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IMPROVED SOLAR STILL USING SOLAR EVACUATED TUBES

Prof. Bhavin khatri[1], Sahil vaghasiya[2], Dev vyas[3], Darshan Thakkar[4], Jainam Shah[5]

[1]*Assistant professor, Department of mechanical engineering, Indus institute of technology, Ahmedabad, Gujarat, India*

[2,3,4,5] *UG students, Department of mechanical engineering, Indus institute of technology, Ahmedabad, Gujarat, India*

ABSTRACT:- *Water is the most important element to survive life on earth. One forth part of earth is filled with water but out of total source of water only 2.7% is drinkable water and rest of 97.3% water is salted water. Solar still is a simple device that utilizes the evaporation and condensation technique to convert sea water into drinkable water in which energy of solar radiation is used to get fresh water. Evacuated tube is generally used in solar water heater system where tube get heat energy from solar radiation and transfer it to water.*

We have design improved solar still where extra heat energy is supplied through evacuated tube in order to increase productivity of fresh water in unit time.

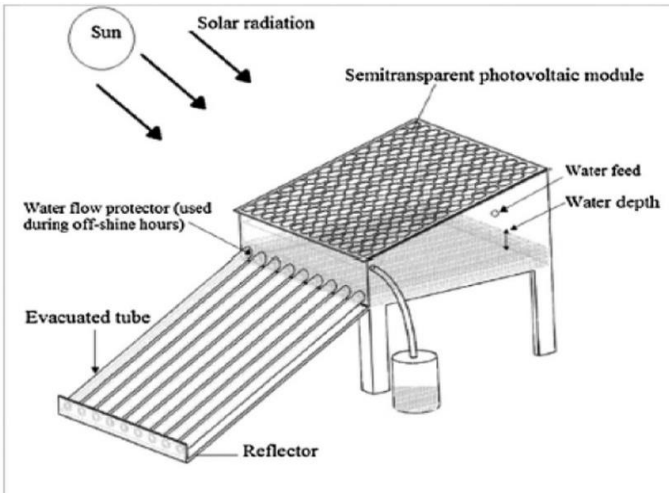
Key words:- *water distillation, solar still, evacuated tube, single slop solar still*

1.INRODUCTION:-

There are many methods to covert salted water into fresh water such as distillation, filtration, chemical treatment, irradiative treatment. Among all these methods, distillation is the most used method in concurrent time. In this method fossil fuel is used to convert water into steam and generated steam is collected and condenses. The main disadvantages of this method are limited source of fuel and gases produce by combustion of fuel that contaminate environment and create adverse effect to human as well and cost of water production. Solar still is the method which eliminates these disadvantages where solar energy is used which is renewable energy and it is completely pollution free process.

2. Working principle:-

Sea water generally consist salt and smaller amount of other substance including dissolved organic and inorganic materials and particulates. Water evaporates at 100◦C where as other particle contains in salt water required far higher temperature than water. So, water is stored in solar still basin and solar radiation enters in still through glass. Salted water get heated by solar radiation energy and evaporate and condense at glass surface in form of droplets which contain no any impurities. This pure water is collected through channel.



3. List of components

- Glass
- Aluminum sheet
- Insulation material
- Saline water collecting U tubes
- Feed pump
- Outer box

- Temperature Measurement device (Thermocouple)
- Automatic water feeding device

3.1 DIMENSIONS OF COMPONENTS:-

Basin	103cm x 83cm x 50cm Thickness 3cm Inclination Angle 20 degree
Glass	103cm x 86cm Thickness 3 to 5mm
Evacuated tubes	Standard size 47mm x 1800mm 55mm x 2500mm

3.2 DESIGN OF MODEL

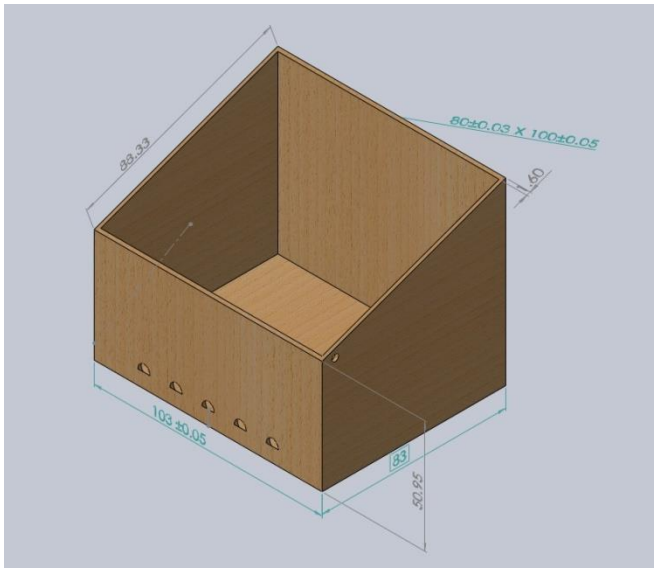


Fig.1 design of basin in solidworks

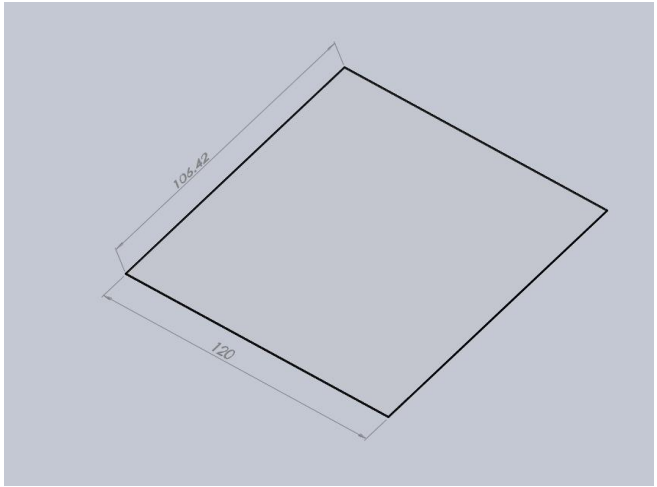


Fig.2 design of glass in solidworks

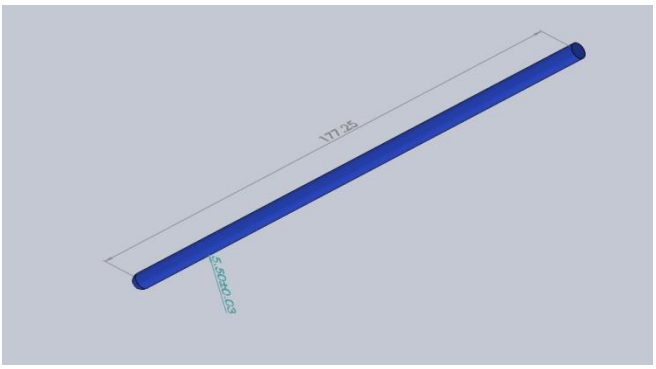


Fig.3 design of evacuated tube in solidworks

4.1 Construction of model

Basin is normally made from wooden material. It is consist of three layers. First layer is made from aluminum sheet and it is painted with the black color paint. After that middle layer is made of insulation material which is use to reduce heat loss and sustain temperature inside the basin for better result. Outer layer is made of wooden material. Inclination angle is taken20 degree because according to previous experiment it is prove that 20 degree gives maximum output. Basin is covered with glass with thickness of 3 to 5 mm. Evacuated tube is jointed with basin at angle 30 degree. In Evacuated tube the outer layer of tube is glass tube. In evacuated tube black absorber plate is used. The absorber plate is absorb the solar radiation. In this tube the third part is Heat pipe. Inside the heat pipe **acetone** liquid is used. Boiling point of **acetone** liquid is **56°c**. The material of heat pipe is Copper material.

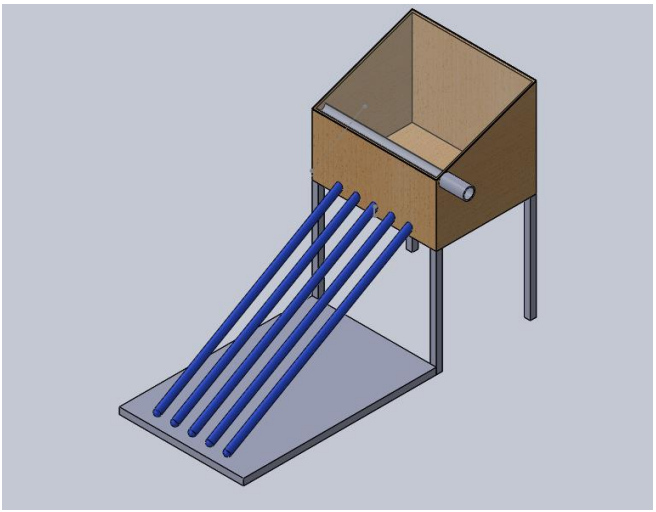


Fig.4 Assembly of model

4.2 Working

As shown in fig, sew water is stored in basin in appropriate amount. Water get hat energy from

evacuated tubes and directly from radiation. When solar radiation impart on aluminum sheet, it absorb some of heat from radiation and reflect rest of radiation and basin act like a black body. Aluminum sheet transfer its energy to stored water and water get heated.

Secondly, when solar radiation imparts on reflective surface of evacuated tube it is get heated and it is transfer their energy to copper tube inside the evacuated tube. Liquid in evacuated tube is stored at vacuum pressure so it is evaporate at very less temperature. This evaporated liquid transfer its heat to sensing bulb which is directly in contact with basin salted water. So this is how water get heat extra energy.

Water get heated by both heat energy and evaporates. These evaporates water condense at inside surface of glass in form of droplets. These droplets are collected through pipe and this is how we get fresh water. Produced fresh water have zero impurities but at the same time it loss necessary minerals as such as calcium, magnesium sodium etc. so these minerals have to added to convert it into drinkable water.

4.3 Design consideration for higher efficiency

- Heat loss from wall of the basin should be minimum. So, higher thermal resistive material should use such as wool, Thermocol etc.
- vapor leakage should be minimum. For that solar still should be airtight.
- Water should absorb higher heat from the radiation. For that solar still material should have higher absobtivity.
- Condensing surface should not absorb any incoming radiation.
- Amount of water in basin should be optimum.
- Evaporated water should leave heat rapidly.

5. Calculation:-

➨ Heat transfer is taking place in all manners

1. **Heat conduction**

Bulb of evacuated tube transfers its heat energy to water present in basin through heat conduction.

Governing equation of heat conduction :

Q = -KA (dt/dx)

K = Thermal conductivity of copper bulb

A= Area of basin

(dt/dx) = Temperature gradient

2 .Heat transfer through convection

In this case, heat convection tacking place between two adjacent layer of water.

Governing equation of heat convection:

Q= hA (Ta - Tb)

H = coefficient of convective heat transfer

A= Area exposed to heat transfer

Ta = surface temperature

Tb=Fluid temperature

3.Heat transfer by Radiation

Sun rays enter into solar still through glass on basin and transfer its heat to water contains inside the basin. This way heat transfer through radiation tacking place.

Governing equation of heat transfer by radiation:

$$Q = \sigma A(Ta^4 - Tb^4)$$

Q= Stefan Boltzmann constant

A = area

Ta and Tb = temperature

➨ **Net useful heat gain by water in side the solar still**

Q = m Cp (Tf-Ti)

M = mass of water inside basin

Cp = Specific heat of fluid (J/KgK) = 4180 J/KgK for water

Tf = Maximum temperature attained by fluid (·C)

Ti = Initial temperature of fluid (·C)

Ac = Area of basin (m^2)

6. Conclusion

Solar still is the method of distillation where water is removed from contaminations rather than to remove

contaminates from the water. Solar energy is a promising source to achieve this. This is due to various advantages involved in solar still. It involves zero maintenance cost and no energy cost as it involves only solar energy.

In this improved design of solar still where water salted water get energy from two different ways, one is from solar radiation imparts on basin through glass and another water get heated by solar evacuated tubes compare to previous design where it it get heat energy only from solar radiation. So, efficiency of solar still can be improved by 70 to 80%.

Overall water production in a day is less than other methods of water purification but it is very cheaper and required very low maintenance cost and involves no any pollution, so it is one of the best method in concurrent time when ground water is about to finish and may countries already experiencing scarcity of water

7. REFERENCES

- https://en.wikipedia.org/wiki/Solar_still
- Thermal Modeling and Efficiency of Solar Water Distillation , American Journal of Engineering Research Volume 02, Issue 12, pp-203-213
- Solar distillation of water. International Research Journal of Engineering and Technology, Volume 02, Issue 07|OCT-15
- Experimental study on various solar still, International Scholarly Research Network, volume 2012