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Design and Fabrication of Water Purification System using Solar Energy

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Abstract: ***The purpose of the project is to design a water distillation system that can purify water from nearly any source, a system that is relatively cheap, portable, and depends only on renewable solar energy. The motivation for this project is the limited availability of clean water resources and the abundance of impure water available for potential conversion into potable water, in addition, there are many coastal locations where sea water is abundant but potable water is not available. Our project goal is to efficiently produce clean drinkable water from solar energy conversion. Distillation is one of many processes that can be used for water purification. This requires an energy input heat, electricity and solar radiation can be the source of energy. When solar energy is used for this purpose, it is known as solar water distillation. Solar distillation is an attractive process to produce portable water using free of cost solar energy. This energy is used directly for evaporating water inside a device usually termed as 'Solar Still'. Solar stills are used to desalinate seawater, in desert survival kits and for home water purification. For people concerned about the quality of their municipally-supplied drinking water and unhappy with other methods of additional purification available tothem solar distillation is an attractive alternative because of its simple technology, non-requirement of highly skilled labour for maintenance work and low energy consumption. The use of thermal energy in seawater desalination applications has so far been restricted to small scale system in rural areas. The reason for this has main it been explained by the relatively low productivity tare compared to the high capital cost. However, the coming shortage in fossil fuel supply and the growing need for freshwater in order to support increasing water in order to support increasing water and irrigation needs, have motivated further development of water desalination and purification by renewable energies.***

1. Introduction

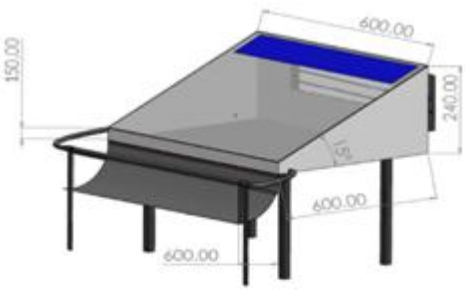
Water is a basic necessity of man along with food and air. Fresh water resources usually available are rivers, lakes and underground water reservoir. About 71% of the planet is covered in water, yet of all that 96.5% of the planet's water is found in oceans , 1.7% in ground water ,1.7 % in glaciers and the ice caps and 0.001% in the air as vapor and clouds , Only 2.5% of the Earth's fresh water and 98.8% of that water is in ice and ground water . Less than 1% of all fresh water is in ice and groundwater. Less than 1% of all fresh water is in rivers, lakes and the atmosphere.

Distillation is one of many processes that can be used for water purification. This requires an energy input as heat, electricity and solar radiation can be the source of energy. When solar energy is used for this purpose, it is known as solar water distillation is an attractive process to produce potable water using free of cost solar energy. This energy is used directly for evaporating water inside a device usually termed a solar still. Solar stills are used in cases where rain, piped, or well water is impractical, such as in remote homes or during power outages. Different versions of a still are used to desalinate seawater, in desert survival kits and for home water purification. For people concerned about the quality of their municipally supplied drinking water and unhappy with other methods of purification available to them, solar distillation of tap water or brackish ground water can be pleasant, energy efficient option. Solar distillation is attractive alternative because of its simple technology. Non requirement of highly skilled labour for maintenance work and low energy consumption.

The use of solar thermal energy in seawater desalination applications has so far been restricted to small scale systems in rural areas. The reason for this has mainly been explained but the relatively low productivity rate compared to the high capital cost. However, the coming shortage in fossil fuel supply and the growing need for fresh water in order to support increasing water and irrigation needs, have motivated further development of water desalination and purification by renewable energies.

2. Experimental Setup

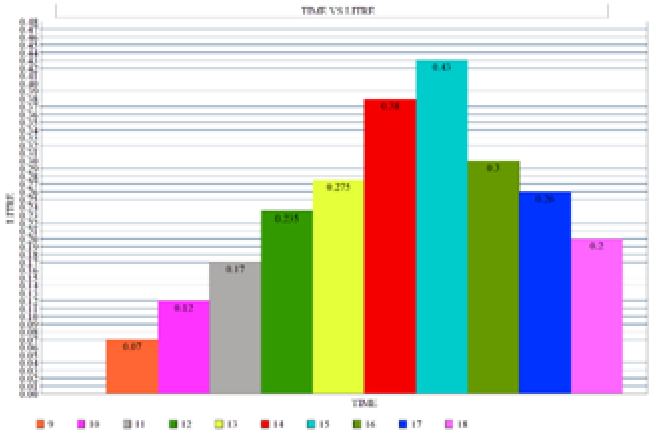
In our experiment we designed and fabricated a solar water purification system at latitude of 23.5˚SW where the average solar radiation is received in the range of 5KWh/m^2/day, the solar still was placed at 23.5˚SW facing, supported by mild steel fabrication. The performance of solar based heating system depends upon temperature distribution in system which includes solar still, heat exchanger & parabolic trough reflector, the solar still is main component of the system which is of 60x60 cm stainless steel used to convert steam from water, a 4mm tufon glass is fixed at the top of still at angle of 15˚, due to angle of glass the water slides down to water channel and distilled water is collected, a parabolic trough reflector is assembled at the front of solar still as shown in figure which helps water to rise its temperature inside the mild steel pipe because of acrylic mirror polish reflector where sunrays are falls and reflected to pipe and almost the water temperature rises to 4-5˚c more then the solar still, a thermocycle effect is generated in mild steel pipe which helps water and steam to regulate from solar still, a simple heat exchanger is used at the back of the solar still which makes the temperature difference in the solar still which helps steam to flow from high pressure region to low pressure area and there steam condensed on the aluminium box in which the cold water is continuously flows through an Dc pump which runs directly through solar panel, the condensed water is collected.

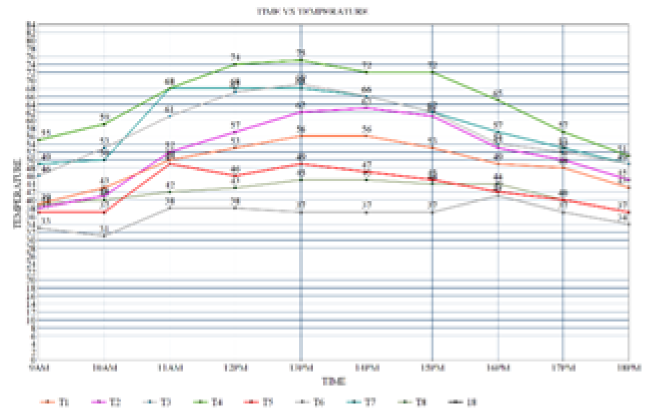


3. Results and Conclusions

Here are the graphs for (1) Time vs Litre graph and (2) Time vs Temperature graph. We have collected data from hourly obtained distilled water measured by beakerand temperature measured with 'k' type thermocouples attached with digital temperature sensing device. the list is below mentioned of where k type thermocouple attached on model.

T1-inlet to parabolic reflector.
T2-parabolic reflector outlet.
T3-bottom base of still.
T4-solar still housing.
T5-inside heat exchanger.
T6-cooling water tank.
T7-outside glass.
T8-free to atmosphere.





Efficiency calculation-*Solar still production :-* ***M e = Q e / L***

Where: M e = Distilled water in a day expressed in kg/m^2
Q e = Vapourized water in still expressed in J/m^2
L= Latent heat of Vaporization of Water expressed in J/kg
M e =Q e /L

2.5=Qe/2264702
Q e = 2264702*2.5
Q e = 56,61,755 kgm^2

Solar still Efficiency:
η =Qe/Qt
Where:- Qt =incident solar energy on still expressed in J/m^2
η =Qe/Qt*100
= 5661755/(5.51*3600000)*100
η =28%

Conclusion

After five run of experimental setup for different litres water filled in solar still we have concluded that if the solar still filled with the maximum water then the efficiency will be less because of maximum water needs more time to heat from all runs, the run for15 litre of water filled in solar still, we get only 1.1litre of distilled water and the run for 6 litres of water filled in solar still gets the highest amount of distilled water which is around 2.5 litres of water in 10 hours, there can be some modification which can implement which we had come up to know after making of model and run, if continuously providing of cooling water of 20-25˚c then it will give more efficiency and extra attachment like fins can be attach to the solar still base for extra heating surface.

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