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Desalination Of Saline Water Using Phase Changing Materials And Nanoparticles

Manoj Kumar.V[1], G.Swaminathan[2], Abhinash Jha[3], Souvik Goswami[4], Aditya Yadav[5], Bishal Debnath[6]

[1,2,3,4,5,6] Department of Mechanical Engineering, SRM Institute of Science and Technology, Ramapuram Campus, Bharathi Salai, Ramapuram, Chennai, India
E-mail: [1]manojkuv1@srmist.edu.in [2]swaminag@srmist.edu.in

Abstract

The most necessary resource for humanity to sustain life on earth is water, which can obtain from nature. The availability of usable water for all purposes is decreasing day by day and it has been turned out to be a great challenge for entire human race. The only available water resource in large quantities is the sea water. Many researches and experiments all over the world had been done to convert the sea water to usable water. This research plan intends to reach the same target by using solar stills to transform seawater to drinkable water. While the solar still is already in use, this work aims to produce more quantity of drinkable water during both day and night using Paraffin wax as a phase change material(PCM) and coconut shell powder as Nanoparticle which act as an insulating material to effectively transfer the heat only into the solar still side. The experiment was categorized into three parts: first in a conventional solar still, then with PCM, and finally with PCM-Nano particles, and the findings are compared. The experimental setup of this solar still is completely economical to operate and more efficient than the normal version because of the addition of PCM and nanoparticles. Based on the experimentation the results showed that there is a significant rise in the output around 4% when using PCM and output increased to 8-10% , this increase is due to addition of Nanoparticles below the PCM which reduces any heat loss from beneath the set up.

Key words: desalination, solar still, nanoparticles, phase change material

1. Introduction

Water is one of the prime resources available by nature for the living organisms to sustain life on earth. Water has numerous applications in any human's life. Usable water or the potable water is one that is said as pure and can be used for drinking and any other purposes. Many civilizations around the world have originated on the banks of some of the rivers & water bodies.

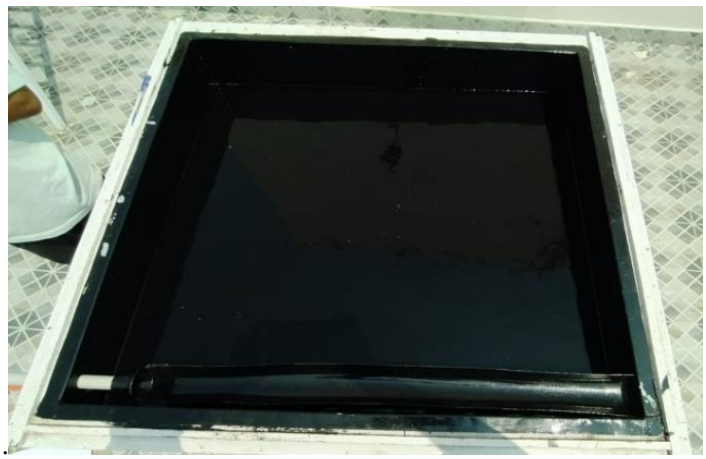


Figure 1.1: Image of Single slope solar still

These civilizations started in the bank of water bodies as there was availability of fresh & clean water for the people to settle in the area. Rivers and water bodies are called as the "cradle of mankind". Rain is the source of water for any fresh water storing water body and are very critical for a region that is dependent on water resources. Rains have started to fail during recent times due to irregularities in seasons in almost major parts

of the world due to global warming factor. Availability of fresh water in the world is rapidly depleting as the consumption rate to the population explosion rate is very high. The only available water resource on the earth in abundant is the sea water or the saltwater. The sea water is not usable water usually and it is not the pure form of water as it contains more proportion of concentrated salts and mineral contents so it not fit for use for any purpose directly. There are many methods available through which the sea water is converted into potable water. One such method is using the solar still device. A solar still works on two scientific principles, one is the evaporation and other is the condensation. The salts, minerals and contaminants doesn't evaporate with the water. Most still are having black bottomed vessels filled with water and has clear glass covered on the top. Sunlight absorbed by the black vessel speeds up the rate of evaporation. The evaporation is then trapped on the glass surface and funnelled away.

2. Methodology

Solar still works on the principle of distillation using solar rays. It is similar to the principle of rain forming and falling. The water evaporates from the ocean due to sun radiation and these water vapours are taken towards land by the clouds and the rain fall occurs, the same working is carried out on the still. The still is made of aluminium tray and the water is poured inside this tray. The tray wall & floor is covered with another wooden box on all sides except on top. The top side is covered with a see-through glass. The gap between the wooden box and the aluminium tray is provided to fill PCM and Nano Particles. The lower tilted end of the still is connected to a PVC piping for collecting the water droplets formed in the inside surface of the glass roof. This water is guided out through the PVC pipe and collected in the storage can for usage.

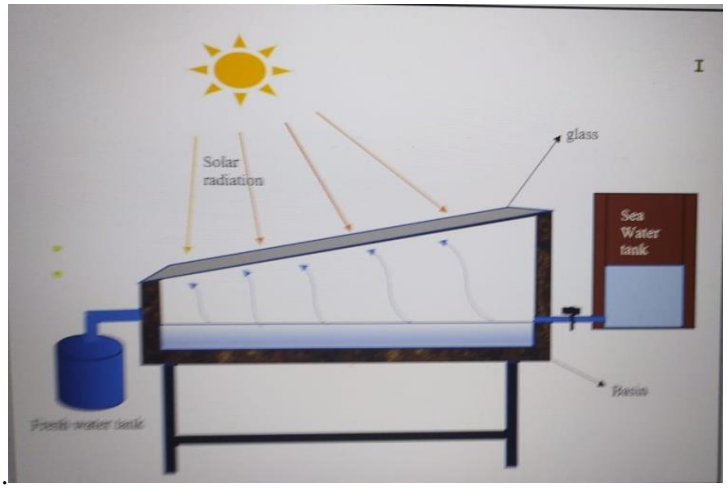
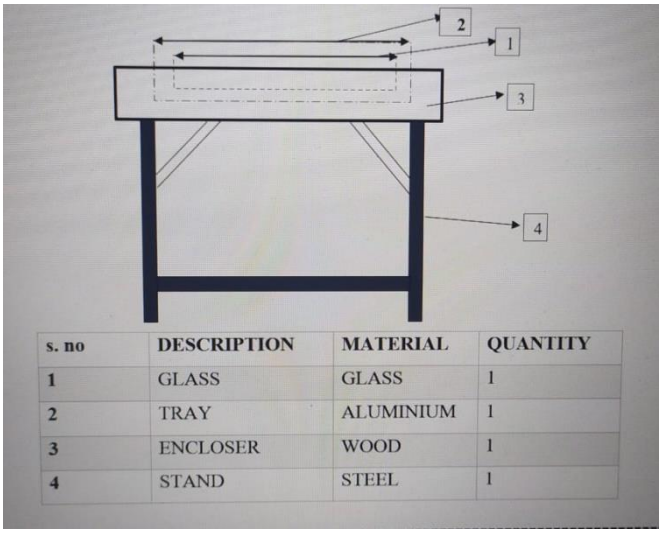


Fig. 2.1. Working of solar still

3. Experimental procedure

The solar still consists of tray , wooden enclosure for 5 sides of the aluminium tray, saltwater tank, fresh water collecting tank, clear glass for covering the top surface of the aluminium tray, stand for placing the solar still at height, PVC pipes and elbow fittings, rubber hose for collecting the fresh water. The aluminium tray is the storage vessel that is coated with black coloured paint. There are two holes given in the aluminium tray to keep PVC piping for water in and outlet. The wooden box is covered on all sides except the top and giving 2 inches gap surrounding the aluminium tray in which the PCM is filled. The top surface is closed with a clear glass and the gaps are closed with sealants Thermometers for measuring water temperature, outside temperature and the PCM temperature are connected and mounted to the still. The lower tilted end PVC piping is connected to the rubber hose that is inserted into fresh water collecting tank. The solar still is placed on a height as such the shadows do not create a hindrance for the still process. The still is one side inclined and is tilted to 10 degrees from top to bottom. This angle is maintained to help in the funnelling process of the water droplets to get collected in the PVC pipe and get drained out.



s. no	DESCRIPTION	MATERIAL	QUANTITY
1	GLASS	GLASS	1
2	TRAY	ALUMINIUM	1
3	ENCLOSER	WOOD	1
4	STAND	STEEL	1

Fig. 3.1. Components of the set up

4. Results and Discussion

The readings for temperature of the water inside the still, readings of PCM temperature and the glass temperature are noted and the relevant water output during the process on hourly basis is measured and noted down. The output water is measured in the bottle by the level indication marking done on the can for every 5ml.The readings taken using the solar still is used for plotting a graph.

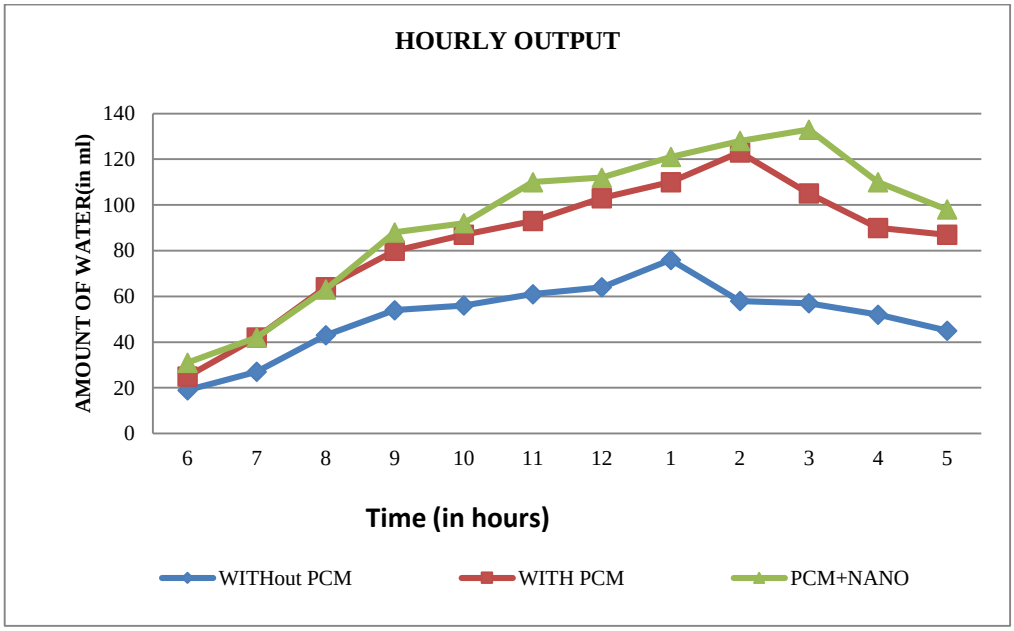


Fig. 4.1. Hourly output comparison chart

The graphs plotted are temperature comparison chart and hourly water output chart. The temperature comparison were the temperature of glass with the temperature of water inside the solar still comparison on various times during a trial day. The hourly water output chart gives the output of water on different hours of a trial day. This chart shows the water collected inside the can in millilitres.

Trial readings taken were plotted as graph to show the water output on hourly basis and temperature differences in the solar still water and outside glass temperature and the PCM insulated with nanoparticles temperature.The

total amount of water we received is 7.35 litres after using 40 litre of sea water as an input. The water test report of the received output is favourable for drinking. Thus, a solar still is designed fabricated, installed and trials have been carried out on it for the required efficiency improvement and the values on normal still and PCM filled still is compared and an efficiency comparison chart is plotted to identify the improvement on the efficiency of the solar still.

The below chart shows the overall efficiency comparison of output water collected from the solar still with and without PCM:

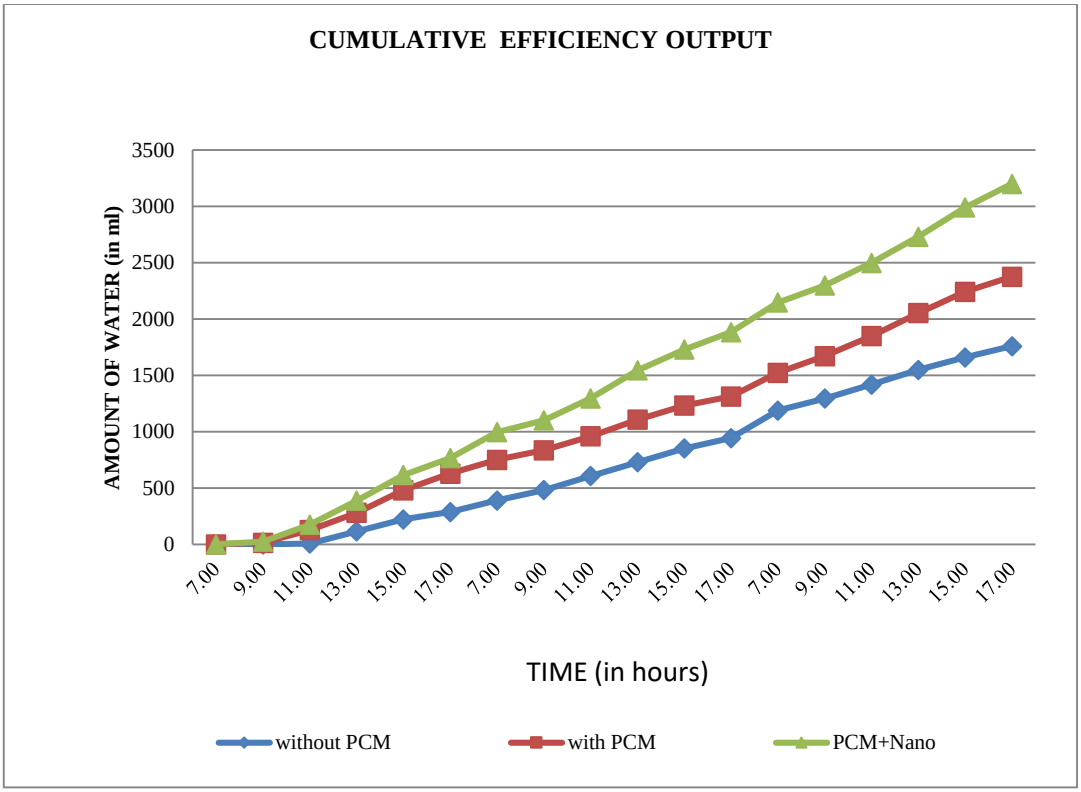


Fig. 4.2. Cumulative output efficiency comparison chart

This is a new approach of compositing a PCM with coconut shell to make the solar still work more efficiently and the proved efficiency is 8 %, which is 3.6 % greater than the normal solar still (without PCM) of similar operating conditions and capacity.

5. Conclusion

A single slope solar still with PCM, without PCM and finally with PCM-Nano particles, and the findings are investigated to enhance the productivity. Based on the experimentation the results showed that fresh water production is increased because of the presence of PCM. There is a significant rise in the output when using nanoparticles; this increase is due to addition of nanoparticles below the PCM which reduces any heat loss from beneath the set up.

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