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# PERFORMANCE ENHANCEMENT OF DOUBLE SLOPE SOLAR STILL INTEGRATED WITH TUBULAR SOLAR COLLECTOR

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## ABSTRACT

Extracting fresh water from seawater requires a great deal of energy, both thermal and mechanical. Solar radiation is usually chosen over other renewable energy sources because its thermal energy can be directly applied to drive desalination systems without the inevitable energy loss associated with energy conversion according to the second law of thermodynamics. Direct solar desalination systems combine solar energy collection and desalination in one process producing fresh water distillate by directly applying collected solar energy to seawater. Solar distillation using a solar still is an example of direct solar desalination. Indirect solar desalination systems comprise two sub–systems: a solar collection system and a desalination system. The solar collection sub–system is used either to collect heat using solar collectors and supply it via a heat exchanger to a thermal desalination process or to convert electromagnetic solar radiation to electricity using photovoltaic cells to power a physical desalination process. The desalination sub–system can be any conventional desalination system. The productivity of the conventional solar still is planned to be increased by using fins with different arrangement and also efficiency of the still made to be increased by integrating with preheating device the overall productivity of the still enhanced economically.

## I. INTRODUCTION

There is an important need for clean, pure drinking water in many developing countries. Often water sources are brackish (i.e. contain dissolved salts) and/or contain harmful bacteria and therefore cannot be used for drinking. In addition, there are many coastal locations where seawater is abundant but potable water is not available. Pure water is also useful for batteries and in hospitals or schools. Distillation is one of many processes that can be used for water purification. This requires an energy input, as heat, solar radiation can be the source of energy. In this process, water is evaporated, thus separating water vapour from dissolved matter, which is condensed as pure water. Solar water distillation is a solar technology with a very long history and installations were built over 2000 years ago, although to produce salt rather than drinking water. Documented use of solar stills began in the sixteenth century. An early large-scale solar still was built in 1872 to supply a mining community in Chile with drinking water. Mass production occurred for the first time during the Second World War when 200,000 inflatable plastic stills were made to be kept in life-crafts for the US Navy

## II. WORKING PRINCIPLE OF SOLAR STILL

In desalination, brackish or saline water is evaporated using thermal energy and resulting vapour is collected and condensed as final product. The simple device which converts the

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brackish or saline water into the fresh distilled water is known as solar still. It uses solar energy as energy source in the form of solar radiation to increase temperature of water. The Water in basin evaporated by the solar radiation and water vapour is transmitted on the glazing cover which is condensed by the wind. The condensed water on inside surface of glazing cover is collected by providing inclination to the glazing cover. Due to the simplicity of this device, it has various applications in the industrial as well as domestic sectors. The system is to use solar energy for getting drinkable fresh water from saline water. The ideal basin used for the solar distillation has shallow and wide structure with the black painted at the inner surface, wide to increase the surface area and black paint is use for to trap maximum amount of solar radiation. The painted surface is baked in the sun to free from the toxicity of colour otherwise the toxic volatiles evaporated with the distilled water. The basin is painted black to increase water temperature so that rate of evaporation can be accelerated. For the collection and condensation of water the transparent cover is used. If the temperature difference between glass cover and basin plate temperature are increase than distilled output is increase. The glass cover kept the radiation inside the basin. The simple concept of this system is to use solar energy for getting drinkable fresh water from saline water. The ideal basin used for the solar distillation has shallow and wide structure with the black painted at the inner surface, wide to increase the surface area and black paint is use for to trap maximum.)

## III. TYPES OF SOLAR STILL

Solar desalination system consists different types of solar still.

### SPHERICAL SOLAR STILL

The still consists of a shallow circular basin that is made of steel. The circular absorber basin is coated with black paint for maximum absorption of incident solar radiation. The circular basin is fixed at the middle of the spherical Aluminum mesh The saline water is stored in a basin The basin in the spherical solar still is fitted without having any physical contact with the top cover made of low-density polyethylene (LDPE) sheet. A gap is maintained between the circular basin and top cover. The evaporated water, which is condensed on the top cover, passes between this gap, and drips down towards the distilled water collection segment

A pyramidal glass solar still is filled with saline water. From the economic point of view, the solar still with sawdust insulating material has less cost of fabrication. Consequently, the cost of fresh water production is less. In the view of eco-friendly material, saws dust would be a good alternative for glass wool. The water storage segment is provided of diameter 0.90m, and the remaining 0.05m is allowed for the water collection segment.

### SOLAR COLLECTORS

Solar collectors transform solar radiation into heat and transfer that heat to a medium (water, solar fluid, or air). Then solar heat can be used for heating water, to heating or cooling systems, or for heating swimming pools.

Solar cooling technologies demand high temperatures and not all the type of solar collectors are capable of producing them. The collectors needed are based on technologies, which can supply hot water at relatively high temperature (90-150˚C)

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APPARENT SOLAR DAY

The duration of one rotation of the earth on its axis with respect to the apparent sun. Also known as true solar day.

**DIRECT SOLAR RADIATION**

That portion x of the radiant energy received at the actinometer direct from the sun, as distinguished from diffuse sky radiation, effective terrestrial radiation, or radiation from any other source.

**SOLAR ABSORPTION INDEX**

A relation of the sun's angle at various latitudes and local times with the ionospheric absorption.

**SOLAR AIR MASS**

The optical air mass penetrated by light from the sun for any given position of the sun.

**SOLAR CONSTANT**

The rate at which energy from the sun is received just outside the earth's atmosphere on a surface normal to the incident radiation and at the earth's mean distance from the sun; it is approximately 1367 watts per square meter.

**SOLAR ENERGY**

The energy transmitted from the sun in the form of electromagnetic radiation.

**SOLAR FLUX UNIT**

A unit of solar radio emission per unit frequency interval, equal to 10-22 watt per square meter per hertz at the earth.

## I. THEORETICAL DESIGN OF SOLAR STILL

The double solar still have many components. There are

- Solar still box
- Absorber plate
- Fins
- Tubular solar collector
- Aluminum pipe

SOLAR STILL BOX

Solar still box made up of galvanized steel. The dimension of the solar still box,

- HEIGHT =50 cm
- LENGTH =100 cm
- BREADTH =50 cm

**ABSORBER PLATE**

The absorber plate is made up of mild steel. The dimension of the absorber plate is 50*100 cm.

FINS

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The fins are made up of mild steel. The dimension of the fins are 10 mm and height is 5 cm.

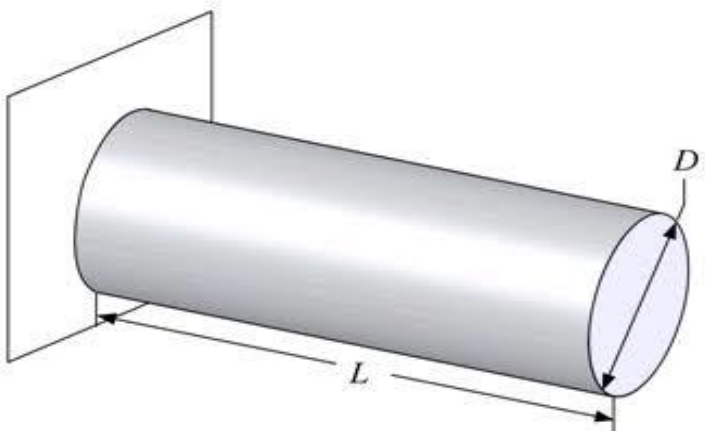


Fig 2.1 Fins

TUBULAR SOLAR COLLECTOR

Tubular solar collector is made up of glass. The dimension of the tubular solar collector 5 cm diameter and 100 cm length.

Fig 2.2 Tubular solar collector

ALUMINIUM PIPE

The Aluminum pipe used as a secondary preheating device. The dimension of this pipe is 25 mm outer diameter and 1m.

## V.LITERATURE SURVEY

Raja Seenivasan et al, conducted the experiment on solar still with an integrated flat plate solar collector.The Jute cloth and black gravels are used in the basin to improve the evaporation rate and heat capacity of the still. FPCB still has higher evaporation rate than the conventional basin still. The effect of extended surface and preheated water supply increases the distillate of the FPCB still about 60% than that of the conventional still for the same basin condition. Stills with jute cloth enhance the productivity in sunshine hours and the black gravel has a significant effect at afternoon hours. The maximum productivity values obtained for conventional and FPCB stills are 3.62 and 5.82 kg/m$^2$·day respectively

Muthusamy et al, increased the productivity of the desalination by using the modification in air heater. The effect of increase of heat transfer rate enhances the productivity of the system.

## VI.PROJET FABRICATION

The line diagram of the double slope solar still integrated with the tubular solar collector with different arrangement of fins in the absorber plate.

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Experimental setup

**SOLAR STILL BOX**

Research has been conducted on the improvement of solar still productivity using cooling water over the glass cover. This idea is very simple because it only involves modifying the way the feed water is introduced to the still. This can be done by simply raising the feed water container to the level of the highest part of the still and directing the flow over the glass. The perforations in the pipe created a smooth, steady film of water. Not only does the water film cool the glass, which increases the rate of condensation, it also slightly preheats the feed water, continuously cleans the glass surface, insulates the still by reducing convection and radiation losses from the glass, and surprisingly, lets lighter in. The way the water lets more solar radiation into the still is by the lower index of refraction, which is 1.33 for water and 1.52 for glass. This reduces the proportion of energy absorbed into the glass

**STILL BASIN**

It is the part of the system in which the water to be distilled is kept. It is therefore essential that it must absorb solar energy. Hence it is necessary that the material have high absorptivity or very less reflectivity and very less transmittivity. These are the criteria's for selecting the basin materials. Kinds of the basin materials that can be used are as follows: 1. Leather sheet, 2. Ge silicon, 3. Mild steel-plate, 4. RPF (reinforced plastic) 5. G.I. (galvanized iron). We are used to GI sheet for the sill basin. The perforations in the pipe created a smooth, steady film of water. Not only does the water film cool the glass, which increases the rate of condensation, it also slightly preheats the feed water, continuously cleans the glass surface, insulates the still by reducing convection and radiation losses from the glass

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Finned solar Basin

## SUPPORTED FRAME

The frame provided for supporting the top cover is an optional thing. I.e. it can be used if required. We have used mild steel as a support to hold solar still box

## VII. MODIFICATION OF THE NEW DESIGN

The arrangement of the fins are differently vary from the previous type of solar still. Two different fins arrangements we are used.

SPRING INSERTS

We are use the spring as a inserts. It will be change of the flow of the inlet fluid temperature and pressure. The spring is made up of spring material. The spring material have high thermal conductivity.

| . No | Date/ Time | Temperature | | | Heat transfer rate of waterQw KJ/Kg | Amount of condensation in lit |
|---|---|---|---|---|---|---|
| | | Inlet water T1 | Exit the preheater T2 | Outlet temperature T3 | | |
| 1 | 20.03.2018/ 12.30 | 42˚c | 54.5˚c | 60˚c | 52.25 | .700 |
| 2 | 19.03.2018/ 3.00 | 40˚c | 51.5˚c | 59˚c | 39.71 | .600 |

## VIII. RESULT AND ANALYSIS- HEAT TRANSFER RATE

The heat transfer rate of the water formula is given by

Qw = mCp( To -Ti )

- Qw = Heat transfer rate of the water
- m = Mass of the water
- Cp = Specific heat of water
- To = Outlet temperature
- Ti = Inlet temperature

AVG. PERCENTAGE OF INCREASED HEAT TRANSFER = 66.77+18.75 = 42.76%

APPLICATIONS

- Produce the pure water.
- No prime movers are required.
- No skilled operator required.
- Low investment.

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- Can purify high saline water.

## IX. ADVANTAGES AND DISADVANTAGES

ADVANTAGES

Solar distillation is a low-cost system. No energy cost is involved due to the use of solar panels. It is a pollution free system with very low maintenance.

DISADVANTAGES

Solar desalination system is suitable only for the requirement of small outputs and it requires a lot of space. Its efficiency is low due to immediate loss of the latent heat of condensation through the glass cover of the still. Various functional processes like solar absorption, evaporation, condensation, and heat recovery occur within a single component.

## X. CONCLUSION

Experiments are carried out for double slope solar stills. The productivity of solar still is strongly influenced with various parameters. Such as solar intensity, basin area, depth of water. Also, the productivity of fresh water increases when depth of water is reduced. To preheat the feed water, tubular solar collector is used as a solar energy collector thereby the productivity of solar still is enhanced. The maximum yield obtained from double slope solar still integrated.

Double slope solar still integrated with tubular solar collector produced higher productivity than the conventional solar still.

Avg. percentage of increased heat transfer rate = 42.76%

## REFERENCES

1. An experimental investigation on a solar still with an integrated flat plate collector, Desalination 347 (2014) 131–137 T. Raja seenivasan a, P. Nelson Raja a, K. Srithar

2.An experimental study on single basin double slope simulation solar still with thin layer of water in the basin, K. KalidasaMurugavel, Kn.K.S.K. Chockalingam, K. Srithar, Desalination 220 (2008) 687–693.

3. Combined probation of bubble column humidification and dehumidification desalination system using solar collectors T. Rajaseenivasn , R.K. Shanmugam, V.M. Hareesh, K. Srithar, Energy 116(2016)459e469

4.Muthusamy.C,Gowtham.M,Manickam S, Manjunathan.M, Srithar.K, Enhancement of productivity of humidification-dehumidification desalination using modified air heater, Desalination and water treatment.2015;56(12):32904-304.https:/doi.org/10.1080/19443994.2014.968876.