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Review Paper on Solar Seawater Desalination by Using Reverse Osmosis

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Abstract- Desalination plants are providing very effective solution to meet the required demand of drinking water from saline water. It focuses on design and modelling of portable solar based Reverse Osmosis (RO) desalination plant. The proposed plant is run by a stand-alone Solar system with battery storage. The total energy requirement of the plant is estimated to predict the capacity of solar panel, sizing the charge controller, power supply, and storage system. Purification of saline water using solar powered desalination methods is an efficient solution to the water scarcity at ships, which represents a promising sustainable solution of desalination plants.

Keywords- Solar, Desalination, Reverse Osmosis.

I. INTRODUCTION

It's true that freshwater scarcity is associated with large quantity of solar resource. It seems also logical and attractive to associate those two parameters for countries where grid electricity is not spread widely and with easy access to seawater or brackish water. Solar desalination is not a new idea: it has been known for ages, antique sailors used to desalt water with simple and small sized solar stills. It's also a fact that production of fresh water requires a large amount of energy: 1000 m3 of freshwater per day requires 10 000 tons of oil per year [1].

Though solar energy is often labelled as 'free energy', it's not so simple to evaluate feasibility and cost for solar desalination. Some technologies will not be taken in account in this paper: solar ponds, which are a direct desalination method, as well as desalination with electrodialysis (whose application is restricted to low salinity water).

II. LITERATURE REVIEW

In October 1977, Saudi Arabia and the United States signed a Project Agreement for Cooperation in the Field of Solar Energy (SOLERAS) under the auspices of the United States Saudi Arabian Joint Commission on Economic Cooperation.

The objectives of the agreement are to:

- Cooperate in the field of solar energy technology for the mutual benefit of the two countries, including the development and stimulation of solar industries within the two countries;
- Advance the development of solar energy technology in the two countries; and
- Facilitate the transfer between the two countries of technology developed under this agreement. The solar energy research institute (seri), as the operating agent, is responsible for implementing

SOLERAS in accordance with directives of the SOLERAS Executive Board, which has approved a five-year technical program plan. As part of this technical program plan, an area of Industrial Solar Applications for solar techno logy has been identified.

The objectives of the Industrial Solar Applications program are to introduce solar energy technologies into industrial applications and foster the establishment of domestic industries using renewable energy sources, thereby lessening industrial dependence on fossil fuels and minimizing deleterious effects on the environment.

A specific objective is to demonstrate the use of solar energy in desalinating water. Water desalination is needed in both Saudi Arabia and the United States. In Saudi Arabia, water is needed principally for municipal and agricultural applications. In the United States, desalination is mainly required to control river salinity and provide potable water to selected communities that have critical water quality problems or water shortages.

Conventionally powered desalting plants have been in operation for several years At the begining of 1977, about 1 500 land-based, fossil- fueled or electric-powered desalting plants with a minimum capacity of 100 m3/day were in operation or under construction throughout the world. These plants are capable of producing nearly 4 million cubic metres of fresh water daily for municipal or industrial uses. Distillation processes account for 77% of the total plant capacity; the balance is almost entirely membrane processes.

III. REVERSE OSMOSIS

RO is the most common desalination process due to its efficiency compared to thermal desalination systems, despite the need for water pre-treatment. Economic and reliability considerations are the main challenges to improving PV powered RO desalination systems. However, plummeting PV panel costs make solar-powered desalination more feasible.

Solar-powered RO desalination is common in demonstration plants due to the modularity and scalability of both PV and RO systems. An economic analysis that explored an optimisation strategy of PV- powered RO reported favorable results.

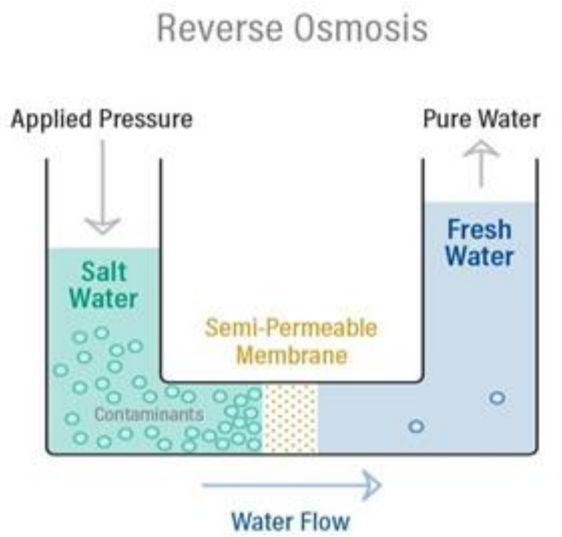

Fig 1. Reverse Osmosis.

1. Working Principle:

The strengthening of requirements for the protection of surface-water sources and increases in the cost of reagents lead to the necessity of using membrane (especially, reverse osmosis) technologies of water desalination as an alternative to ion-exchange technologies.

The peculiarities of using reverse osmosis technologies in the desalination of waters with an increased salinity have been discussed. An analogy has been made between the dependence of the adsorptive capacity of ion-exchange resins on the reagent consumption during ion exchange and the dependence of the specific ion flux on the voltage in the electrodialysis and productivity of membrane elements on the excess of the pressure of source water over the osmotic pressure in reverse osmosis.

It has been proposed to regulate the number of water desalination steps in reverse osmosis plants, which makes it possible to flexibly change the productivity of equipment and the level of desalinization, depending on the requirements for the technological process.

2. Solar:

Solar energy technology can be divided into two general categories: solar thermal and solar electric. Solar thermal refers to the collection of solar energy as heat. Low and medium temperature systems are flat plate collectors with a large number of tubes encase d in a transparent plastic enclosure. The transparent plastic creates a greenhouse effect and the trapped heat is then transferred to the working fluid which has a high heat capacity.

High temperature systems use reflectors to concentrate solar energy in order to generate water vapours to power a steam turbine. While these systems are highly efficient, the application of concentrated solar power for electricity generation is somewhat restricted to large scale installations. These systems can be used as a direct source of thermal energy for distillation processes. Thermal energy can be stored in large masses of concrete, ceramics, or other such media (Eltawil et al., 2009).

3. Simple Water Filter:

Very little of the water we use every day comes out of the ground completely pure. Some of the impurities are microscopic, but many are large enough to remove with a crude filtration system that you can make yourself using sand and rocks.

It's important to remember that this filter does not render the water potable. Enjoy the experiment, noting how much clearer the water appears after passing through it, but don't drink any of the filtered water, because it may still contain pathogens.

4. RO Membrane:

RO membranes are typically capable of removing 90%–99% of contaminants such as total dissolved solids (TDSs) in the water supply. The membranes are usually manufactured as a flat sheet of thin composite membranes consisting of an active polyamide layer (high permeability but impermeable to dissolved salts and particulate matter) supported by a porous polysulphone layer wound round a central collection tube.

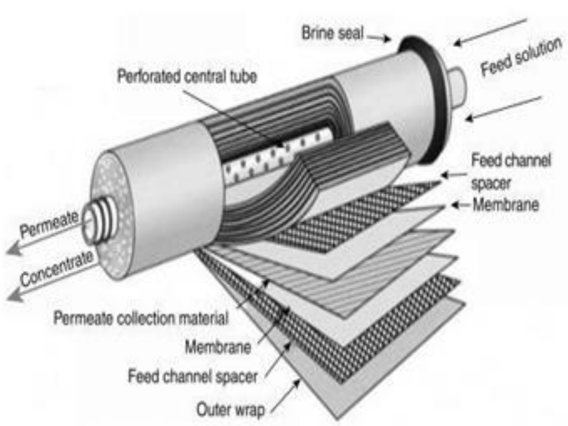

Fig 2. RO Membrane.

The RO membranes used are semi-permeable polymeric thin layers adhering to a thick support layer. Membranes are usually made of cellulose acetates, polyamides, polyimides, and poly-sulfones.

IV. MINERAL CARTRIDGE

After the water has passed through the RO membrane, it is then made to pass through a mineral cartridge.

During the process, it extracts minerals from the mineral balls present in the cartridge. Some cartridges come with PH booster balls and in that case, the PH of water improves and the water becomes alkaline.

Fig 3. Mineral Catridge.

1. Working Methodology:
The machine makes use of a 3 stage process to convert salty seawater to pure drinkable water. The system first allows user to pour salty water via a mesh based inlet where large waste like plastic granules or stones, weed etc. gets separated. This water is then pumped into a large purification chamber having 3 layers of purifiers including sand and gravel for filtering weed, sand and large salt particles.

The output of this process is still salty water but without any particles. This water is then passed on to the second filtration where we use reverse osmosis to filter out salt from the water. Here we use 3 filtration membranes to filter out fresh water from salty water and trap the salt particles in membrane filters.

This water is now stored in a tank just above the system. The system tap when opened allows water to run from the tank to the tap where we detect the flow when on and turn on the UV light for stage 3 filtration to deactivate any remaining bacteria and virus in the water. This water is now in drinkable form using 3 stage processes without the use of any chlorine.

Now the pumps used in the system are powered by a large battery. This battery is in turn charged by 2 x 50Watt solar panels due to large availability of solar power in sea areas. This makes it very portable to be used on any beach front or on long sea voyages for easy and instant sea water filtration.

V. SCOPE

Desalinated water is produced by either using brackish water (water with salt content of less than 10,000 mg/L), or seawater which salinity in a range of 30,000 to 44,000 mg/L. While desalination of brackish water offers opportunities to produce lower cost water, it's unlikely to be a main source of alternative water supply in the future. The total volume of brackish water worldwide is limited (less than 1% of the world's water) and, in most arid regions of the world, it is almost fully utilized.

The world's oceans contain over 97.2 % of the planet's water resources. The high salinity of ocean water, and the significant costs associated with seawater desalination, means most of the world's water supply has traditionally come from fresh water sources: groundwater aquifers, rivers and lakes. However, changing climate patterns combined with population growth pressures and limited availability of new and inexpensive fresh water supplies, are shifting the water industry's attention – the world is looking to the ocean for fresh water.

VI. OBJECTIVE

While making the project following points should be covered as much as possible:

- Low energy consumption.
- Easy and ready to use: immediate stop and start.
- Needs important pre-treatment: pre-filtration and chemical (anti-scalant) to avoid fouling on the membrane.
- Outlet salt concentration around 500 ppm.
- It should be made at possible low cost.
- Its maintenance should be simple and no skilled labours should require.

VII. CONCLUSION

In this paper we compared the cost-effectiveness, energy-efficiency, and other relevant quantities of these potential solardesalination systems, and concluded that the direct solar-desalination systems using solar-thermal collectors appear to be most attractive for highly energy-efficient solar-desalination systems, although there are significant technical challenges remaining.

Further, we overviewed the economics and practical issues associated with employing cost-effective solardesalination systems to provide for economic water sources for urban and also agricultural areas.

We considered factors that have significant impact to these solar-desalination systems: including location, climate, and access to ocean water or brackish water sources, as well as land-use and ecological issues. We observe that the most favorable locations are those with high solar irradiance, lack of fresh water but access to large brackish water sources and/or seawater.

The most favorable locations appear to include considerable sections of North and East Africa, the Middle East, Southern Europe, Western South America, Australia, Northern Mexico, and South-West USA; each has particular issues and challenges unique to their location.

Nevertheless, we conclude that the development of cost-effective and energy-efficient solar-desalination systems may well be key to a future “terraforming” of otherwise desert and near-desert regions of the world, providing a “Greening” of these regions.

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