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A COMPLETE OVER REVIEW ON WORLD OF WATER PURIFICATION OF REVERSE OSMOSIS

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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, colour, 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.

Water scarcityis a grand challenge that has always stimulated research interests in finding effective means for pure water production. In this context, reverse osmosis (RO) is considered the leading and the most optimized membrane-based desalination process that is currently dominating the desalination market. In this review, various aspects of RO desalination are reviewed. Theories and models related to concentration polarization and membrane transport, as well as merits and drawbacks of these models in predicting polarization effects, are discussed. An updated review of studies related to membrane modules (plate and frame, tubular, spiral wound, and hollow fiber) and membrane characterization are provided. The review also discusses membrane cleaning and different pre-treatment technologies in place for RO desalination, such as feed-water pre-treatment and biocides. RO pre-treatment technologies, which include conventional (e.g., coagulation-flocculation, media filtration, disinfection, scale inhibition) and non-conventional (e.g., MF, UF, and NF) are reviewed and their relative attributes are compared. As per the available literature, UF, MF and coagulation-flocculation are considered the most widely used pre-treatment technologies. In addition, this review discusses membrane fouling, which represents a serious challenge in RO processes due to its significant contribution to energy requirements and process economy (e.g., flux decline, permeate quality, membrane lifespan, increased feed pressure, increased pre-treatment and membrane maintenance cost). Different membrane fouling types, such as colloidal, organic, inorganic, and biological fouling, are addressed in this review. Principles of RO process design and the embedded economic and energy considerations are discussed. In general, cost of water desalination has dropped to values that made it a viable option, comparable even to conventional water treatment methods. Finally, an overview of hybrid RO desalination processes and the current challenges faced by RO desalination processes are presented and discussed.

Keyword: Beverage Industry, Boiler Feed Water, Distillery Spent Wash, Recovery of Phenol Compounds, Reclamation of Wastewater, Sea Water Reverse Osmosis , Reverseosmosis, Membranes,Pretreatment, Fouling,Desalination,Concentration polarization.

Introduction:

Reverse Osmosis (RO) is a process that uses semi-permeable spiral wound membranes to separate and remove dissolved solids, organic, pyrogens, submicron colloidal matter, color, nitrate and bacteria from water.Feed water is delivered under pressure through the semi permeable membrane, where water permeates the minute pores of the membrane and is delivered as purified water called permeate water. Impurities in the water are concentrated in the reject stream and flushed to the drain is called reject water. These membranes are semi-permeable and reject the salt ions while letting the water molecules pass.materials used for RO membranes are made of cellulose acetate, polyamides and other polymers. The membrane consists of hollow-fiber, spiral-wound used for treatment; depend on the feed water composition and the operation parameters of the plant.Reverse Osmosis (RO) is a membrane based process technology used for desalination.

Reverse osmosis (RO) water desalination was conceived and laboratory-demonstratedin the late 1950s. A quantum jump to practicality was made in 1960 with the discovery of the anisotropic RO membrane which combined good desalination with adequate permeate flux at a reasonable hydrostatic pressure. Since then there has been progressive improvement in these membranes and development of ingenious means for packaging them. As a result, present day RO plants are compact and simple to operate,and can take advantage of the fact that in RO there is no phase change required.Therefore, the required energy input can approach fairly closely to the thermodynamic minimum free energy of separation, an advantage no other desalination process can surpass, and usually cannot approach.An important factor in the commercial success of reverse osmosis desalination has been the development of pretreatment methods appropriate for the particular feed brine being used.For all of these reasons reverse osmosis enjoys a leading position today in the installation of commercial water desalination capacity and plants.

Historical Development

In the 1950s Reid conceived and with his colleagues demonstrated reverse osmosis desalination using cellulose acetate films (sheets), but he received a very low permeat flux. In 1959–1960 Loeb and Sourirajan (L–S) found that anisotropic cellulose acetate membranes, those possessing a skin surmounting a porous substructure, could have both good desalination and an adequate permeate flux. The L–S membranes obtained the anisotropic character by dividing the nascent membrane into a skin and a porous substructure, a process historically labeling the membranes as "asymmetric". Later, in the 1960s and 1970s, Francis and Cadotte, and separately Riley fabricated anisotropic membranes by adding the skin to the porous substructure, initially physically and later by interfacial polymerization at the upper surface of the porous substructure. Membranes thus fabricated are called composite. For application both of these sheet type membranes are interlaced with flow spacers, rolled into a tight spiral, and inserted into a pressure cylinder. The housing assembly, invented by Westmoreland and Bray in the 1960s is called a spiral module. Hollow fiber membranes were first fabricated by Mahon in the early 1960s but his permeate flux was very low, probably because the fiber was isotropic. Starting in 1965, DuPont developed very successful asymmetric polyamide hollow fibers and appropriate modules for both brackish and seawater desalination. In the latter 1970s, the Toyobo Company began marketing asymmetric cellulose triacetate hollow fibers and modules.

Principle of Reverse Osmosis:

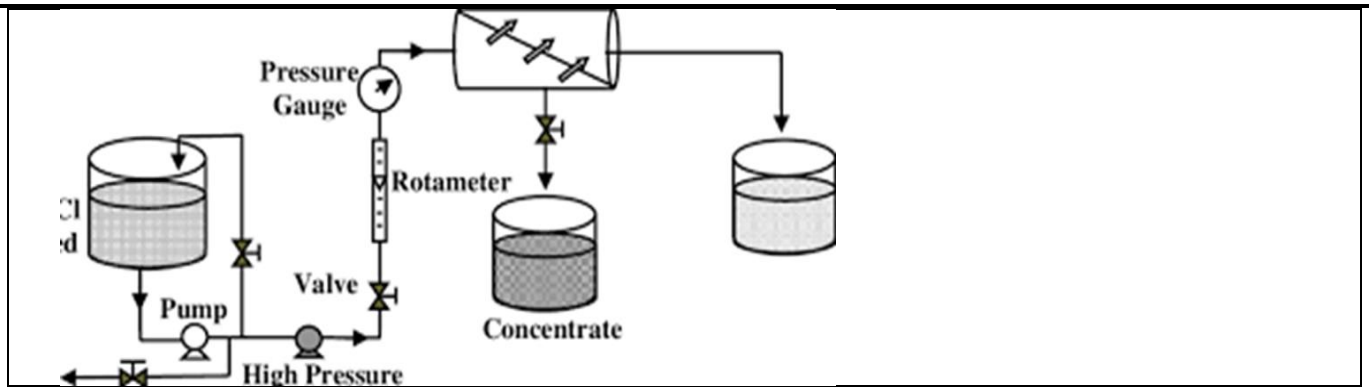
A solution is separated from its solvent by a semipermeable membrane, one permeabl to the solvent but not the solute. The natural permeation from solvent to solution is called osmosis. If hydrostatic pressure is applied increasingly on the solution side the permeation rate will decrease accordingly, stop at a hydrostatic pressure called the osmotic pressure, and reverse direction at a greater hydrostatic pressure. This is reverse osmosis (RO).

Technical and Economical Relevance of Reverse Osmosis:

Reverse osmosis has a number of innate advantages. Because it is all-liquid and uses hydrostatic pressure as an energy source, RO modules and plants can be very compact,operation is relatively simple, and modules are readily replaced. Furthermore, the energy input can be quite low because it can approach the free energy of separation.An important and necessary factor in RO's success has been the development of customized pretreatment, suiting feed brines to membranes to increase membrane life.Starting from zero in 1968 reverse osmosis now occupies a dominant position in desalination.

Scope of Reverse Osmosis:

The process has also been applied to treat municipal waste water.Since conventional municipal treatment processes do not remove dissolved solids, but RO process is used for the removal of dissolved solids. RO is increasingly used as a separation technique in chemical and environmental engineering for the removal of organics and organic pollutants present in waste water.Removal of organic contaminants by RO processes was first demonstrated by Chian et al. (1975)



Fig, Schematic Diagram of the RO Process:-

Reverse Osmosis Process Description:

When two solutions of different concentrations are separated by a semi-permeable membrane, the solvent (water) flows from the dilute solution to the concentrated solution till the concentrations of two solutions become equal. This process is known as osmosis.[4] Formally, reverse osmosis is the process of forcing a solvent from a region of high solute concentration through a semi-permeable membrane to a region of low solute concentration by applying a pressure in excess of osmotic pressure. The largest and most important application of reverse osmosis is the separation of pure water from seawater and brackish water; seawater or brackish water is pressurized against one surface of the membrane, causing transport of salt – depleted water across the membrane and emergence of portable drinking water from the low pressure side. The membranes used for reverse osmosis have a dense layer in the polymer matrix, either the skin of an asymmetric membrane or an interfacial polymerized layer within a thin-film composite membrane, where the separation occurs. 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 solids and using high pressure pump given feed through semi permeable membrane.

Reverse Osmosis Requisites:

Reverse osmosis desalination plant essentially consists of four major systems: (a) pretreatment system (b) high pressure pumps (c) membrane systems and (d) post-treatment.Pretreatment system is provided to remove all suspended solids so that salt precipitation or microbial growth does not occur on the membranes. Pretreatments 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 pass through the membrane and have the salt rejected. The pressure ranges from 17 to 27 bars for brackish water, and from 52 to 69 bars 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 membranesfor desalination generally come in two types: Spiral wound and hollow fiber. Depending upon water quality of permeate and use of permeate; post treatment may consist of adjusting the pH

Advantages of RO Process:

- Some of the advantages of the reverse osmosis process are as follows.
- It is the best method for water softening.
- The semipermeable membrane will block all ion particles.
- Maintenance of the system is very simple.
- It gives us clean and pure water by blocking all contaminants.
- The available RO systems are very compact, and it requires little space.
- The useful life of the full system, including the membrane, is over two years.
- This system does not require any use of chemicals to purify water.
- The energy requirement for the RO system is very low.
- RO systems are totally automated and are designed to start and stop on their own.

Disadvantages of Reverse Osmosis:-

- Some of the disadvantages of the reverse osmosis process are as follows.
- Sometimes reverse osmosis leads to clogging of the whole system.
- It requires routine filter changes and maintenance.
- The installation cost of a reverse osmosis system is high.
- The whole process is very slow when it comes to household application, as the pressure used is very low.
- The process does not help in disinfecting the water. You will require a separate process to disinfect the water.
- Hard water can damage the system.
- The damaged membrane will allow any small microorganism to pass through it.
- The applied pressure has to be more than the osmotic pressure, or the system won't work.
- The RO system is not self-sustaining.

Applications of Reverse Osmosis:

- 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:-

Reverse osmosis process has been embraced by the world as a safe and affordable way to purify drinking water, since the process is effective in getting rid of dissolved chemicals, heavy metals, getting rid of harmful bacteria and chlorine from water as they pass through the thin semi-permeable membranes. RO is also energy efficient as it doesn't require use of electricity, all it requires is sufficient water pressure to power it through the entire process. Therefore, priority should be given to the membrane maintenance and cleaning as well as move extensive search for multi-functional membrane materials that offer higher permeability, high ion and organic contaminants rejection.

Future Scope

Currently, the two practical challenges limiting the advance in the nano-structured membrane materials are the high cost of nanomaterials and the difficulty in scaling up nano-membrane manufacturing processes for commercial use. In addition, health and safety issues around the use of nano-materials. Therefore the key future area of study in RO desalination technology should target at development single-pass reverse osmosis using multifunctional membranes, eliminating the need for pretreatment, development of novel RO-membranes with improved salt rejection and permeability at a reasonable maintenance, capital investment and operating cost.

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