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Survey of Solar Desalination System

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Abstract

This paper review the importance of of solar desalination system. It talks about the current and future global energy scenario and explores the possibility of renewable energy in area of solar desalination. it discusses increases in energy demand and supply. it discusses an alternative of fossil fuel. it talks about different available technology of solar desalination systems such as solar collector, solar gradient pound, solar still and flat plate solar collector. It also discussed different solar desalination units installations in India .

Keyword : Solar desalination system, Renewable energy, solar collector, solar gradient pound, solar still and flat plate solar collector

Introduction

The World Health Organization approximates that more than a billion people lack access to healthy drinking water. Most of these people live in socially and economically backward areas where the small population density and isolated locations make it very difficult to set up conventional clean water solutions. (S. Kalogirou 2005) had approximated that 1000 m3 per day of freshwater conversion needs 10,000 tons of oil yearly. This is a substantial amount, as it involves a continuing energy expense, which few of the water-scarce areas of the world can afford. Large commercial desalination plants using fossil fuels are used in many oil-rich countries to supplement conventional water supply sources. Most of the nation has enough petroleum and other energy resources needed in such desalination plants.

Traditional Energy sources and fuels, such as fossil fuels total, fill most of our energy requirements. The way global consumption is going on and known fossil fuel resources exist, Fossil fuel will last hardly 46 years (BP Statistical Review of World Energy 2010 2010). However, the world will not be out of fossil fuels shortly. However, its extraction shall not be economically viable.

Apart above, the use of fossil fuel-based Desalination also affects Climate change and is now recognised as one of the main threats to humanity. (Stern 2006). Climate changes link to rising temperatures, increasing sea levels, more significant inconsistency in weather patterns, changed rainfall patterns, and

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the likelihood of significantly disrupting commercial activity. In particular, climate change can affect business activity through industry-specific risk (Sadorsky 2011). To check the Effect of climate change, a global Consensus emerges to shift toward clean, renewable energy and Bioenergy provides an alternative to Clean, renewable energy.

The Global requirement for energy is increasing day by day. There is a continuous increase in energy demand; in 2016-17 annual increase in energy requirement was 1.5 % in 2016 and 2% in 2017. The increase in total main energy supply has been met by oil 40%, coal 20%, and natural gas 20% while renewables lag (0.7%) and the rest by other resources such as wood etc. Hence, Combined, fossil fuels accounted for 80% of global energy consumption. This trend appears to continue in 2018 and 2019 also.

Past data suggests that global oil discovery peaked in 1960, and the study suggests that global oil production will peak in 2010 – 2020 (Aleklett, et al. 2010) (Campbell 2002).

Peak oil theories propose that it is domineering to discover an alternative to oil before the peak in oil production (Stern 2006). Concern about global warming and its linkage to energy dependency on fossil fuels has raised this issue in many global forums, created a consensus in favour of renewable energy, and many policies have been framed and globally accepted. Industry-specific risks like regulatory and physical risks have a linkage due to Climate change (Weyant 2011) and this can affect business activity which leads to risks for companies and their reputation, litigation and competitive risks (REN21 2010). This all creates an environment that paves the adaptation of renewable resources.

These problems could be resolved by considering the possible utilisation of renewable resources such as biomass, wind, geothermal energy or solar energy. It is very significant to understand that the geographical areas where water desalination is needed have abundant renewable energy sources (R.E.S.). Thus, combining those renewable energy sources with a desalination plant to provide drinking water with lots of resources is required, which is also tricky in an underdeveloped and developing country where large areas are remote and not connected to the electric grid but have well-versed in renewable energies. And these R.E.S. could be significantly used even in remote geographical locations, sufficient enough to power low to medium size desalination plants. These days, the importance is well understood of the use of renewable energy as a source for desalination, particularly in isolated areas and islands, because of the high costs of fossil fuels, difficulties in acquiring it, challenge to preserve fossil fuels, awareness in reducing air pollution, and scarcity in of electrical energy in remote areas. With the abovementioned considerable characteristics, the acceptance of renewable energy contribution to cover energy demand worldwide, though increasing, is still marginal. Apart from hydroelectric energy, which has a significant contribution but is not available in arid areas, the other principal

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resources (solar, wind, geothermal) contribute slightly more than 01% of the total world energy (Cesare 2001).

Solar Desalination System

Strictly speaking, all forms of energy on the earth are derived from the sun. However, the more conventional forms of energy, fossil fuels, are being used rapidly and will be depleted in the distant future. All countries in the world receive some solar energy ranging from a few hundred hours per year, as in the countries of the north and the lower part of South America, to four thousand hours per year, as in the case in most of the Arabian peninsula and the Sahara Desert. Thus, solar energy, the ultimate source of most forms of energy, is clean, safe and exists in viable quantities in many countries.

Due to the disseminated nature of solar energy, the major inconvenience with using solar thermal energy in industrial-scale desalination plants are the comparatively slow and small productivity rate, the considerably low thermal efficiency and the significantly land area required. Hence is still to be considered that solar desalination plants are regarded as no price energy and insignificant operation cost, and needed low technical skill is, therefore, suitable for small-scale production, especially in far-flung arid areas and islands, where the availability of traditional energy is insufficient (Gomez-Camacho 2000) (M. Naim 2003) Apart from the cost issues, there are environmental distresses concerning the carbon emission due to using of fossil fuels. Several scientists and planners consider pairing renewable energy resources with desalination practice as having the potential to offer a sustainable route for increasing potable water supplies. Solar energy can directly or indirectly be considered for converting non-drinkable water to pure drinking water.

Water desalination gathering systems that use solar energy to distillate directly in the solar collector are called direct collection systems. Conversely, those systems that combine solar energy collection systems with usual desalination systems are described as indirect systems. In indirect systems, solar energy is used for heating required for desalination or to produce electricity used to supply the necessary electric power for usual desalination plants such as multi-stage flash (M.S.F.), multi-effect (M.E.) or reverse osmosis (R.O.) systems (Gomez-Camacho 2000)

Solar Collector

Many types of solar energy collectors are available and could be used for converting solar energy to thermal energy. The commonly used process is that liquid is heated through solar radiation as it flows along the solar collector using the black-coated copper tube. Water or synthetic oil is often used as a

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heat transfer fluid. The fluid heated at the solar collector field usually accumulate in an insulated container or is used to heat an additional thermal storage medium. The solar collector may be stationary or more efficient if a sun-tracking device is used.

The research and development on solar energy utilisation are receiving wide attention worldwide. Solar energy can be used directly as electricity through photovoltaic systems and thermal energy through appliances referred to as solar thermal energy devices/systems. Among several solar thermal appliances/devices/systems, solar stills, flat-plate solar collectors, and solar greenhouses are enjoying considerable research interest today.

On the other, it could have single or multiple axes of sun tracking for optimum solar concentration, and solar collectors are now readily available industrially; It's also worth seeing that many collector enhancements and sophisticated solar technologies are evolved very economically. The primary solar collectors to be used for seawater distillation are described below.

Salinity-gradient solar ponds

A solar pond (S.P.) is a heat-absorbing setup that uses direct and diffuse sunlight. It has multiple layers of brine water with different salt concentrations. Salt-gradient solar ponds have a more concentration of salt near the Bottom of the pond, a non-convicting salt gradient internal layer (such a way that salt concentration is higher with depth), and a surface convicting layer with significantly lesser salt concentration. Sunlight penetrates the pond's surface, and its heat gets absorbed in the internal layer due to its high salt concentration. The solar energy captivated in the pond base temperature increases the highly saline water. That significantly more saline water cannot rise owing to its remarkable density and thus reside Bottom of the pond. There Bottom high-temperature increases until it almost boils; on the other hand, the top layers of water remain relatively more relaxed. The storage zone is the bed layer of water of the solar pond, which is very dense, and its temperature rises to 100°C. This heated brine can then be used as a day or night heat source from which electricity could be generated using a particular organic-fluid turbine. The mid-gradient layer in the solar pond acts as an insulator, preventing convection and heat loss to the surface.

Temperature dissimilarity between the Bottom and top surface layers is significant enough to drive a generator. A moving-out fluid piped through the bottom layer holds heat away for further direct application. The thermal energy may also be a component of a closed-loop Rankine cycle system that rotates a turbine to produce electricity. The annual gathering efficiency for useable thermal energy for desalination is 12–16%. More extensive ponds are relatively more efficient compared to smaller ones. This happens because of loss due to a smaller pond's larger volume surface ratio. However, solar ponds produce comparatively low-grade, less than 1000C, heat energy and are hence, well suited for providing

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direct heat for thermal distillation processes. Therefore, Solar ponds also produce electricity because they hold thermal energy.

In many cases, Solar ponds are well suited to be attached to desalination plants and are used for brine production. This brine is the salt source for the solar pond density gradient. This provides a preferable alternative to environmental disposal and a convenient and inexpensive source of solar pond salinity.

This type of low-death pond with a non-horizontal saltwater gradient. Therefore, saltier water straightens out at the deeper level of the pond as its specific gravity is higher and does not mix with the up-higher layer of low-saline water. Thus it had different layers or strata of water in the pond. In such a setup, the lesser salty strata become warmer (70 –850 C). Therefore, such a heat solar collector setup and a storage system also work as heat collectors. Such a solar pond collects solar energy, and by supplementing a conventional heating source, this setup can be easily used to generate electricity. And also provide enough power for desalination and, on the other hand, supplies energy space heating home structure.

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Solar Stills

A solar still is a thermal device distilling water using solar energy. There are many popular designs developed for Solar stills; among the most popular design is basin-type solar stills. This is because of their simplicity and easy fabrication from the manufacturing point of view, and they are also very cost-effective.

The most popular Basin-type solar stills are single-basin solar still and double-basin solar still. The concept of a double-basin solar still was proposed by (Lobo and Arango 1977). The main advantage of a double-basin solar still over single-basin Solar is that the latent heat of vaporisation released on condensation over the lower glass cover's lower surface is utilised to heat the upper water mass rather

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than being wasted on the ambient. These solar stills are called single-basin passive Solar still and double-basin passive Solar still. These stills are considered active solar stills integrated with flat-plate solar collectors or heat exchangers. The flat-plate solar collector is introduced in the following section.

Flat-plate solar collector

Usually, a flat-plate collector has a heat exchanger. This heat exchanger converts solar radiant energy into heat energy, and It contains a blackened absorbing plate, at least one or more transparent covers on the roof, and suitable insulation underneath the area. The fluid that circulates inside it absorbs the energy from the plate, which receives solar radiation energy. The fluid and plate are in good thermal contact. The thermally insulated wall diminishes the convective heat loss through the wall and base of the collector.

On the other hand, the transparent cover reduces the heat losses due to long-wave radiation emitted by the plate and by convection. The such designee is the simplest in flat-plate solar collector among all other type of solar collectors. They are very popular and widely used applications in industrial and domestic water heating.

thermal performance of solar thermal energy devices depends significantly on the availability of solar energy on the absorber surface. The solar radiation available at the absorber surface is a significant independent variable of the function of numerus parameters namely weather based parameter , Geographical parameter , time based parameter such as time of the day and year, surface location and geometric parameter of construction like tilt, ground reflections, and so on;

Major Solar Desalination Plant in India

Sr.No	Year of installation	Location	Capacity (L/day)	Evaporating area (m2)	Quality of saline water
1	1965	CSMCR1 Salt works. Bhavnagar	1000	350	Seawater
2	1968	Navinar Lighthouse near by Mundra, Gulf of Kutch	130	49.9	Seawater
3	1978	Awania village, nearby Bahvnagar	5000	1866.6	Saline well water TDS 3000-4500 ppm. fluoride 10 ppm
4	1978	Chhachl Lighthouse at Mandvi, Gulf of Kutch	250	108.0	Seawater

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5	1983	Narayana Sarovar, Kutch District. Gujarat	3000	1244.4	Saline well water. TDS 15.000 ppm
6	1979	Bhalen, Churu District, Rajasthan	8000	3110.0	Saline well water. TDS 3800 ppm. nitrates 340 ppm. fluoride 4-5 ppm
7	1983	Bitra Island. Ut of Lakshdweep	2000	750.0	Seawater

(Yadav YP 1991)

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