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Solar Still Productivity Enhancement Systems: A Review

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Abstract: ***Because of lower productivity solar still is not popular in the current market of drinking water. There are so many work has been carried out to enhance the productivity and apart from that active solar still gives the higher productivity as compared to the passive solar still. From the study it has been observed that the solar air heater integration gives the higher productivity with conventional solar still which is working as an active solar still, but Multilayer solar still is increasing the productivity without any external heat source in the same space. It is need to observe the effect of solar air heater integration with multilayer absorber plate type solar still.***
Keywords: Multilayer, Solar still, integration, solar air heater, Absorber plate.

I. INTRODUCTION

After Air and Food the water is water is the basic need for Human being. There is only 3% of water is available as potable water on the earth from the existing water resources. Apart from that due to development of life standard and industries water gets polluted day by day, for that so many developed and under developed countries facing a problem of water scarcity. In rural areas so many people not having a drinkable water and they uses brackish water for the daily routine use for that the people facing a diseases by impure water, because of impure water so many countries facing problem of water borne diseases such as cholera, Hepatitis, Diarrhea, Malaria, Polio, etc. The global picture by WHO of health and water has a strong local dimension for approximately 1.1 billion people who still lack access to improved drinking water sources. Around 2.4 billion people on Earth have inadequate sanitation. There is strong evidence that sanitation, water and hygiene-related diseases account for around 2,223,000 deaths each year, as well as an annual loss of 82,196,000 Disability Adjusted Life Years (DALY's).[1] The solution of the pure water has been found by some researchers as desalination systems. The desalination is a system which convert the brackish water into the drinkable water, for that certain Techniques has been developed by researchers such as Reverse Osmosis, Electrolysis, Vapour compression Technique, Solar Desalination, Etc. From the available desalination technique most are consuming electricity or fossil fuel which is directly affected on the Environment and economy of the country. So apart from that Solar desalination is the best alternative solution for generating drinking water and solar still is a device which is working on the principle of solar desalination system.

Solar still is divided into two basic parts passive and active solar still. The solar still without any external heat source connected and directly exposed to the sunlight is called as passive solar still; the solar still with external heat source attached and directly exposed to the sunlight is called as active solar still. Because of lower productivity and higher space requirement the solar still is not commercialized. There are so many research work has been done and going on to enhance the productivity of solar still to make it commercialized and make helpful to the rural areas. Multilayer Absorber Plate type Solar Still (MAPSS) is a passive type solar still in which absorber plate is divided into two layers with certain height between two. The productivity of the multilayer absorber plate type solar still is much higher as compared to the conventional solar still. For that this work is carried out to enhance the productivity of it with the help of air heater integrated at the bottom of the absorber plate with different flow rate of air and measuring the effect on performance of MAPSS in climatic condition of Gujarat.

A. Principle of Solar Still

The basin of the solar still id generally made up of Galvanized iron/concrete, FRP, Acrylic or wood material. It has been painted black at the absorber and inner surface to absorb maximum solar radiation and packed with brackish water. The transparent cover is fixed at the top of the solar still to make solar still air tight and to transfer the maximum solar radiation towards the absorber plate. The solar still is directly exposed to the sunlight towards north to south facing to receive the maximum solar radiation during the day period. The solar rays are passing through the glass cover to heat the water in the blackened internal surface of basin and as a result of temperature difference between water and glass inner surfaces water gets evaporated. As the water inside the solar still evaporates, it leaves all microbes and contaminates in a basin. The pure water vapour will condensate on the internal side of the glass runs through the minor side of the still and then gets collected in a closed container which is used as potable water.

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B. Problem Definition

It is required to enhance the productivity of Solar still and reduction in the required Space of basin. Because of lower Productivity as well as Efficiency of the Solar Still, it is not used commercially. Improvement in the performance of multilayer absorber type solar still is needed.

C. Objectives and Goals of the Study

To improve the productivity of the multilayer absorber plate type solar still.
Measure the effect of hot air flow rate on the performance of solar still.
To observe the effect of various parameters on the multilayer absorber plate type solar still.

D. Application of Solar Still

Hospitals and Dispensaries	for sterilization
Garages and Automobile Workshop	for radiator and battery repairs
Telephone Exchange	for battery repairs
Laboratory Use	for diagnostic work
Marshy and costal area	To get drinkable water

There are so many researcher have been worked on the Active and Passive solar still to enhance the productivity. From the available research work few studies are introduced in the Literature survey report as following:

1) *A.S. Abdullah* working to improving the performance of stepped solar still coupled with a solar air-heater. The Air heater collector area fabricated with 0.5 m^2. They also studied the effect of water flow over the condensing glass cover. The results observed was 112% productivity increased as compared to the conventional solar still. [1]

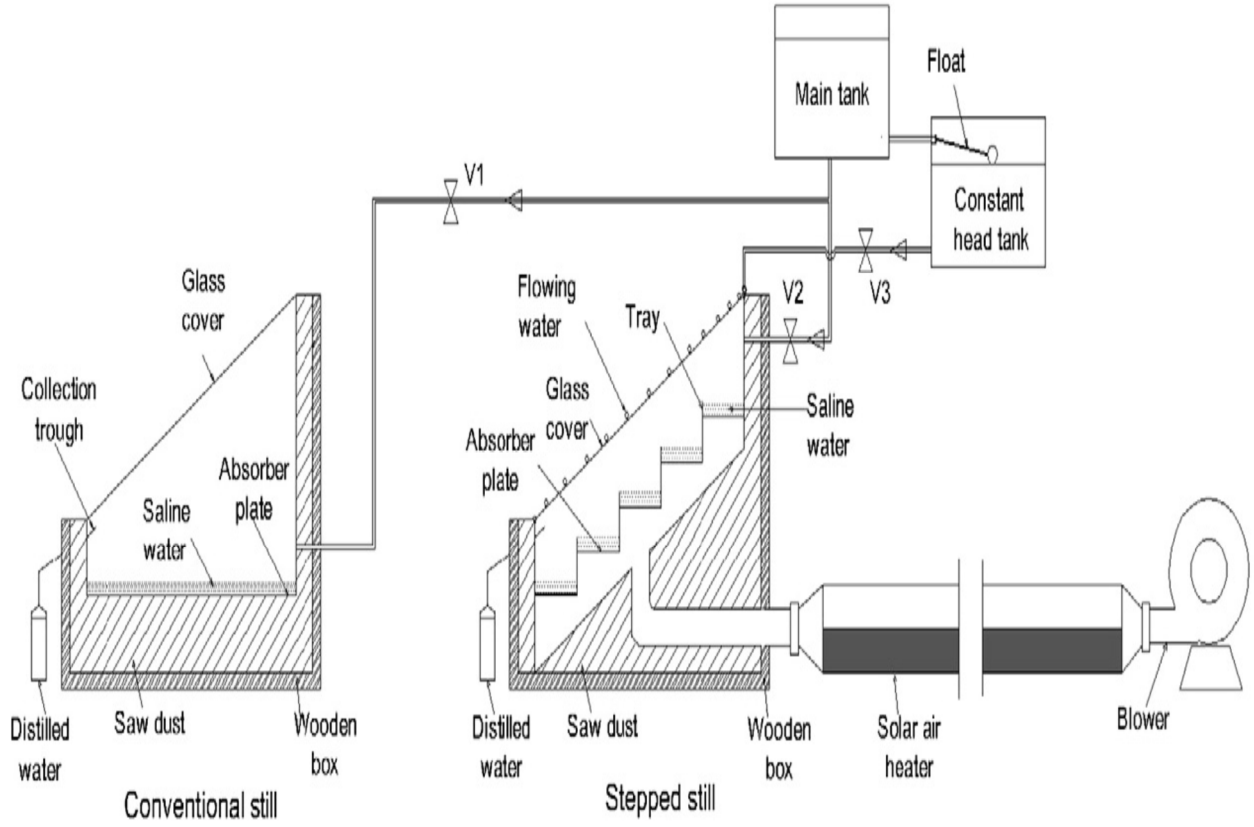


Figure 1 Schematic diagram of the Experimental Setup [1]

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2) *SN Rai and GN Tiwari* coupled Single basin solar still with flat plate collector and they found the average distilled water production is 24% higher than conventional solar still. The daily distillate output per unit area in both stills increases with increasing insulation thickness up to 4 cm rapidly. [2]

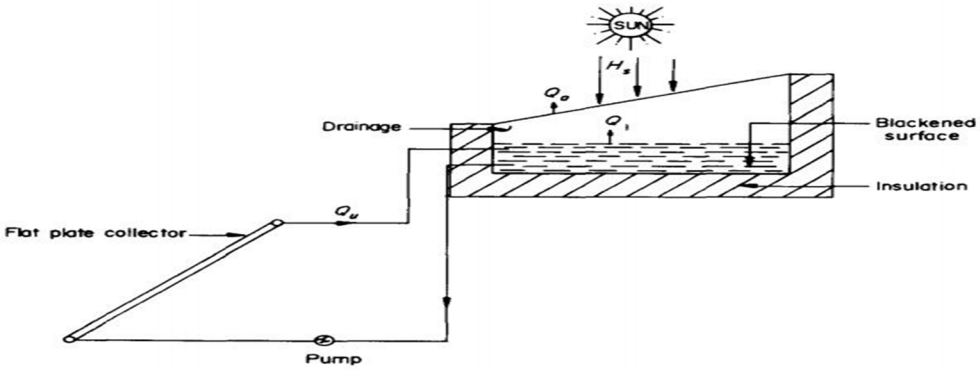


Figure 2 Sketch of single-basin solar still coupled with flat plate collector [2]

3) *S.W. Sharshir et al.* performing on hybrid solar still desalination using humidification-dehumidification integrated with evacuated solar water heater. The drain water increases the gain output ratio of the system by 50% and efficiency of single solar still to about 90% during reusing and the maximum production of hybrid system by single solar still by 200% up to 66.3 kg/day. [3]

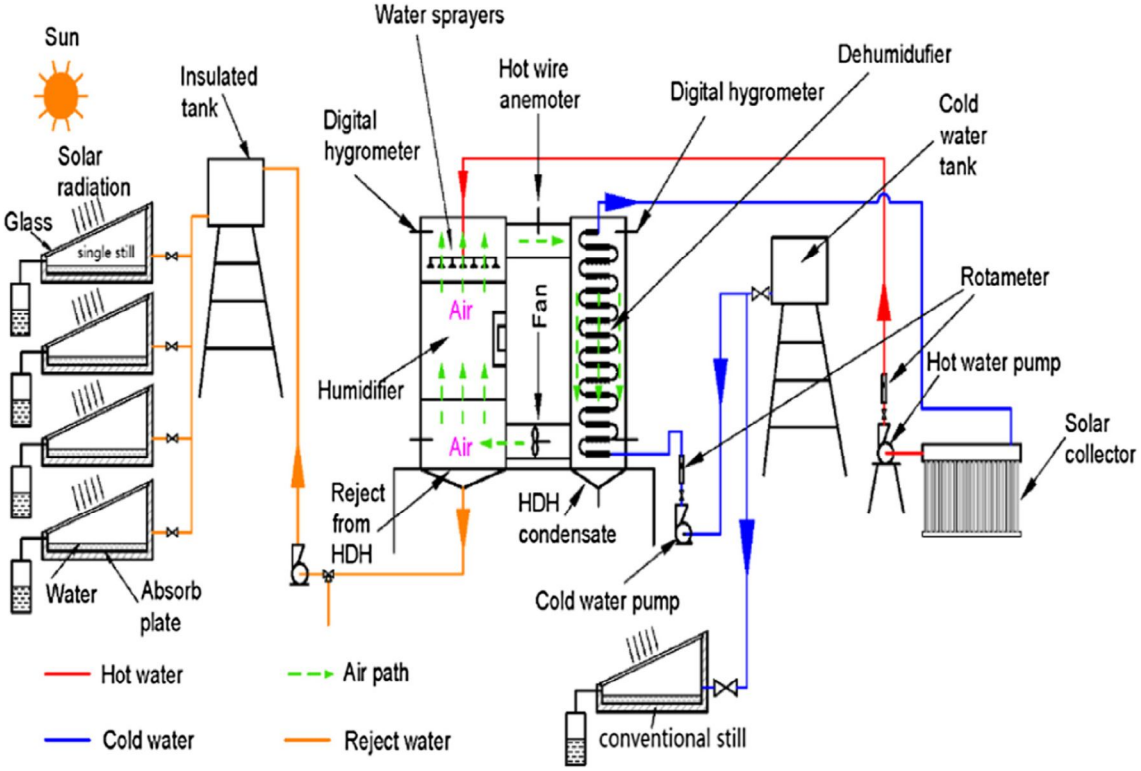


Figure 3 Detailed drawing of the Experimental setup. [3]

4) *Mohamed S. Yousef and Hamdy Hassan* incorporated a latent heat storage system with single slope solar still in hot climate conditions. They performed an experiment such as compared conventional solar still, solar still coupled only with phase change material attached to the still base, solar still with hollow cylindrical pin fins imbedded in the phase change material, solar still with phase change material and steel wool fibres in the still basin and solar still with only steel wool fibres in the still basin. From the experiment they observed steel wool fibres only filled solar still gives the highest productivity of distilled water as compared to the other solar stills. [4]

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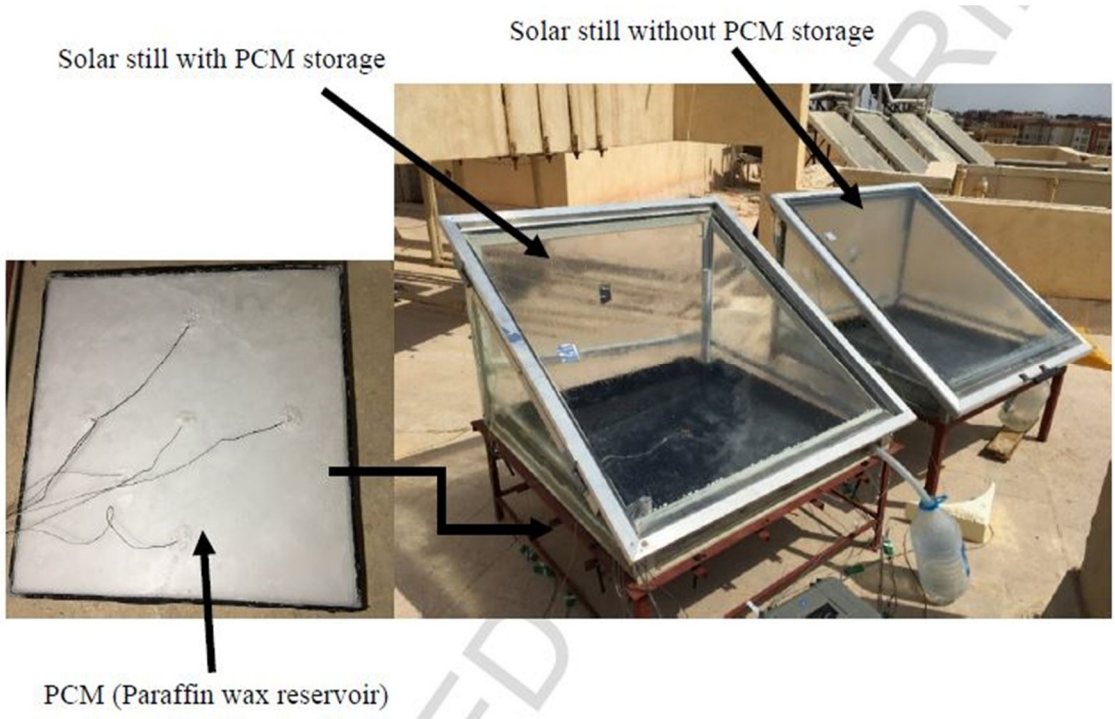


Figure 4 A photographic of the experimental setup of the solar still with PCM [4]

5) *Farooq R. Siddiqui et al.* improved a performance of solar desalination system by using solar air heater with humidification – dehumidification with 1KW electric water heater and condenser. They compared performance of only two electric water heaters with solar air heater and one electric water heater. They observed higher productivity gain ratio in one electric heater and solar air heater set as compared to the only two heaters in the desalination system. [5]



Figure 5 Experimental Test Rig (a) without solar air heater (b) with solar air heater. [5]

6) *Palak Patel et al.* working on multilayer absorber plate type solar still to comparative study with and without multilayer absorber plate in passive solar still. They observed day productivity decreasing and night productivity increasing with increasing the water depth in solar still in both the cases. The day and night productivity of multilayer absorber solar still increasing by 3.9% and 28.94% at 0.5 cm water depth, 4.9% and 29.06% by 1 cm water depth, 5% and 40% by 1.5 cm water depth, 5.2% and 40.38% by 2 cm water depth respectively. [6]

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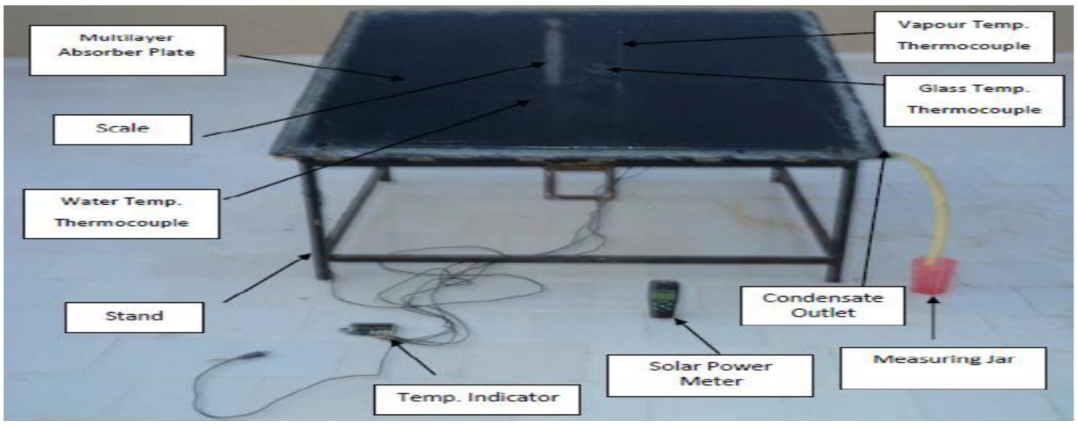


Figure 6 Experimental setup of Multi-Layer Absorber Type Solar Still [6]

7) *A.Muthu Manokar and Dr.D.Prince Winston* compared finned acrylic solar still with conventional galvanized iron solar still. The acrylic sheet as casing has very low thermal conductivity and it reduces the heat loss from bottom of the still basin which leads to increase in the evaporation rate of water. They observed daily productivity of single basin single slope acrylic solar still is 660 ml/0.25m^2/day and galvanized iron solar still is 585 ml/ 0.25m^2. [7]

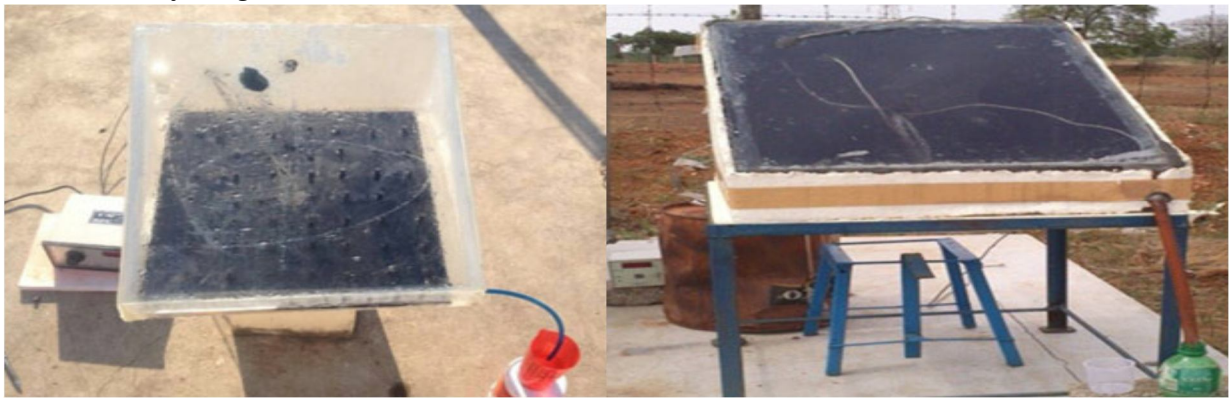


Figure 7 Experimental setup (Acrylic solar still and galvanized iron solar still) [7]

8) *Mohamed A. Eltawil and Z.M. Omara* coupled a conventional solar still with a spraying unit, flat plate collector, external condenser, perforated tubes which is powered by PV module and it compared with the conventional solar still productivity. They found the Conventional solar still productivity ranging about 3 to 4 l/m^2/day and the designed solar still was 51 to 148% higher productive as compared to the CSS. [8]

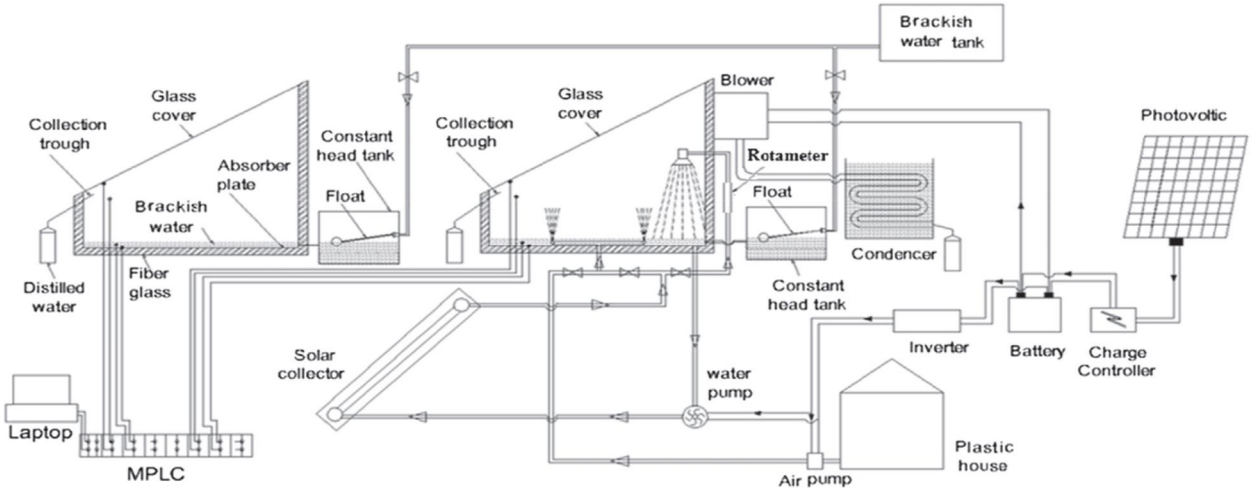


Figure 8 A schematic diagram for the hybrid experimental setup (conventional solar still and designed solar still). [8]

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9) *Xing Li et al.* developed a humidification and dehumidification desalination system model coupled with evacuated glass tube solar air heater of solar air heater with evacuated tubes and tested experimentally. They optimized a humidifier and dehumidifier by mathematical model. They conclude that different inlet sprayed water temperature in the pad humidifier from 9□C - 27□C can effectively improve relative humidity of outlet moist air from 89% to 97% and outlet air temperature from 35□C to 42□C. These results are valuable for the optimal design of 1000 /day solar HDH desalination system with 140 m^3/h air flow rate. [9]



Figure 9 Photograph of solar desalination pilot plant. [9]

10) *Zine Saadi et al.* developed a new stepped solar still to improve the productivity of conventional solar still with multi tray evaporator integrated to rear wall of solar still. They observed 47.18 %– 104.73% higher productivity in new solar still as compared to conventional solar still. And estimated productive cost for payback period of new solar still is 0.01 $/kg in 70 daysand conventional solar still productive cost for payback period is 0.0145 $/kg in 100days. [10]

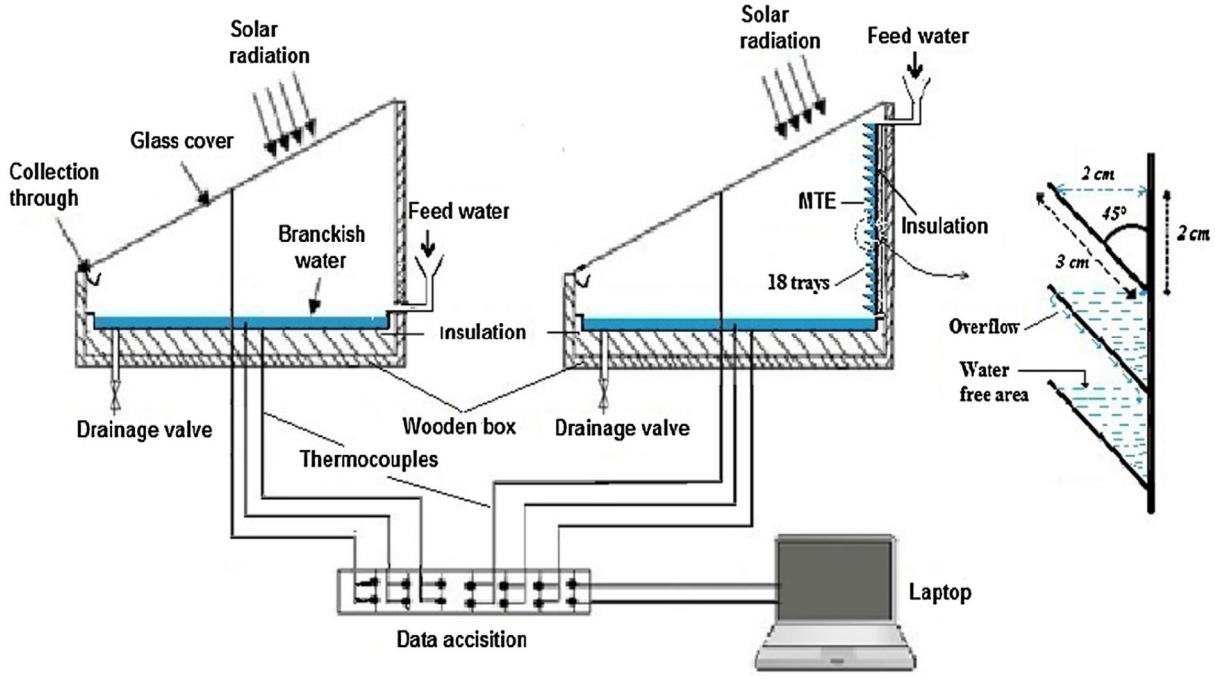


Figure 10 Schematic diagram of the experimental setup. [10]

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11) *Salah Abdallah et al.* tried to improve the passive solar still with metallic wiry sponge in the basin. They compared conventional solar still with black coated, uncoated metallic wiry sponge and black volcanic rocks inserting in the basin of solar still. They observed over night production of 28% in coated metallic wiry sponge, 43% in uncoated metallic wiry sponge and 60% in black volcanic rocks. [11]

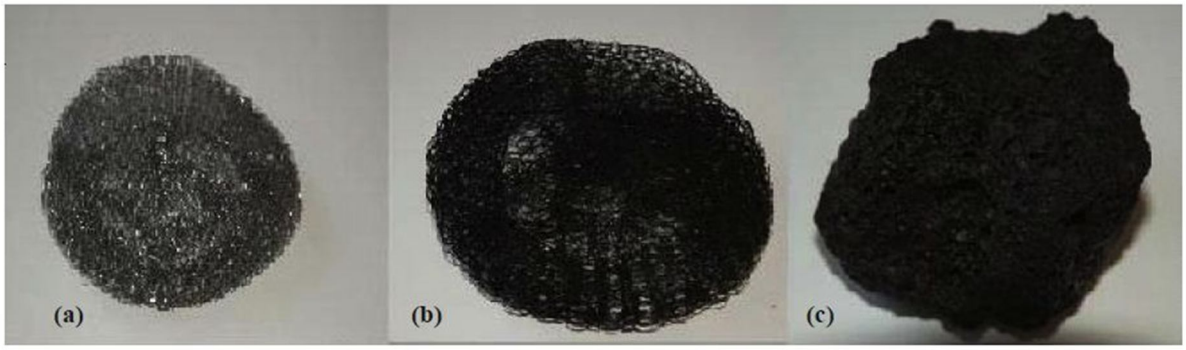
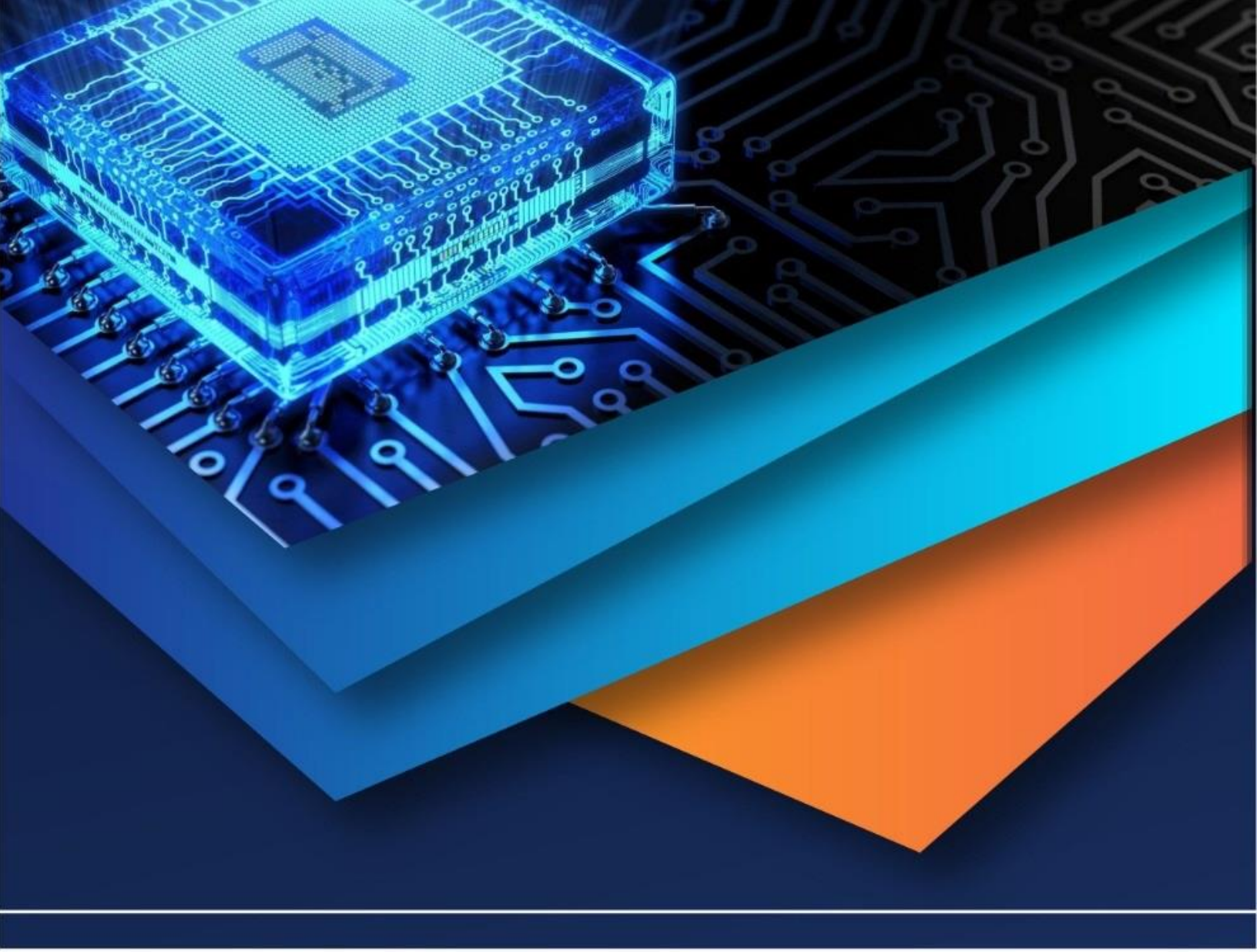


Figure 11 Various absorbing materials used in solar stills a) uncoated metallic wiry sponge b) coated metallic wiry sponge, and c) black volcanic rocks. [11]

II. SUMMARY

Air heater is helps to enhance the productivity of solar still. To improve the Multilayer solar still productivity it is required to find the optimum flow rate of Air Passing to the bottom of it. Use the metallic wiry sponge for additional thermal storage beneath the absorber plate of solar still.

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