Analysis on Single Slope, Single Basin Solar Still with Insulation, Reflector and Fins

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Abstract— The purpose of this project is to design a water desalination system that can purify water from near, any source. A system that is relatively cheap, portable and depends only on renewable solar energy. The motivation for this analysis is the limited availability of clean water resources and the abundance of impure water available for potential conversion into potable water. In addition there are many coastal locations where seawater is abundant but potable water is not available. Our project goal is to efficiently produce clean drinkable water from solar energy conversion. Distillation is one of many processes that can be used for water purification. This requires an energy input as heat. Electricity and solar radiation can be the source of energy. When solar energy is used for this purpose, it is known as Solar Water Distillation. Solar Distillation is an attractive process to produce portable water using free of cost solar energy. This energy is used directly for evaporating water inside a device usually termed as a 'Solar Still'. Solar stills are used in places where water through rain, irrigation channels or well is not viable, such as in remote areas or during power outages. Solar Distillation is an attractive alternative because of its simple technology, easy maintenance and low energy consumption. The use of solar thermal energy in seawater desalination applications has so far been restricted to small-scale systems in rural areas. However, the coming shortage in fossil fuel supply and the growing need for fresh water in order to support increasing water and irrigation needs have further motivated development of water desalination and purification systems by renewable energies.

Key words: Solar Desalination, Distillation, Solar Still

I. Introduction

Water is essential to sustain any life form. Though it covers three-fourths of the planet, a very minimal proportion of this can be used for drinking purposes. This shortage of water especially in a country like India having a huge population is a massive problem and needs paramount attention. In rural areas or in remote places, where the supply of fresh water is expensive due to transportation costs, the problem of water shortage is critical. Due to urbanization, drinking water across the world is getting impure with contamination from industrial and domestic wastes. As it is known that this problem should be tackled immediately, researchers have worked in this direction for the last decade to find a solution for the same. It is found that the simplest solution to this problem is desalination. The major source of water that can be harnessed on Earth is sea water and this can be used for converting it into drinkable water. Most of the cities as well as towns are based near a water body and so the availability of this water is easy. Desalination, as the word suggests, is the conversion of saline or salty water into pure or drinkable water. It can be obtained by simply evaporating the water and then condensing the vapour to reduce all the impurities from it. But as the heat capacity of water is very high, it requires large amount of energy in the form of heat for the conversion process. This energy can be either obtained from conventional sources or from renewable sources. The water obtained from this process is as pure as rain water and can be used directly for drinking purposes as it follows the same cycle. Researchers have been working in this field for a long time now and many designs have been proposed for modifying a solar still by adding improvements like internal and external reflectors, adding wick, using corrugated surfaces and other methods which will be discussed in the next chapter. In near future, the problem of having sufficient potable water supply is going to be a serious one. Many solar based industries are shifting towards water purification field, because there is a huge scope, especially in the rural area. So, if a feasible product can be made available to these areas, it can solve the problem as well as the company can dominate the market.

A. *Aim*

Aim of the analysis is to carry out extensive literature review, theoretically design a solar still, conduct experiments on solar still in different weather conditions and different sun direction. Moreover, take readings of PPM of salted water and distil water. Also analyse the water distillation rate during different time and different facing situation of solar still top and inclination of top. At the end draw different graphs of comparison.

B. *Scope*

The scope of this analysis is to carry out extensive study of various designs of solar still only. Theoretical design and mathematical modelling is to be done at the end of the project. Also, after the theoretical analysis, possible solutions and improvements are to be suggested.

II. Experimental setup

The setup available is made up totally of ordinary window glass on all six sides. It is a single sloped still with 22º tilt. At the end of the glass, a channel is provided from where the condensed water flows out. The basin liner is made up of copper. The glass is 4 mm thick. One hole is provided to fill the water as well as to empty the still when required. No provision to clean the still is present. The glasses were sealed using silicon gun. Another hole is provided to insert the tip of the thermocouple into the basin water to measure the water temperature. While conducting the experiments, the water depth was kept 2cm.

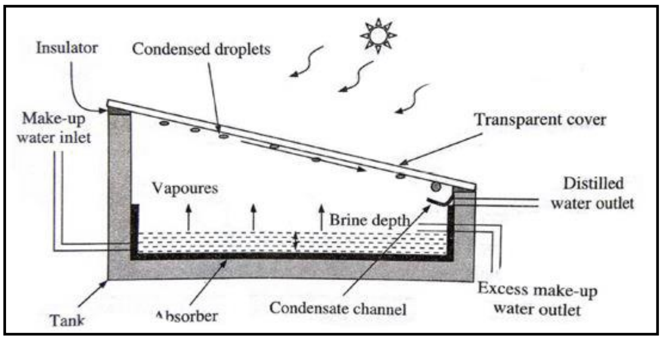

Fig. 1: Cross Section sowing construction of solar still

Many improvements had to be made to make it a workable model. First, the inner walls of the glass were painted black to retain heat. Thermocol was attached on the sides of the still and at the bottom of thickness 1cm so that it acts as an insulator and thus, retain heat. An aluminium foil was placed on the south side glass wall so that it acted as an internal reflector. Though this last improvement was necessary to make this model workable.

Fig. 2: Experimental Setup

The experimental approach was such that after adding each improvement, readings were noted. These improvements included blackening the interior surface, adding insulation, adding fins and cooling the above glass to lower the glass temperature.

III. RESULTS & DISCUSSIONS

After conducting various results and plotting graphs, the following points were to be noted. In the analysis part, three parameters were considered, namely, basin water temperature, efficiency and productivity. All the six cases mentioned above have been compared as shown.

A. *Basin Water Temperature Comparison*

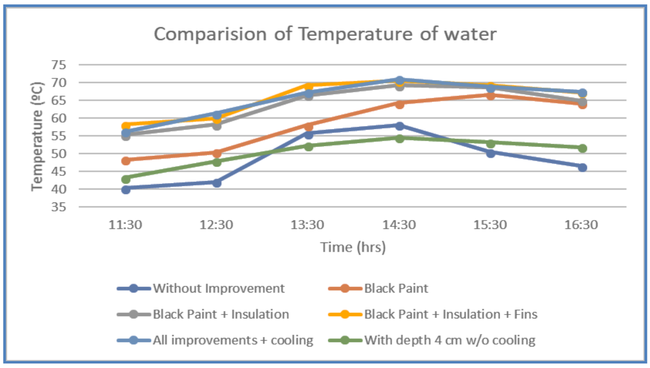

Fig. 3: Comparison of Temperature of Basin Water

It can be clearly seen that for increasing the basin water temperature, improvements are compulsory. Without them, the temperature achieved is very less when compared. Adding insulation and fins to the blackened surface did increase the temperature by some degrees. Increasing the water depth reduced the water temperature drastically. General nature of the graph is that as irradiation increases, temperature increases and with decrement of irradiation, temperature will decrease.

B. *Comparison of Productivity*

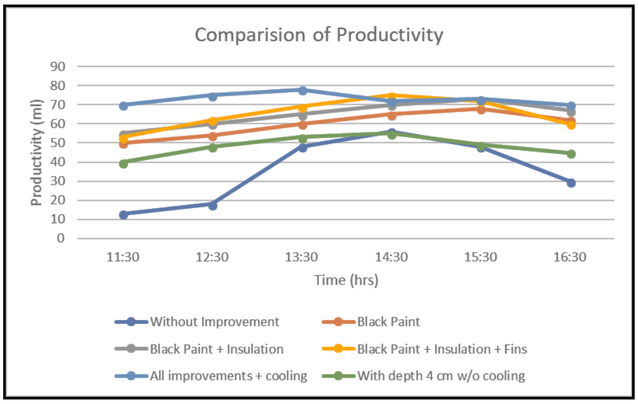

Fig. 4: Comparison of Productivity

Productivity achieved is highest with having all modifications and by cooling the outer surface of glass. From this, we can conclude that reducing the glass temperature or, increasing the temperature difference between water and glass increases the productivity considerably. Without improvements, the productivity is very low. Only blackening the surface will considerably increase the productivity. Again, decreasing the water depth will reduce the productivity. Again, as irradiation increases, productivity increases.

C. *Comparison of Efficiency*

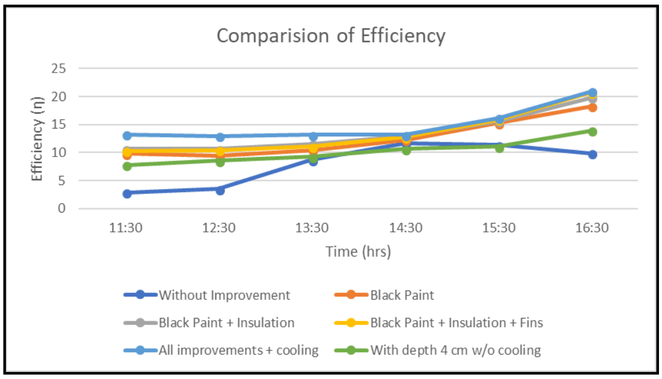

Fig. 5: Comparison of Efficiency

General nature of this graph is that it increases as time progresses. Overall Efficiency is considerably increased by applying improvements and modifications. As water depth is increases, efficiency decreases. It is highest when cooling is also applied with all the modifications.

IV. CONCLUSION

Conclusion of this is that, many changes have to be made and the overall design has to be modified. Depth should be kept as low as possible and 2cm is ideal. Increasing the depth will decrease the basin water temperature and the productivity as well.

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