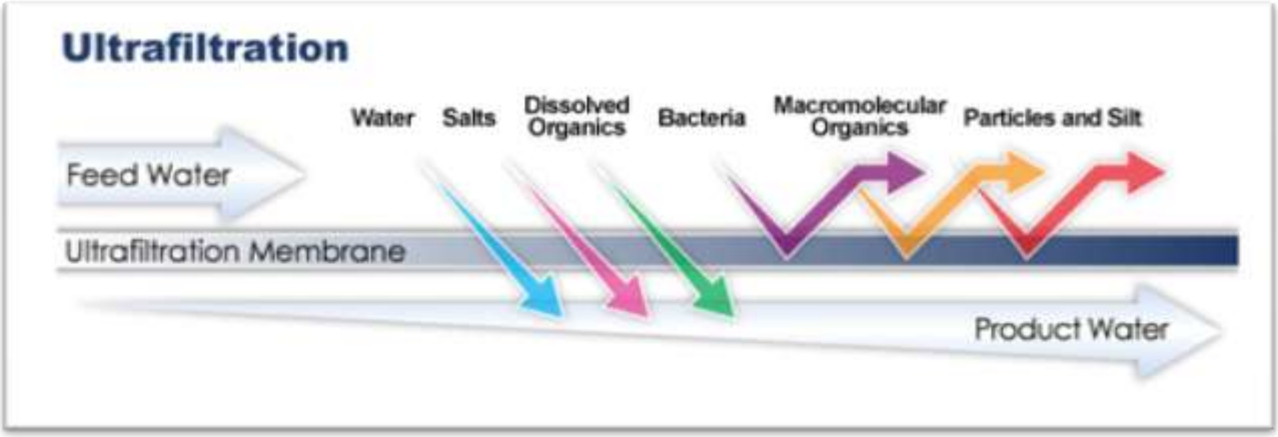

Figure 3.1(b): ultrafiltration (http://www.filterwater.com/p-70-inline-ultrafiltration-membrane.aspx)

Nanofiltration:

Nanofiltration is known as a process between ultrafiltration and reverse osmosis. The membranes used in nanofiltration contain pores close to or lower than nanometer that the size is usually around 0.5 to 1.5 nm. Some researchers believe the reverse osmosis membranes and nanofiltration membranes have no holes (pores), and instead, there are empty cavities between polymer chains

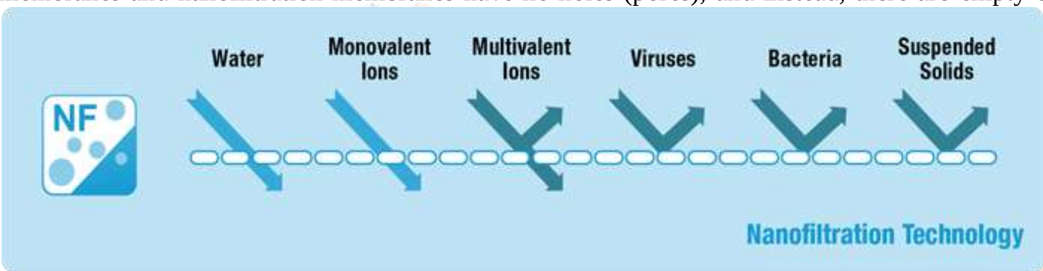

Figure3.1(c):nanofiltration(http://www.kochmembrane.com/Learning-Center/Technologies/Whatis-Nanofiltration.aspx

3.2***Reverse osmosis :***

Reverse osmosis (RO) is a membrane-technology filtration method that removes many types of large molecules and ions from solutions by applying pressure to the solution when it is on one side of a selective membrane. The result is that the solute is retained on the pressurized side of the membrane and the pure solvent is allowed to pass to the other side. In the normal osmosis process, the solvent naturally moves from an area of low solute concentration (High Water Potential), through a membrane, to an area of high solute concentration (Low Water Potential). The movement of a pure solvent to equalize solute concentrations on each side of a membrane generates osmotic pressure. Applying an external pressure to reverse the natural flow of pure solvent, thus, is reverse osmosis. Reverse osmosis, however, involves a diffusive mechanism so that separation efficiency is dependent on solute concentration, pressure, and water flux rate. Reverse osmosis is most commonly known for its use in drinking water purification from seawater, removing the salt and other substances from the water molecules. Reverse osmosis is a process that industry uses to clean water, whether for industrial process applications or to convert brackish water, to clean up wastewater or to recover salts from industrial processes. Reverse osmosis will not remove all contaminants from water as dissolved gases such as dissolved oxygen and carbon dioxide not being removed. But reverse osmosis can be very effective at removing other products such as trihalomethanes (THM's), some pesticides, solvents and other volatile organic compounds (VOC's) and this process removes over 70% of the following: Arsenic-3, Arsenic-4, Barium, Cadmium, Chromium-3, Chromium-6, Fluoride, Lead, Mercury, Nitrite, Selenium-4 and selenium-6,Silver S. *(S. AL-JLIL ,2017).*

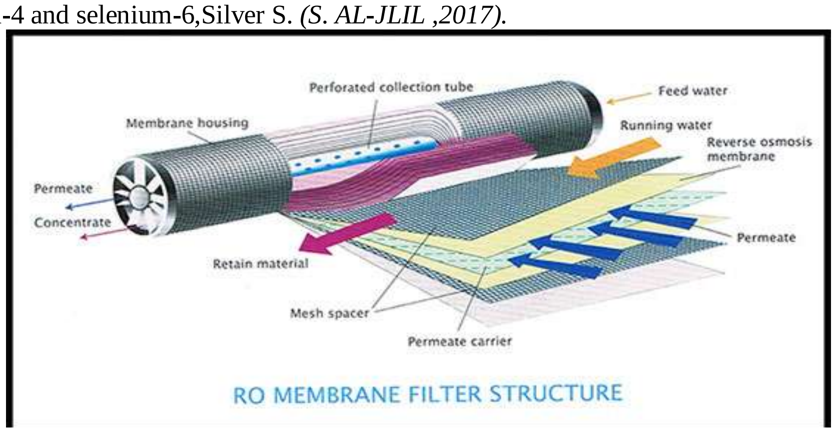

Figure 3.2: RO(https://www.amtaorg.com/Reverse_Osmosis_Membrane_Separation.html)

3.3***Electrodialysis:***

Electrodialysis is effective in removing fluoride and nitrate from water. This process also uses membranes but direct electrical currents are used to attract ions to one side of the treatment chamber. This system includes a source of pressurized water, direct current power supply and a pair of selective membranes.

Electrodialysis Process In this process, the membranes adjacent to the influent steam are charged either positively or negatively and this charge attracts counter-ions toward the membrane. These membranes are designed to allow the positive or the negative charged ions to pass through the membrane, where the ions move from the product water stream through a membrane to the two reject water streams *(Larchet et., al 2008).*

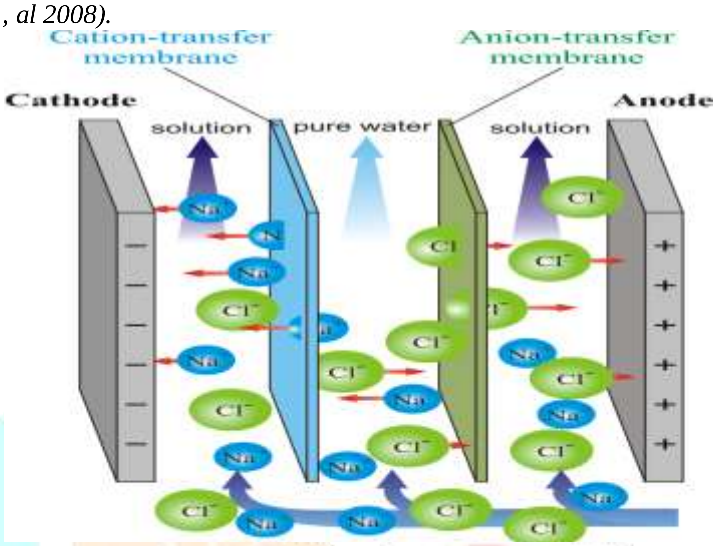

Figure 3.3 ED(https://glossary.periodni.com/glossary.php?en=electrodialysis)

3.4***Ultraviolet (UV):***

Using UV light in drinking water treatment requires the generation and application of UV light in a way to maximize its effectiveness. All UV drinking water treatment devices require power to generate UV light. When a UV lamp is turned on, mercury in the lamp is “excited” and takes on energy. The mercury quickly discharges that extra energy in the form of UV light. Mercury is a necessary component of UV lamps because it emits light in the germicidal wavelength (200-300 nm). However, there are new UV lightemitting-diodes (UV LEDs) being developed that do not use mercury and show promise as effective UV disinfection devices . A UV device used in drinking water treatment typically consists of a UV lamp, a clear quartz sleeve to protect the lamp and allow the UV light to penetrate the water, and in some cases a means to measure the intensity of UV light produced. Having the ability to measure UV light intensity is Ultraviolet (UV) Disinfection in Drinking Water Treatment important since certain water quality characteristics can reduce intensity and UV intensity degrades the more the lamp is used. Additionally, the UV device is designed to ensure all the water being treated is channeled through the device as close to the quartz sleeve as possible to ensure the water receives the longest amount of exposure possible at the maximum UV intensity. UV devices work best when treating clear water, so UV devices are typically located after filtration treatment processes. The effectiveness of UV light is highly dependent on the turbidity, or cloudiness, of the water and any color present in the water. In highly turbid or colored water the UV light won’t be able to penetrate through the water. A well-designed UV device will incorporate indicators of operation to measure the UV intensity, or UV dose, provided to the water and will also include indicators of lamp function (on/off). UV devices can be scaled to fit any size or type of drinking water treatment need, from small handheld devices to large systems capable of treating millions of gallons per day. A number of commercially available water treatment systems designed to fulfill the needs of the military squadsized unit incorporate UV as a disinfectant. These water purifiers are meant to be portable and therefore present inherent risk of breakage or damage to the UV device during transport. Care must be exercised when transporting a UV device and they should be closely inspected prior to operation to ensure no damage has occurred. A significant disadvantage of using UV for disinfection is its inability to provide a residual. If UV disinfected water is to be stored a chemical disinfectant such as chlorine or iodine, capable of providing a long-lasting disinfectant residual, should be added to the stored water to prevent recontamination *(Adegbola and Adedayo, 2012).*

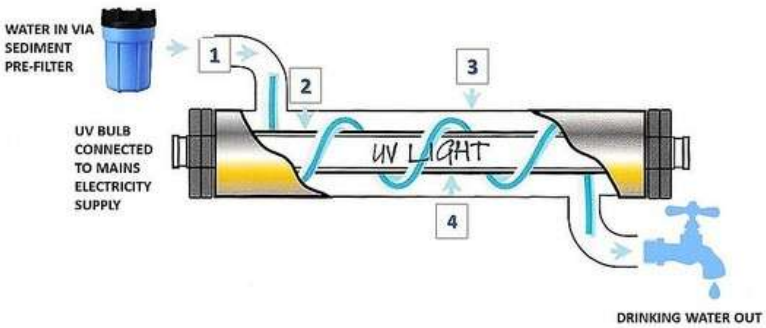

Figure 3.4: UV(https://www.caerfagu.co.uk/water-purification/)

4.RESULTS AND DISCUSSION FOR VARIOUS METHOD:

4.1 ***MEMBRANE SEPARATION TECHNOLOGY:***

*(ZuzanaHonzajkova et.,al 2011)*The results were as expected. Nanofiltration membrane was the most effective in removing chemical pollutants. But its disadvantage is low permeates flow. Ultrafiltration membranes have higher permeate flow than nanofiltration membrane, but they only able to remove organic matter. All tested membranes have hundred-per-cent efficiency in remove pathogens. In permeates were measured higher values of cultivable bacteria. But it should be noted that these values meet the limits for drinking water in the Dec. 252/2004 Coll. Positive readings of cultivable bacteria in permeate does not mean the fact that these bacteria could pass through the membrane. It is a secondary contamination of the permeate output tubes, where it has been idle facilities to increase biofilm. In other experiments, this problem will be eliminated by thorough cleaning of tubes before each experiment.

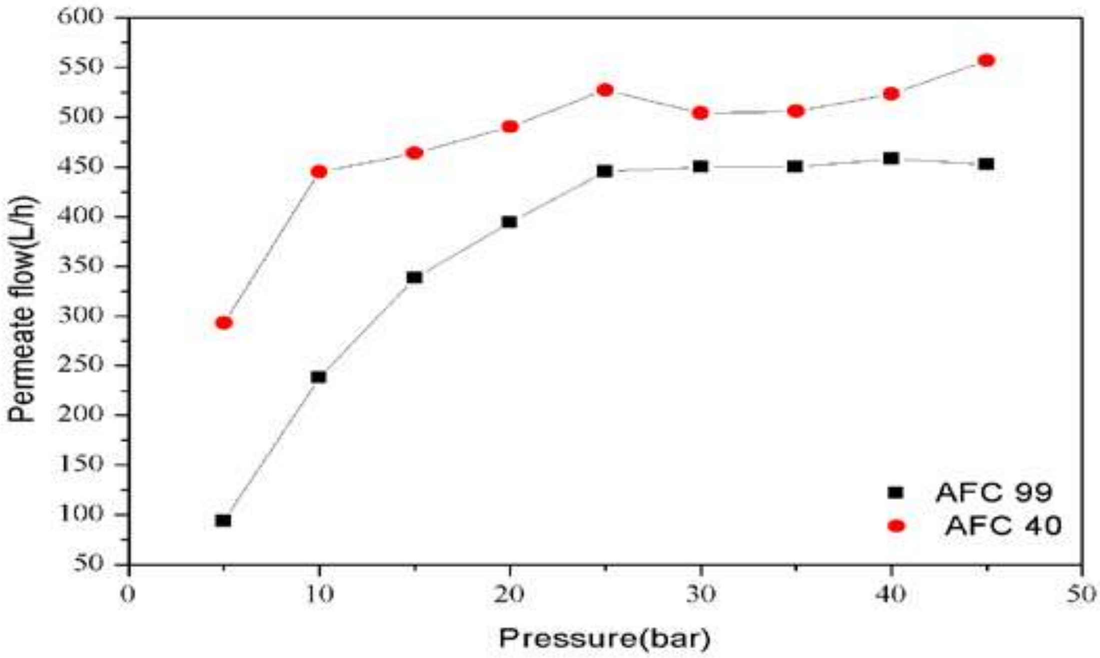

Fig 4.1. Permeate flow (L/h) vs Pressure (bar) in the membrane technology.(ZuzanaHonzajkova te.al(2011))

4.2 ***Ultraviolet radiation:***

The results of the averages over a seven day-period of physical, chemical and bacteriological analyses performed on samples taken from the contaminated well at the inlet and outlets ***(****Adegbola et., al 2012*). The outcome of the investigation is as outlined below:

Seven day-average of Ultraviolet Purification Method Sample: <25(satisfactory)

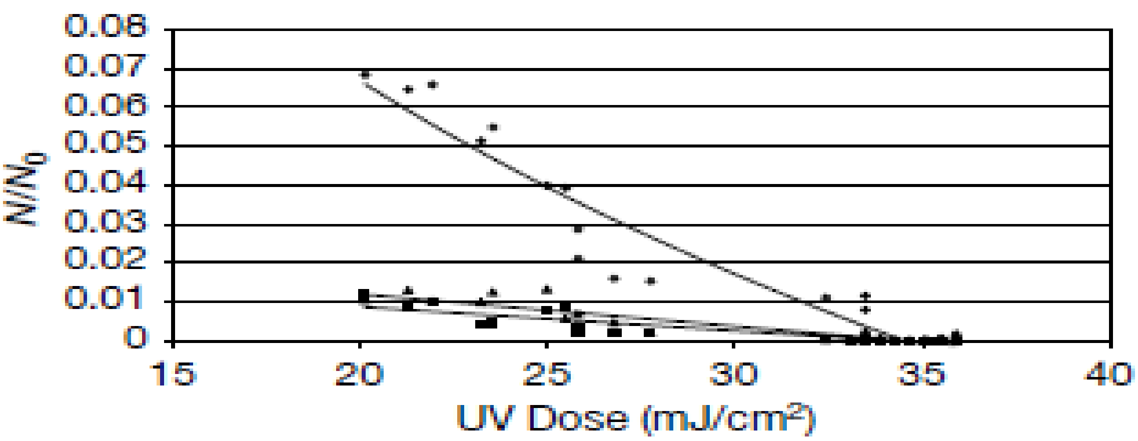

Fig. 4.2. Inactivation ranges according to dose of UVradiation applied for faecal coliforms (d), *E. coli* (j)andcoliphages (m). *N*/*N*0 (effluent units/influent units).***(***Adegbola,et.al (2012))

4.3 ***Electrodialysis Technology***

In recent years membrane technology has become an important useful tool for thedesalination of seawater, the use of brackish water and polluted water resources which were not suitable for producing drinking water, and for the physicochemical and microbiological improvement of the water obtained by conventional treatment. Based in the important advantages of ion-exchange membranes (rugged, resistant to organic fouling, chlorine stable, broad range for pH and Temperature,..) compared with other membranes technologies, the improvement of EDR allows to use it for many applications that are cost effective than other technologies with a better commercial marketing like UF or RO. Maybe the use of EDR still has a label of a technology to solve local problems involving small communities or specific industrial applications. However, during last year's big systems are in operation showing good performances and cost effective results. In this sense the T. May bry Carlton WTP located at Sarasota (FL, USA) was pioneer in operate a big system since 1995. In that case, EDR was selected due to its ability tomaximize recovery of freshwater and minimize wastewater volume. The plant produces45.420 m3/d and is equipped with 320 stacks. Later, improvement of EDR allows installing more systems worldwide, some of them in Spain related with drinking water and water reuse. EDR was introduced in the Canary Islands during the 80's, but during lasts years some big facilities were building in the Spanish Mediterranean area: two plants (16,000m3/d each) in Valencia to reduce nitrate levels and two more in Barcelona: the first to reduce bromide levels and then the THMs formation (200.000 m3/d, 576 stacks) and the last to reduce salinity for reuse water for irrigation (55.296 m3/d, 96 stacks).In addition, desalination of brackish water using membranes technologies like ED and specially EDR it is a cost effective method to supply good quality drinking water and could be a good solution for some industrial water utilities. Besides, EDR systems now are simpler and more reliable, which means that the demineralization of difficult-to-treat water is easier for municipalities to handle. In addition, the costs are becoming easier to swallow. Some aspects could be improved in a near future: spacer configuration, membranes chemistry, materials and configuration of electrodes, specific anti scalants for EDR, elimination of degasifiers and the increase of the production of the stacks .Finally, there are some interesting works related with the use of hybrid systems to get synergies between technologies (*Turek, 2002; Kahraman, 2004*), and some innovations are under study to improving the EDR technology (*Balster et al., 2009; Charcosset, 2009; Ortiz etal., 2008; Turek et al., 2008; Veerman et al., 2009).*

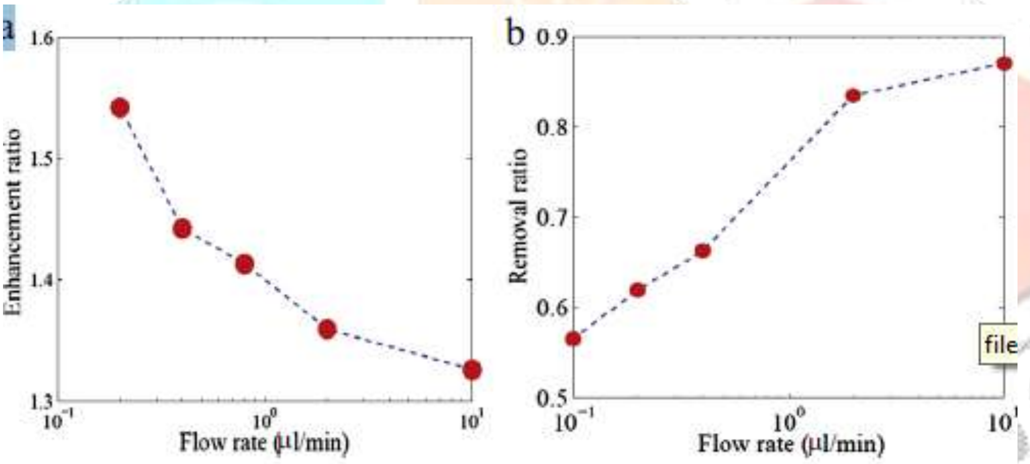

Figure 4.3. flow rate in electrodialysisvs the enhancements ratio and removable ratio.*Veerman et al., 2009)*

4.4***NANO-FILTRATION AND REVERSE OSMOSIS PROCESSES***

The results of the RO and NF wastewater treatment technologies containing cations and anions are presented. Only moderate rejection was observed for the monovalent species, as expected with NF. However, the rejection of polyvalent cations and anions was high. The results of the advanced treatment RO and NF of waste water containing cations and anions using old RO and NF membranes (worked for 3 years). It was found that the rejection of the cations and anions decreased for monovalent species. This behavior is expected with old membranes. Also, modest rejection was observed for polyvalent cationsandanions.

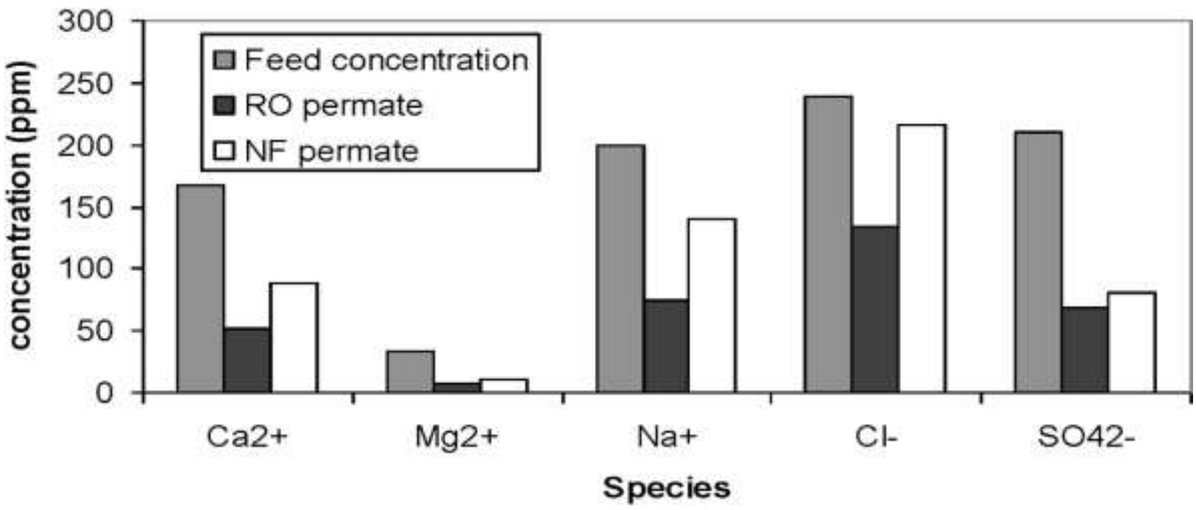

Fig.4.1 Species vs Concentration(S. AL-JLILet.al 2017)

The performance of the NF and RO membranes for the rejection of TDS at the same pH of feed water. The percentage rejection of the Na+ ion byRO membrane was higher than the NF membrane. This could be attributed to the fact that the rejection of monovalent ions such as Na^+ by NF is weak. In addition,the pH did not affect the membrane rejection when the polyamide membrane pH operating range is 4–11.

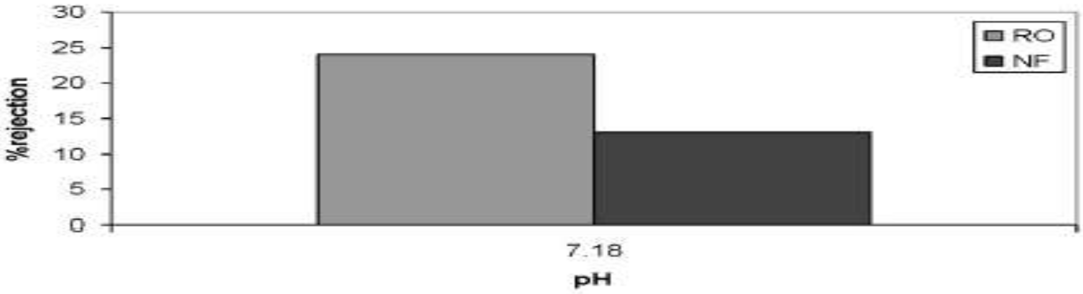

Fig 4.2 pH Effect *(S. AL-JLILet.al 2017)*

5. ADVANTAGE AND DISADVANTAGE VARIOUS METHOD:

5.1***Advantages of Reverse Osmosis (RO) Process:***

1) RO systems are simple to design and operate, have low maintenance requirements, and are modular in nature, making expansion of the systems easy.
(2) Both inorganic and organic pollutants can be removed simultaneously by RO membrane processes.
(3) RO systems allow recovery/recycle of waste process streams with no effect on the material being recovered.
(4) RO systems require less energy as compared to other technology.
(5) RO processes can considerably reduce the volume of waste streams so that these can be treated more efficiently and cost effectively by other processes such as incineration
(6) The RO plant is normally operated at ambient temperature which reduces the scale formation and corrosion problems, because of antiscalent and biodispersent use, which will reduce maintenance cost.
(7) The modular structure of the RO process increases flexibility in building desalination plants within a wide range of capacities.
(8) The specific energy requirement is significantly low 3- 9.4 kW h/m3 product.
(9) The process is electrically driven hence it is readily adaptable to powering by solar panels(*Cartwright 1985; Sinisgalli and McNutt, 1986; Cartwright, 1990; McCray et al., 1990; Cartwright, 1991; Williams et al., 1992*).

5.2***Disadvantages of RO Process:***

1. It removes some useful mineral with the removable of harmful substance.
2. Acidity of water is higher so some time can be harmful for health.
3. Some time you feel water tasteless if you are not used to with high purified water.
4. It required high amount of water than the other system. Wastage of water it bit high.
5. The process is slow compare to other water treatment alternative (*Cartwright, 1985; Sinisgalli and McNutt, 1986; Cartwright, 1990; McCray et al., 1990; Cartwright, 1991; Williams et al., 1992*).

5.3Advantage ***ofElectrodialysis:***

1. All the contaminant ions and many of the dissolved non-ions are removed.
2. Insensitive to flow and TDS levels.
3. Possible low effluent concentrations (*Balster et.,al 2009).*

5.4***Disadvantage of Electrodialyisis:***

1. Operating costs and capital are high
2. Level of pretreatment required is high
3. Twenty to ninety percent of feed flow is rejected stream
4. Replacement of electrodes (*Balster et.,al 2009).*

5.5***Advantages of Membrane Separations:***

1. Membrane processes can separate at the molecular scale up to a scale at which particles can actually be seen, this implies that a very large number of separation needs might actually be met by membrane processes.

2. Membrane processes generally do not require a phase change to make a separation (with the exception of pervaporation). As a result, energy requirements will be low unless a great deal of energy needs to be expended to increase the pressure of a feed stream in order to drive the permeating component(s) across the membrane.

3. Membrane processes present basically a very simple flow sheet. There are no moving parts (except for pumps or compressors), no complex control schemes, and little ancillary equipment compared to many other processes. As such, they can offer a simple, east-to-operate, low maintenance process option.

4. Membranes can be produced with extremely high selectivity for the components to be separated. In general, the values of these selectivities are much higher than typical values for relative volatility for distillation operations.

5. Because of the fact that a very large number of polymers and inorganic media can be used as membranes, there can be a great deal of control over separation selectivities.

6. Membrane processes are able to recover minor but valuable components from a main stream without substantial energy costs.

7. Membrane processes are potentially better for the environment since the membrane approach require the use of relatively simple and non-harmful materials (Charcosset et.,al 2009).

5.6***Disadvantages of Membrane Separations:***

1. Membrane processes seldom produce 2 pure products, that is, one of the 2 streams is almost always contaminated with a minor amount of a second component. In some cases, a product can only be concentrated as a retentate because of osmotic pressure problems. In other cases the permeate stream can contain significant amount of materials which one is trying to concentrate in the retentate because the membrane selectivity is not infinite.

2. Membrane processes cannot be easily staged compared to processes such as distillation, and most often membrane processes have only one or sometimes two or three stages. This means that the membrane being used for a given separation must have much higher selectivities than would be necessary for relative volatilities in distillation. Thus the trade-off is often high selectivity/few stages for membrane processes versus low selectivity/many stages for other processes.

3. Membranes can have chemical incompatibilities with process solutions. This is especially the case in typical chemical industry solutions which can contain high concentrations of various organic compounds. Against such solutions, many polymer-based membranes (which comprise the majority of membrane materials used today), can dissolve, or swell, or weaken to the extent that their lifetimes become unacceptably short or their selectivities become unacceptably low.

4. Membrane modules often cannot operate at much above room temperature. This is again related to the fact that most membranes are polymer-based, and that a large fraction of these polymers do not maintain their physical integrity at much above 100 ^{o}C. This temperature limitation means that membrane processes in a number of cases cannot be made compatible with chemical processes conditions very easily.

5. Membrane processes often do not scale up very well to accept massive stream sizes. Membrane processes typically consist of a number of membrane modules in parallel, which must be replicated over and over to scale to larger feed rates.

6. Membrane processes can be saddled with major problems of fouling of the membranes while processing some type of feed streams. This fouling, especially if it is difficult to remove, can greatly restrict the permeation rate through the membranes and make them essentially unsuitable for such application (Charcosset et.,al 2009).

5.7 ***Advantages of Ultra Violet Radiation:***

1. The process only requires a minimal amount of electricity.

2. It is also very environmental friendly. This is because it does not emit any by-products such as sodium into the environment. Therefore, there are no chemicals handled.

3. The UV system is very cost effective.

4. The process also destroys each and every microorganism that is in the water.

5. The water flow in the whole system is just pure (*Durbeej et., al 2002).*

5.8***Disadvantages of Ultraviolet Radiation:***

1. The water must be very clear so that the Ultra Violet radiation can pass through and destroy the pathogens.

2. The process can occur in a place which has no electricity.

3. The method is only suitable when microorganisms needed to be destroyed but not as a form of water softening. It should be considered because it is only able to kill microorganisms but not remove minerals.

4. Ultraviolet radiation method is only able to deal with microorganisms, and that means that if the hard water contains minerals such as magnesium and calcium, then the rays will not be able to eliminate them (*Durbeej et., al 2002)*

CONCLUSIONS

Consider for a moment the entire water resources issue on a global scale. Various aspects of the water problem need to be considered not only by developing nations but also by developed countries. Water is required for urban, development, industrialization and agriculture. An increase in the world population results in an increase in water usage. So, the development of antifouling and self-cleaning properties are an important research in ultrafiltration membrane technology for water and wastewater treatment and it has attracted wide attention in recent years. This paper critically reviews of Membranes Technology, UV Electrodialysis RO the superior technique for creating those properties have been discussed. From the above survey of information it clearly indicates that it is very important to remove contaminants from water to make it useful for both household and industrial purpose.The available data appear to demonstrate the different methods used in water purification process. This review provides information on Water treatment methods Reverse osmosis,Electrodialyisis,Ultraviolet Radiation, Membrane Separations.

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