DESIGN AND DEVELOPMENT OF SOLAR DRINKING WATER FILTER

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ABSTRACT

The present paper reports on an experiment to improve the productivity of solar still using Nano-particles. Solar distillation is a relatively simple treatment of brackish or impure water. In this solar energy is used to evaporate water then this vapour is condensed as pure water. This process removes salts and other impurities. Latest trend to improve the efficiency of the solar still is use of Nano-particles like metal oxides.

These particles increase surface area of absorption to solar radiation. In this work the Al2O3 nanoparticles mixed black paint is used to enhance the productivity of solar still. The solar radiations are transmitted through the glass cover and captured by a black painted inner bottom surface of the solar still. Water absorbs the heat and is converted into vapour within the chamber of the solar still. Single slop solar still is used from past decades but in this study effect of Nano-particles on productivity of solar still is Analyzed. Experimental work is performed for the single slope solar still (SS-SS) under climatic conditions of Coimbatore. The use of the Nano-particles mixed with black paint increases the temperature of the solar still basin. We are Designing a compact Solar Desalination filter system for Domestic Utility in low cost.

INTRODUCTION

1. INTRODUCTION TO SOLAR DESALINATION:

In the present scenario, the demand of fresh water is increasing continuously . To meet this growing demand, ground water has been intensively exploited. Fresh water is required for drinking, and other domestic purposes . Solar still is a simplest desalination device which uses solar energy for converting available impure or brackish water into distilled water. It is easy to fabricate and require no maintenance . The productivity of single basin solar stills is very low , which must be increased with some modifications. An inverted absorber solar still is a combination of a simple single slope solar still and a curved reflector under its basin which gives additional heat to basin. in this way the solar still takes an advantage of double sided heating of basin i.e. from top as well as bottom which increases the temperature of basin, which results in increased productivity . Latest trends to improve the efficiency of the solar still is, use of Nano-particles like metal oxides, coupling of other solar energy devices like solar air heater, solar pond etc, thermal storage tank. Previous study shows that use of Nano-particles demonstrate better results for solar collecting devices. In domestic buildings lots of heat is used by occupants it can be very useful for distillation process. Mathematical modelling of solar still is done by lots of researchers and this can be helpful for present study . For small or remote communities where there is lack of water but also of electrical grid the only solution is the use of renewable energies, as solar, wind etc., in connection either to small capacity conventional desalination units but better to use solar energy with solar stills. Conventional thermal desalination methods, as Multi-Stage-Flash, MultipleEffect Diffusion (MED) and minor Thermal and/or Mechanical Vapor Compression found application for large capacity installations. Reverse Osmosis, a membrane operating method which functions by electricity, is used as well in small or large capacity plants. All these methods found application worldwide, but especially in places with a total lack of fresh water and more or less dense population.

2.2 LITERATURE SURVEY:

Hardik K. Jani Kalpesh V. Modi (2018)"A review on numerous means of enhancing heat transfer rate in solar-thermal based desalination devices" 302-317 Desalination through single slope has low yield of potable water so double or dual slope has been created to boost the productivity. Various ways to improve rate of heat transfer from absorber plate to basin water are use of corrugated plate, augmentation of Fins

Maria Karolina Borba Cardoso, Karyna Steffane da Silva, Camylla Barbosa Silva, Geralda Gilvania Cavalcante de Lima, Keila Machado de Medeiros & Carlos Antônio Pereira de Lima "Low-cost solar still with corrugated absorber basin for water desalination" 214. The maximum temperatures of 90, 87.3, and 72 °C were obtained for the basin, water, and condensation glass.

production of desalinated water is directly associated with the incidence of solar radiation

PRASAD, V. C. S., & GANVIR, V. (2005). STUDY OF THE PRINCIPLES OF INNOVATION FOR THE BOP CONSUMER — THE CASE OF A RURAL WATER FILTER. International Journal of Innovation and Technology Management, 02(04), 349–366. The process has three sub-processes ie. ash treatment, container preparation and casting process.

The model is based on centralized production and the use of local distribution channels. In contrast, the present model is based on decentralized low volume production with local distribution giving a reasonable profit margin

Prasad, V. (2002). Low-cost domestic water filter: The case for a process-based approach for the development of a rural technology product. Water SA, 28(2). The process of making the filter element involves thorough mixing of RHA, pebbles and cement in required proportion along with water to the consistency of a concrete mix. The mix was rammed into a sanitary-ware pipe closed at the bottom end with a nylon mesh. Providing safe drinking water to the rural poor at an affordable cost needs novel technical, managerial and financial solutions.

Custodio, E., Acosta, L., Sebastian, P.., & Campos, J. (2001). A better solar module performance obtained by employing an infrared water filter. Solar Energy Materials and Solar Cells, 70(3), 395–399. Analyzing the solar spectrum it is observed that, about 40% of the solar energy incident on a Si cell is transmitted through due to its energy being lower than the band gap of Si: But the sealing and other protective materials used in the module absorb a major part of it. The increment in the efficiency is observed in the present study for the Si photovoltaic modules when an infrared water filter was used. This system is of low cost and easy to implement M Boubekri, A Chaker (2011). This study related to the numerical simulation of a solar active still improved by the use of reflectors (intern and external) and of a thermal storage tank for three typical days of the year. The results of the study demonstrated the direct impact of the effect of the reflectors and the storage tank on the daily productivity of the still. It appears without ambiguity that the increase in the production resulting from the reflectors and much more significant in winter (72.8 %), and in spring (40.33 %) that in summer (7.54 %) the effect of the storage tank is also very significant in winter and summer.

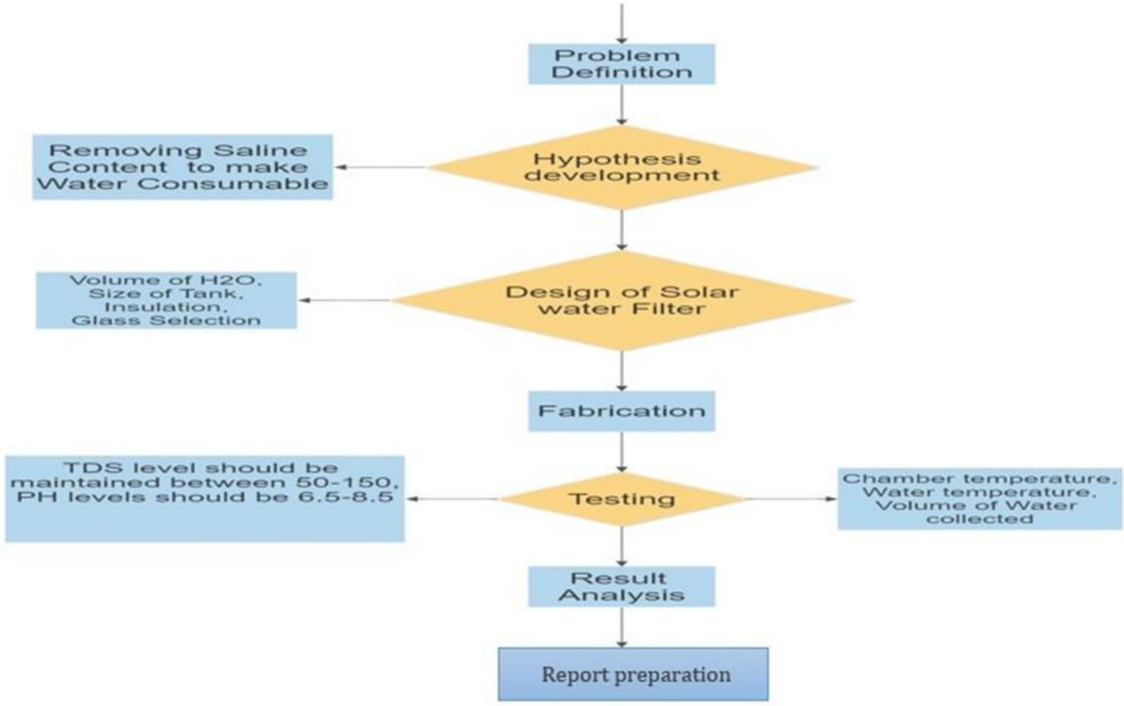
The daily productivity of the still coupled with the tank is about 27.54%, 21 % and 23.28% respectively for the winter, spring and the summer.

Vikas THAKUR M.k. GAUR M.k. SAGAR G.n. TIWARI (2021). The paper presents the recent modifications made in still to improve their productivity like the application of phase change materials (PCM), connecting flat-plate collector (FPC), use of nanoparticles, stepped solar still, and attaching separate condenser in the still. Active solar stills are found more productive than passive ones and the thermal efficiency of active solar stills lie in the range of 50–70%, which is far better than passive still having 20–55% thermal efficiency. According to the literature studied in the paper, the maximum productivity of active solar still is 10 litres per day and in passive solar stills, it is 6 litres per day. The different approaches used to carry out the heat and mass transfer analysis of single and double slope active and passive solar stills are also discussed in the paper.

Kalidasa, M.K. and Srithar, K. (2011). A layer of water with wick material in the basin will increase the evaporation area and enhance the production.A basin type double slope solar still with mild steel plate was fabricated and tested with minimum mass of water and different wick materials like light cotton cloth, sponge sheet, coir mate and waste cotton pieces in the basin. Still with aluminium rectangular fin arranged in different configurations and covered with different wicks were also tested. It was found that, the still with light black cotton cloth is the effective wick material. The still with rectangular Aluminium fin covered with cotton cloth and arranged in length wise direction was more effective.

El-Sebaii, A.A., Ramadan, M.R.I., Aboul-Enein, S. M. and El-Naggar (2015).

In this work to enhance the rate of heat transfer from the basin liner to the basin water, fins were integrated at the basin liner of the still. Experiments were performed on a finned plate solar still during June and August 2014 under Tanta (lat. 30° 47′ N, Egypt) weather conditions. For the first time, the dependence of the still efficiency and productivity on the fin configuration parameters such as the number nf, height Hf and thickness xf was studied



3.5 DESIGN OF SINGLE SLOPE SOLAR WATER FILTER

Single slop solar drinking water filter is a common device which is used from past decades. In this study the effect of Al2O3 Nano-particle on productivity of single slope solar still is analyzed. Diagram below shows the isometric view of solar still used for study. The height, length and width of the solar still are shown in Diagram. The area of basin of still is 1 m2. Solar still is made by MS sheet and cover of solar still is made by clear glass. All sides of solar still are insulated with fibre wool of thickness 50 mm. Al2O3 Nano-particles mixed black paint is painted on basin to increase the radiation absorption.

The solar radiations partially reach to the water surface directly after transmission through the glass cover, the water surface receives the rest of the radiations after the reflection from reflector. The water also partially reflects and partially absorbs the total solar radiations falling on the water surface and the rest are absorbed by the absorber painted with Nano-particles mixed black paint. Most of the solar radiations are used by water after absorption, which gets heated and vaporization is started. Due to wind some heat is transferred to the atmosphere through outer layer of glass cover and then condensation is started. This condensed water is collected through the channel.

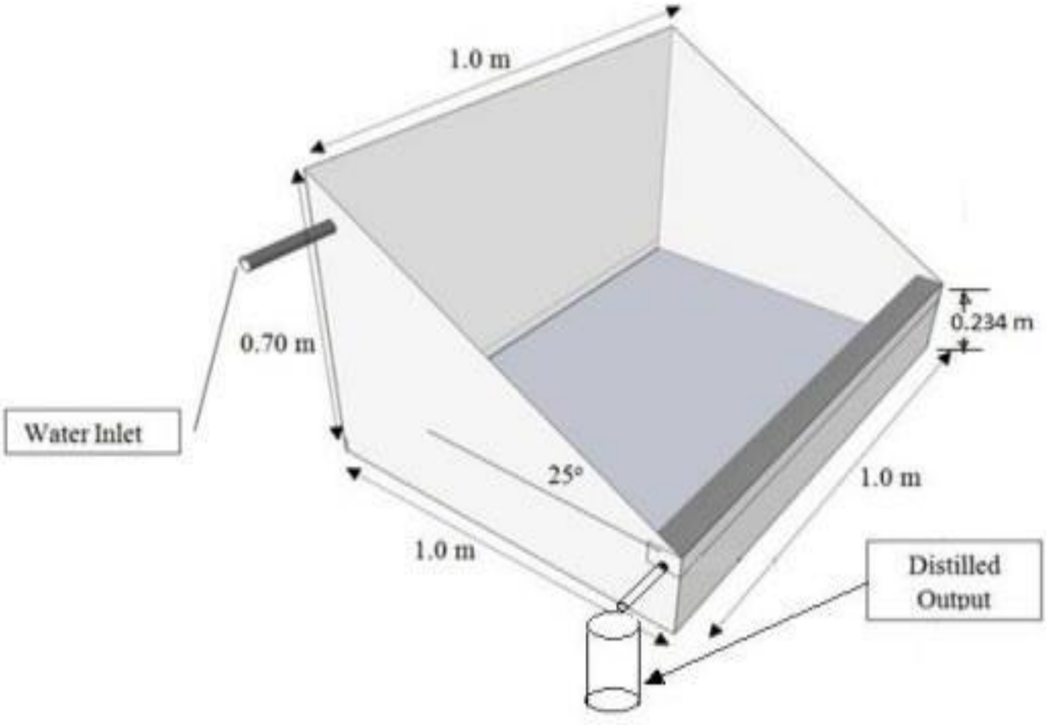


Fig 1 Isometric view of solar still

Photographs and Testing

1 Fabrication in progress

2 After Fabrication

3 Testing Done

Day 1

Time in sec	T1 (°C)	T2 (°C)	T3 (°C)	T4 (°C)	Solar Radiation (W/m^2)	Yield per day (7hrs)
9-10am	30	30	31	30	720	
10-11am	33	37	35	36	780	
11-12pm	39	40	37	47	850	
12-1pm	41	44	40	52	937	
1-2pm	44	38	45	49	908	
2-3pm	40	36	35	40	862	
3-4pm	38	34	33	39	790	800 ml

Day 2

Time in sec	T1 (°C)	T2 (°C)	T3 (°C)	T4 (°C)	Solar Radiation (W/m^2)	Yield per day (7hrs)
9-10am	28	29	29	29	660	
10-11am	30	34	34	34	690	
11-12pm	33	34	35	35	727	
12-1pm	36	41	37	37	750	
1-2pm	40	39	43	43	810	
2-3pm	38	37	39	39	765	
3-4pm	36	33	34	34	700	700 ml

Day 3

Time in sec	T1 (°C)	T2 (°C)	T3 (°C)	T4 (°C)	Solar Radiation (W/m^2)	Yield per day (7hrs)
9-10am	29	30	30	32	710	
10-11am	34	36	36	36	760	
11-12pm	38	39	38	48	830	
12-1pm	39	43	38	53	923	
1-2pm	43	38	42	45	794	
2-3pm	40	35	36	41	723	
3-4pm	39	33	34	40	705	900 ml

Conclusion

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, computing and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between institution and industries.

The Solar desalination system using nanoparticals and water purification is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality. We have done to our ability and skill making maximum use of available facilities.

In conclusion remarks of our project work, let us add a few more lines about our impression project work. The chief advantage of our system is that, simple stills type low cost solar desalination system using nanofluids and water purification when compared to other solar collectors which are available in market. Operating principle of solar desalination system using nanoparticals and water purification is also very easy. We can move the solar desalination system using nanofluids and water purification from one place to another place very easily.

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