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Review on Desalination of Water using Different Solar Still Techniques

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Abstract: ***Solar still (SS) technology is one of the economic technologies for the conversion of saline or impure water to pure form. It is proven technique for the removal of hazardous chemicals such as arsenic, fluoride etc. Solar still can become very useful and eco-friendly process in rural and remote areas suffering from acute water crisis due to contamination of ground water and other manmade problems. In this work, we have studied different methods of desalination of water using solar still. The work discusses modifications in solar still, heat absorbing factors, reflectors, use of solar panel, trays, solar collector, nanofluid, condenser. This paper presents a mini review on single slope solar distiller by incorporating various different methods. Based on study, sensible conclusion is drawn and reported.***

Keywords: Solar still, solar collector, heat transfer

I. INTRODUCTION

Water is at the source of sustainable development and is critical for socio-economic development, healthy ecosystems and for human survival itself. The scarcity of freshwater due to various reasons causes dangerous effect on human being like harmful disease, skin disease etc. The total water available on earth's surface cannot be used for drinking purpose because 97% of that water is brackish, 1.7% of water is available in the form of ice and glaciers and only 1.3% of water is available for drinking purpose. As populations grow and natural environments become reduced, ensuring there are sufficient and safe water supplies for everyone is becoming increasingly challenging. Solar desalination is good technology for fresh water production because it requires solar energy for its operation which is abundantly free in nature and have no environmental pollution as well. The basin type solar still is simplest desalination system that can be used for the purpose of freshwater production. Out of passive and active solar stills, active solar still have greater production rate because it uses external source of thermal energy. Many researches on single slope active solar distillers have been reported by researchers around the globe with an aim to increase the production of fresh water for the use of society. This paper presents a mini review on solar energy based single slope water purifier using different techniques.

II. PERFORMANCE OF ACTIVE SOLAR STILL

A. Integration of trays with PCM

A. S. Abdullah et al. [1] reviewed the performance of active solar still integrated with trays and the found production from conventional and trays solar still are 2.4 kg/m2 and 5 kg/m2 a day. It happens because trays solar still have greater evaporation and condensation rate when using nanoparticles than reference solar still because the heat transfer characteristics and water temperature were taken that without nanoparticles. The productivity of the trays distiller with using the CuO nano-particles in paint was more than that of the reference still by around 14%. They also conclude that the upper tray has higher water temperature than either the other trays (intermediate or lower trays) or the basin liner. The average temperatures of the water for both conventional and trays solar stills are nearly similar during the charging time, but they are different during the discharging time. This is because of the released heat from the PCM during the discharging time which increases the water temperature of the tray's distiller compared to that of the reference distiller. F.A. Essa [2] was modify solar still by installing fixed suspended trays over the vertical walls of the steps to increase the evaporative and exposure surface areas. Also, we created a parallel cavity under the lining of the steps to serve as a heat storage space. This cavity was filled with paraffin wax mixed with Al_2O_3 nanoparticles as phase change materials (PCM). They found that, the daily distillate of the conventional and stepped distillers was 4 kg/m2 and 6.2 kg/m2, respectively. Amina Abdessemed et al. [3] experimentally investigated effects of tray shape of a multi-stage solar still coupled to a parabolic concentrating solar collector. They tested for the first time and in active two types of stages of shapes and they found that "V" shaped trays are most efficient to producing distilled water. M. S. S. Abujazar [4] in this study, an inclined stepped solar still with copper trays, 3-cm deep water and 6 cm of sawdust insulation was designed and tested. The daily productivity of stepped solar still 4383 ml/m2. The performance of the inclined stepped solar still is high because copper has high thermal conductivity and high rate of heat transfer to water in still. It concludes that the productivity increase with the increase in temperature difference ($T_i - T_o$) while decrease in humidity increases the system productivity.

B. Coupled With Solar Collector

Al-harahsheh Mohammad et al. [5] performed experiment on water desalination using solar still enhanced by PCM and a solar collector as shown in figure. They found that the selected PCM worked well to supply energy during night time period without any change in thermal behavior. The selected PCM worked well to supply energy during night time period without any change in thermal behavior. Result shows the highest daily productivity of the unit achieved 4300 ml/m2. It also concludes that the external solar collector improved the productivity of the system by complementing the energy required to operate the unit continuously. Its major effect was on the energy stored by the PCM resulting in great enhancement on unit productivity at night. Madiouli et al. [6] performed an experiment with single slope solar still coupled to FPC and PTC and they found that the efficiency increased by 16.24% and 21.83% and yield increased by 172% and 203% in winter and summer season respectively as compared to conventional solar still. Taghvaei et al. [7] experimentally investigated the singe slope active solar still for continuous

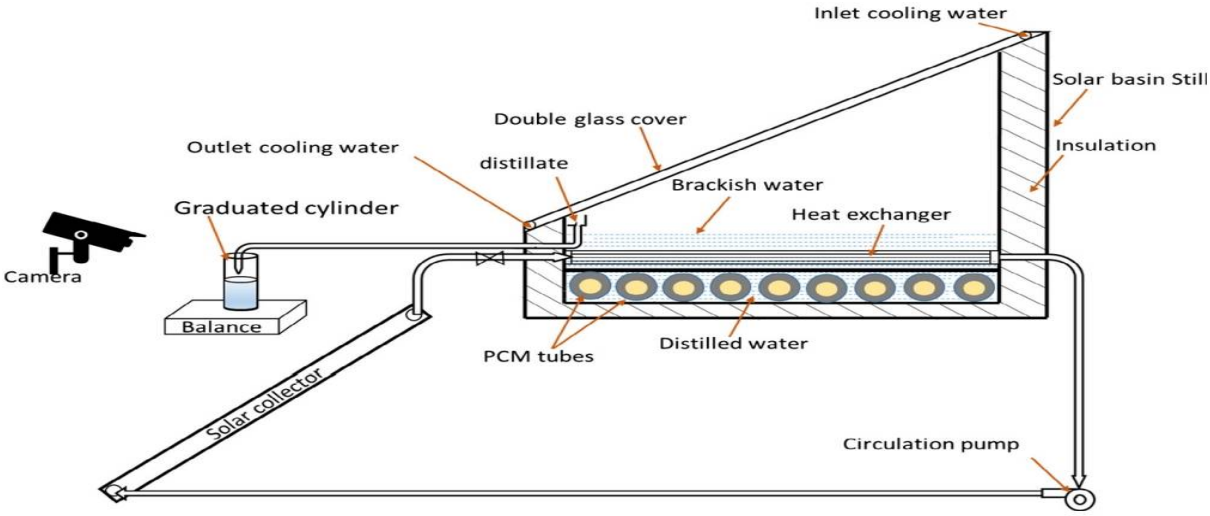

Fig: Schematic diagram of experimental setup using solar collector

Operation i.e. for long time operation integrated with flat plate collector and they found that the efficiency and yield from the still increased as depth increased for first two days of operation but after that they start decreasing, therefore they concluded that water depth must be high for longer time of operation. Narayana and Raju [8] performed an experiment with active solar still connected with three parallel FPC's and they concluded that the rate of evaporative and convective heat transfer was found to depend strongly upon the number of FPC's connected to basin liner. The maximum yield of 4.229kg/m2 was found to be maximum for three FPC's connected in parallel, but efficiency was found to be maximum for two FPC's connected in parallel.

C. Solar Still Integrated With Solar Pond

Shivangi Bisht, Dhindsa et al. [9] preformed experiment for solar still having wicks in the basin and integrated with solar pond. The performance of modified still with conventional still were compared. It was observed that the percentage gain of distillate of modified still during night was higher than that at the day-time. The overall gain in distillate of modified still with wicks and solar pond was found to be 2146 g as compare to conventional still without wicks and solar pond. It indicates the success to use solar pond and wicks in the basin of modified still. Dhindsa and Mittal et al. [10], in this work conventional basin type multiple effect diffusion solar still has been modified to enhance the diurnal productivity of still and produce nocturnal distillate from the still. It concluded that the use of solar pond for supply of heat to solar still during night time, paves the way of round the clock utilization of solar still for production of distillate using solar energy. The daily cumulative efficiency of 4 -effect modified and conventional solar still was found to be 80.29% and 59.6% respectively. El-Sabaii et al. [11] experimentally found that productivity of solar still integrated with shallow solar pond was 6.68 kg/m2 -day as compared to 5.29% kg/m2-day of still without solar pond. El-Sabaii et al. [12] theoretically estimated that the performance of basin solar still integrated with solar pond enhanced by 52.36% through open mode of heat extraction from pond. Appadurai and Venumurugan [13] conducted experiment on fin type solar still integrated with fin type solar pond. Result revealed that productivities were higher with modifications.

D. Integration Of Solar Panel And Use Of Porous Material

Abd Elbar and Hamdy Hassan [14] experimentally studied the solar still integrated with solar panel utilizing porous material. The influence of the salty water preheating by using SP incorporated over the back glass of a single slope solar still on the solar still-SP hybrid desalination system performance is investigated experimentally. Additionally, using BSWF in the basin with preheating 60% of the salty water rises its temperature by 8 °C maximum compared to still-SP system only. The findings reveal that the maximum obtained daily freshwater productivity is achieved in case of SDS + BSWF with preheating 60% of an increase of 51.4% to the daily yield in case of CSS. Rashidi et al. [15] investigated the influence of utilizing plexiglass black sponge rubber as porous material with solar distiller. It was indicated from their findings that still with selected absorbent material produced potable water 17.35% higher than CSS yield with cost of production 12% lower than corresponding value in traditional still. Agrawal and Rana [16] examined the utilization of black jute cloth as V-shaped floating wicks in the still basin to enhance the absorptivity of salty water media and hence increase the evaporation rate of pure water. As a result of this used medium, the surface area of heat transfer for modified still was higher than corresponding value in CSS by 26%, resulting in a significant rise in the potable water yield

E. Use of Reflectors

Reflectors are inexpensive and beneficial in increasing the distillate of the solar still. In the solar still they are used to concentrate the solar radiation on the desired area which increases the heat flux received by the area. Waste heat energy from the still is also reduced by the use of reflectors by Omara ZM [17]. Many types of internal and external reflectors have been used by researchers for increasing the efficiency of the still by Tanaka [18]. Abdallah et. al. [19] found that by using mirrors on the internal walls, the thermal performance of the still was improved by 30%. Kamiri et. al. [20] performed numerical modeling of a still with internal reflectors on front and side walls and observed an 18% increase in efficiency. Omara et. al. [21] reported the efficiency of stepped solar still of 53% was increased to 56% by use of internal reflectors. The mirrors can be adjusted to sun angle and it reflects the excess radiation to the water. The still efficiency was found to increase by 45% by El-Samadony [22].

III. CONCLUSION

The inclusion of various components such as trays, solar panel, solar collector, solar pond in the conventional single slope raises the distillate of the still. The efficiency and output of SS solar still is high by performing modifications in the experimental setup. The proper utilization of insulations, glass roof angle, heat exchanger, condenser, solar radiation and basin, absorbing elements will produce a combined effect and enhance the output & effectiveness of the SS solar still.

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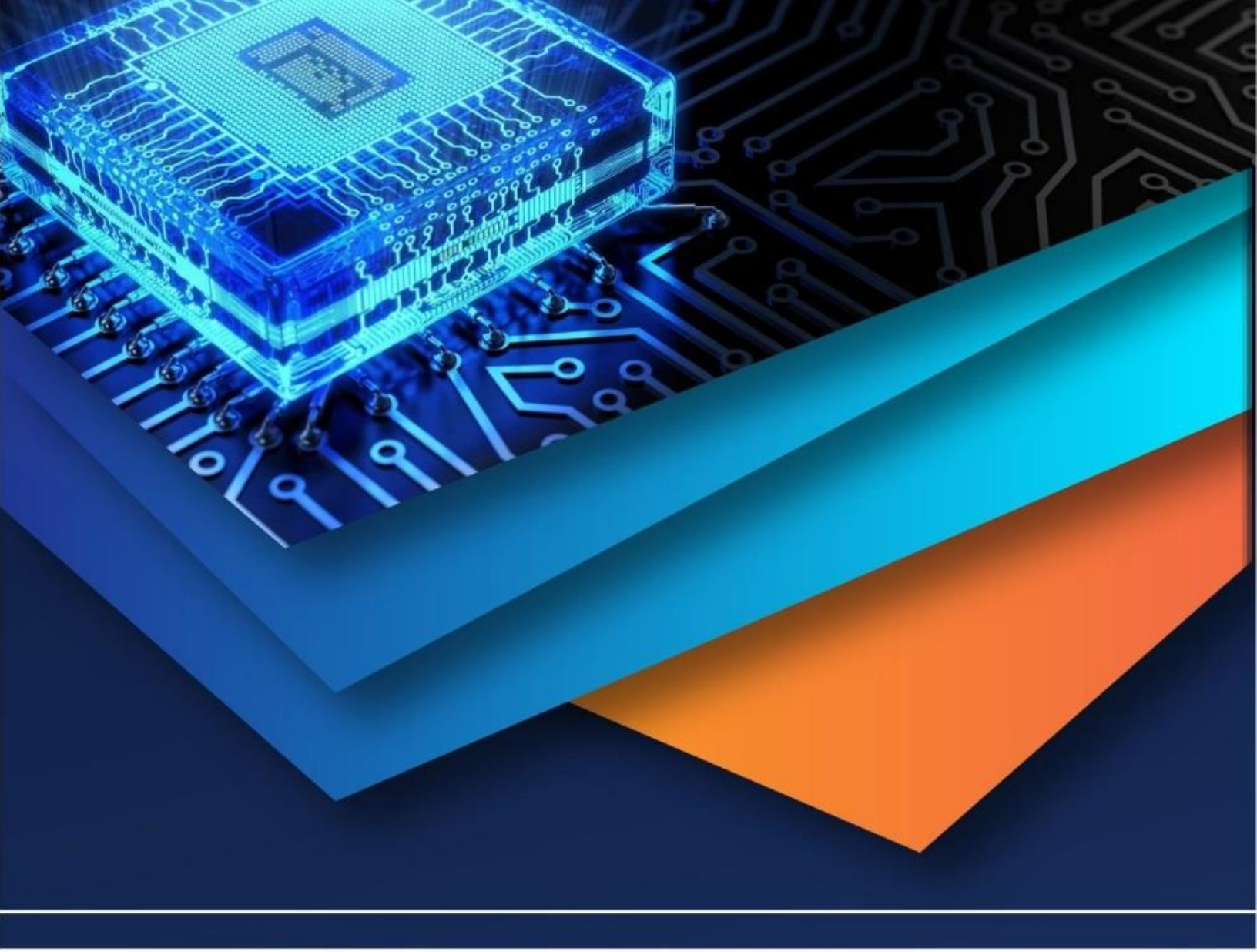

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