REMOVING OF PATHOGEN BY USING GRAMICIDE DOSING AND HEAT EXCHANGER

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ABSTRACT
Water is a key ingredient used in many pharmaceutical and life sciences operations. Water is widely used as a raw material, ingredient, and solvent in the processing, formulation, and manufacture of pharmaceutical products, active pharmaceutical ingredients (APIs) and intermediates. Control of the quality of water throughout the production, storage and distribution processes, including microbiological and chemical quality, is a major concern. Water can be used in a variety of applications, some requiring extreme microbiological control and others requiring none. Pharmaceutical water production, storage and distribution systems should be designed, installed, commissioned, qualified and maintained to ensure the reliable production of water of an appropriate quality. It is necessary to validate the water production process to ensure the water generated, stored and distributed is not beyond the designed capacity and meets its specifications. The microbiological and chemical testing for Water used in pharmaceutical plant, Conductivity testing establishes a sample's ability to conduct electricity, which relates to the number of dissolved salts (ions) in the sample, a high ion count, lowers water purity and may indicate a processing problem. Total organic compounds (TOC) testing finds whether carbons in the sample are maintained below a mandated limit of 500 parts per billion (ppb), bio burden testing establishes the number of microorganisms in a water sample, Microbial test of water includes the estimation of the number of viable aerobic bacteria present in a given quality of water.

***Keywords—Water, Water Treatment, Total organic* Compound,**

INTRODUCTION
[1] [2] ***Reverse osmosis (RO)*** is a water purification process that uses a partially permeable membrane to separate ions, unwanted molecules and larger particles from drinking water. In reverse osmosis, an applied pressure is used to overcome osmotic pressure, a colligative property that is driven by chemical potential differences of the solvent, a thermodynamic parameter. Reverse osmosis can remove many types of dissolved and suspended chemical species as well as biological ones (principally bacteria) from water, and is used in both industrial processes and the production of potable water. 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. To be "selective", this membrane should not allow large molecules or ions through the pores (holes), but should allow smaller components of the solution (such as solvent molecules, i.e., water, H_2O) to pass freely.

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 driving force for the movement of the solvent is the reduction in the Gibbs free energy of the system when the difference in solvent concentration on either side of a membrane is reduced, generating osmotic pressure due to the solvent moving into the more concentrated solution. Applying an external pressure to reverse the natural flow of pure solvent, thus, is reverse osmosis. The process is similar to other membrane technology applications.

Reverse osmosis differs from filtration in that the mechanism of fluid flow is by osmosis across a membrane. The predominant removal mechanism in membrane filtration is straining, or size exclusion, where the pores are

0.01 micrometres or larger, so the process can theoretically achieve perfect efficiency regardless of parameters such as the solution's pressure and concentration. Reverse osmosis instead involves solvent diffusion across a membrane that is either nonporous or uses Nano filtration with pores 0.001 micrometres in size. The predominant removal mechanism is from differences in solubility or diffusivity, and the process is dependent on pressure, solute concentration, and other conditions.

Reverse osmosis is most commonly known for its use in drinking water purification from seawater, removing the salt and other effluent materials from the water molecules.

TREATMENT OPTION OF REVERSE OSMOSIS

In India, distillery uses various forms of primary, secondary and tertiary treatments of wastewater. The units processes used are screening and equalization, followed by biomethanation. Fertiirrigation and biocomposting with sugarcane pressmud are the most widely used options for effluent disposal (Ramana et al., 2002).In case of grain based distillery the treatment given is by way of DWGS separation, incineration and biomethanation. The process streams that can be recycled are namely, thin slop and process condensate. The effluent generated after removal of the solids. Thin slop contain high TDS, high temperature and contain carbohydrates, organic acids, dead yeast cells etc. which may have an impact on the fermentation process. The process condensate from the evaporator has high temperature, low pH, organic acids etc. This can be treated by RO system and used in the process or for utility operations.

REVERSE OSMOSIS PROCESS DESCRIPTION

The RO process is simple in design consisting of feed, permeate and reject stream. For feed water it is necessary to provide pretreatment in order to remove inorganic solids and suspended solid and using high pressure pump given feed through semi permeable membrane. Depending upon the permeate where it is used necessary post treatment is given. A schematic diagram of the RO process is shown figure 1.

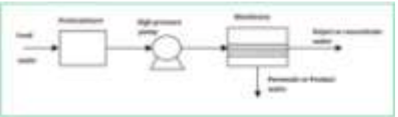

Figure1. Schematic Diagram of the RO Process

REVERSE OSMOSIS REQUESITIES

An RO desalination plant essentially consists of four major systems: (a) Pre-treatment system, (b) High-pressure pumps, (c) Membrane systems, and (d) Post-treatment. Pre- treatment system is provided to remove all suspended solids so that salt precipitation or microbial growth does not occur on the membranes. Pre-treatment may involve conventional methods like a chemical feed followed by coagulation/ flocculation/sedimentation, and sand filtration or membrane processes i.e. micro filtration (MF) and ultra-filtration (UF). High-pressure pumps supply the pressure needed to enable the water to pass through the membrane and have the salt rejected. The pressure ranges from 17 to 27 bar for brackish water, and from 52 to 69 bar for seawater. Membrane systems consist of a pressure vessel and a semi-permeable membrane inside that permits the feed water to pass through it. RO membranes for desalination generally come in two types:

Spiral wound and Hollow fibre. Depending upon water quality of permeate and use of permeate; post treatment may consists of adjusting the pH and disinfection (Djebedjian et al, 2006)

ADVANTAGE OF RO PROCESS

Following are the advantages of the RO process that make it attractive for dilute aqueous wastewater treatment include.

- RO systems are simple to design and operate, have low maintenance requirements, and are modular in nature, making expansion of the systems easy.
- Both inorganic and organic pollutants can be removed simultaneously by RO membrane processes.
- RO systems allow recovery/recycle of waste process streams with no effect on the material being recovered.
- RO systems require less energy as compared to other technology and 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 (Cartwright, 1985; Sinisgalli and McNutt, 1986; Cartwright, 1990; McCray et al., 1990; Cartwright, 1991; Williams et al., 1992).
- 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. In your paper title, if the words "that uses" can accurately replace the word "using", capitalize the "u"; if not, keep using lower-cased.
- The process is electrically driven hence it is readily adaptable to powering by solar panels.

In addition, RO systems can replace or be used in conjunction with others treatment processes such as oxidation, adsorption, stripping, or biological treatment (as well as many others) to produce high quality product water that can be reused or discharged.

COMPONENTS

- Activated Filter Media:

AFM Activated Filter Media is a direct replacement for sand, doubling the performance of sand filters without the need of additional investments in infrastructure. AFM resists bio fouling, bio coagulation and transient wormhole channeling of unfiltered water and never needs to be recharged or replaced.

The activated surface of AFM is self-sterilizing which prevents bacteria mud-balling, coagulation and channeling of unfiltered water through the filter bed. Activation increases the surface area by up to 300 times for catalysis and adsorption reactions. Similar to activated carbon, the surface Nano-structure adsorbs pollutants from the water but unlike carbon, AFM is recharged by just back-washing with water.

Fig.2.1Activaed Carbon Filter

- SMBS Dosing System

Sodium Metabisulfite (SMBS) is a common form of pretreatment for reverse osmosis systems and works in removing free chlorine, including being used as a biostatic. SMBS is preferred to be used for larger water treatment systems than other chemical reducing agents such as carbon filters and sulfur dioxide due to its advantage of reducing the chance of bacteria growth than produces biological fouling.

Fig. 2.2 Sodium Met bisulfite (SMBS)

- Gramicid Dosing

Gramicid dosing is a powerful sterilizing agent, effective against bacteria, virus, fungi, algae and spores. More important is that Gramicid is equally effective against bacterial species, which are normally resistant to other biocides. In addition to its strong biocide action, which is long lasting, Gramicid is also non – toxic, nonmutagenic, non – polluting, non – residual and an environmental friendly biocide. In fact, it is the biocide which is suitable for all industries.

Fig. 2.3 Gramicide Dosing System

- UF System

Ultrafiltration (UF) is a variety of membrane filtration in which forces like pressure or concentration gradients lead to a separation through a semipermeable membrane. Suspended solids and solutes of high molecular weight are retained in the so-called retentate, while water and low molecular weight solutes pass through the membrane in the permeate.
In addition to providing a dependable, locally controlled water supply, water recycling provides tremendous environmental benefits.

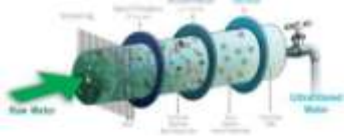

Fig. 2.4 UF system

- RO Membrane

Reverse osmosis (RO) membranes are commonly used as a filtration method to remove many types of dissolved solids (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

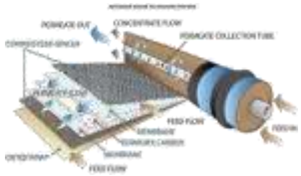

Fig. 2.5 RO Membrane

- Plate Type Heat Exchanger

A plate exchanger consists of a series of parallel plates that are placed one above the other so as to allow the formation of a series of channels for fluids to flow between them.
The space between two adjacent plates forms the channel in which the fluid flows.
Inlet and outlet holes at the corners of the plates allow hot and cold fluids through alternating channels in the exchanger so that a plate is always in contact on one side with the hot fluid and the other with the cold.

Fig. 2.6 Heat Exchanger

- UV System

UV Disinfection System is an extremely effective way to combat microbial contamination in water. However, microbes have to be exposed to UV-C light in the proper amount in order to effectively disinfect the water. UV Disinfection Systems are used in many different applications ranging from the purification of drinking water in individual homes to disinfecting water supply of entire townships to industrial wastewater treatment. UV treatment for water is recognized as a safer and more cost-effective way to disinfect water for industrial applications

Ultraviolet water purification is the most effective method for disinfecting bacteria from the **water**. **Ultraviolet** (**UV**) rays penetrate harmful pathogens in **water** and destroy illness-causing microorganisms by attacking their genetic core (DNA). UV system is installed after EDI unit to control microbial counts.

*A. **Problem***

I. WATR SAMPLING REPORT

I. ADVANTAGE AND APPLICATION

A. Advanatge

Pathogen was appearing into the treated water

Sr. No.	Water Parameter	Result	Limit
1	Turbidity	<1 NTU	<5 NTU
2	TSS	Nil	Nil
3	pH	6.4	5.0 – 7.0
4	SDI	< 3	< 5
5	Total dissolved solid	800 ppm	1000 ppm
6	Colour	<1 Hz	<1 Hz
7	Hardens as $CaCO_3$	468 ppm	500 ppm
8	Total Alkalinity	315 ppm	320 ppm
9	Sulphate	40 ppm	42 ppm
10	Chloride	370 ppm	370 ppm
11	Colloidal Silica	0.060	0.061
12	TOC	<10000 ppb	<10000 ppb
13	**Pathogens**	**Present**	**Absent**
13.1	Escherichia Coli	Present	Absent
13.2	Pseudomonas aeruginosa	Present	Absent
13.3	Staphylococcus aureus	Absent	Absent

A. *Solution*

Gramicide Dosing, which is more concentrated, has been provided instead of NaOCl dosing, Heat exchanger is also used for heating purpose to get zero pathogen.

B. *Water Sampling After Solution*

Sr. No.	Water Parameter	Result	Limit
1	Turbidity	<1 NTU	<5 NTU
2	TSS	Nil	Nil
3	pH	6.8	5.0 – 7.0
4	SDI	< 3	< 5
5	Total dissolved solid	786 ppm	1000 ppm
6	Colour	<1 Hz	<1 Hz
7	Hardens as $CaCO_3$	455 ppm	500 ppm
8	Total Alkalinity	302 ppm	320 ppm
9	Sulphate	35 ppm	42 ppm
10	Chloride	343 ppm	370 ppm
11	Colloidal Silica	0.059	0.061
12	TOC	<10000 ppb	<10000 ppb
13	**Pathogens**	**Absent**	**Absent**
13.1	Escherichia Coli	Absent	Absent
13.2	Pseudomonas aeruginosa	Absent	Absent
13.3	Staphylococcus aureus	Absent	Absent

I. ADVANTAGE AND APPLICATION

A. Advanatge

Following are the advantages of the RO process that make it attractive for dilute aqueous waste water treatment include:

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- RO systems allow recovery/recycle of waste process streams with no effect on the material being recovered.
- RO systems require less energy as compared to other technology.
- 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.
- 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.
- The modular structure of the RO process increases flexibility in building desalination plants within a wide range of capacities.
- The specific energy requirement is significantly low 3- 9.4 kW h/m3 product.
- The process is electrically driven hence it is readily adaptable to powering by solar panels.

In addition, RO systems can replace or be used in conjunction with others treatment processes such as oxidation, adsorption, stripping, or biological treatment (as well as many others) to produce high quality product water that can be reused or discharged.

B. Application of RO water

[5]This technology has advantage of a membrane based process where concentration and separation is achieved without a change of state and without use of chemicals or thermal energy, thus making the process energy efficient and ideally suited for recovery applications. The bibliographic 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.

CONCLUSION

Feed Water containing suspended particles, organic matter as well as inorganic salt may deposit on the membrane and fouling will occur or damage the membrane because of applied pressure and size of particles. Therefore the priority to remove these by way of pre-treatment will determine the RO efficiency. Hence RO membrane performance can be checked to avoid the irreversible damages to the RO membrane. In fact success of RO system depends upon efficiency of the pre-treatment. Post treatment of brine streams present a major problem with growing desalination capacity to minimize the damage on the ecology which depends upon the location of plant.

FUTURE SCOPE

Use of pre-heated feed water, operation at low pressure, advanced feed water pre-treatment, advanced energy recovery systems, site specific optimization and automatic real time plant management systems are the possible area where

R&D is required with development of membrane material to sustain maximum temperature which will increase the productivity of plant thereby reduction of cost of treatment.

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