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International Journal of Advanced Research in Civil,Structural,Environmental and Infrastructure Engineering and Developing

Volume: 3 Issue: 1 Mar,2017,ISSN_NO: 2320-723X

REVERSE OSMOSIS TREATMENT OF WATER IN LOW POWER CONSUMPTION

Sharan Kumar. K , [1] , Prabin Jeba.V[2] ,Sathish Kumar. P 3

Asst.Professor, Department of Civil engineering Panimalar Engineering College Chennai, India [1].
Student scholar Department of Civil engineering Panimalar Engineering College Chennai, India [2]
Student scholar Department of Civil engineering Panimalar Engineering College Chennai, India [3]

ABSTRACT-*Reverse Osmosis (RO) is a membrane based process technology to purify water by separating the dissolved solids from feed stream resulting in permeate and reject stream for a wide range of applications in domestic as well as industrial applications. It is seen from literature review that RO technology is used to remove dissolved solids, color, organic contaminants, and nitrate from feed stream. Hence RO technology used in the treatment of water and hazardous waste, separation processes in the food, beverage and paper industry, as well as recovery of organic and inorganic materials from chemical processes as an alternative method . This paper intends to provide an overall vision of RO technology as an alternative method for treating wastewater in different Industrial applications. The present short review shows applicability of RO system for treating effluents from beverage industry, distillery spent wash, ground water treatment, recovery of phenol compounds, and reclamation of wastewater and sea water reverse osmosis (SWRO) treatment indicating efficiency and applicability of RO technology.*

Keywords— extensively to convert brackish or seawater to drinking water

1.INTRODUCTION:

Reverse Osmosis is a technology that is used to remove a large majority of contaminants from water by pushing the water under pressure through a semi-permeable membrane. People considering the installation of a water treatment system to reduce toxic chemicals should first have their water tested to determine how much if any hazardous compounds are in the water. Public water supplies are routinely monitored and treated as required under the federal Safe Drinking Water Act and state regulations. Private water systems should be tested at the owners initiative based on knowledge of land use and contamination incidents in the area.

2.OSMOSIS:

To understand the purpose and process of Reverse Osmosis you must first understand the naturally occurring process of Osmosis.
Osmosis is a naturally occurring phenomenon and one of the most important processes in nature. It is a process where a weaker saline solution will tend to migrate to a strong saline solution. Examples of osmosis are when plant roots absorb water from the soil and our kidneys absorb water from our blood.

Below is a diagram which shows how osmosis works. A solution that is less concentrated will have a natural tendency to migrate to a solution with a higher concentration. For example, if you had a container full of water with a low salt concentration and another container full of water with a high salt concentration and they were separated by a semi-permeable membrane, then the water with the lower salt concentration would begin to migrate towards the water container with the higher salt concentration.

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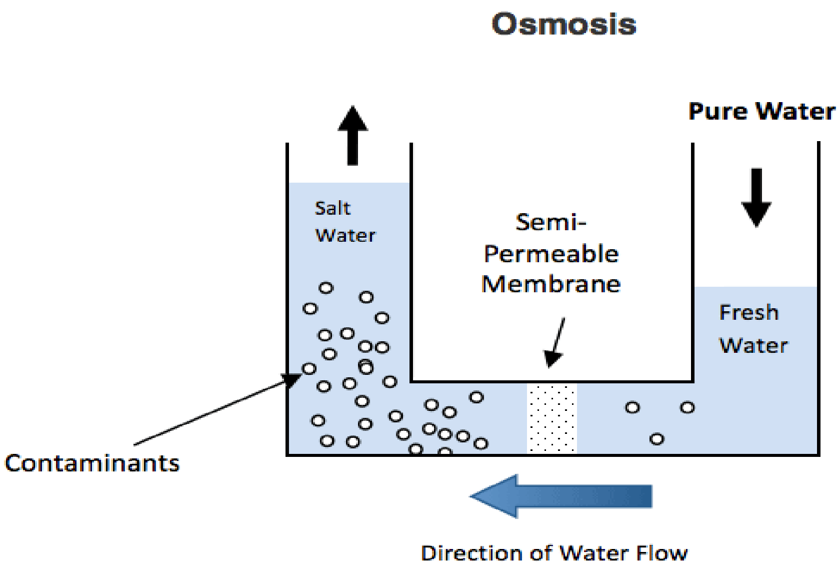
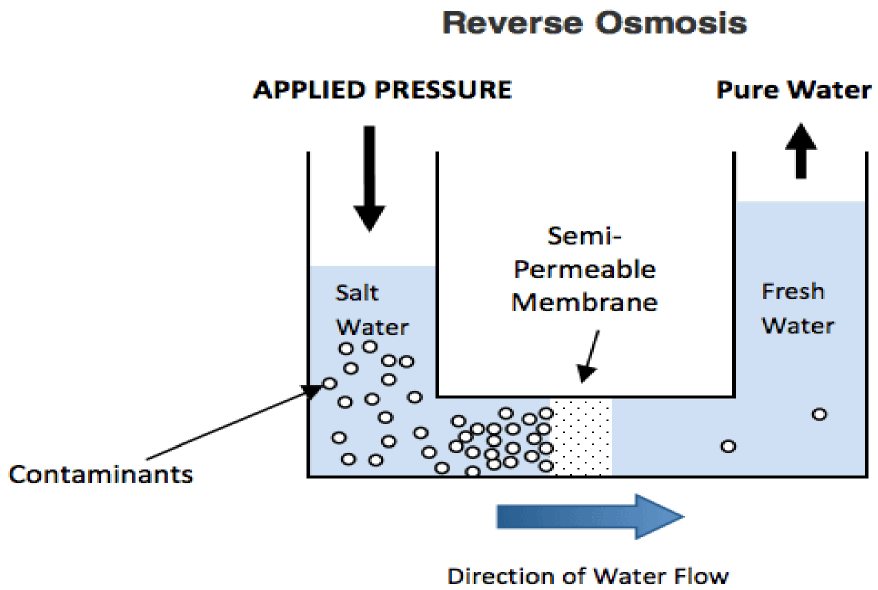
A semi permeable membrane is a membrane that will allow some atoms or molecules to pass but not others. A simple example is a screen door. It allows air molecules to pass through but not pests or anything larger than the holes in the screen door. Another example is Gore-tex clothing fabric that contains an extremely thin plastic film into which billions of small pores have been cut. The pores are big enough to let water vapor through, but small enough to prevent liquid water from passing.





3. REVERSE OSMOSIS PROCESS:

In the reverse osmosis process a cellophane-like membrane separates purified water from contaminated water. An understanding of **osmosis** is needed before further describing RO. As we seen osmosis occurs when two solutions containing different quantities of dissolved chemicals are separated by a semi permeable membrane (allowing only some compounds to pass through). **Osmotic pressure** of the dissolved chemical causes pure water to pass through the membrane from the dilute to the more concentrated solution. There is a natural tendency for chemicals to reach equal concentrations on both sides of the membrane.

In reverse osmosis, water pressure applied to the concentrated side forces the process of osmosis into reverse. Under enough pressure, pure water is "squeezed" through the membrane from the concentrated to the dilute side. Salts dissolved in water as charged ions are repelled by the RO membrane. Treated water is collected in a storage container. The rejected impurities on the concentrated side of the membrane are washed away in a stream of wastewater, not accumulated as on a traditional filter.

The RO membrane also functions as an **ultrafiltration** device, screening out particles, including microorganisms that are physically too large to pass through the membranes pores. RO membranes can remove compounds in the 0.0001 to 0.1 micron size range (thousands of times smaller than a human hair).

4. DESIGN OF AN RO SYSTEM:

Although the reverse osmosis process is simple, a complete water treatment system is often complex, depending on the quality of the incoming water before treatment and the consumers needs. Most home RO systems are point-of-use (POU) units placed beneath
the kitchen sink to treat water used for cooking and drinking. Point-of-entry (POE) systems that treat all the water entering the household are more expensive to purchase and operate than POU systems.

A typical home reverse osmosis system consists of pre-treatment and post-treatment filters as well as the RO membrane, flow regulator, storage container for the treated water, and dispensing faucet . The pressure for RO is usually supplied by the feed line pressure of the water system in the home, but a booster pump may be needed to produce an adequate volume of treated water. A sediment pre-filter is essential for removing relatively large sand grains and silt that may tear or clog the RO membrane or clog a pump or flow regulator. Water softeners are used in advance of the RO system when household water is excessively hard. If the water is chlorinated or contains other oxidizing chemicals such as bromine, an
activated carbon pre-filter is needed to protect membranes sensitive to these chemicals.

To remove certain pesticides and organic solvents, an activated carbon (AC) post-treatment must be included in the system. A standard AC filter positioned after the storage tank removes compounds that cause unpleasant taste and odors, including those from the tank or plastic tubing, just before water is dispensed. To remove high levels of organic chemicals such as trihalomethanes, volatile organic chemicals, and chloramines, an additional prolonged contact carbon filter (PCCF) is placed between the RO membrane and the storage tank. Combining an

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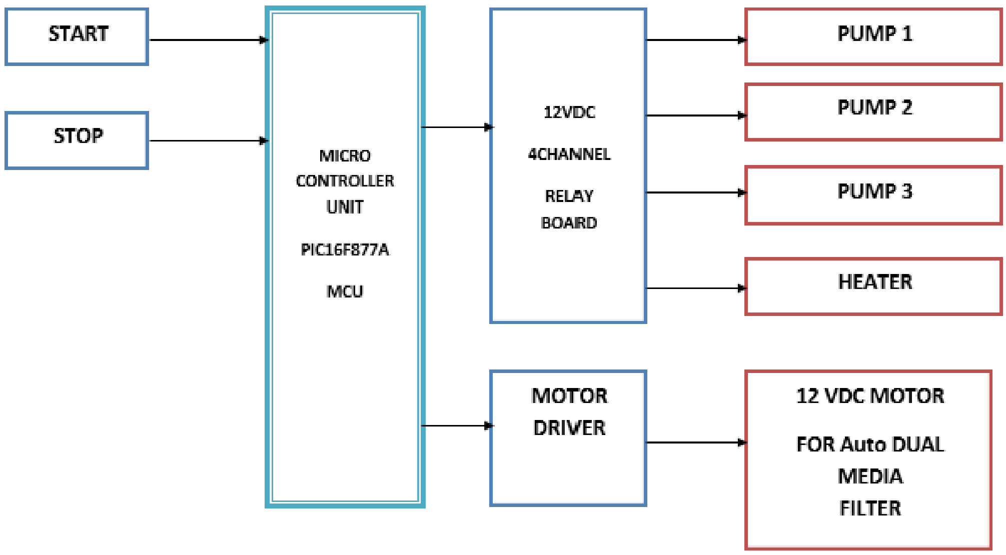
Volume: 3 Issue: 1 Mar,2017,ISSN_NO: 2320-723X

activated carbon filter with RO expands the range of chemicals the system can remove

Automatic Controller for RO purification Unit



5. RO MEMBRANE MATERIALS:

The most common RO membrane materials are polyamide thin film composites (TFC) or cellulosic types (cellulose acetate [CA], cellulose triacetate [CTA], or blends). Very thin membranes are made from these synthetic fibers. Membrane material can be spiralwound around a tube, or hollow fibers can be bundled together, providing a tremendous surface area for water treatment inside a compact cylindrical element. Hollow fiber membranes have greater surface area (and therefore greater capacity) but are more easily clogged than the spiral-wound membranes commonly used in home RO systems.

The flux, or capacity, of the RO membrane indicates how much treated water it can produce per day. Typically, RO membranes for home systems are rated in the range of 24 to 100 gallons per day. Thus, under standard operating conditions it could take from two to six hours to fill a two and-a-half-gallon storage tank. CA/CTA membranes have adequate capacity for most households, but TFC membranes should be used if large volumes of treated water are needed. RO membranes are rated for their ability to reject compounds from the contaminated water. A rejection rate (% rejection) is calculated for each specific ion or contaminant as well as for reduction of total dissolved solids (TDS). It is important that consumers know their specific requirements for water quality when buying a system. For example, high rejection rates are essential when high nitrates or lead concentrations in the water must be brought below the EPA maximum contaminant or action levels.

Although thin film composite membranes are initially more expensive, they have superior strength and durability, as well as higher TDS rejection rates (>95%), than cellulosic membranes (88 - 94%). TFC membranes are more resistant to microbial attack, stand up better to high pH (greater than 9) and are better able to handle higher levels of total dissolved
solids (1, 500 -2,000 ppm) than cellulosic (CA/CTA) membranes. The advantages of cellulosic membranes are their lower cost and ability to tolerate chlorine, which curtails the growth of microorganisms in the system. Thin film composites deteriorate in chlorinated water but perform well with an activated carbon prefilter to remove chlorine. Membranes made of sulfonated polysulfone (SPS) are chlorine tolerant (like CTA) and can withstand
higher pH levels (like TFC), but they do not match the low costs of CTA or the performance of TFC. SPS membranes are best used in RO systems when the feed water is soft and high in pH or when high nitrate levels are a primary concern. Nanofiltration membranes (also referred to as loose RO or softening membranes) have much higher flow rates than other membranes. They tend to reject negatively charged ions such as sulfates very well but do
not perform well in removing total dissolved solids.

6. EFFICIENCY OF RO SYSTEM:

The performance of an RO system depends on membrane type, flow control, feed water quality (e.g., turbidity, TDS, and pH), temperature, and pressure. The standard at which manufacturers rate RO system performance is 77 °F, 60 pounds per square inch (psi), and TDS at 500 parts per million (ppm).Only part of the water that flows into an RO system comes out as treated water. Part of the water fed into the system is used to wash away the rejected compounds and goes down the drain as waste. The recovery rate, or efficiency, of the system is calculated by dividing the volume of treated water produced by the volume of water fed into the system. If not properly designed, RO systems can use large quantities of water to produce relatively little treated water. Most home RO systems are designed for 20 to 30% recovery (i.e., 2-3 gallons of treated water are produced for every 10 gallons put into the system).

Home RO systems can operate at higher recovery rates, but doing so may shorten membrane life. The flow regulator on the reject stream must be properly adjusted. If the flow is slow, the recovery rate is high, but RO membranes are easily fouled if concentrated impurities are not washed away quickly enough. If the flow is too fast, the recovery rate is low and too much water goes down the drain. Overall water quality affects the efficiency of an RO system and its ability to remove specific contaminants. The higher the TDS, the lower the recovery rate of treated water. The amount of treated water produced decreases 1 to 2 percent for every degree below the standard temperature of 77 °F. An RO system supplied with well water at a temperature of 60 °F produces only threequarters of the volume it would produce at 77 °F.
For an RO system to function properly, there must be enough **water pressure.** Although most home RO systems are rated at 60 pounds per square inch, the incoming **feed fine pressure** of many private water systems is less than 40 psi. The RO system must work against **back pressure** created in the storage tank as it **fills** with water and compresses the air in the tank.
The RO device must also overcome **osmotic pressure,** the bonding between water molecules and the dissolved impurities; the higher the TDS level, the greater the osmotic pressure. The **net water pressure** at the RO membrane can be calculated by subtracting back pressure and osmotic

pressure from the feed line pressure. If the net water pressure at the membrane is lower than 15 psi, treated water production is less efficient and contaminant rejection rates are lower.

In some systems, once the storage tank is **filled,** surplus treated water is discarded; water loss from such units is frequently excessive. A system that automatically shuts off when the pressure on the tank reaches a given level saves water.

7. MAINTAINENCE OF RO SYSTEM:

An RO system must be well maintained to ensure reliable performance. Clogged RO membranes, filters, or flow controls will decrease water flow and the systems performance. If fouling is detected in the early stages the membrane can often be cleaned and regenerated. The cleaning procedure varies depending on the type of membrane and fouling. Completely clogged or torn RO membranes must be replaced. In addition, pre- or post-filters must be replaced once a year or more often, depending on the volume of water fed through the system and the quality of the feed water.

Damage to RO membranes cannot be seen easily. The treated water must be analysed periodically to determine whether the membrane is intact and doing its job. Many systems now have a built-in continuous monitor that indicates a high TDS level, a sign that the system is not operating properly. It may also be necessary to test regularly for specific health-related contaminants such as nitrates or lead.

Microorganisms, dead or alive, can clog RO membranes. To prevent bio-fouling, RO units must be disinfected periodically with chlorine or other biocides provided by the manufacturer. Continuous chlorination can be used with cellulose membranes to protect the system from biofouling and eliminate the particle trapping slime that worsens other forms of fouling such as scaling.

8. CONCLUSION:

RO removes many inorganic impurities from drinking water. Its effectiveness depends not only on the type of membrane but on feed water, quality, temperature, pressure, and flow control, as well as the type and concentration of specific contaminants to be removed.
• Look for the NSF certification mark on the RO system to be sure that the manufacturers claims for reducing contamination are true.
• RO is not effective for removing dissolved gases, some pesticides and solvents, hydrogen sulphide gas, THMS, VOCs, and chloramines.
• A typical RO system consists of a sediment filter, pump, reverse osmosis membrane, flow regulator, storage tank, final activated carbon filter (for taste and odors), and dispensing faucet. An AC pre filter is sometimes needed for dechlorination.
• RO is commonly used to treat only the water used for drinking and cooking at the point of use rather than at the point of entry for all household use.
• RO membrane types vary in their ability to reject contaminants and differ in capacity (the volume of treated water produced per day).
• Water pressure is an important factor in determining the RO systems rejection rate, capacity, and recovery rate (amount of treated water producedper amount of feed water used).
• Maintenance of an RO system is essential for reliable performance. High levels of TDS and microorganisms in the system are commonly the cause of fouled membranes.

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• The treated water should be monitored for TDS and the level of any specific contaminants that may affect your familys health.

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BIOGRAPHY

Prabin Jeba , Final year in Civil Engineering, Panimalar Engineering College

Sathish Kumar, Final year in Civil Engineering, Panimalar Engineering College