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IMPACT OF REVERSE OSMOSIS ON PURIFICATION OF WATER

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ABSTRACT

With increasing demand for potable water in regions lacking fresh water sources, various potential technologies have been explored for eliminating water shortage. Raw water (from sea, and other water sources) emerged as a potential source for such water deprived areas. The development of raw water reverse osmosis technology proved to be a ground breaking innovation, making it easier to extract pure water from raw water (sea water and Brackish water). Raw water reverse osmosis technology has taken many leaps towards the development of energy efficient and high yielding systems. The reduction in energy consumption, improvement in membrane life and increase in energy recovery emerged as the primary criteria for research in this field. The key objective of the work involves the optimization of the variables involved in the pre-treatment process of different water sources (pond, canal and surface water) reverse osmosis plant which would lead to an increase in the membrane life by reducing solids content of the raw water. Experiments were carried out to ensure maximum total solids reduction and also reduction of different chemical parameters (BOD, TDS and Bacteria). These parameters were found to be desirable for the discharge from the pre-treatment to be fed into the reverse osmosis part of the plant and RO water plant is used drinking purpose and free from contaminants.

Keywords: Reverse osmosis, Chlorination, BOD, Bacteria.

INTRODUCTION

More than 60% of the world's population resides in Asia, and the continent is fast becoming a powerful engine for global economic growth. Rapid economic growth can be buttressed only by the strong support of infrastructure like power and water facilities. Moreover, continuous population expansion calls for more and better quality fresh water, thereby underscoring the increasingly critical need for reliable sources of water. Given the fixed supply of fresh water globally from conventional sources like streams and underground aquifers, simple economic thinking dictates that to meet rising demand, supply from non-traditional sources must rise, such as sea water desalination. Global sea water desalination capacity has continuously increased over the past 30 years, especially in the past decade. This is a clear indication that drawing fresh water from the sea has gained traction in time in Asia, and today, sea water desalination in Asia accounts for almost 70 % of the global capacity [6]. Water is the most common liquid on our planet, vital to all life forms. It is the dispersion medium for all biochemical reactions of the living process and takes part in many of these reactions. In spite of the chemical simplicity of the water molecule, its physical properties are quite remarkable. Safe drinking water is essential to humans and other lifeforms.To overcomes the problem of water scarcity, the best way is to reuse the water. For this purpose the more suitable plant is the RO plant. Reverse Osmosis is the finest level of Filtration available. The RO membrane acts as a barrier to all dissolved solids and inorganic molecules with a molecular weight greater than approximately 100.Reverse osmosis system is a process of membrane application. In this process water is passed through at a high pressure (12, 13, and 14). Thus separating pure water and dissolved salts. Water coming out is free from TSS, BOD, and Bacteria and contains very low TDS. In this technology, the reverse osmosis takes place with high pressure and because of this the flow of water gets reversed through the semi permeable membrane.

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This assists us in clearing the water from excess salts using the high pressure produce in the RO module. The Reverse Osmosis System (RO) is designed to purify water by forcing water through a semi-permeable RO membrane. Water purified by reverse osmosis has approximately 97-98% of the dissolved ions and approximately 99% of most other contaminants removed. The purified water exiting the system is referred to as Permeate. Reverse osmosis (RO) desalination is one of the main technologies for producing fresh water from seawater and other saline water sources (2).

The membrane properties greatly affect the water productivity and energy costs in the reverse osmosis desalination processes. Recent years have seen significant research efforts devoted to developing high-performance RO membranes. The recent activities in the development of RO membranes with improved flux and salt rejection, chlorine tolerance, fouling resistance and thermal stability. Membrane processes such as Reverse osmosis (RO), Nano filtration (NF), and electrodialysis (ED) have drawn more attention because of their strong separation capabilities and exhibiting a great potential for the treatment of water worldwide [1-5]. The scarcity of fresh water problem may be overcome by using the alternative membrane technology such as membrane distillation for groundwater surface water, brackish water, sea water.

Hence, In the present study, an attempt has been made to use of Reverse osmosis process for purification of water collected from different sources (surface water of ponds, canal, ground water and lakes).

MATERIALS AND METHOD

Collection of Water

Water is mainly collected from the different sources surface water of pond surface, sea water and sea water.

Para meters analyzed

Physical parameters like PH, Turbitity and chemical parameters Nitrates, COD,BOD, sulfates, acidity, alkalinity and total hardness according to APHA (2005). Biological parameters identified (E.coli) according standard protocol.

Operating procedure of Ro plant

Water is passed through at a high pressure. Thus separating pure water and dissolved salts. This process yields 75% permeate and 25% concentrate of the feed volume. It depends upon the characteristics of the water being passed. The typical single-pass RO system consists of the following 5 steps:

Intake

Type of the water intake mainly depends on the pre and post treatment. The RO system is used for the purification of water like river water, sea water ground water, and brackish water.

Pretreatment

It is essential step in reverse osmosis. It is carried out either by physical and chemical treatment or by passing through filter beds. When working with RO and Nano filtration (NF) membrane, pretreatment is essential due to the nature of their spiral wound design.

By physical and chemical methods

Screening of solids

Solids within the water must be removed and the water treated to prevent fouling of the membranes by fine particle or biological growth, and reduce the risk of damage to high-pressure pump components.

Cartridge filtration

Generally, string-wound polypropylene filters are used to remove particles of 1–5 μm diameters.

Dosing

Oxidizing biocides, such as chlorine, are added to kill bacteria, followed by bisulfite dosing to deactivate the chlorine, which can destroy a thin-film composite membrane. There are also biofouling inhibitors, which do not kill bacteria, but simply prevent them from growing slime on the membrane surface and plant walls.

Pre filtration pH adjustment

If the pH, hardness and the alkalinity in the feed water result in a scaling tendency when they are concentrated in the reject stream, acid is dosed to maintain carbonates in their soluble carbonic acid form.

$$CO_3^{2-} + H_3O^+ = HCO_3^- + H_2O$$

$$HCO_3^- + H_3O^+ = H_2CO_3 + H_2O$$

Carbonic acid cannot combine with calcium to form calcium carbonate scale. Calcium carbonate scaling tendency is estimated using the Langelier saturation index. Adding too much sulfuric acid to control carbonate scales may result in calcium sulfate, barium sulfate or strontium sulfate scale formation on the RO membrane.

Pre filtration anti-scalants

Scale inhibitors (also known as antiscalants) prevent formation of all scales compared to acid, which can only prevent formation of calcium carbonate and calcium phosphate scales. In addition it inhibit sulfate and fluoride scales, disperse colloids and metal oxides. Despite it claims that antiscalants can inhibit silica formation.

By passing through filter beds

Pressure Sand Water Filter

Sand filtration is frequently used and very robust method to remove suspended solids from water. Raw

water is passed through Multigrade Sand Filter at a pressure of 3.5 kg / cm2 to reduce the suspended solids present in the raw water. The filter will effectively remove up to 30 – 50 micron of the suspended solids to less than 5 ppm.

Activated Carbon Filtration System

The activated carbon filtration system is also one type of filtration process to polish the treated water after sand filtration system. By this process the odors, free chlorine; present in the water will be reduced.

Start up procedure

Before starting up an RO system, it should be verified that all pretreatment systems are working according to their specifications On startup, the inlet valve should open prior to the initiation of the high-pressure pump, to completely fill the system with low pressure water (<100 psi [< 7 Bars]). This "soft start" will prevent hydraulic shock at startup. Pre-treatment chemical making sure the chemicals are not over-injected.

High Pressure Pump

One No. of Vertical Mounted Multi stage centrifugal High Pressure Pump with SS construction. The High Pressure Pump supply raw water with pressure of 12 to 15 kg/cm2 to RO Membranes, where permeate is separated.

PROCESS

Reverse Osmosis (RO) *water treatment* process involves water being forced under pressure (Osmotic Pressure) through a semipermeable membrane. The Reverse Osmosis Process is generally used for desalination of Sea water treatment and Brackish Water treatment for its conversion into potable water. In the whole *Water Treatment* fields Reverse Osmosis *water treatment* Process usage in Industrial water treatment and Domestic water *treatment* is huge. Reverse Osmosis water treatment is the main key of modern water treatments field to solve water requirements.

In Reverse Osmosis water treatments, feed water is pumped at high pressure through permeable membranes, separating salts from the water. It is called Desalination of Reverse Osmosis (RO) *water treatment.* The feed water is pretreated to remove particles that would clog the membranes.

Remineralisation and pH Adjustment

The desalinated water is very corrosive and is stabilized to protect downstream pipelines and storages, usually by adding lime or caustic to prevent corrosion of concrete lined surfaces. Liming material is used to adjust pH between 6.8 and 8.1 to meet the potable water specifications primarily for effective disinfection and for corrosion control.

Post-Treatment

Post-treatment consists of preparing the water for distribution after filtration. It provides secondary protection against compromised membranes and downstream problems. Disinfection by means of UV lamps. Store the treated water in storage tank before it is supplied.

Table 1. Variation of pH at different sampling times the variation depends upon the pollutant concentration of the raw water

S.No	Parameter	First week		Second week		Third week		WHO Standard value	
		Rw (ex v)	Ow(ex v)	Rw(exv)	Ow(ex v)	Rw (ex v)	Ow (ex v)	Ow (ex v)	
1.	PH	6.0	7.8	6.25	8.0	6.45	8.2	8.4	7.5-8.5
2.	Turbidity	50	2.5	58	3.5	53	2.4	2.8	2.5
3	BOD	10.24	2.8	13.25	3.12	12.12	3.2	2.96	3
4.	COD	30.5	7.4	36.0	7.2	35.00	7.3	7.6	<10ppm
5.	TSS	1050	230	1000	270	1450	230	280	300-500
6.	TDS	550	300	650	240	700	260	220	500
7.	Chlorides	250(chl)	Nil	300(chl)	Nil	430(chl)	Nil	Nil	200
8.	Total hardness	430	130	450	100	420	134.50	200	200
9.	E.coli	8per100ml	1per100ml	13per100ml	1per100ml	11per100ml	1per100ml	15	200
								3.69 0.5per100ml	<20 1per100ml

RESULTS AND DISCUSSION

The study of physical and chemical characteristics of water provides a clear idea about quality of water present on the surface. (River, Lake, Ponds, Oceans, Canals etc).

Some of the parameters tested are as follows:

pH

Data presented in Table 1 shows variation of pH at different sampling times the variation depends upon the pollutant concentration of the raw water. pH in raw water was varying from 6.0-6.25 and after RO treatment it is

found that the pH value is between 7.8-8.0 which is in permissible limit.

Turbidity

Turbidity at different sampling times the variation depends upon concentration of color causing agents of the raw water. Turbidity in raw water was varying from 55-60 and after RO treatment it is found that the it is between 2.5-2.8which is in permissible limit.

Biological oxygen demand (BOD)

BOD at different sampling times the variation depends upon the pollutant concentration and oxygen availability of the raw water. BOD in raw water was varying from 10.24-13.25 and after RO treatment it is found that the BOD value is 2.8 which is in permissible limit (1).

Chemical oxygen demand (COD)

COD variation depends upon the chemical concentration of the raw water. COD in raw water was 30.5-36 and after RO treatment it is found that the COD value is less than 7.4 which is in permissible limit (1).

Total suspended solids (TSS)

pH at different sampling times the variation depends upon the pollutant concentration of the raw water. TSS in raw water was varying from 1050-1400 and after RO treatment it is found that the TSS value is less than 400 which is in permissible limit.

TDS (Total dissolved solids)

TDS at different sampling times the variation depends upon the pollutant concentration of the raw water. TDS in raw water was up to 700 and after RO treatment it is found to be less than 500 which is in permissible limit.

Chlorides

Chloride should be removed from raw water before enter in to the system by adding chlorides and anti scalents because membranes are sensitive to chlorine.

Total Hardness

After RO treatment the values are reduced from 100-150 which is in permissible limits.

E.COLI

After RO treatment the values are reduced from 12 per 100 ml _<1 per 100 ml,which is in permissible limits The water quality is directly relate to health, various chemicals releasing from the industries and release from the domestic waste. I have examined some parameters of raw water whose values are much more than the permissible limit which causes diseases on continuous exposure to untreated water. So that the purification is necessary for raw water. By passing through Ro plant the out-put water from the plant may have the values with in permissible limit given by WHO, so it is suitable for drinking.

The procedure of RO plant is well suited for purification of raw water collected from the different locations. The product water is free from the nutrients, metal ions and bacteriological impurities. Some of the important precautions taken during the storage of water is to prevent from the bacterial attack and treated with chlorine to disinfect that bacteria passes through the membrane. The main disadvantage is the fouling of membrane so is to prevent from fouling it requires pretreatment of feed.

The present study on purification of raw water by reverse osmosis plant in chemical laboratories has been carried out at different locations surrounding located at Vijayawada. Natural water bodies such as lakes, ponds, streams, river and seas acquire microorganisms on exposure to air. Water found in nature contains number of impurities which are essential .Water should be free from all objectionable matter. It is the best process for the purification of the raw water. Reverse osmosis is a process of flow of pure water from a dilute saline solution through a membrane into a higher concentrated saline solution is being forced under pressure through a semi permeable membrane (7, 8, 9 and 10). The purification of raw water is completed in three stages.1.Pretreatment 2. RO treatment. 3. Post treatment. The product water from the membrane assembly usually requires pH adjustment and degasification before being transferred to the distribution system for use as drinking water. In many cases, this water is discharged to a storage cistern for later use. The physical, chemical and microbiological parameters are monitored.

CONCLUSION

It is well established that there is an evolving lack of fresh water availability due to several reasons like population blast, ground water depletion, climatic change, global warming, etc. To meet this rising demand of potable water, there is an ever-growing requirement of novel, energy efficient, economically viable technologies that would yield fresh water for domestic and industrial consumption. Hence, Reverse osmosis technologies are being worked upon all around the world to device an efficient method to purify water for human consumption .Pre-treatment of raw water is an absolute necessity before sending in the feed for desalination into a RO plant. Failing to do so exponentially reduces the membrane, and hence, the plant life.The primary aim of this entire process is to reduce the TS content of the water as much as possible to make free from other physicochemical parameters and potable for drinking.

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