Experimental Investigations on Solar Still Integrated with Parabolic Trough For Desalination Process

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Abstract- *Solar still is widely used in distillation processes. But the productivity of the solar still is very low. To enhance the productivity of the single basin solar still many research works is being carried out. The various factors affecting the productivity of solar still are solar intensity, wind velocity, ambient temperature, water–glass temperature difference, free surface area of water, absorber plate area, temperature of inlet water, glass angle and depth of water. The solar intensity, wind velocity, ambient temperature cannot be controlled, as they are metrological parameters. Whereas, the remaining parameters can be varied to enhance the productivity of the solar stills. Depth of water in the solar still inversely affects the productivity of the solar still. Maintaining minimum depth in the solar still is very difficult. For maintaining minimum depth, are getting higher efficiency we can increase the fresh water we can improve the yield of absorbing intensity of solar radiation. For that we can use the solar parabolic trough. By this parabolic trough we can achieve the maximum yield of fresh water*

Keywords- Solar still, solar intensity, wind velocity, ambient temperature, water–glass temperature difference, minimum depth

I. INTRODUCTION

The greatest advantage of solar energy as compared with other forms of energy is that it is clean and can be supplied without any environmental pollution. Over the past century fossil fuels have provided most of our energy because these are much cheaper and more convenient than energy from alternative energy sources, and recently environmental pollution has been of little concern.

Clean water is essential for socio-economic development. Nevertheless, there is limited access to water that meets standard limits of water quality, especially in the African region. The quality of water can be improved through desalination. Solar distillation is a process for distilling saline/brackish water by using solar energy. Single basin solar still is a very simple solar device used for converting available brackish or wastewater into potable water. This device can be fabricated easily with locally available materials. The maintenance is also cheap and no skilled labor is required. Moreover, it can be a suitable solution to solve drinking water problem.

The still can be used in most of the places because of its low cost. But it is not implemented in society because of low efficiency. After stepped solar still as implemented for increase the efficiency of yield in fresh water. However, it is not popularly used because of its low productivity.

Naveen Kumar Sharma[etal], [1] investigated Renewable energy sources and technologies have potential to provide solutions to the longstanding energy problems being faced by the developing countries like India. Solar energy can be an important part of India's plan not only to add new capacity but also to increase energy security, address environmental concerns, and lead the massive market for renewable energy. Solar thermal electricity (STE) also known as concentrating solar power (CSP) are emerging renewable energy technologies and can be developed as future potential option for electricity generation in India.

Himanshu Manchanda[etal], [2] introduced simplest and easily accessible type of solar distillation is passive solar still which utilizes freely and abundantly available sun energy for removal of salinity/impurity from saline/brackish water. The basic passive solar still structure consists of an airtight basin usually made of concrete, cement, or galvanized iron sheet containing contaminated or saline water.Upper side of the still is covered with a transparent material like glass, plastic, etc. The inner surface of the basin is black coated for maximum absorption of the solar radiation.

Rutukesh Bhosale[etal],[3] investigated Coastal areas are facing the problem concerning water like intrusion of sea water into fresh water aquifers and making it saline, which results in reduced availability of good quantity drinking water. As there is no shortage of solar energy, our aim is to use solar energy to achieve the objective at low cost. Our purpose is to design water distillation system which converts the saline water into portable water.In this parabolic dish collector. we can use the mild steel for covering the parabolic dish. We can the silvered foil as a mirror. The components used in this dish are natural condenser, reflector dish and vessel.

ChoksiPinkal[etal], [4] introduced Solar energy is the highest potential of renewable energy available compared to all other sources of renewable. The magnitude of solar power where sun hits atmosphere in 1000 times more power than what is required. If we can use 5% of this energy still it will be 50 times more than what the world will require. The energy radiated by the sun on a normal bright, sunny day is around 4 to 7 kwhper m^2. To use this energy a solar parabolic collector is made. It uses mirrors placed in parabolic cylinder shape which reflects and concentrates sun radiation towards a receiver tube which is located at the focal line of the parabolic cylinder. The temperature attained by the working fluid is more in concentrator system as compared with flat plate collector system.

Syed Firozuddin[etal], [5] in the last few years the demand for fresh water has increased tremendously all over the world. The future demand will be very high and the fresh water resources are getting depleted at a faster rate. We need to depend on the saline water resources for meeting the fresh water demand. One best option is to use solar energy for water distillation. Distillation has long been considered a way of making water drinkable and purifying water in remote location. for ninety seven percent of the earth's mass lies in the oceans, of the remaining 3%,is brackish, 0.5% as fresh water as result many people do not access to adequate and inexpensive supplies of portable water this leads to population concentration around existing water supplies, marginal health condition and generally allow standard of living.

Stephen Lighter[etal], [6] introduced system for converting polluted liquid into pure water, and it relates more specifically to improvements in the construction and operation of solar heat actuated stills for transforming sea water into wholesome drinking liquid.The primary object of my invention is to provide a so called solar still which is simple in construction and highly efficient in operation.Many different kinds of devices for converting sea water into portable drinking water. But prior methods is complicated to utilize solar heat to efficient transformation. Some of prior methods are complicated system or bulk weight, high cost, lack of reliability, and inefficiency.

Imad Al-Hayeka[etal], **[7]** introducedSolar distillation is one of the important methods of utilizing the solar energy for the supply of potable water to small communities where the natural supply of fresh water is inadequate or of poor quality, and where sunshine is abundant. Solar energy utilization in two different types of solar stills is considered, and factors that influence the productivity of solar stills are discussed. The present investigation showed that the productivity of asymmetric greenhouse type still (ASGHT) having mirrors on its inside walls was higher than that of the symmetric greenhouse type still (SGHT) and more efficient

A. E. Kabeel[etal], **[8]** implemented the important method is minimizing the flow rate of saline water feeding. An experimental investigation on a stepped solar still with intermittent spray feeding system using flash evaporation was studied. That procedure was executed by feeding the saline water into the still through a controlled transverse reciprocating spray system on the form of fine droplets. This technique helps on the uniform spread of droplets on the top surface of a stepped-absorber solar still in an intermittent process. The still was tested at 250 rpm motor speed and at 15.606 l/h and 9.333 l/h rates of saline water spray flow. The spray frequency was 5, 4, 3, 2.5 spray per hour. Optimum operating conditions were identified. An accumulated productivity of 5.519 l/m2 over only 10 h with efficiency of 65.11% was obtained.

Robert M. Fox[etal], [9] invention relates to a lens dome solar distiller for converting sea water or other nondrinking water to pure drinking water. A pilot forced down at sea or in a remote area or survivors of a ship afloat on the life rafts often would survive expect for the absence of portable water.There are two accepted methods of producing portable water for emergency use. One is by means of chemical treatment and filtration and the other is by means of an inflatable solar distillation unit.The drawback of chemical treatment is the limitation in the amount of portable water that may be produced. The amount of portable that may be produced is a direct function of the amount of chemical available.

A.E. Kabeel[etal], [10] next important point is minimizing the flow rate of saline water feeding. An experimental investigation on a stepped solar still with intermittent spray feeding system using flash evaporation was studied. The procedure was executed by feeding the saline water into the still through a controlled transverse reciprocating spray system on the form of fine droplets. This technique helps on the uniform speed of droplets on the top surface of a stepped absorber solar still in a intermittent process. The still was tested at 250 rpm motor speed and at 15.606 1/h rates of saline water spray flow. The spray frequency was 5, 4, 3, 2.5 spray per hour. Through the investigated range, the optimum frequency of intermittent spray feeding is three times per hour at a water flow rate 0f 9.333 l/h and motor speed of 250rpm. The still efficiency is 65.11%.

II.COMPONENTS OF SOLAR PARABOLIC TROUGH

The main components of the parabolic trough

1. Collector
2. Receiver
3. Mirror support
4. Trough stand

COMPONENTS OF SOLAR STILL

The main components of solar still

1. Step System
2. Glass plate
3. Frame and pillars
4. Inlet and exit pipes
5. Trays

III. WORKING OF SOLAR STILL

The Solar Still with the above-mentioned components work as follows.As the air medium in between the water surface and the glass surface, there is a chance of higher heat transfer. This is because of the fact that the heat transfer between the water steps and glass surface is inversely proportional to the air medium between the two surfaces. Amount of gap (air medium) is inversely proportional to the Heat transfer rate.The solar energy radiation, from the sun enters into the still through the glass surface. As per the inclination, the amount of solar radiation entering into the still varies. Then the air medium inside the still is heated. Then this heat is transferred to the water contained within the trays in each step. This heat is transferred to the water and water evaporates. This evaporated vapour, in turn condenses on reaching the glass surface. After the water entered into the the evacuated tube for further heating.

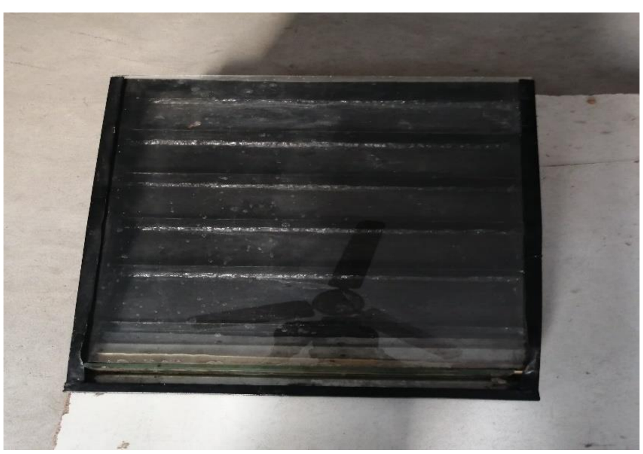


Fig.1 Solar still

Calculation of volume of water that can be stored inside the still

Volume of each tray = 60 x 10 x 1 cm^3 = 600 cm^3

There are 6 trays in the still therefore, volume of water = 3600 cm^3

On the whole maximum of 6 liters can be held in 6 trays in total..

IV. RESULTS AND DISCUSSION

The results of the mentioned testing are obtained at the end of experimentation. The experimentation details and the results obtained are shown in the below table.

CALCULATION OF CAPACITY OF THE STILL

Total number of trays = 5
Volume of each tray = 0.1 x .006 x 0.5
= 0.0003
= 0.3liters
Total volume of the still = 5 x 0.3
= 1.5 litters

OBSERVATIONS RECORDED WITH SOLAR STILL

S. No .	Energy storage material	Date 2021	Temperature observed (°C)	Volume flow rate litres /hour	Volume flow rate litres/s	Productivity of the still (%)
1	Nil	14th Feb	41.2	0.31	$8.6x10^5$	47.33
2	Solar parabolic trough	15th Feb	48.4	0.62	$17.2x10^5$	62

Time taken for saline water to Evaporate from the still= 2 hours 15 minutes
The output obtained = 0.71 litres
Volume flow rate per hour = 0.71 / 2.25
= 0.31 litres/ hour
Volume flow rate per second= 0.31 /3600
=$8.61x10^{-5}$ litres/ s
Productivity = 0.71/1.5
= **47.33%**

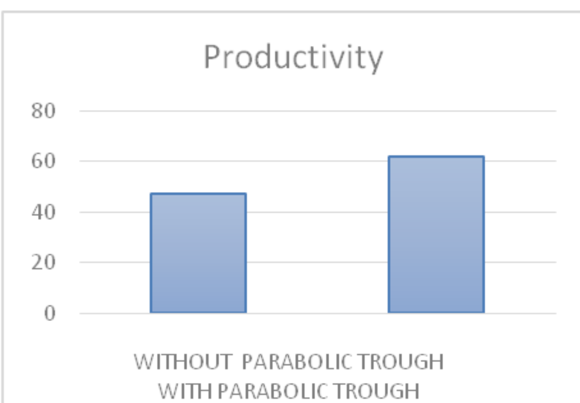
Observations recorded during operation

Based on the above experimentation the results observed were enlisted. The numerical observations suggest the following things.

The solar still would work effectively between 12:30 pm and 2:00 pm. This is because, in India, the sun's heat reaches the earth with maximum intensity in that time interval. The stepped solar still has the productivity which is larger than the conventional still by at least 5. The stepped solar still has higher productivity when used with energy storage materials. Once chosen the best one for domestic use, there is no need to change the energy storage material periodically.

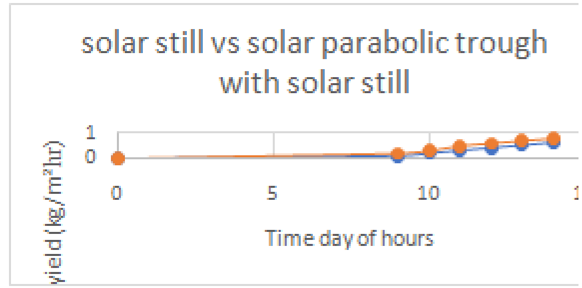
The still gives higher productivity, if the still is moved opposite to the sun periodically. This can be done with automatic solar sensor fixed to the still and making the stand rotatable. The solar still gives improved productivity (per day) with energy storage materials. The energy storage materials get heated during the day time and liberate heat during the night time. GI sheets are preferred to copper sheets because it can heat up as quickly as copper and the cost is much lower. Leakages heavily affect the productivity of the stepped solar still. Hence if there is any leakage, it must be detected and sealed properly for further use. Black coating improves the performance of the solar still. Uncoated still easily get rusted and the productivity is much lower.

Results indicate that productivity (based on the capacity of the still) is also increased when energy storage materials used. Example, without solar parabolic trough the productivity is 47.33% i.e., 0.71 litres, whereas when we use solar parabolic trough, the productivity is 62%. Productivity of the still with varies in solar still shown in the graph.



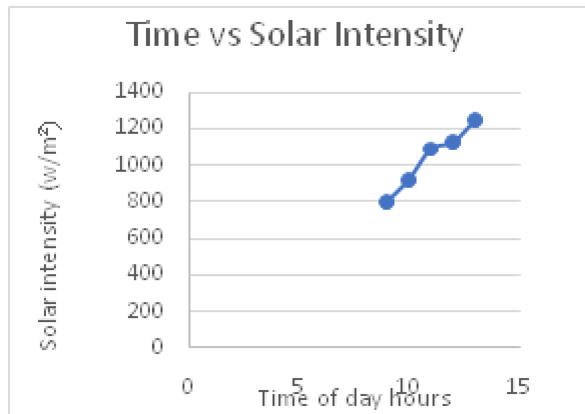
Productivity obtained using solar still and solar parabolic trough

The above figure shows x axis as time and y axis as solar intensity. As the time increases the solar intensity also increases.



Time vs yield

Solar still



Solar parabolic trough with solar still

The above figure show x axis as time and the y axis as y_1& y_2. solar still without solar parabolic trough & solar still with solar parabolic trough. By using the solar parabolic trough, the temperature increases the output also increase.

V. CONCLUSION

Our project can be used for obtaining the fresh water by solar energy and also by implementation of the project we can produce electricity. It is the one of the methods for quick Acollection of fresh water. In future this method can connected with real time monitoring method. This method of collecting the freshwater is very easy and cost is also comfortable for maximum number of the users in future. Collected fresh water is fit for any activities like drinking, washing, etc,. our project will improve the efficiency of yield in collecting fresh water.

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