A REVIEW ON THE VARIOUS HIGH-PERFORMANCE STRUCTURES OF SOLAR STILL.

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Abstract: Solar desalination is a way to economically produce fresh water to meet the needs of the rural population. Many researchers worked on passive and active solar still with single effect, resulting in very little fresh water. To overcome the drawbacks of single-effect, attention has been focused on developing multi-effect solar still. In the current study, various combinations of flat plate and concentrated collectors is presented which having more productivity. This study also describes the advantages and disadvantages of various solar stills.

Keywords **– Solar still, desalination, solar energy, performance.**

I. INTRODUCTION

Water can be used for many purposes, such as farming, irrigation, and cooking for home use. Fresh water today is the most serious health problem in the world. Less than 1% of water on earth is available for human being to fulfill all need, rest on the water either in ocean or in the form iceberg. To fulfill the increasing demand of fresh water the only viable solution is of desalination. The removal unwanted contaminant from water with the help of solar energy which is widely available at no cost carried out in desalination process. Solar desalination has proven to be the most economical and viable technology for obtaining fresh water. Solar still is a very simple device to distill water. It consists of a container with black paint inside and a glass cover on top. The container is filled with salt water and solar radiation incident on it which passes through the glass cover, which in turn heats the water. Evaporated water condenses on the inner glass surface and stored at allocation after flowing through collecting channel. In this paper different types of solar still configurations are discussed. Solar stills are mainly of two types as single and multi-effect. Based on the way of solar energy utilization each of these is further classified as active and passive types.

II. SOLAR STILL

2.1 Active Type Solar Stills

2.1.1 Evacuated Tube Collector (ETC)

Evacuated tube collectors are high efficient as compared to any other type of tube collectors. It can be used and found economical at operating higher temperature. ETC are widely used in all types of applications like domestic, industrial, power plat etc[1]. ETC can be used for medium to high temperatures with a working range of 50-120°C. With the help of nanofluid efficiency of ETC can be further improved. ETC consists of large number of evacuated with absorber surface [2]. Heat pipes are inserted into the evacuated tube, in the case of a heat pipes of ETC, as shown in fig. 1. ETC with heat storage materials are also found to be beneficial with higher productivity [1]. Heat storage material inside the evacuated tube is shown in fig. 2.

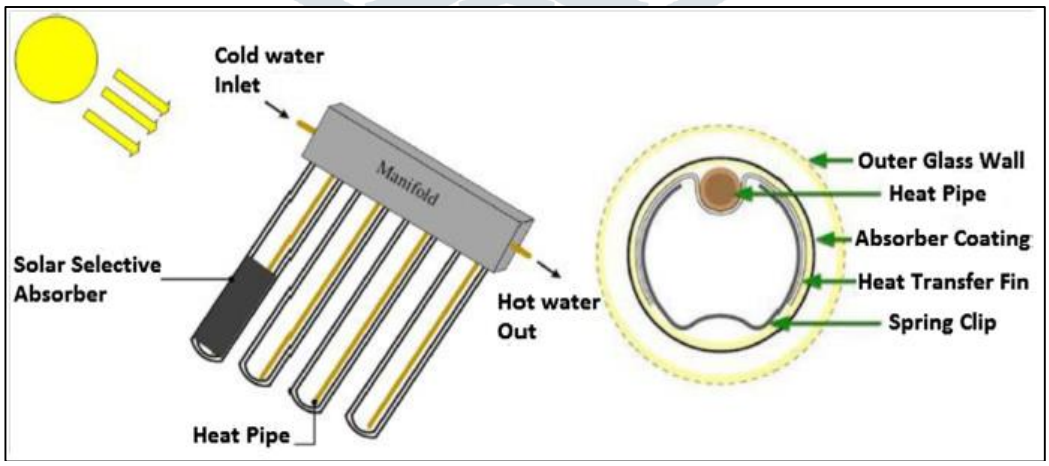


Fig. 1. Schematic diagram of heat pipe ETC [1].

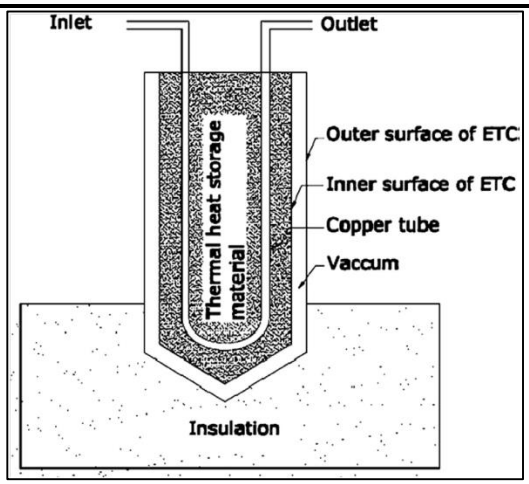
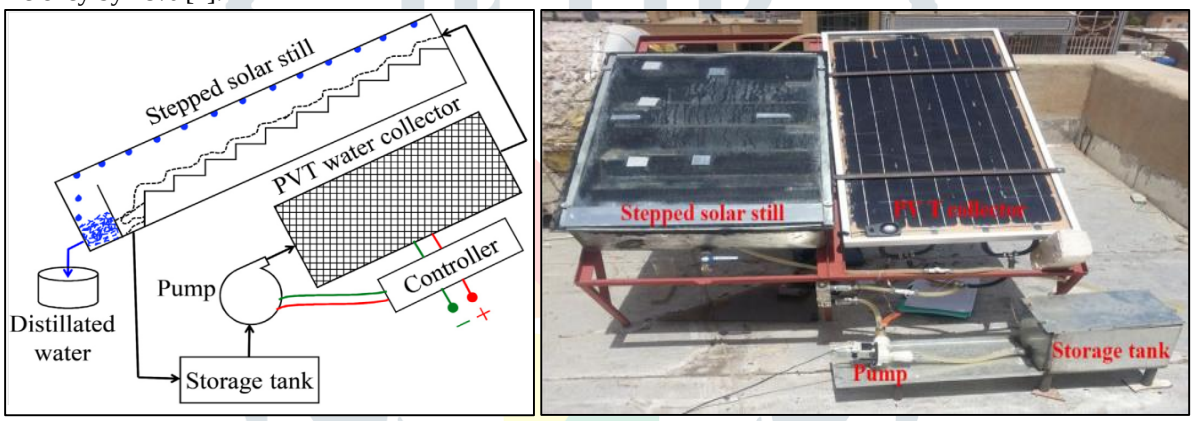


Fig. 2. Evacuated tube with thermal energy storage [1].

2.1.2 Stepped Solar Still and PVT Collector

Stepped solar stills are still more efficient than conventional solar still. With increase in number of steps depth of brine requires less. As mass of water in each stage is less so evaporation rate becomes higher with high productivity [3,4 and 5]. The PVT collector is used as a preheater as show in fig. 3 to heat the brine supply temperature results into increase in the productivity of fresh water.

Effect of heat storage material on the performance on stepped solar still using a transient numerical model proved, that the efficiency increases by 57% as compared with conventional solar still [6]. In case of parabolic collector preheating of brine improves efficiency by 18% [7].



(a) (b)

Fig. 3. Stepped solar still connected to PVT collector (a) layout (b) experimental setup [3].

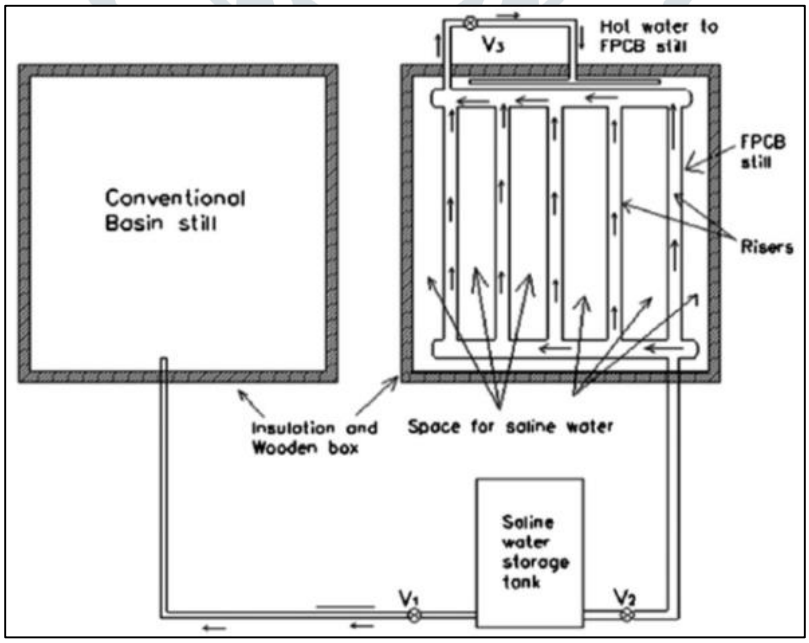


Fig. 4. Flat plate collector in combination with solar still [8].

2.1.3 Flat Plate Collector

Conventional solar still in combination with flat plate collector gives better productivity of fresh water. This type of combination is as shown in fig. 4. Flat plate collector arrangement with convectional solar still having productivity of 3.62 kg/m^2/day [8]. Flat plate collector is used to preheat the saline water. Due to preheating evaporation rate of water increases. Temperature difference of glass cover and basin water also increases. As compare to single basin solar still of same temperature

difference glass cover having less temperature. Cold glass temperature plays main role in condensing water vapor on its lower surface.

2.2 Passive Type Solar Stills

2.2.1 Basin Solar Still

Single effect, single basin solar still as shown in Fig. 5, For the basic type, the solar still productivity with a single effect is in the range of 2-4 liters per square meter per day. This type of solar still is having low productivity as compared with any other combination of solar stills. With optimized geometry and orientation of solar still, productivity of this type of solar still increases upto 3-5 liters per square meter per day [2].

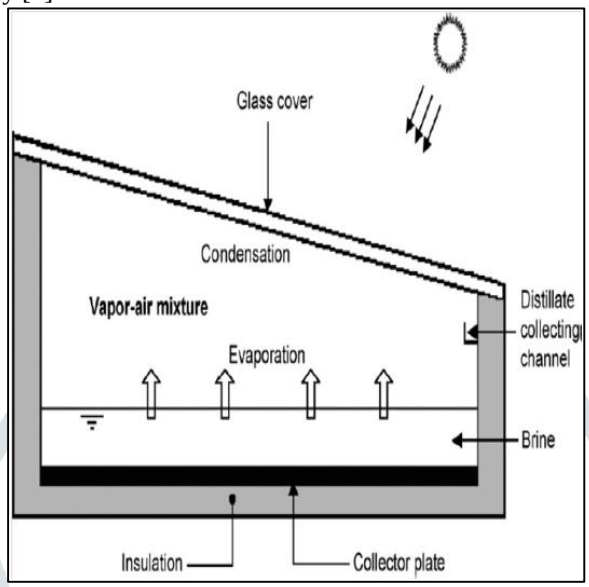


Fig. 5. Schematic diagram of single basin single slope solar still [2].

2.2.2 Pyramid Solar Still

Pyramid-type solar still consists of two parts: the cover (pyramid) and the basin as shown in fig. 6. In pyramid type solar still, the side walls on the surface of the water are less obscured than the usual single-slope solar and condensation regions [9]. The advantage of multi layer basin is that the surface of basin itself acts as condensation surface on another side [10].

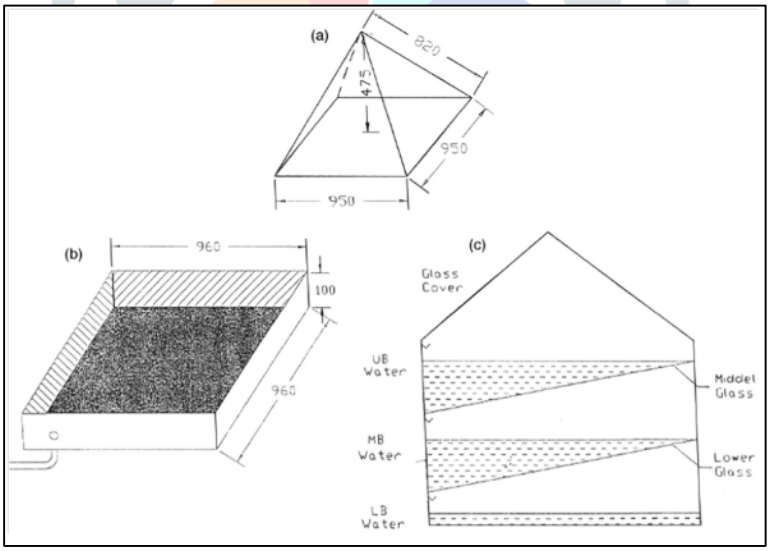


Fig. 6. (a) Square pyramid top cover (b) Lower Basin (c) Cross section view of triple layer basin solar still [10].

2.2.3 Solar Still with Reflector

One way to improve performance is to increase the amount of solar energy that reaches solar still basin. This can be done with a reflector. In an experiment on a single basin solar still with internal and external reflectors, as shown in fig. 7, It is observed that productivity of solar still can be improved by tilting the external reflector back in summer and tilting forward in the remaining seasons [11,12]. Boubekri et. al. performed numerical simulations of the productivity of solar still, with the addition of internal and external reflectors more by 72.8% [13]. Angle of inclination of the external and internal reflectors should be for igh productivity, and the optimum angle of inclination of the glass cover is in the range of 10-50 ° depending on the season [14].

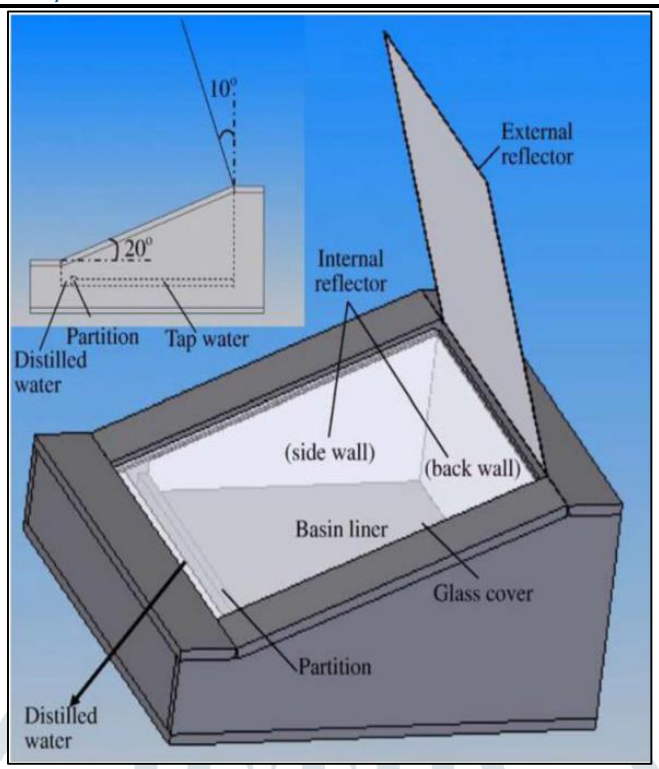


Fig. 7. Schematic diagram of single basin single slope solar still with reflector.

2.2.4 Wick type solar still

Wick type solar still is shown in fig. 8. The use of wick material in solar still increases the residence time of water on the absorber plate, with the result that the brine quickly reaches a higher temperature, and thus the evaporation rate increases. The advantage of the wick is that the brine level to a possible optimum low level while avoiding dry spots. The effectiveness of the wick material depends on parameters such as the rate of absorption, capillary action and thermal conductivity of the wick. Using various cotton wick materials like cotton, jute, metal fragments, stones, etc. it has been observed that this method is the most effective and efficient way to increase productivity [14]

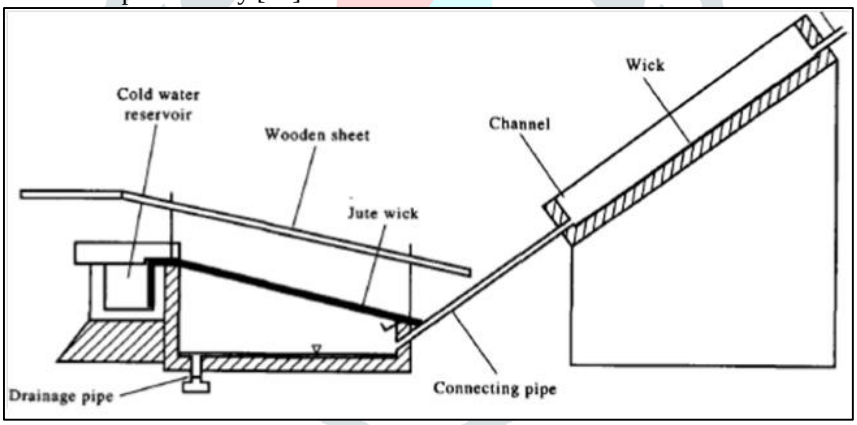


Fig. 8. Schematic of wick type solar still.

It was found that a decrease in the brine depth in pools with single effect solar still increases the productivity of the solar still, mainly due to the higher basin temperatures [15,16]. The experiment was conducted on wicks of jute, malva and canamo and results shows a productivity of 3.8 to 4.4 liters per square meter per day and an operating efficiency of 40% to 46%.

2.2.5 Spherical Solar Still

Diman [17] proposed a mathematical model for predicting the thermal characteristics of spherical solar energy. The diagram is shown in Fig. 9. The still having a spherical glass cover with a black metal plate horizontally located in the center. Water condenses along the inner surface of the glass, and fresh water is collected in a reservoir located at the bottom. Their results show an increase in efficiency of 30% compared with traditional solar still.

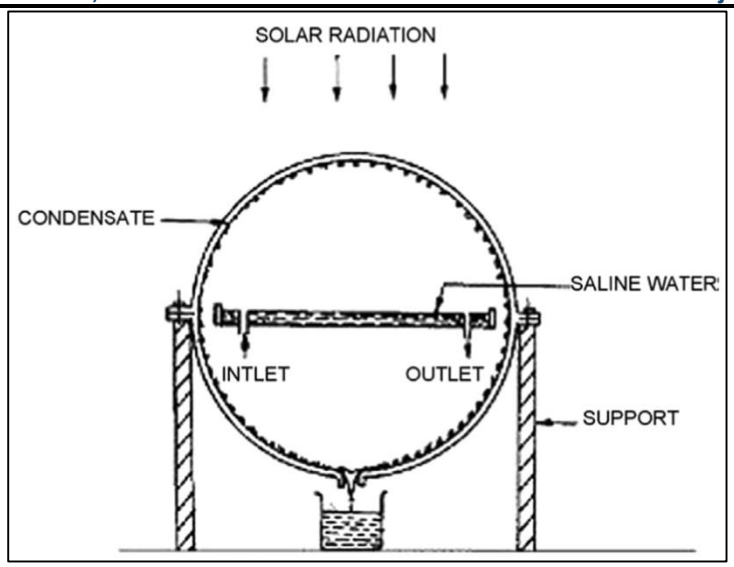


Fig. 9. Spherical Solar Still [18].

III. CONCLUSION

Active solar still having more productivity as compared to passive solar still. In active solar still more energy is provided to basin water by one of the method like, evacuation of tube, heat storage material, PVT, stepped basin, parabolic and flat plate collector etc. Working temperature of basin water is more in active solar still. Parabolic collector improves productivity by 18%.

In case of passive solar still, single basin solar still is having very low productivity as compared any other type. Pyramid type solar still having very good productivity due to low water depth and multi layer effect and less shadow. External reflector angle less than 25° can be improve productivity by 72.8%. Wick material improves rate of evaporation of basin water and results into 40% to 46% higher yield. Spherical solar still having 30% higher productivity than the conventional solar still.

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