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Solar Powered Desalination- Energy, Technology and Future

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Abstract: ***Removal of salt from sea water or brackish water to extract fresh drinkable water need lots of energy. This energy can be in two different forms, that is, thermal or mechanical energy. Although these methods have costly infrastructure, they are being used more and more as they do not liberate detrimental emissions to the surroundings. Solar energy is the renewable energy source which is widely used, the reason being its extensive availability.***
Solar desalination techniques can be categorized as direct and indirect processes which is dependant on the type of resources to fresh liquid. The collection of solar energy from various reserves is gathered for the process of direct solar desalination. Next is indirect solar desalination which consists of 2 sub-systems, i.e., (i). a solar collection scheme and (ii). a desalination technique. First one is used for the collection of heat by the use of solar collectors. This heat is supplied to a thermal desalination process by a heat exchanger. The later sub system involves any sort of desalination technique.
Keywords: Solar desalination, solar distillation, solar power, photovoltaic

I. INTRODUCTION

Freshwater requirement is obstinately rising as population around the world keep growing and as current fresh water stocks keep diminishing due to utilisation and pollution. Desalination is a technique which involves different procedures to remove salt and other minerals deposits from salt-water to extract freshwater. In recent years, this technology has established rapidly and is becoming widespread.
The paper emphasizes on desalination, it's requirement and various technologies of desalination of seawater with reasons of its popularity. Further, it will reveal the environmental and economic benefits and downsides of the same.
Water is the vital part for the growth and survival of mankind. Various researches have however showed that the quality and quantity available to the mankind is not up to the mark or not satisfactory. We are aware that global population is increasing and industrial as well as agricultural activities are expanding. This leads to increasing water demands. The requirement of water cannot be fulfilled by the existing traditional water supply system. This calls for a technique that could lessen the existing water related problems. Hence, increasing the popularity of Solar Powered Desalination Technique.
Sun based radiation is an exceptionally engaging wellspring of vitality since it is accessible at no expense; moreover, abusing it has no prominent unfriendly impact on the earth. A lot of innovative work has been attempted to use this free type of vitality to grow progressively productive feasible procedures, for example, water desalination and power age. Sun-powered vitality is irregular and would presumably require capacity; be that as it may, boosting its utilization close by creating vitality proficient procedures can enormously broaden vitality assets, spare the earth, and diminish the forced social expense.

II. SOLAR DESALINATION

Desalination is the process of removing dissolved minerals from saline or brackish water in order to make drinking water. Solar desalination is a technique to desalinate water using solar energy.
Sun powered desalination is basically a small– scale copy of the characteristic hydrological cycle that produces downpour, which is the essential wellspring of new water around the world. Insightful research and modern experience have appeared warm desalination plans are more appropriate than mechanical desalination plans for large– scale applications. Different desalination frameworks driven by sustainable power source have been created in the course of the most recent couple of years; in any case, most have not yet been financially actualized because of the high capital cost related with using sustainable power source.

Solar powered desalination can be broadly classified into two types:

A. Direct solar desalination
B. Indirect solar desalination

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III. DIRECT SOLAR DESALINATION

Direct Solar Desalination use solar energy to produce distillate directly in the solar collector. It requires large land areas and has a relatively low productivity. There are two methods for conventional desalination as follows:

A. Solar Pond

Sunlight based lakes are pools of water with an obscured base to expand light ingestion. They are intended to have to expand saltiness with profundity making a thickness angle that represses regular convection flows. Water retains sun-based radiation experiencing it making its temperature rise. The shorter the wavelength of daylight, the more profound it can infiltrate the water section. The measure of retained vitality increments with profundity creating a vertical temperature slant causing a thickness slope diminishing with profundity. On the other hand, saltiness increments with profundity creating a vertical saltiness slant causing a thickness slope expanding with profundity. The ultimate result of these differing occasions is a stratified lake with expanding temperature and saltiness with profundity, as appeared in Figure 1. Sunlight based lakes work as both sun-powered authorities and warm vitality stockpiling media.

For Figure 1,
UCZ= Upper convective zone
NCZ= Non-convective zone
LCZ= Lower convective zone

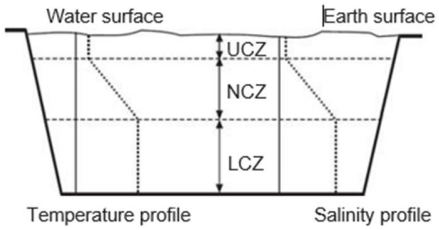

Figure 1. Vertical cross section of a Solar Pond

B. Solar Still

In a sun-powered still, the warmth accumulation and refining forms happen inside a similar structure where sun-oriented vitality is utilized legitimately for refining by methods for the nursery impact. Seawater is set in a darkened bowl inside an impermeable straightforward structure where it vanishes because of ingestion of sun-based radiation at that point gathers on the inclining structure by losing its inactive warmth of build-up to the environment. Consolidated beads rundown the spread to aggregating troughs to be gathered as new water. Their productivity is reliant on meteorological impediments. They are joined with other desalination techniques to expand their productivity.

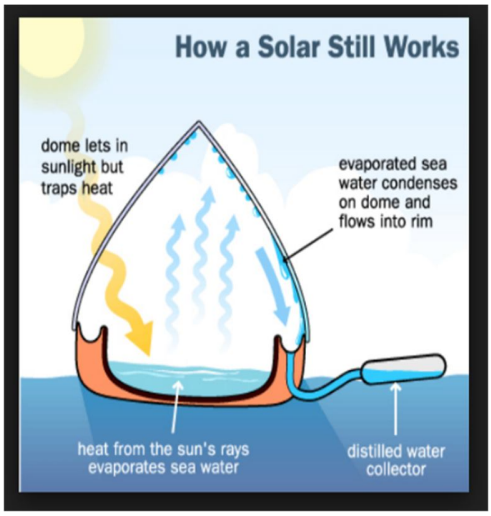

Figure 2. Working of Solar Still

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IV. INDIRECT SOLAR DESALINATION

Indirect Solar Desalination includes combining conventional desalination techniques. It is used for small scale production due to its relatively low cost and simplicity. It has 2 separate systems: (i). A solar collection array and (ii). Conventional desalination plant. Here are various methods for indirect solar desalination.

A. Solar Assisted Multi-Stage Flash

MSF forms utilize both warm and electrical vitality which can be drawn from sun-oriented radiation in different plans, as appeared in Figure 4. It is basic to utilize a viable warm vitality stockpiling framework to compliment sun based helped MSF forms.

It was discovered by Farwati that 1 m² of level plate gatherer working at 80 * could create 8.2 m³ of refined water yearly, while a similar size compound illustrative authority working at 122 * could deliver 13.2 m³ of refined water. Joseph tentatively concentrated a single– organize streak desalination framework working with level plate sun-oriented gatherers acquiring a most extreme distillate yield of 8.5 litres/day with an authority region of 2 m².

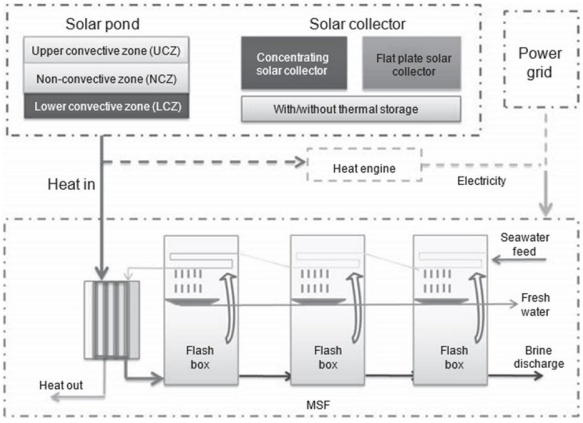

Figure 3. Solar assisted multi–stage flash desalination

B. Solar Assisted Multiple–Effect Distillation

MED processes utilize both warm and electrical vitality which can be drawn from sun-based radiation in different plans, as appeared in Figure 4. A sun-powered lake helped MED like a sunlight-based lake helped MSF however progressively practical because of the lower temperature necessities. it is discovered that ideal thickness of upper convective, non-convective, and lower convective zones should be 0.3 m, 1.1 m, and 4 m, individually, for sunlight-based lake helping a low-temperature MED framework. intermediate steam temperatures provided between 80−90°C are most appropriate to work them.

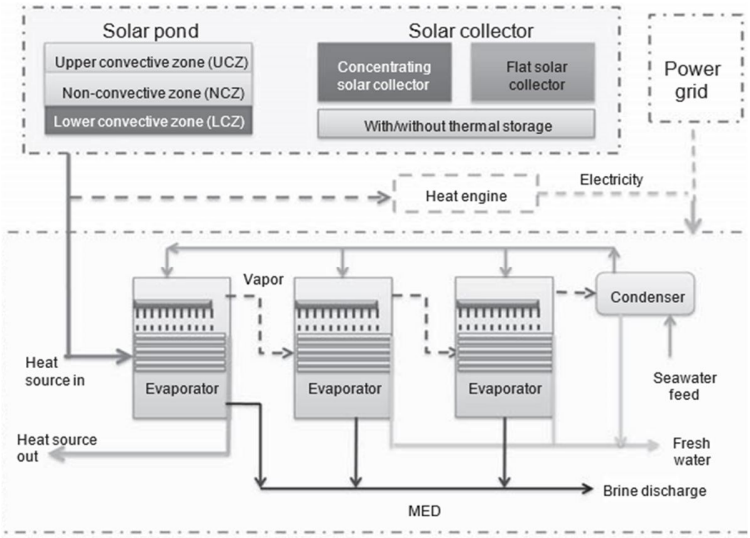

Figure 4. Solar Assisted Multiple–Effect Distillation

C. Solar Assisted Heat Pumps

Heat Pumps forms are commonly utilized for little to medium scale applications and they are typically joined with other warm procedures to support their efficiencies by recuperating poor quality steam and warming it to higher temperatures. In addition, this poor-quality steam recuperation diminishes the general cooling water request bringing about less power use. There are four essential kinds of HP desalination forms: warm vapor blower (TVC), mechanical vapor blower (MVC), assimilation heat siphon (ABHP), and adsorption heat siphon (ADHP).

D. Solar Driven Reverse Osmosis

Assimilation is a characteristic marvel in which water goes through a film from a lower to a higher fixation arrangement. The stream of water can be turned around if a weight bigger than the osmotic weight is connected to the lower focus side. In RO desalination frameworks, seawater weight is raised over the normal osmotic weight of 2.5 MPa however kept underneath the film resistance weight, ordinarily 6 to 8 MPa, constraining unadulterated water through layer pores to the freshwater side.

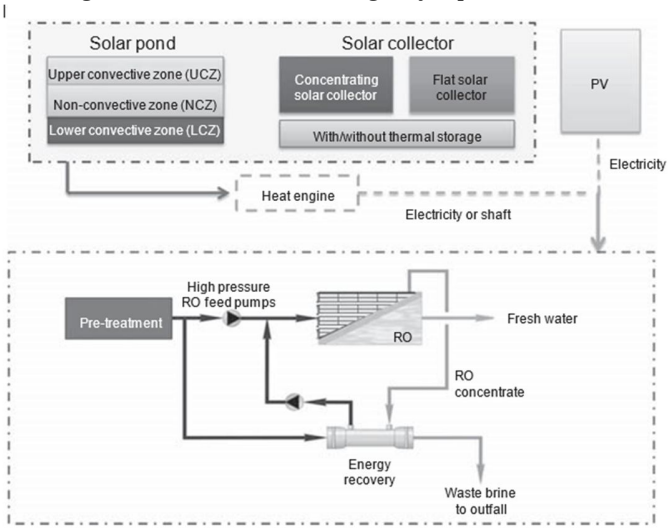

Figure 5. Solar driven reverse osmosis

E. Solar Driven Humidification–Dehumidification

Humidification-dehumidification (HDH) is a warm desalination innovation that mirrors nature's downpour cycle. Its fundamental parts are a humidifier, a dehumidifier, and a radiator. In the humidifier, air is humidified through direct contact with salt water. In the dehumidifier, hot damp air is placed in indirect contact with cold salty water. Hence, water vapor consolidates and which delivers a freshwater stream.

The main energy input to an HDH system is thermal energy to the heater. If the system produces purified water at a rate of m_p (kg/s) and heat input is Q_h (W), we may describe the energy efficiency in a first law sense using the Gained-Output-Ratio, or GOR:

$$GOR = h_{fg} m_p / Q_h$$

where h_{fg} is the latent heat of vaporisation (J/kg).

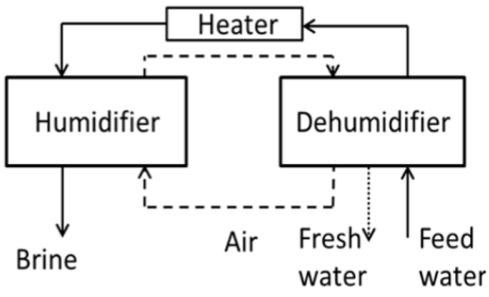

Figure 6. Humidification–Dehumidification Desalination Cycle

V. ENVIRONMENTAL IMPACT

So, we found that a desalination framework has its own favourable circumstances regardless of monetary and ecological viewpoints. However, it is obvious that this innovation still has a few disadvantages listed below.

Firstly, the desalination procedure has a side-effect called brackish water. It is a sort of water that contains twofold salt of seawater and furthermore contains layer cleaning synthetic concoctions and different synthetics utilized for scale and consumption control. Brackish water released from desalination plants has a higher temperature and higher saltiness than the seawater encompassing the plant. Some sea creatures couldn't endure high saltiness conditions, for example, maritime Posidonia, which could just endure a greatest saltiness of 39 g/L NaCl while most release brackish water salinities are higher than 60 g/L NaCl; in this way, high recuperation or almost zero fluid release advances should be additionally created. Secondly, we have a problem of noise pollution. The big machines used produces intolerable noise.

VI. CONCLUSION

Desalination is as of now turning into an imperative water supply choice, particularly in these vitality rich, dry and absence of freshwater asset territories, for example, these Middle East nations. This innovation gives people another alternative to take care of the water deficiency issue. Despite the fact that, this innovation has couple of issues, but since of its own favourable circumstances and the pattern of desalination innovation improvement, we can trust that desalination will have a brilliant future. This innovation will assume a progressively vital job later on.

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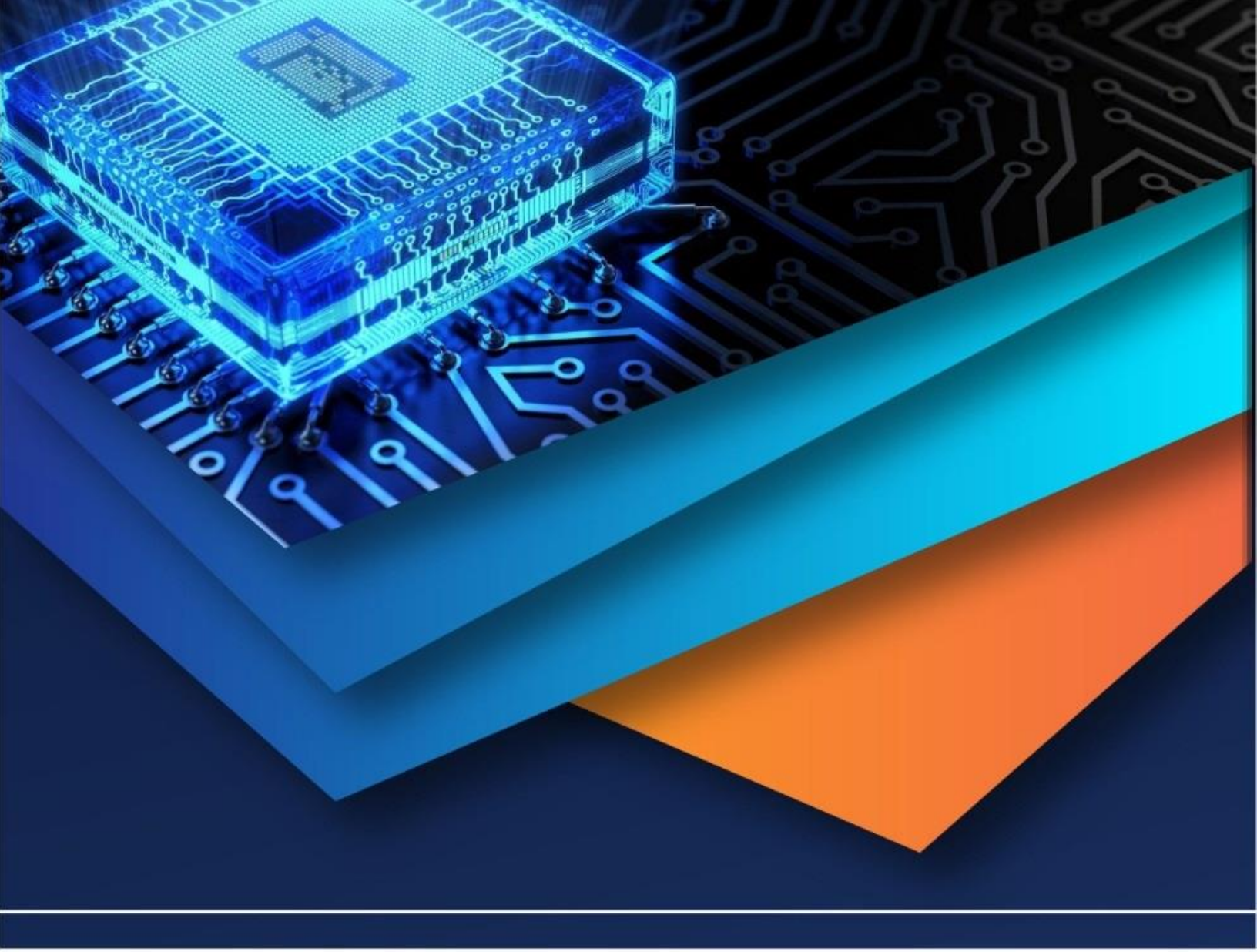

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