A Review on Various Methods of Seawater Desalination

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***Abstract* - Water is the basic need which is used for variety of purposes like drinking, washing, bathing recreation as well as numerous other varied industrial applications. The increasing amount of discharged sewage, urbanization, use of chemicals in agriculture and various anthropogenic activities effects the quality of underground water. The availability of fresh water sources is limited. Water shortage and unreliable water quality are major obstacles to achieve sustainable development and improvement in quality of life. Seawater accounts for 94% of the Earth's water and support numerous commercial activities. The main drawback is their high salinity. Desalinization of salt water is done to eliminate dissolved minerals including salts from feed water resources that are salty. This paper includes review of various methods used for sea water desalination.**

Keywords: Water, Seawater, Desalination

I. INTRODUCTION

The worldwide availability of fresh water is very limited but the demand of water in the country is increasing at a rapid rate due to increased use of water for irrigation, industrialization, population growth and improving the standard of living. This increased demand for water has put pressure on water supply system, which has lead to overexploitation of water resources, and breaks in the balance of the ecosystem. Safe drinking water is essential to humans and other life forms but increased amount of discharged sewage, chemicalization of agriculture and industry, as well as anthropogenic activities all affects the quality of underground water. The only inexhaustible source of water is the seawater which covers 94% of the earth's surface but this water contains about 3.5% salts. Brackish water is totally unfit for drinking. When there is no other source of water there is no alternative except to do the desalination of available water.

II. METHODS OF DESALINATION

The most widely used methods which are adopted for the conversion of salt water into fresh water are a) Reverse osmosis b) Solar distillation method c) Freezing Process d) Electro dialysis Two thousand years ago, Greek sailors used to get fresh water from sea water by distilling sea water. Among these processes, RO method employed in the bulk of the plants (90%) to desalinate seawater worldwide (Marc et.al. 2010). Reverse Osmosis RO) is a pressure driven membrane process where a feed stream flows under pressure through a semi-permeable membrane, separating two aqueous streams, one rich in salt and other poor in salt. Water will pass through the membrane, when the applied retained. As a result, a low salt concentration permeate stream is obtained and a concentrated brine remains at the feed side pressure is higher than the osmotic pressure, while salt is retained (Bahusaheb et.al. 2011). The RO process is effective for removing total dissolved solids (TDS) concentrations of up to 45,000mg/L, which can be applied to desalinate both brackish water and seawater (Younos et.al. 2005).

Seawater RO plants have two options for feed water source: seawater wells (beach wells) or surface water (open seawater intake). Some of the first plants built in the Caribbean Sea during the 1970s and the 1980s used open seawater intakes and had severe fouling problems on the RO membranes, even with chemical pretreatment (Lauren et.al. 2009).

Typical seawater concentrations around the world can range from less than 35,000 mg/L to greater than 45,000 mg/L (Gaid et.al. 2007). Brackish water sources are often groundwater; these groundwater can be naturally saline aquifers or groundwater that has become brackish due to seawater intrusion or anthropogenic influences (e.g., overuse and irrigation). Surface brackish waters are less common but may occur naturally or through anthropogenic activities. Brackish waters can have a wide range of TDS (1000–10,000 mg/L) and are typically characterized by low organic carbon content and low particulate or colloidal contaminants.

Membrane fouling is caused by the deposition of organic and inorganic water contaminants and can occur in several layers. Suspended and colloidal particles foul a membrane by coagulating together and forming a cake-like layer on the membrane surface, while dissolved organics will interact directly with the membrane surface and with each other to cause fouling (Tran et.al. 2007).

Recovery rate is a major parameter for evaluating membrane effectiveness. Recovery is defined as the volume of freshwater produced as a percentage of the volume of feed water processed. Typical recovery rates for RO systems can be 30 percent to 80 percent depending on the quality of feed water, pressure applied, and other factors. Reverse osmosis membranes that operate at low pressures but maintain high recovery rates have been developed. Typically, these ultra low-pressure reverse osmosis membranes (ULPRO) are made of thin film composites of polymers, with an active surface layer that is negatively charged with improved fouling resistance properties (Bertelsen, 2005). Since deep-sea water is relatively free from critical organic and inorganic contaminations just a coarse filtration is sufficient and chemical pre-treatment can be reduced or completely eliminated which result in economic benefit as well as minimization of harmful environmental impact (Reza et.al. 2012).

Membrane distillation (MD) is a thermally driven separation process that involves phase conversion from liquid to vapor on one side of the membrane and condensation of vapor to liquid on the other side. The exploitation of waste heat energy sources such as solar energy enables MD more promising separation technique for industrial scale (Selvi et.al. 2014) Membrane distillation can be employed in four different configurations namely direct contact membrane distillation (DCMD), air gap membrane distillation (AGMD), Vacuum membrane distillation (VMD) and Sweeping gas membrane distillation (SGMD). Integrated mode of solar power with thermal membrane distillation for potable water utilizing low waste heat energy is ongoing research in most of the academic institute.

Solar energy can be used to convert saline water into fresh water with simple, low cost and economical technology and thus it is suitable for small communities, rural areas and areas where the income level is very low. Two types of solar power MD is classified as direct and indirect systems. In direct systems are those where the heat gaining and desalination processes take place naturally in the same device, (Solar still). In indirect method, the plant is separated into two subsystems, a solar collector and a desalination unit. The solar collector can be a flat plate, evacuated tube, solar pv cell or solar concentrator and it can be coupled with any of the distillation unit types which use the evaporation and condensation principle, Recent developments have demonstrated that solar powered desalination processes are better than the alternatives membrane desalination technology.

Freeze Separation is freezing saltwater forms pure crystals, which have to be separated from brine and then melted to get potable water. This method is not fully developed (El-Dessouky et al. 2000).

Electro dialysis is the closest cousin of capacitive deionization systems and has been successfully used for the desalination of brackish waters. Due to its similarity to CDI processes, it is instructive to examine this technology from two perspectives. Firstly, it is a commercially accepted technology for water treatment. Secondly, there are commonalities between CDI and electro dialysis processes particularly with respect to ion transport in solution as well as through membranes that are worth noting and comparing. Electro dialysis involves moving ions in a potential field across polymeric anion and cation-exchange membranes.is a pictorial illustration of the process. Cation- and anion-exchange membranes are placed alternatively between the cathode and the anode. When a potential difference is applied between both electrodes, the cations are drawn towards the cathode (negative electrode) and anions towards the anode (positive electrode). The cations migrate through the cation-exchange membranes, but are retained by the anion-exchange membranes. The opposite occurs with the anions that migrate through the anion-exchange membranes but not through the cation-exchange membranes. This movement produces a rise in the concentration of ions in some compartments (brine streams) and the decrease in the adjacent ones (dilute streams), from which purified water exits. As a result of the anion and cation migration, electric current flows between the cathode and anode with equal charge equivalents transferred so that charge balance is maintained in each stream (Marc et.al. 2010).

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