

**COMPARATIVE STUDY OF SOLAR STILL WITH AND WITHOUT PASSIVE
STORAGE ELEMENT**¹Pushpak .R. Gharat, ²Soham .A. Chandorkar, ³Apurv .V. Bhusari, ⁴Akash Bidwaik, ⁵Nikhil .U.
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, akashbidwaik007@gmail.com⁴, nikhil371@gmail.com⁵**ABSTRACT**

Shortage of good, clean drinking water is a major problem for most developing countries of the world. In most cases, ponds, streams, wells and rivers are often polluted that they are unsafe for direct use as drinking water. Often water sources are brackish and or contain harmful bacteria. Therefore cannot be used for drinking. In addition there are many coastal locations where sea water is abundant but potable water is not available. Solar distillation is one of the important methods of utilizing solar energy for the supply of potable water to small communities where natural supply of fresh water is inadequate or of poor quality. In this direction an experimental performance analysis was carried out on a single basin still compared with modified one. In the Experimental setup, Conventional still is compared with modified still. The modified still is filled with two passive heat storage elements which are ethylene glycol water mixture and second is Normal water. Yields from both stills were compared.

Keywords— *Solar Still, Modified Solar Still, Ethylene Glycol Mixture, Yields, Distillation.*

INTRODUCTION

Solar water distillation is the process of using energy from the sunlight to separate freshwater from salts or other contaminants. The untreated water absorbs heat, slowly reaching high temperatures. The heat causes the water to evaporate, cool, and condense into vapor, leaving the contaminants behind. Solar water distillers are typically used in remote areas where there is limited access to freshwater and centralized distribution systems. Technical experts may be required to introduce the system and train direct users in use and maintenance. The systems require sitting on flat and open areas with access to water and sunlight. The “roof” of the system is installed with a transparent cover (often glass), placed at an angle to receive maximum sunlight. The sun penetrates through the cover and into the underlying still basin. The untreated water is collected in the still basin and heated up by the sun, eventually evaporating and separating from the contaminants. It is important that the material used for the still basin can absorb heat, for example a leather sheet, silicon, reinforced plastic, or steel plate. The slanted cover funnels the thin layer of condensed water from its underside into a channel (pipe, tube), which leads to a separate water storage container.

OBJECTIVES

1. To increase the yield of the still.
2. To increase the productivity of the still.
3. To maximize the efficiency of the still.

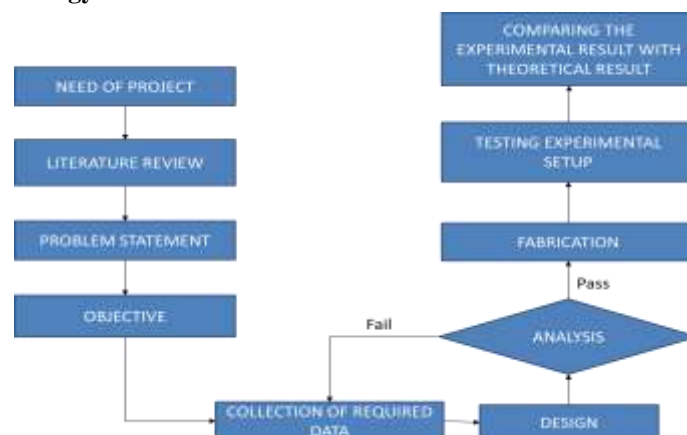
LITERATURE SURVEY

- a) **Khaoula Hidouri(2009)** published the paper “Hybrid Solar still by heat pump compression” in which, he used a hybrid system in which, a heat pump to increase the efficiency of the system and consequently the output of the still surface area. This improved the evaporation process and also the condensation of the vapours.

- b) **Mahmoud I MShatat, K Mahkamov(2009)** worked on the paper “**Determination of rational design parameters of a multi-stage solar water desalination still using transient mathematical modelling**”. It describes the experimental investigations of the performance of a multistage water desalination still. A computer program was developed for the transient simulations of the evaporation and condensation inside the multistage still.
- c) **Farshad Farshchi Tabrizi, Ashkan ZolfaghariSharak(2009)** worked on “**Experimental study of an integrated basin solar still with a sandy heat reservoir**”. In this, The sand reservoir gets heated during the day and as the solar radiation decreases, it radiates out the energy
- d) **Shiv Kumar, Arvind Tiwari(2010)** published “**Design ,Fabrication and performance of a hybrid photovoltaic/thermal active solar still**”. Using the hybrid photovoltaic solar still increases the thermal efficiency about 20%. The material used was Glass Reinforced Plastic.
- e) **M Sakthivel, Shanmugasundaram,T Alwarsamy(2010)** worked on “**An Experimental study on regenerative solar still with energy storage medium Jute cloth**”. Here, Jute cloth provides more surface area for evaporation. The yield was found to be 12.5 L/m².
- f) **M Zeroual(2011)** wrote “**Experimental investigation on a double slope solar still with partially cooled condenser**”. It consisted of the direct use of solar energy in brackish water demonstrate a competitive chance to offer a secure source of water.
- g) **Guofeng Yuan(2011)** published “**Experimental study of solar desalination system based on humidification dehumidification process**”. Which concluded that fresh water production increases as solar radiation strengthens. The material used was stainless steel and yield was 12 L/m².
- h) **Veera GnaneswarGude(2011)** wrote “**Desalination using solar energy**” which was an analysis paper. The result indicates that solar energy is best used when source is integrated with best desalination process.
- i) **A M I Mohamed(2011)** worked on “**Theoretical investigation of solar humidification Dehumidification desalination**”. It justified that the highest fresh water productivity is found to be in summer.
- j) **Patricia Paleuzucia(2011)** wrote “**Assessment of different configuration for combined parabolic trough solar power and desalination plants**“. From this paper, the conclusion was that It is also suitable in cold regions was made. The yield was found to be 48.8 m³/day.
- k) **A M EL Zahaby(2011)** published “**Enhancement of solar still performance using reciprocating spray feeding system**”. The material used was iron and galvanized steel. The performance is enhanced by using reciprocating spray feeding system.
- l) **HananeAburideh, Adel Deliou, Brahim.Abbad, Fatma Alaoui, Djilali.Tassalit and Zahia.Tigrine(2012)** published “**An Experimental Study of a Solar Still: Application on the sea water desalination of Fouka**” in Algeria.This experimental study permits to examine the influence of some internal and external parameters on the operating system and their temporal evolution.
- m) **Yazan Taamneh,Madhar M. Taamneh (2012)** wrote “**Performance of pyramidshaped solar still: Experimental study**”.It was found that using a small power consumption fan work with photovoltaic solar panels improves the vapour flow and evaporation rate.

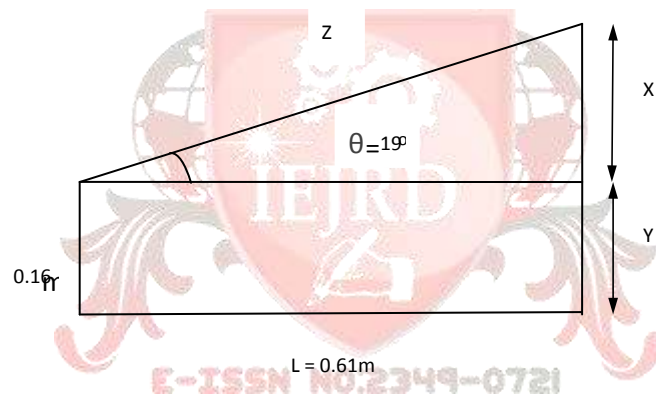
- n) **T. Arunkumar a , R. Jayaprakash ,D. Denkenberger , Amimul Ahsan c , M.S. Okundamiya , Sanjay kumar , Hiroshi Tanaka , H.Ş. Aybar (2012)** published “An experimental study on a hemispherical solar still”.The output of the hemispherical solar still with the same amount of solar radiation was improved by a factor due to effect of cooling water.
- o) **A.E. Kabeel, A. Khalil, Z.M. Omara, M.M. Younes (2012)** wrote “**Theoretical and experimental parametric study of modified stepped solar still**”. The productivity of the stepped still decreases by increasing the water depth. Preheating increases the productivity but decreases the efficiency.
- p) **N. Rahbar, J.A. Esfahani (2012)** wrote “**Experimental study of a novel portable solar still by utilizing the heatpipe and thermoelectric module**”. The daily productivity is directly proportional to solar radiation and ambient temperature, but wind velocity has an inverse effect on productivity. Combination of heatpipe and thermoelectric cooler can increase the productivity of PTSS.
- q) **M.R. Rajamanickam, A. Ragupathy (2012)** published “**Influence of Water Depth on Internal Heat and Mass Transfer in a Double Slope Solar Still**” in India. It stated that increase in depth of water in the basin resulted with a decrease in productivity of the still. The values of radiative heat transfer co-efficient and convective heat transfer co-efficient falls in the same range for all depths.
- r) **K. Sampathkumara,P. Senthilkumar (2012)** published “**Utilization of solar water heater in a single basin solar still—An experimental study**”. It stated that the thermal efficiency of active solar still is lower than the passive solar still. This system operated with a hybrid nature and was capable of producing hot water and distilled water based on the situational requirement.
- s) **Gang Xiao, Xihui Wang, Mingjiang Ni, Fei Wang, Weijun Zhu, Zhongyang Luo, Kefa Cen (2013)** published the review paper “**A review on solar stills for brine desalination**”. Here, the yield was found to be 1.25L/m².
- t) **Z.M. Omara, Mohamed A. Eltawil, ElSayed A. ElNashar (2013)** wrote “**A new hybrid desalination system using wicks/solar still and evacuated solar water heater**”. The continuous feeding of hot brackish water especially during night time increased the water productivity by about 215% as compared to conventional basin still. Analysis of distilled water quality proved its suitability for domestic and industrial usage.

Methodology



DETAILS OF THE SOLAR STILL

| Components Required | Dimensions or type |
|---------------------|--|
| Still dimensions | 0.61 × 0.61 m ² area 19 ⁰ Inclination 0.369 m height 0.160 m lower height |
| Sensors | W1209 Temperature Sensors |
| Passive element | 1. Ethylene Glycol mixed coolant 2. Water |



CALCULATIONS

By Trigonometry, we have

$$\cos \theta = L / Z$$

$$Z = L / \cos \theta = 0.61 / \cos (19)$$

$$Z = 0.645\text{m}$$

Also,

$$\sin \theta = X / Z$$

$$X = (\sin \theta) \cdot Z = (\sin \theta) \times (0.645)$$

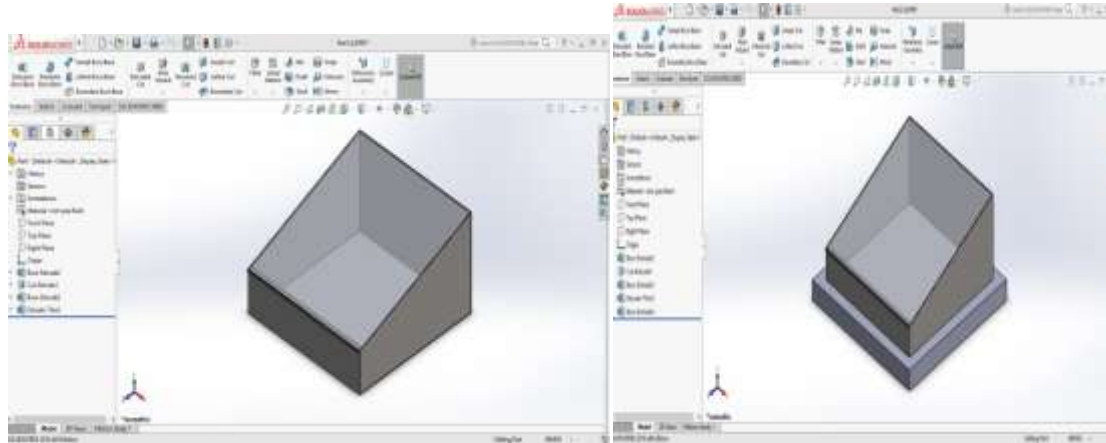
$$\underline{X = 0.209 \text{ m}}$$

Take Y = 0.16 m

Height (H) = X + Y

$$H = 0.209 + 0.16$$

$$\underline{H = 0.369 \text{ m}}$$

CAD MODEL**EXPERIMENTAL SETUP**

Experimental setup consists of a Conventional Still and a Modified Still. Both stills contain water in it. The water in the still gets heated up due to the solar radiations and is evaporated. The evaporated water then gets condensed on the glass surface, which then slides down and is collected inside the trough. This water is then transferred into the collecting vessel. The Modified still contains a tank attached below it. The tank is filled with passive heat storage element(ethylene glycol water mixture and water), which stores the heat during daytime and radiates during the night time. Hence, Yield from modified still is more. The setup consists of each 5 Temperature sensors inside the basin which gives the temperatures of water, still base, still atmosphere, still wall and glass surface. The Modified still has one additional sensor which gives the temperature of the passive heat storage element.

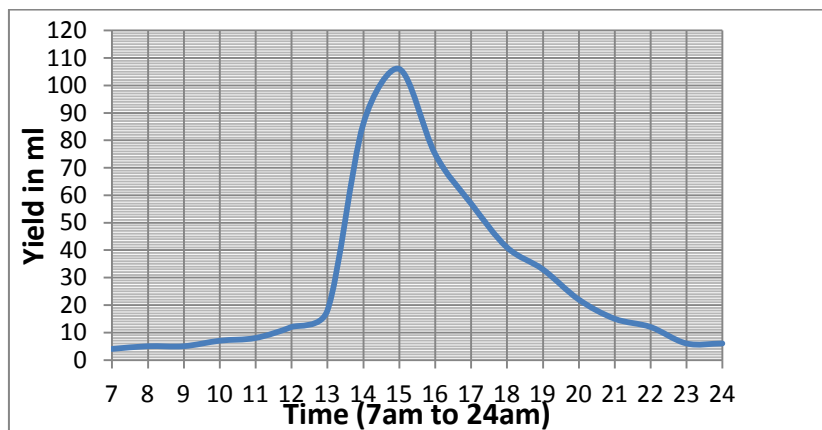




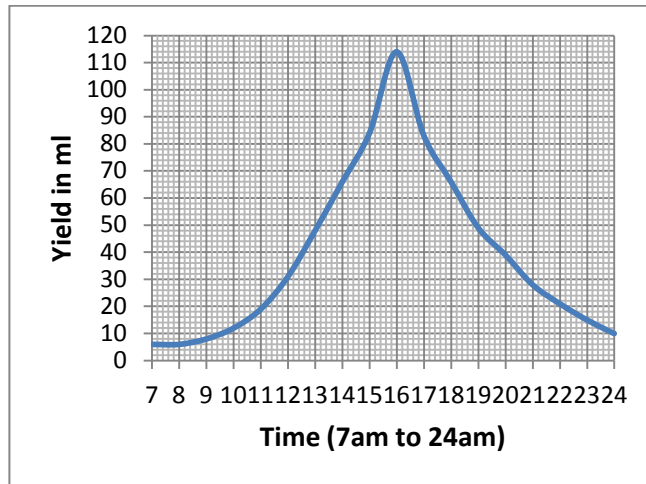
RESULT

- A number of reading are taken in seven days for 18 hours a day. Yield table shows the variation of distillate water productivity for conventional and modified Basin type solar still unit.
- It has been observed that the output is higher in the afternoon from 3.00pm to 4.00pm and lower in the morning but at night compare to conventional the modified solar still gives better performance and distillate more water at night because of its modification.
- And by using Two passive elements we got different outputs from modified one. We used “Water” and “Ethylene Glycol Water Mixture”.

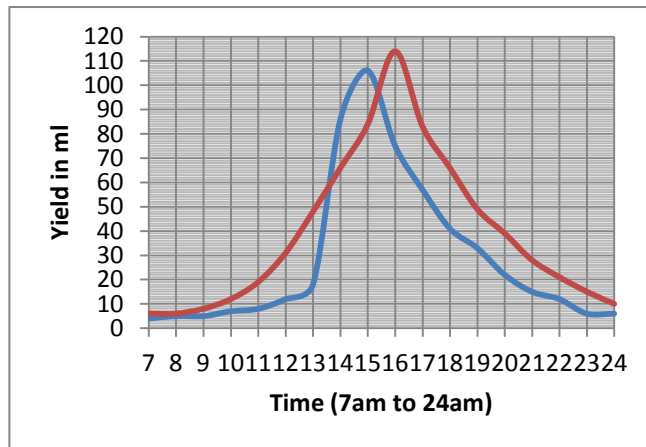
Yield V/S Time graph of Conventional Still



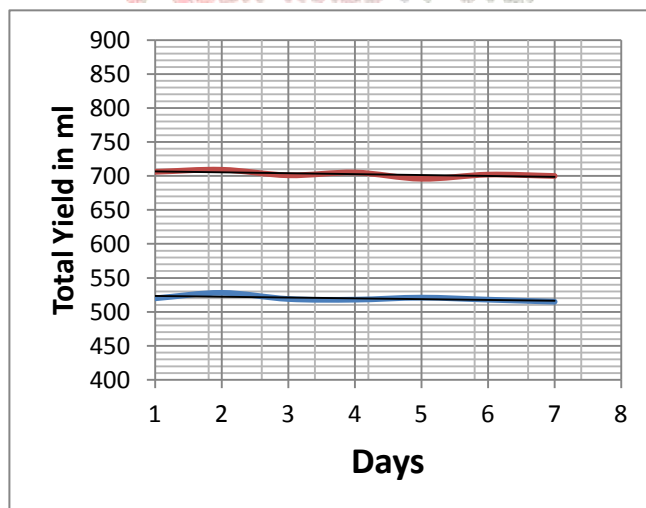
Yield V/S Time graph of Modified still



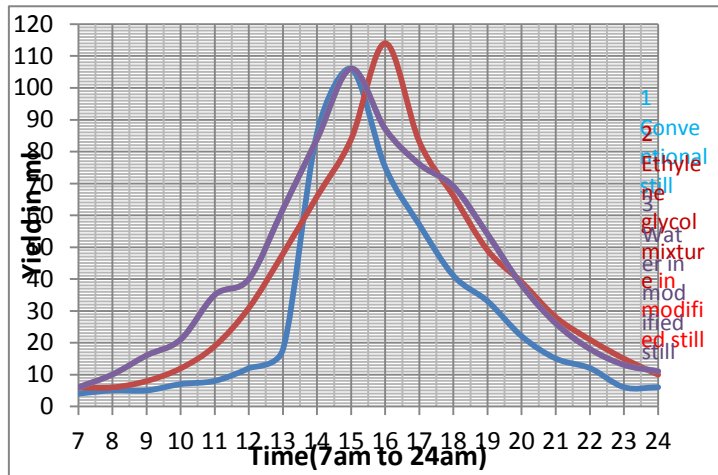
Comparative graph of Conventional still and modified still



Day wise Yield in ml



Comparative graph of conventional still v/s modified still with passive element as ethylene glycol water mixture and water.



Yield with coolant:

| Date | Yield(ml) | | Difference(ml) |
|---------|--------------|----------------|----------------|
| | Normal still | Modified still | |
| 04-Apr | 520 | 706 | 186 |
| 05-Apr | 528 | 709 | 181 |
| 06-Apr | 519 | 701 | 182 |
| 07-Apr | 518 | 705 | 187 |
| 08-Apr | 521 | 696 | 175 |
| 09-Apr | 518 | 702 | 184 |
| 10-Apr | 515 | 700 | 185 |
| Average | | | 182.86 |

Yield with water:

| Date | Yield(ml) | | Difference(ml) |
|---------|--------------|----------------|----------------|
| | Normal still | Modified still | |
| 15-Apr | 512 | 786 | 274 |
| 16-Apr | 519 | 772 | 253 |
| 17-Apr | 517 | 782 | 265 |
| Average | | | 264 |

CONCLUSION

1. Various researchers used various passive elements like wax, stones, cotton, jute cloth and they got different yields as per there basin area.
2. As per the experimental study we have used two different passive elements water and Ethylene Glycol water mixture in modified tank from which we got more yield using water compare to coolant because water has higher specific heat value which is 4.187 KJ/KgK as compared to coolant which is 2.73 KJ/KgK
3. Hence, we can use water in modified still as water is easily available and economical.

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