A Review on Seawater Desalination with Solar Energy

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Abstract-*Water is essential to life. Water is one of the most abundant resources on earth, covering three-fourths of the planet's surface. However, about 97% of the earth's water is salt water in the oceans, and a tiny 3% is fresh water. A number of seawater desalination approaches have been designed during the decades to contribute for overcoming fresh water shortage. this paper covers a large variety of systems used to convert seawater into fresh water suitable for human use.*

I. INTRODUCTION

Fresh water is playing a critical role in human life as well as in agriculture and industrial process. About 97% of the earth is covered by sea and ocean's water, which are unsuitable for human desires. While the global population rises, the supplement of fresh water is becoming a major concern. One of the main strategies to solve this problem is water management through investigation of new source of water supply such as water desalination. One of the main strategies to solve this problem is water management through investigation of new source of water supply such as water desalination.

II. DESALINATION PROCESS

Desalination can be achieved by using a number of techniques. Industrial desalination technologies use either phase change or involve semi-permeable membranes to separate the solvent or some solutes. Thus, desalination techniques may be classified into the following categories:
(i) phase-change or thermal processes; and
(ii) membrane or single-phase processes.

In Table 1, the most important technologies in use are listed.

Phase- exchange process	Membrane process
1.Multi-stage Flash(MSF)	1.Reverse Osmosis
2.Multiple effect Boiling (MEB)	-RO without energy recovery
3.Vapour Compression(VC)	-RO with energy Recovery(ER-RO)
4.Freezing	2.Electrodialysis(ED)
5.Humidification/ dehumidification	
6.Solar stills	
-conventional stills	
-special stillls	
-cascaded type solar stills	
-multiple wick type stills	

In the phase-change or thermal processes, the distillation of seawater is achieved by utilising a thermal energy source. The thermal energy may be obtained from a conventional fossil-fuel source, nuclear energy or from a non-conventional solar energy source or geothermal energy. In the membrane processes, electricity is used either for driving high-pressure pumps or for ionisation of salts contained in the seawater[1].

Commercial desalination processes based on thermal energy are multi-stage flash (MSF) distillation, multiple effect boiling (MEB) and vapors compression (VC), which could be thermal (TVC) or mechanical (MVC). MSF and MEB processes consist of a set of stages at successively decreasing temperature and pressure. MSF process is based on the generation of vapors from seawater or brine due to a sudden pressure reduction when seawater enters an evacuated chamber. The process is repeated stage by stage at successively decreasing pressure. This process requires an external steam supply, normally at a temperature around 100 8C. The maximum temperature is limited by the salt concentration to avoid scaling and this maximum limits the performance of the process. On MEB, vapours are generated due to the absorption of thermal energy by the seawater. The steam generated in one stage or effect is able to heat the salt solution in the next stage because the next stage is at a lower temperature and pressure. The performance of the MEB and MSF processes is proportional to the number of stages or effects. MEB plants normally use an external steam supply at a temperature of about 70 8C. On TVC and MVC, after initial vapors is generated from the saline solution, this vapors is thermally or mechanically compressed to generate additional production.

Not only distillation processes involve phase change, but also freezing and humidification/dehumidification processes. The conversion of saline water to fresh water by freezing has always existed in nature and has been known to

man for thousands of years. In desalination of water by freezing fresh water is removed and leave behind concentrated brine. It is a separation process related to the solid–liquid phase change phenomenon. When the temperature of saline water is reduced to its freezing point, which is a function of salinity, ice crystals of pure water are formed within the salt solution. These ice crystals can be mechanically separated from the concentrated solution, washed and re-melted to obtain pure water. Therefore, the basic energy input for this method is for the refrigeration system [2]. Humidification/dehumidification method alsouses a refrigeration system but the principle of operation is different. The humidification/dehumidification process is based on the fact that air can be mixed with large quantities of water vapour. Additionally, the vapour carrying capability of air increases with temperature [3]. In this process, seawater is added into an air stream to increase its humidity. Then this humid air is directed to a cool coil on the surface of which water vapour contained in the air is condensed and collected as fresh water. These processes, however, exhibit some technical problems which limit their industrial development.

The other category of industrial desalination processes does not involve phase change but membranes. These are the reverse osmosis (RO) and electrodialysis (ED). The first one requires electricity or shaft power to drive the pump that increases the pressure of the saline solution to that required. The required pressure depends on the salt concentration of the resource of saline solution and it is normally around 70 bar for seawater desalination. ED also requires electricity for the ionisation of water which is cleaned by using suitable membranes located at the two appositively charged electrodes. Both of them, RO and ED, are used for brackish water desalination, but only RO competes with distillation processes in seawater desalination. The dominant processes are MSF and RO, which account for 44 and 42% of worldwide capacity, respectively [4]. The MSF process represents more than 93% of the Thermal process production, while RO process represents more than 88% of membrane processes production [5].

III. CONCLUSION

In this paper, a review of various desalination processes are presented. As most of the worlds water resources are covered by sea and oceans, desalination is the best method for producing drinking water.

However, most of the desalination technologies are expensive and depend on fossil fuels. The future demand for water may in turn deplete the fossil fuel reserves thereby increasing greenhouse gas emissions.

Hence, the utilization of renewable energies such as solar energy for powering desalination plants could be sustainable solution.

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