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Performances of Solar Desalination Systems

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ABSTRACT –

Solar thermal energy is highly beneficial in current technologies, thus several analyses must be performed. One of the considerations is the use of solar energy in fresh water. Solar energy provides the necessary amount of fresh water in portable places. As a result, solar stills are used to generate fresh water. Using solar intensity, a variety of technologies may be employed to create effective fresh water. The many techniques for creating fresh water may be adopted, and each method can change their producing quantity. In this review, the study of novel materials for effective water production by solar stills has been explored in this literature of solar energy. This involves concentrating on various solar stills, models, designs and solar still performance. The review results indicate their performance and improvement of solar still productivity when compared to other solar stills. The results show that double solar stills are more productive than single sun stills. By preventing heat transmission through various materials, solar still production may be increased. This assessment also includes a cost analysis and environmental parameters for solar desalination. A summary of the key groups, journals, and nations involved in the advancement of solar desalination models is provided. Finally, proposals for advanced improvements in solar desalination are made, allowing researchers to investigate effective water production techniques.

Keywords: Passive solar, Membrane distillation, Hydrogels, Photovoltaic cells, Packing Factor

Introduction

There is a lot of water in our system, but we can't use it as fresh water has a lower salinity than salt water. Since there is a limited amount of fresh water to feed the expanding population, there is a rapid increase in population. Therefore, the only way we can supply fresh water to expanding human populations is by distillation. Sunlight is one of the energy sources among all energy sources. Acid rain and global warming are two examples of the environmental damage caused by the use of fossil fuels. Solar desalination is the most effective method of producing more freshwater, which is needed for freshwater supply. solar energy is harvested as thermal or electrical energy which in turn is used to drive desalination. Instead of enhancing the productivity of solar stills as can be found in the current technologies the researchers review in new materials and methods for desalinations, Examples of indirect solar desalination include membrane distillation (MD), reverse osmosis (RO), humidification-dehumidification (HDH), multi-effect distillation (MED) and multi-stage flash (MSF).

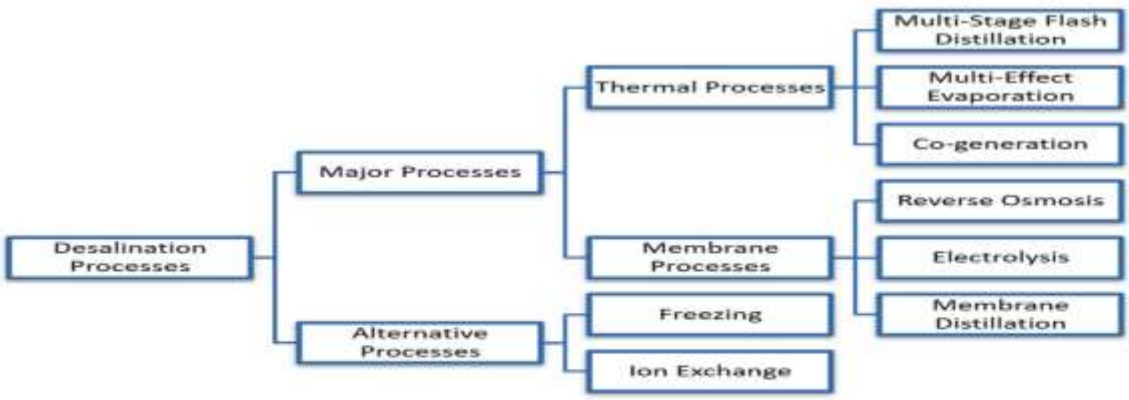

Figure 1 Classification of solar desalination

Thermal desalination

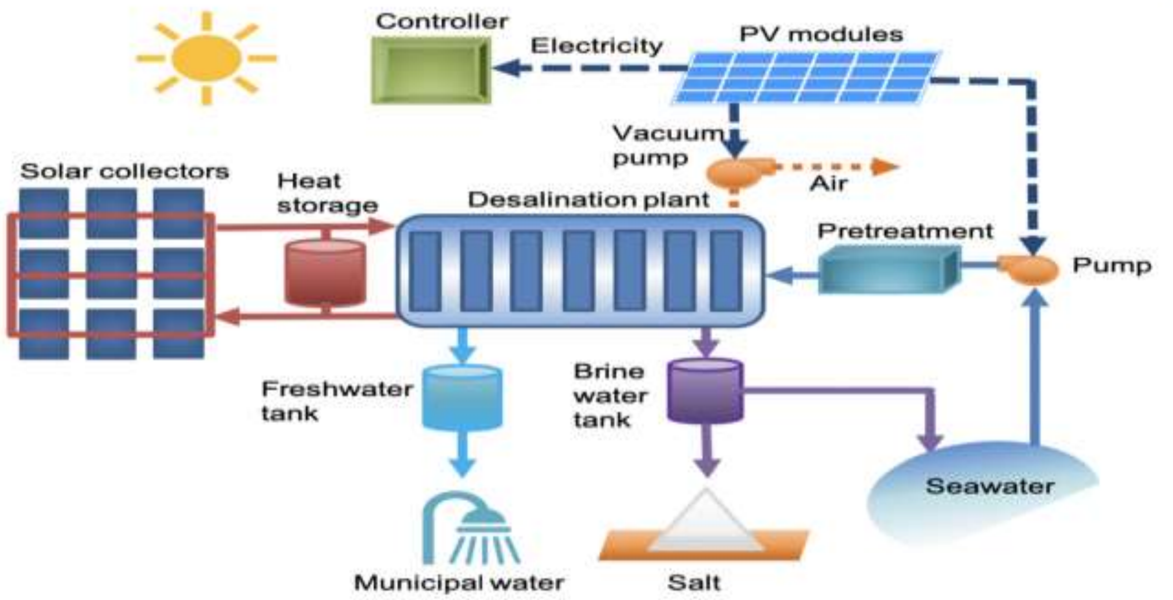

Figure 2 Overview of solar thermal desalination plant which shows economic considerations

In this thermal solar desalination, the productivity of the plant normally increases, but the plant cost is dependent on some more factors, such as system scale, and the service life time is nearly 30% more expensive. The cost is mitigated by the maintenance costs, and it extends to the life period of the plant. When performance is higher and the plant period is shorter, the unit price is dependent on the plant period due to the efficient devices used. The investment cost is less, but the maintenance cost is high. It is suitable for the solar intensity, and the water scarcity is higher. [1]

Solar still with Phase change material (PCM)

After investigating the parameters influencing unit productivity, it was discovered that the temperature of phase change material (PCM) is lower than the base temperature, but it is more efficient in the night hours to supply more energy; there is no change in thermal behaviour; the rate of cooling water is increasing through the double glass cover; and productivity is increasing. The energy storage capacity of PCM material is higher [2]. The rate of heat transfer coefficient increases at night without PCM. The increase in h1 with an increase in the mass of PCM is mainly due to the increased rate of heat transfer from the basin liner to basin water. Day and night production with increasing the mass of PCM is due to the increased amount of heat stored within the PCM [12].

Multiple wick solar still

A specific amount of water is required for multi-effect solar to function properly. If the water is not correctly provided, drought may occur during the evaporation process, reducing the system's effectiveness. Overfeeding is also caused by inefficiency. Depending on the kind of system, an ideal feed rate must be used. Because direct solar rays are falling on that surface in this situation, energy conversion is decreased. Because the wick absorbs the most water, the water is fed as slowly as possible. When heat energy increases, so does total surface energy. It's not a big budget. Because each water-stressed country has its own unique natural conditions as well as social and economic necessities [3]. The variation of hourly and accumulated productivity is dependent on the inlet of the flow water which is nothing but impure water, water temperature increases when hourly and accumulated productivity is decreases.

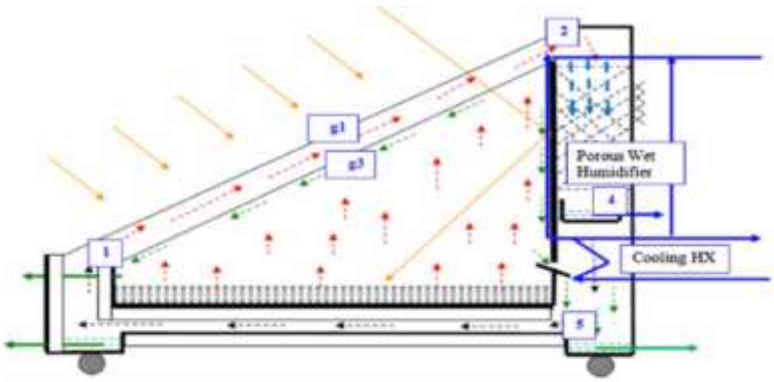

Figure 3 Multi effect solar desalination system [3]

Concave wick evaporation

In the concave wick evaporation surface the wick temperature is more compared to basin and surface temperature between 11AM-12PM because of the intensity of solar radiation is more when the wick temperature is low when the solar intensity is decreases. The condensation is rapid because, Four side walls of glass temperature is increases when the intensity of radiation is increases. The cold surfaces of glass covers are those which are not subjected to direct solar radiation. Wind direction also has a marked effect. Vapor condenses at the inner surfaces of the glass covers. The present accumulated productivity is higher than the conventional type and roof type solar still with corrugated wick of clothes with about 20–40%. It also is higher than the tilted-wick type solar still with water flowing over the glass cover.[4]

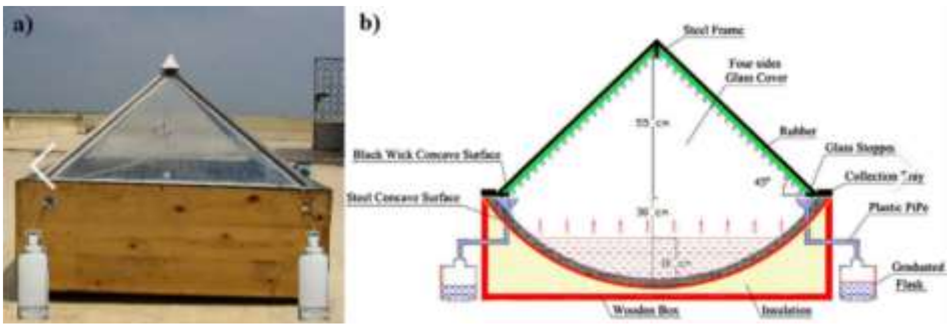

Figure 4 Concave wick type evaporation [4]

Membrane Distillation

Light concentration in the hydrogel based on carbon-based materials, conjugated polymers, and bio-inspired nano-/micro- structures in this to achieve more sun radiation. In the hydrogel CTH diameter is tens of microns small pores distributing on the wall of the structure capillary channels are to be found with a dimeter of several microns. The rough surface of wall with rGO in the network of PVA hydrogel as compared to smooth surface of pure PVA hydrogel the swelling ratio is more. when the swelling ration ratio is more the rate of water is absorbed is more due to the solar intensity in day time it cannot allow in night time the rate of capillarity action of water increases it evaporation takes place quickly .the water distribution is varying through the polymeric network chains its interaction with rGO additives to balance the water transport and solar evaporation , therefore, the efficiency is increases when to develop high-rate solar evaporators under weak sunlight by confining the heat to the molecular meshes is increases [5].

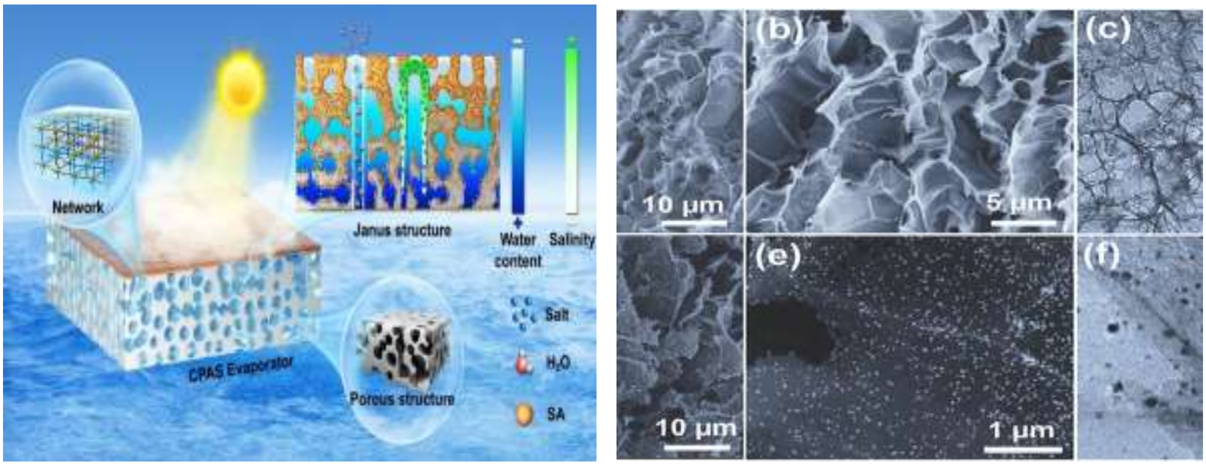

Figure 5 Schematic illustration of solar vapor generation based on hybrid hydrogels with capillarity facilitated water transport (CTH), Chemical and Structural Characterization of the CTH [5]

Humidification - dehumidification desalination

A specific amount of water is required for multi-effect solar to function properly. If the water is not correctly provided, drought may occur during the evaporation process, reducing the system's effectiveness. Overfeeding is also caused by inefficiency. Depending on the kind of system, an ideal feed rate must be used. Because direct solar rays are falling on that surface in this situation, energy conversion is decreased. Because the wick absorbs the most water, the water is fed as slowly as possible. When heat energy increases, so does total surface energy. It's not a big budget. Because each water-stressed country has its own unique natural conditions as well as social and economic necessities. [6]

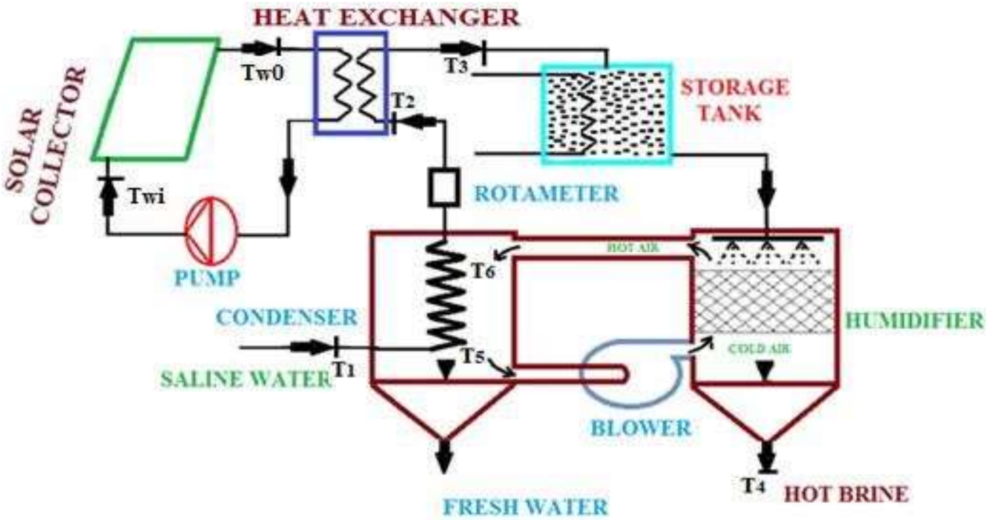

Figure 6 Humidification-dehumidification process [6]

Built in passive condenser

Water vapours from the passive condenser are transported to the condenser chamber and condense there on the side or back wall of the condenser. The cold condenser, which is nearly at room temperature, serves as a mass sink and heat sink. The external condenser's constant suction or extraction of water vapours from the solar still cavity keeps the solar still at low pressure. This allows the semi-transparent photovoltaic module to achieve higher efficiency because incident solar radiation is directly transmitted through the module's non-packing area. The packing factor, which is made up of a higher packing factor value, lowers the ohmic losses between consecutive solar cells, and lowers the temperature of the PV module, all work together to increase the overall electrical efficiency of the solar power module [7].

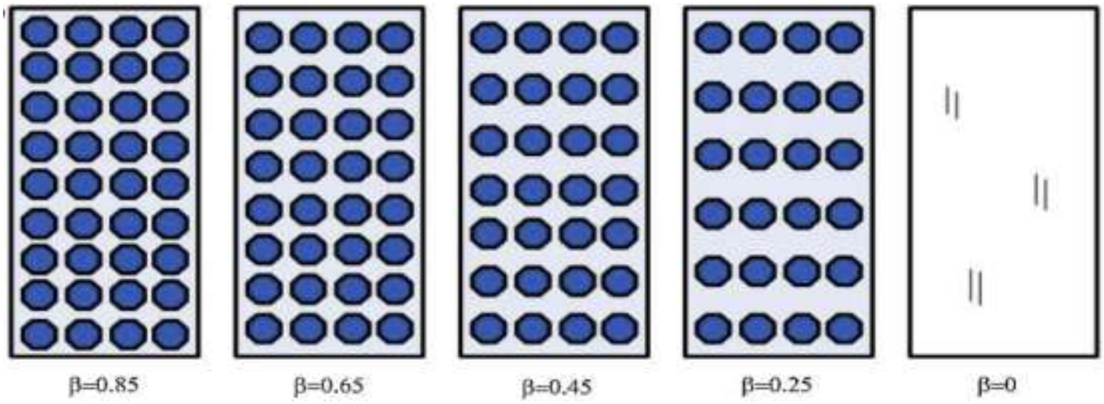

Figure 7 Packing factor of different values [7]

Convective Heat Transfer

It is found that from any given standard values of C and n, the performance of solar stills cannot be evaluated precisely unless these values are validated experimentally convective mass transfer for different Gasthof Number range is changed by different solar stills in solar distillation process. In this the convective heat transfer changes at certain solar stills at certain Gershoff number therefore The modified values of C and n for Nu= C(GrPr)", are proposed as C=0.0322; n=0.4114 for $1.794x10^6$ Gr< Gr < 9.128×10^6 in an active solar still. The production rate is proportional to the area of the solar still, which means the cost per unit of water produced is nearly the same regardless of the size of the installation.[8] [10].

The instantaneous efficiency for the proposed system has been evaluated at N = 6, m_f = 0.03 kg/s and water depth = 0.14 m for a typical day, the development of analytical characteristic equation for N identical fully covered photovoltaic thermal (PVT) compound parabolic concentrator collector (CPC) integrated solar distillation system which is similar to Hottel-Whillier-Bliss equation of flat plate collector (FPC). The average instantaneous efficiency of N-PVT-CPC integrated active solar distillation system is higher than the fully covered N identical PVT-FPC integrated solar distillation system (10.60%) but lower than conventional N identical FPC active solar distillation system (20.74) [9].

Integrated passive solar distillation

Performance of single slope solar still integrated with SPV module and passive condenser has been studied for the hot climatic conditions the effect of packing factor of the overall efficiency of 57.5%, 55.2%, 53.4%, 53.1%, and 41.4% at βc= 0.85, 0.65,0.45,0.25 and 0 respectively for c-Si SPV module, productivity of the system is calculated 1.78 kg, 2.83 kg, 3.66 kg, 4.12 kg and 4.92 kg per day [9]. Fresh water and production electricity are mainly dependent on the rate of intensity of radiation. The velocity of the wind is about to increase when the rate of temperature increases, so improving the wind velocity automatically improves efficiency. The rate of wind speeds is higher, which leads to a solar panel and still [11]

Conclusion

From the analysis conclude that comparing in different types of methods solar energy is more economical use in solar desalination, because of the productivity of the system is dependent on the solar intensity during summer seasons the intensity of radiation is more by coupling solar

photovoltaic-thermal (PVT) with desalination is a practical and sustainable solution for solar desalination. Renewable energy reduces air pollution and environmental consequences solar thermal energy is better usage of both thermal desalination and membrane. By using the solar energy, the carbon emissions are reduced and Combination of solar power and desalination can give fresh water. Technology is developed the water scarcity is decreased by the thermal model solar desalination.

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