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Design of Water Purification System Working on Solar Radiation

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Abstract: Nowadays, World has put a main focus on "How to use Renewable source of energy in efficient way." And also one more point to save water as it get exhaust day by day. Here, we discuss one method to Purify water by the use of Solar Radiation. The water purification system we are developing works on the phenomenon of solar radiation where we uses sun rays to make water vapour and condensed to distilled water in faster way and by adding minerals to water so that it is drinkable.
Keywords: Water Purification Process, Condenser, Parabolic Reflector, Condensation Process, Parabolic Trough, Solar Evacuated Tubes and Eco-Friendly.

I. INTRODUCTION

A. Solar Still

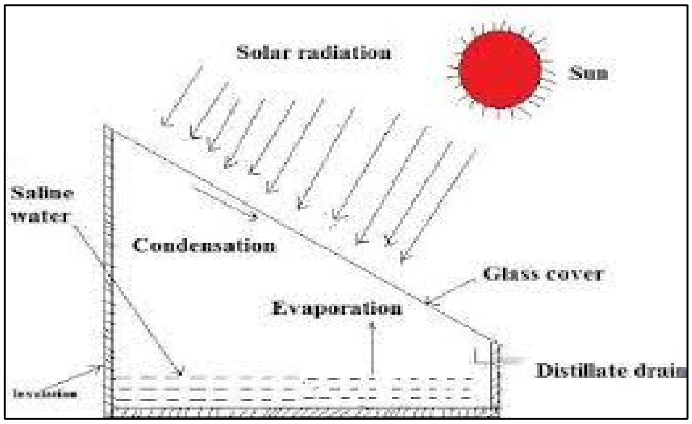
A solar still is a traditional way to purify water using solar radiation. But the main problem associate with this process is that its efficiency, which is very low and cannot be used in daily life. Because it purify water very slowly which cannot match the daily need of normal family. Losses during evaporation and condensation process in the traditional way of purification of water through Solar Still is very high which reduce their efficiency. Its efficiency also depends on surface area exposed to the Solar Radiation, so in order to increase its efficiency we have to increase its **Surface Area** exposed to Solar Radiation which required large Space to accommodate.

B. Problem associate with solar still

Required large area, Low efficiency, Time consuming process.

C. Methods available

This method was first used by the peoples of the Andes. A pit is dug into the earth, at the bottom of which is placed the receptacle that will be used to catch the condensed water. Small branches are placed with one of their ends inside the receptacle and their other ends up over the edge of the pit, forming a funnel to direct the condensed water into the receptacle. A lid is then built over this funnel, using more small branches, leaves, grasses, etc. The completed trap is left overnight, and moisture can be collected from the receptacle in the morning. With the time, the only change that occurs in this whole process is the use of material. Which somehow increase their efficiency to some extent but fails to meets daily requirement of Water by average family size.



(Fig. No. 1.1 Solar Still)

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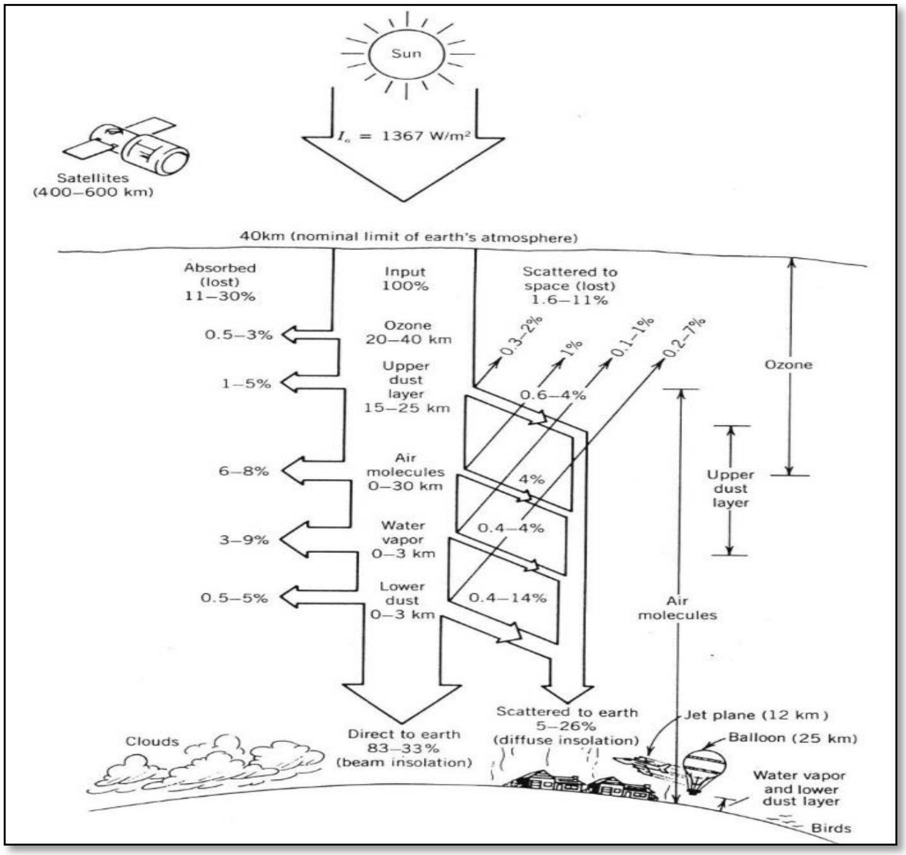
II. ATMOSPHERIC EFFECT

The atmosphere causes a reduction of the extraterrestrial solar input by about 30 per cent on a very clear day to nearly 90 percent on a very cloudy day. Figure gives an indication of the range of the absorption and scattering caused by different components of the atmosphere. On the surface of the earth, we perceive a beam or direct solar irradiance that comes directly from the disc of the sun and a diffuse or scattered solar irradiance that appear to come from all directions over the entire sky. In this text we will use the term direct to signify solar irradiance coming directly from the sun's disc, and the term diffuse to indicate solar irradiance coming from all other directions. We use the traditional subscript (b) to represent the direct component of solar irradiance and the subscript d to indicate the diffuse component. The sum of direct and diffuse solar irradiance is called the global or total solar irradiance and is identified by the traditional subscript (t). On a clear day, direct solar irradiance represents about 80 or 90 percent of the total amount of solar energy reaching the surface of the earth. Local blockage of the direct component of solar irradiance produces shadows. On a cloudy or foggy day when "you can't see the sun," the direct component of solar irradiance is essentially zero and there are no shadows. The direct component of solar irradiance is of the greatest interest to designers of high-temperature solar energy systems because it can be concentrated on small areas using mirrors or lenses, whereas the diffuse component cannot.

As depicted on Figure, diffuse radiation is the result of downward scattering of solar irradiance by nitrogen, oxygen, and water molecules, water droplets, and dust particles in the atmosphere. The amount of this scattering depends on the amount of water and dust in the atmosphere and the altitude of the observer above sea level. Since diffuse solar irradiance cannot be concentrated, only flat-plate (non-concentrating) solar collectors and some low-temperature types of concentrators (having wide acceptance angles) can collect diffuse solar irradiance. Few of the collectors used in industrial applications can utilize the diffuse component of solar radiation. The variation of these factors, especially that of water droplets (i.e. clouds) as they attenuate the direct component and change the diffuse component, is the major unknown parameter in the design of systems to collect solar energy. Consequently, a considerable amount of effort has been and is being spent in measuring, cataloging, and developing analytical models to predict these effects.



(Fig. No. 2.1 Nominal range of clear sky absorption and scattering of incident solar energy)

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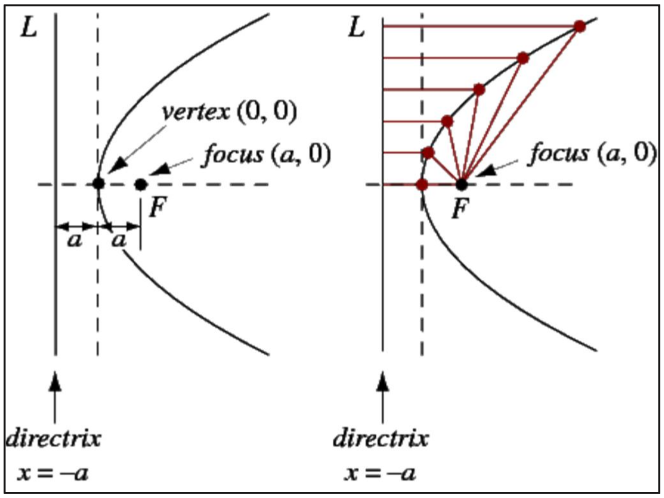
Due to the above reason, the total solar radiation released by Sun is not received on Earth, only approx. 1367 W/m^2 received at Earth. As we know that we cannot use 100% energy of Solar Radiation. *Considering 80% of Solar Radiation, i.e. around 1100 W/m^2 we can use for our daily purpose.*

III. COMPONENTS OF PROJECT

A. Parabolic Reflector

Parabolic geometry is the basis for such concentrating solar power (CSP) technologies as troughs or dishes. Parabolic trough is also considered one of the most mature and most commercially proven technologies in the utility scale CSP facilities, so we will look at the physical principles of parabolic concentrators in some more detail.



(Fig. No. 3.1 Geometry of Parabola)

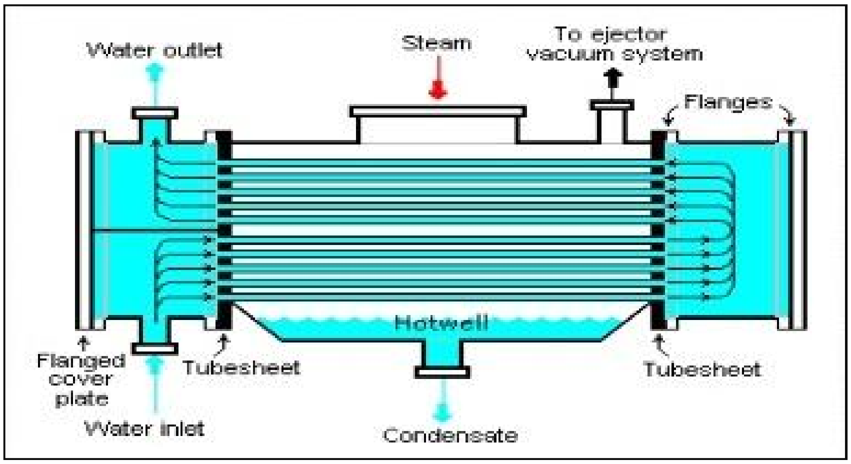
Geometrically, a parabola is a locus of points that lie on equal distance from a line (directrix) and a point (focus) - see Figure. For each point of the parabola, DR = FR. The distance VF between the vertex and focus of the parabola is the focal distance (f). The line perpendicular to the directrix that passes through the focus is the axis of the parabola; the axis divides the parabola into two parts that are symmetrical.

With origin at its vertex, and the axis of the parabola taken as x-axis, a parabola is described by the equation:

$$y^2 = 4fx$$

Where, f is the focal length

By definition of the focal point of the parabola, all incoming rays parallel to the axis of the parabola are reflected through the focus. This provides an opportunity for light concentration by using parabolic surfaces.



(Fig No. 3.2 Condenser)

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B. Ellipsoidal Bowl

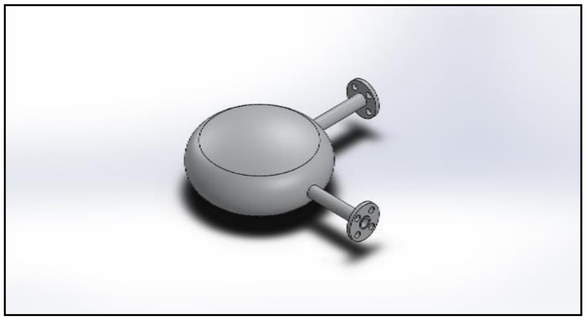
Ellipsoidal bowl is a component in which water is converted to steam. Concentrated sun's rays through parabolic reflector is focus on this bowl only.

C. Condenser

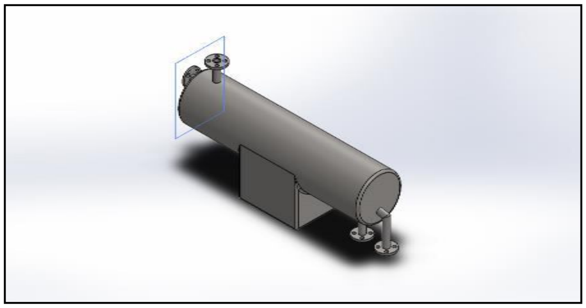
A condenser is a type of heat exchanger in which vapors are condensed into liquid state by removing the latent heat with the help of moving coolant such as water.

Description	Formula
Calculate the provisional area	$A = \frac{Q}{U D \Delta t}$
Based on the assumed tube diameter (ID and OD at a given BWG) and tube length, L, calculate number of tubes	$N_t = \frac{A}{\pi d_o L}$
Calculate the bundle diameter	$D_b = d_o \left(\frac{N_t}{K_1}\right)^{1/n_1}$
Mass flow rate of cooling water	$m = \frac{Q}{C_p \Delta t}$
Calculate the mean temperature difference using	$DTm = Ft * LMTD$
Calculate the area for cross-flow	$A_s = \frac{(p_t - d_o) D_s B_s}{p_t}$

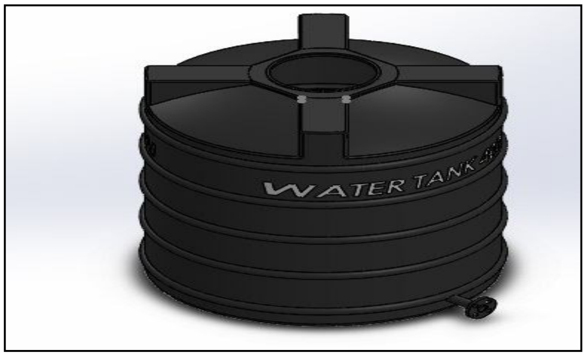
IV. SOFTWARE DESIGN OF COMPONENTS USED IN PROJECT



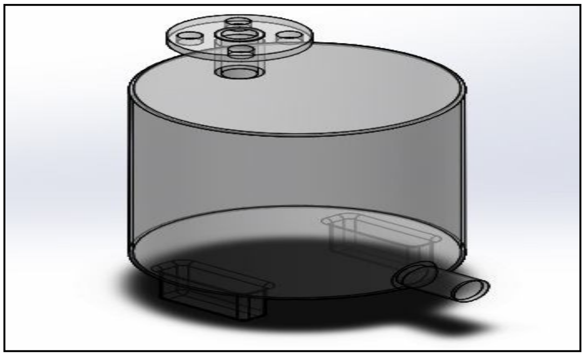
(Fig. No. 4.1 Ellipsoidal Bowl)



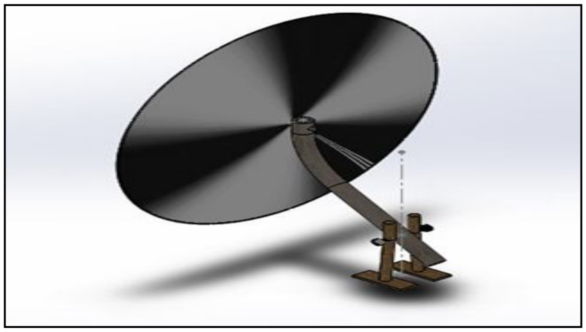
(Fig. No. 4.2 Condenser)



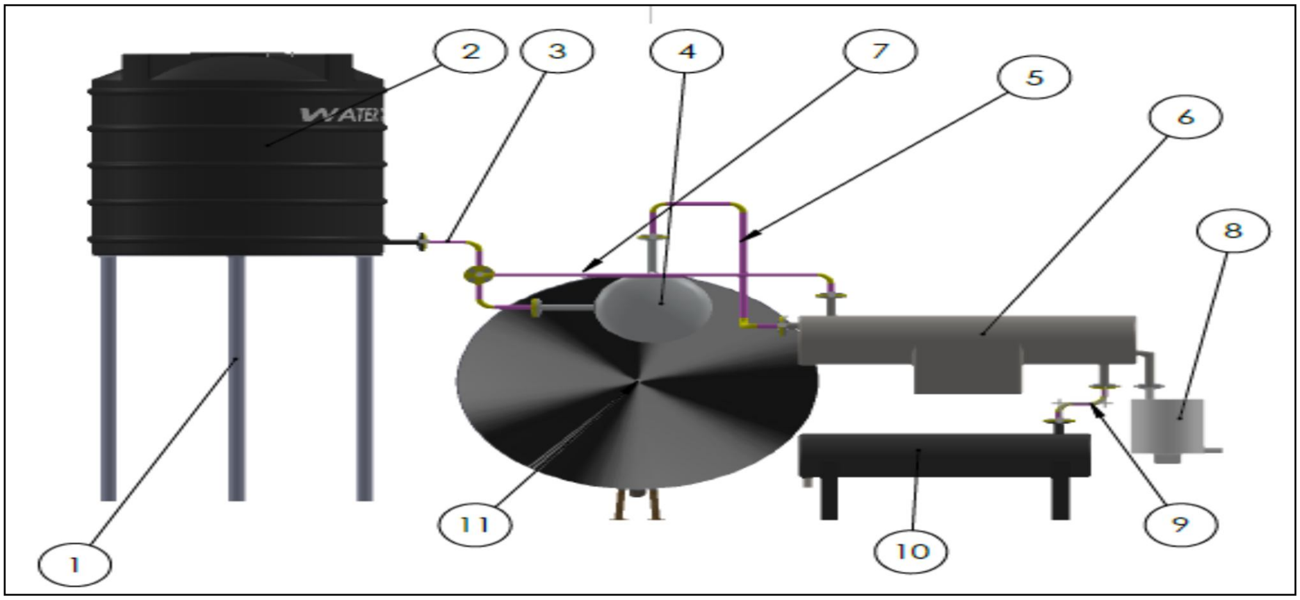
(Fig. No. 4.3 Water Storage Tank)



(Fig. No. 4.4 Purified Water Storage Tank)



(Fig. No. 4.5 Reflector Assembly)



(Fig No. 4.6 Final Assembly)

Balloon No.	Name of Components
1.	Water Storage Tank Support
2.	Water Storage Tank
3.	Water Line from Storage Tank to Ellipsoidal Bowl
4.	Ellipsoidal Bowl
5.	Steam Line from Ellipsoidal Bowl to Condenser
6.	Condenser
7.	Water Line from Storage Tank to Condenser
8.	Purified Water Collector
9.	Hot Water Line from Condenser to Hot Water Collector
10.	Hot Water Collector
11.	Parabolic Reflector

V. FABRICATION PROCEDURE AND ASSEMBLY

First we had started manufacturing of Parabolic Reflector, after three to four attempts we had found that the parabolic reflector was not capable of producing much better result. As aperture size must be large to concentrate more sun energy at a point, its takes more space and it also incurred more manufacturing cost and more over difficultly in handling.

So, we started thinking about alternate of Parabolic Reflector. After referring some article, Internet and from discussion with our faculty, we came to conclusion that Parabolic Trough would be a better for our project. As its manufacturing process is simpler, Easy Handling and Low Manufacturing Cost.

A. Parabolic Trough

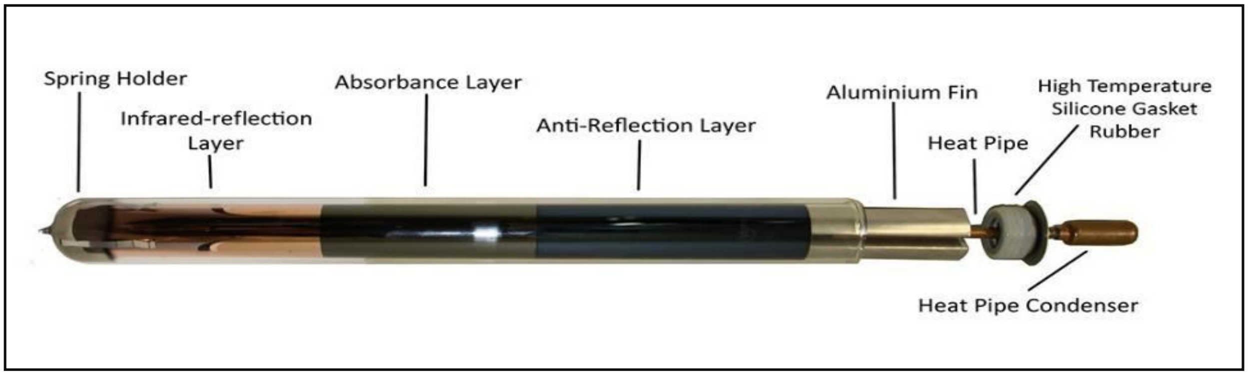
A parabolic trough is a type of solar thermal collector that is straight in one dimension and curved as a parabola in the other two, lined with a polished metal mirror. The sunlight which enters the mirror parallel to its plane of symmetry is focused along the focal line, where objects are positioned that are intended to be heated.

(Fig. No. 5.1 Parabolic Trough)

As we had moved from Parabolic Reflector to Parabolic Trough, we also have to change Ellipsoidal Bowl which were works as a Receiver of the Sun's Energy by Solar Evacuated Tube.

B. Solar Evacuated Tubes

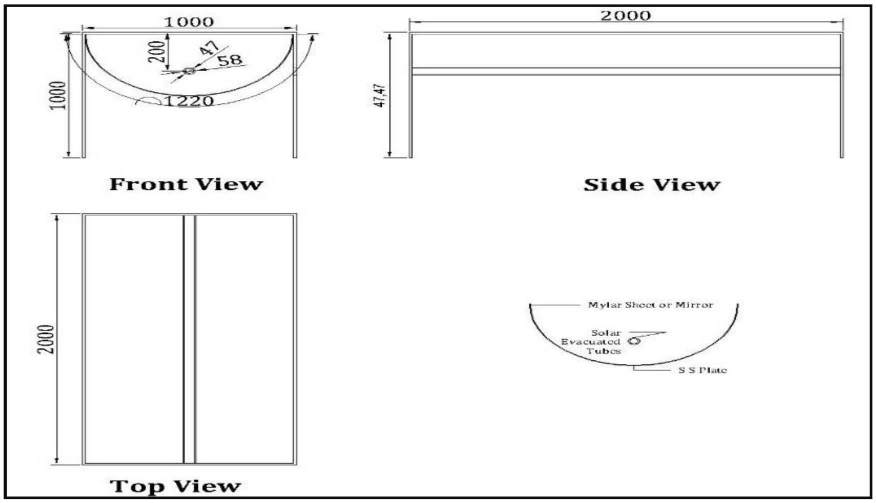
Evacuated heat pipe tubes (EHPTs) are composed of multiple evacuated glass tubes each containing an absorber plate fused to a heat pipe. The heat is transferred to the transfer fluid of a domestic hot water or hydronic space heating system in a heat exchanger called a "manifold". The manifold is wrapped in insulation and covered by a protective sheet metal or plastic case. The vacuum inside of the evacuated tube collectors have been proven to last more than 25 years, the reflective coating for the design is encapsulated in the vacuum inside of the tube, which will not degrade until the vacuum is lost. The vacuum that surrounds the outside of the tube greatly reduces convection and conduction heat loss, therefore achieving greater efficiency than flat-plate collectors, especially in colder conditions. This advantage is largely lost in warmer climates, except in those cases where very hot water is desirable, e.g., for commercial processes. The high temperatures that can occur may require special design to prevent overheating.



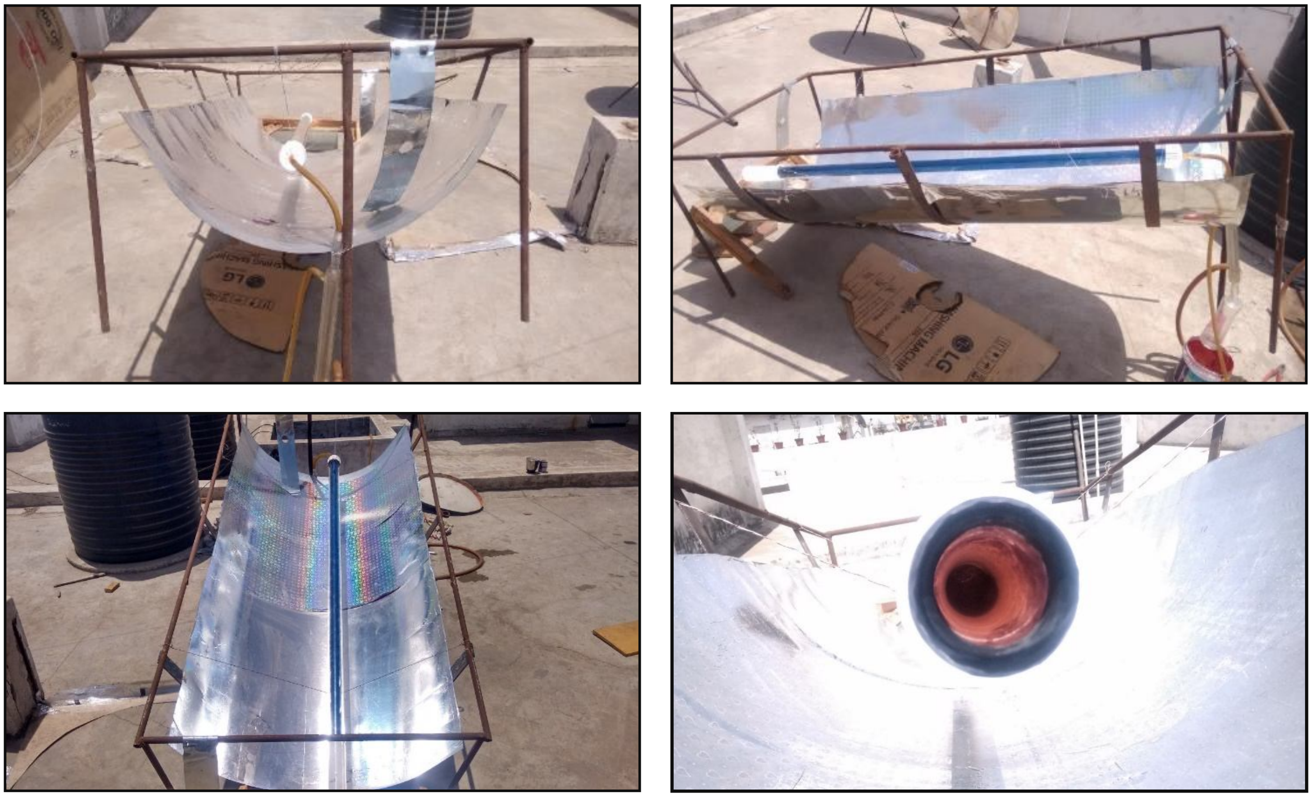
(Fig. No. 5.2 Solar Evacuated Tube)

Some evacuated tubes (glass-metal) are made with one layer of glass that fuses to the heat pipe at the upper end and encloses the heat pipe and absorber in the vacuum. Others (glass-glass) are made with a double layer of glass fused together at one or both ends with a vacuum between the layers (like a vacuum bottle or flask), with the absorber and heat pipe contained at normal atmospheric pressure. Glass-glass tubes have a highly reliable vacuum seal, but the two layers of glass reduce the light that reaches the absorber. Moisture may enter the non-evacuated area of the tube and cause absorber corrosion. Glass-metal tubes allow more light to reach the absorber, and protect the absorber and heat pipe from corrosion even if they are made from dissimilar materials.

Software Design of Parabolic Trough and Solar Evacuated Tube:



We manufacture and assemble all the components of our project as per design.
Photographs of our Actual Project (Working Model) are shown below:



(Fig. No. 5.3 Front view, Side View, Top view and Solar Evacuated Tube)

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VI. PERFORMANCE AND RESULT ANALYSIS

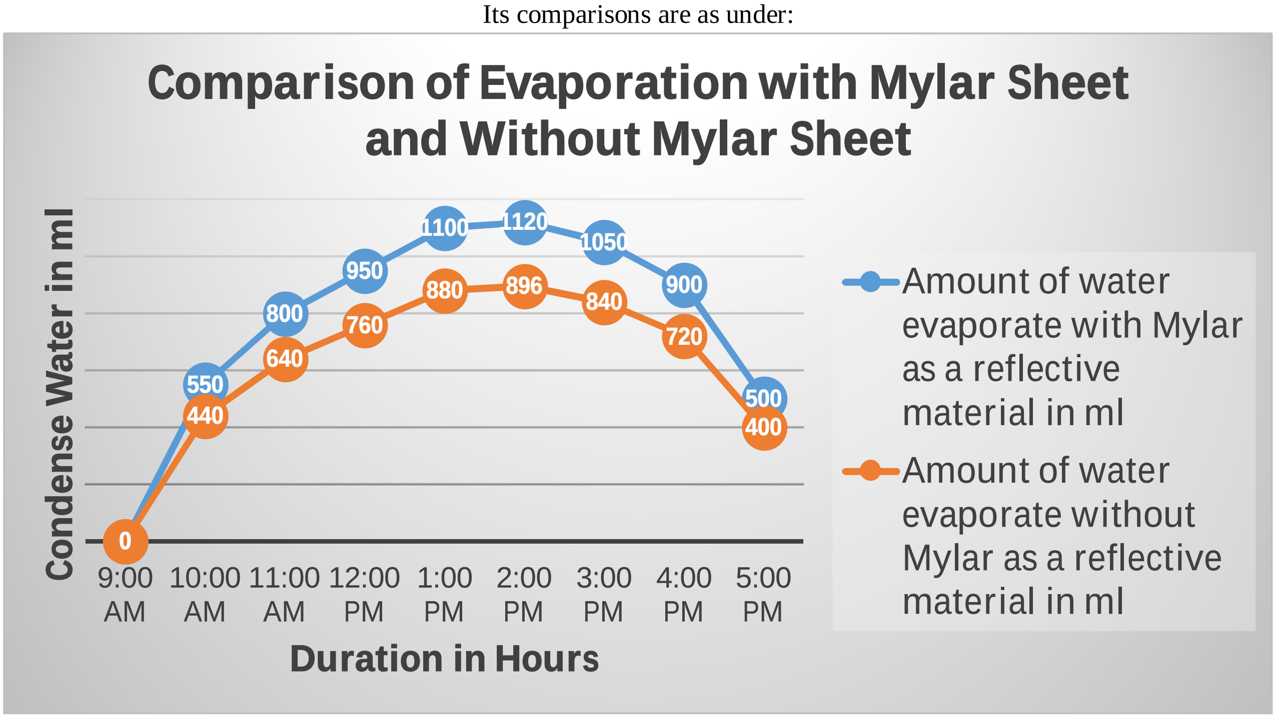
We have tested our working model which initially have SS plate as a Reflective Material whose reflectivity is nearly 70-75%, its performance is as under:

Duration in Hours	Amount of water evaporate without Mylar as a reflective material in ml
9:00 AM	0
10:00 AM	440
11:00 AM	640
12:00 PM	760
1:00 PM	880
2:00 PM	896
3:00 PM	840
4:00 PM	720
5:00 PM	400

We have tested our working model with Mylar Sheet on SS plate as a Reflective Material whose reflectivity is nearly 90-95%, its performance is as under:

Duration in Hours	Amount of water evaporate with Mylar as a reflective material in ml
9:00 AM	0
10:00 AM	550
11:00 AM	800
12:00 PM	950
1:00 PM	1100
2:00 PM	1120
3:00 PM	1050
4:00 PM	900
5:00 PM	500

Its comparisons are as under:



(Graph No. 6.1 Comparison Graph)

VII. CONCLUSION

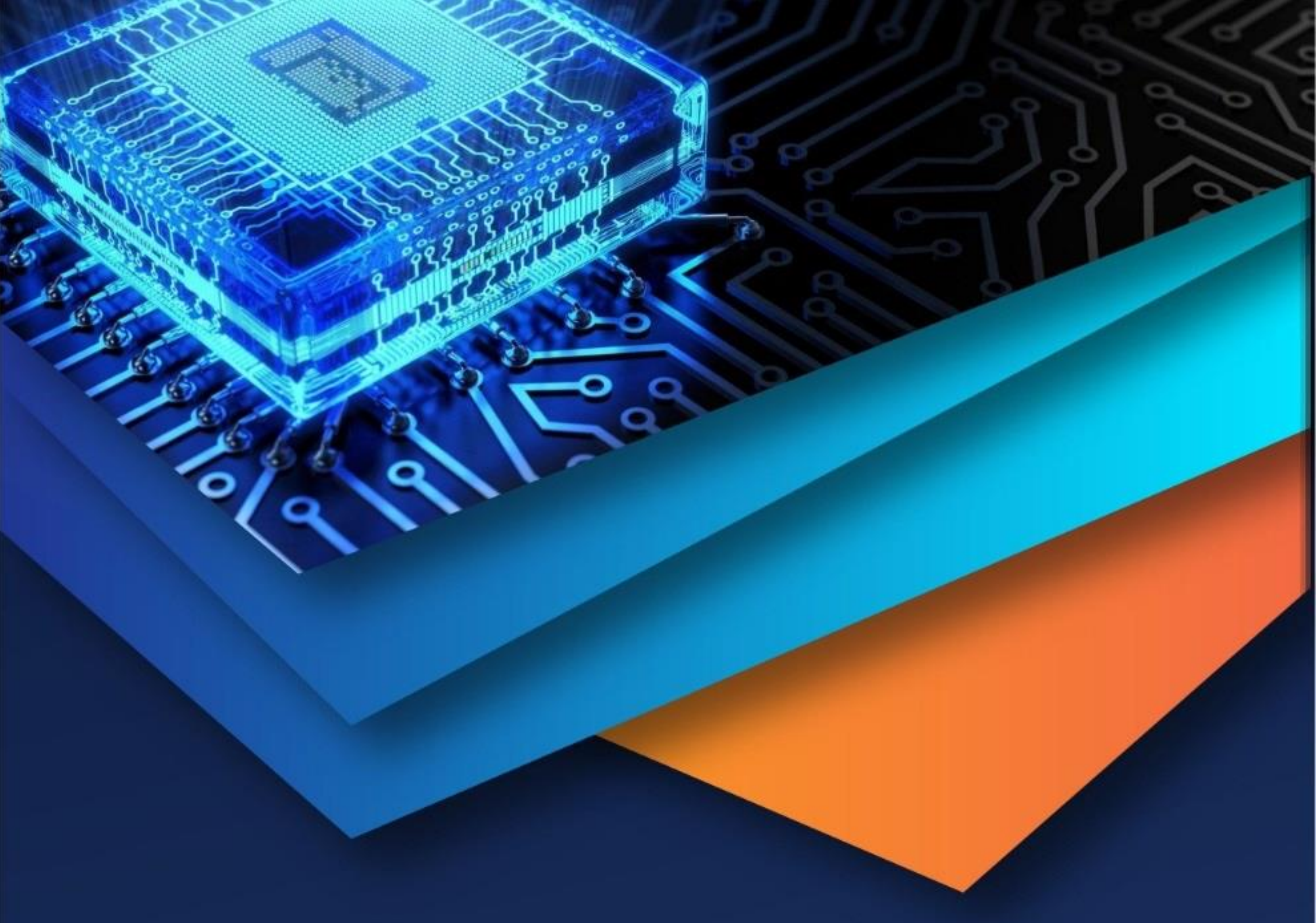
Here, we conclude that by the implementation of this system we can utilize maximum amount of sun's energy for purification of water. Water obtained is germ free and bacteria free and can be used in any dry climate conditions.

VIII. FUTURE SCOPE

A. As the reflectivity of Mirror is about 99%, so replacing Mylar Sheet with Mirror as reflective material, we can achieve better evaporation rate.
B. As the water obtained is distilled, so in order to make it drinkable we can add Mineral Membrane.
C. By implementing it on a large scale, we can effectively utilize Renewable Source of Energy and it can be used for Electricity Generation as well as for Cooking Purpose.
D. The water used in condenser to condense the steam can be used for Commercial and Industrial purpose.

REFERENCES / BIBLIOGRAPHY

[1] http://keisan.casio.com/exec/system/1223291032
[2] https://www.e-education.psu.edu/eme812/node/557
[3] https://www.youtube.com/watch?v=8CLRTa_ocmo
[4] https://www.youtube.com/watch?v=12Zj7Bux5Bs
[5] http://www.distilledwaterassociation.org/adding-minerals-to-distilled-water-is-very-easy/
[6] https://en.wikipedia.org/wiki/Sunlight
[7] http://www.powerfromthesun.net/Book/chapter02/chapter02.html
[8] https://www.quora.com/What-is-the-exact-temperature-required-to-convert-liquid-water-form-to-vapour-water-form
[9] http://www.powerfromthesun.net/Book/chapter02/chapter02.html
[10] https://www.researchgate.net/signup.SignUp.html
[11] https://www.erpublication.org/published_paper/IJETR033480.pdf
[12] Machine Design Data Book-McGraw-Hill Higher-V B Bhandari-2016
[13] Cengel, Yunus A. and Ghajar, Afshin J. "Heat and Mass Transfer: Fundamentals and Applications", McGraw-Hill
[14] Faghri, Amir; Zhang, Yuwen; Howell, John (2010). Advanced Heat and Mass Transfer. Columbia, MO: Global Digital Press. ISBN 978-0-9842760-0-4.
[15] Fundamental of Heat and Mass Transfer by Incropera / DeWitt / Bergman / Lavine (chapter 11 Heat Exchanger)
[16] Renewable Energy by B. L. Singhal
[17] Muni Seva Ashrma, Vadodara (Deepak Gadhia)
[18] Concentrating Solar Power Technology (First Edition) by K. Lovegrove and W. Stein
[19] https://www.youtube.com/user/GREENPOWERSCIENCE
[20] Parabolic Trough Collector Prototype for Low – Temperature process Heat by Coccia, Gianluca, Di Nicola, Giovanni, Hidalgo and Alejandro. ISBN 978-3-319-27084-5.



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