

WASTE WATER TREATMENT USING SOLAR ENERGY

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ABSTRACT–In this modern world the water scarcity is rapidly increasing because of the increase in the usage of water for various purposes. There is an inflated demand in the purified water in rural even in the urban areas. By using the solar energy there is an efficient way of treating the water and using it for our household purposes. By doing such efficient treatment process, water can be treated and also the scarcity of water can be greatly reduced. Here the renewable energy used is solar energy which uses solar collector to heat the water after the purification process. The purification method uses several natural material and distillation process so as to maintain the potential of hydrogen and also reduces Total Dissolved Solids. This process will eventually reduce the hardness of the water and can be used for various household applications. The biggest challenge in this treatment process is to reduce the Total Dissolved Solids to certain range without using reverse osmosis membrane. Further development of this project is to bring down the value of Total Dissolved Solids and can be use it for even drinking purpose in the place where the purified water is in significant demand.

Key words:reverse osmosis, distillation, Total Dissolved Solids

1. INTRODUCTION

Water is one of the three basic needs of the human life. Our earth holds 98% of water in total but woefully only less than 2% of the available water is fresh water so the drinking water is the big challenge in our modern world. The water that we receive from the nature is predominantly used by human activities and industries. Researches are going to extract energy from the naturally available or renewable source such as sunlight, water, wind etc. Providing ingress to safe and drinking water to people improves health and also it reduces the poverty says World Health Organization. It also recommends Total Dissolved Solids in between 50 to 100. Water that is being purified using reverse osmosis membrane has Total Dissolved Solids of 50 and

below. Scientists have proven that the water having Total Dissolved Solids below 50 is said to have mineral deficiency. In order to avoid mineral deficiency the water having Total Dissolved Solids of 50 -100 is recommended. It is efficient to use renewable energy for lower income people because of less maintenance. Solar energy is being used for the purification of contaminated water. Solar collector uses solar energy to heat the water and remove the impurities and hardness of the water that comes from the filter. The filter consists of various natural materials such as corn husk, carbon etc. it greatly helps to reduce Total Dissolved Solids from the contaminated water. Furthermore the filter paper is used for additional purification of the contaminated water. The filter paper aids in removing solid particles and micro particles in contaminated water. Carbon is being used which greatly removes the color and odor from the water. It also helps to maintain the potential of hydrogen in the water. Carbon which is soaked in Hydrochloric acid is called activated carbon. Corn husk which is considered as a food waste is being dried for two days is used as filter to remove some of the remaining micro particles in contaminated water. After this filtration process the water is led in to solar water distillatory which operates by evaporation and condensation of water and those water is collected in the tank. The collected water is then passed to the solar collector which is evacuated type of solar collector. The maximum operating temperature of evacuated type solar collector is about 75 degree Celsius. The water that comes after all this purification process will obtain Total Dissolved Solids of 500 parts per million.

2. OBJECTIVE

The main objective of this project is to treat the waste water in order to reduce the purposeless minerals such as magnesium, calcium; fluoride which eventually removes the hardness in the water. It can also reduce harmless taste. This treatment involves heating of water using solar collector to kill bacteria and pathogens these bacteria and pathogen makes water unsafe to drink. Treated water can be collected in a tank and can be

reused again for gardening and household purposes. The solar water distillation is the process by which the water is evaporated and condensed using solar energy. The water that comes after distillation process will have hardness less than previous tested water samples. Solar collector is use after the distillation process to heat the water further to maximum available temperature to kill the pathogen and other dissolved solids. The water outlet from the solar collector is collected in the tank. This tank contains arduino which indicates the overflow of water once the tank gets filled. The temperature of the water from solar collector is measured using water proof temperature sensor and also it senses room temperature. Solar collector which carry non-return valve allows water flowing through single direction. Solenoid valve is used in another end which allows water to come out after the water in solar collector reaches its maximum operating temperature.

3. NATURAL FILTRATION METHOD

Filtration involves three stages of treatment method to remove the impurities from the waste water. They are primary, secondary and tertiary treatment. Primary treatment involves in removing impurities, solid waste and suspended particles. Secondary treatment involves further purifying the water by removing the unusual odor and taste. This includes in maintaining the value of potential of hydrogen and also the value of Total Dissolved Solids. It also helps in reducing the hardness of the waste water. Tertiary treatment involves in removing bacteria and pathogen which can cause diseases like flu etc. Tertiary treatment also helps in reducing micro particles from the particles with the help of solar distillator. Primary treatment includes filter paper and cotton bed. Filter paper with less than 2 microns is generally used since it removes all the suspended particles and solid wastes. The cotton bed is spread in the several rays which also stop the flow of solid or micro particles to going into the further layer of the natural filter. Secondary treatment consists of layer of activated carbon, corn husk and also sand filter. Activated carbon acts an adsorbent. It removes volatile organic compounds, chlorine in excess. It also removes bad odor and unpleasant taste from the waste water. It greatly removes the color of the water if the waste water contains some colored components. Carbon which is obtained in powered or rock form is being soaked in the hydro chloric acid for one day. This makes the carbon being activated and so it is called as activated carbon.

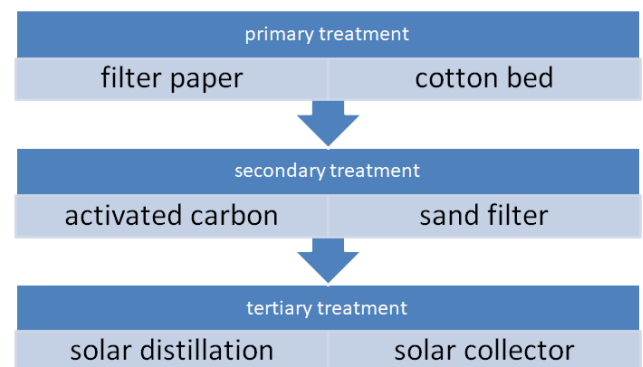
Secondary treatment also includes sand filter in which fine sand is used in several layer which removes the turbidity of the waste water. Sand filter removes sinkable particles. These particles are being removed by the physical encapsulation. If any excessive pressure is been lost in the filter it should be rinsed. Sand filter removes the particles with the size of 20 to 40 microns. There are many ways in using sand filter as pressure sand filter, slow sand filter, gravity sand filter and upflow sand filter. The following flow chart shows the different types of treatment used in order to remove the waste materials from the water.

TDS TEST FOR CHEMICAL SOLUTION



Figure: (a) – TDS Test in laboratory

PURIFICATION PROCESS



Flow chart: (b) –steps involved in filtration

4. FILTRATION BY SOLAR ENERGY

Furthermore the filtration process is done using solar energy. It consists of two main components which uses solar energy to purify and heat the water. Solar water distillation is the process which uses sunlight that

separates fresh water from other contaminants. It includes two processes such as evaporation and condensation. The distiller chamber contains inlet and outlet for the flow of water. The saline or waste water that is getting in poured into the black coded closed chamber. Since black colored surface absorbs more solar energy than any other colored surface. The water that is allowed to enter inside the chamber is put in for certain hours. The water inmost the chamber starts evaporating. During the process of evaporation the micro particles present in the water stays down and water as vapor starts depositing on the glass. The vapor that gets evaporated is condensed and the water condensed is being collected in another chamber through outlet pipe. After the solar water distillation comes the purification by solar collector. The main principle of solar collector is to transform the sun's radiation into the thermal energy. The water that comes from solar water distillate is collected, cooled and then the coolant water is again heated to certain temperature to remove the hardness and also to kill pathogens and bacteria. There are two main types of solar collector that is being used in purification of water. Flat plate collector has maximum operating temperature of 30-60 degree Celsius. Evacuated tube solar collector has above 80 degree Celsius of maximum operating temperature. Evacuated types have comparatively more efficient than flat plate solar collector. The capacity of evacuated type solar collector is made up to 15 liters. Evacuated type solar collector has two openings such as inlet and outlet. Evacuated type solar collector has several tubes. The number of tubes used is according to the capacity of water that is being used. Inlet of solar collector has a non-return valve which controls the flow of waters. It allows water flow in single direction which is from collected water tank to the solar collector. Evacuated type solar collector has number of tubes in which water is getting heated. The number of tubes depends on the capacity of water being heated. For the capacity of 15 liters of water six tubes are used. The tubes are coated with aluminium. Normally the evacuated type solar collector tubes are manufactured in Germany. Tubes should be placed vertically through the angle of 60 degree. The solar collector should be placed in such a way that it faces south direction for effective collection of solar radiation. The tubes are aluminium coated with glass covered outside of the tube. Above the tube there is a horizontal tank like structure which is called as manifold. The manifold is made up of stainless steel inside it. Pressurized water should be used inside the solar collector. The water tank that collects water from solar distiller should be kept just above the level of solar collector. Tube like structure is made in the upper part of manifold. It helps vapor to come out of the manifold. Tubes are fitted in the way of slanting position. During the sunny days it takes up to two hours to three hour to reach require temperature. During cloudy weather

condition water heating may take up to six hours. While filling the water in evacuated type solar collector it should be filled up to the manifold. Thus the principle of this is described as, when the sun rays falls on the tube, the tube starts heating up, vapor that forms during heating process goes out through the tubes which is placed above manifold. The vapor tube and the water tank (i.e. the water collected from solar water distiller) should be in same level.

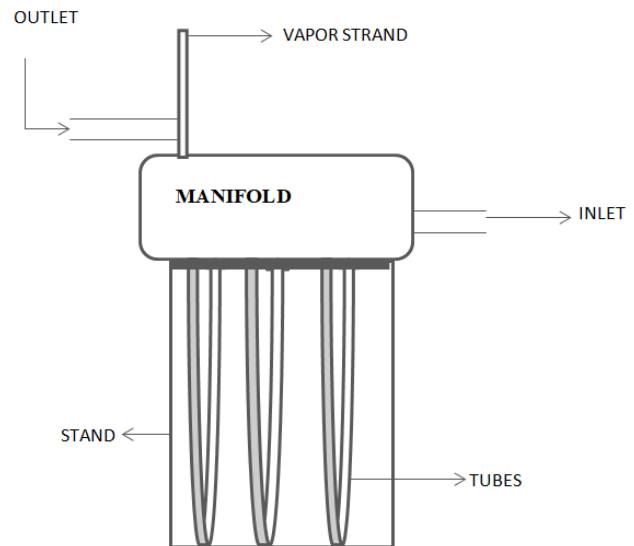


Figure: (c) – Evacuated solar collector model

5. ARDUINO

The water that is being purified in the evacuated type solar collector is collected in the container tank automatically using arduino when the temperature of water inside the collector reaches 65°C. The temperature of water inside the collector is measured using water proof temperature sensor. This sensor is fitted inside the collector.

TEMPERATURE SENSOR INTERFACING WITH SOLENOID VALVE

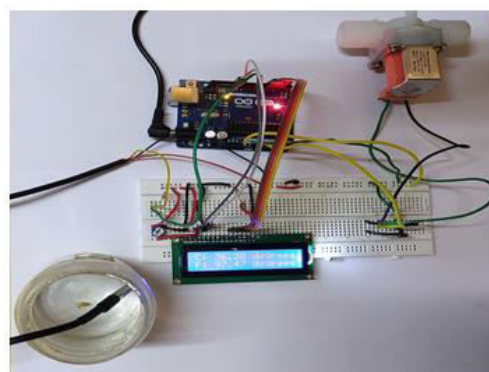


Figure: (d) – Interface structure of Arduino

The temperature sensor used here is DS18B20. For the opening of solenoid valve at the outlet of solar collector, the temperature sensor sends signal to solenoid valve. Once the water reaches the maximum temperature, temperature sensor sends signal to valve thus causing the opening of valve and once the storage tank gets filled it also stops the valve by again sending the signal by interfacing the arduino program.

CIRCUIT DIAGRAM

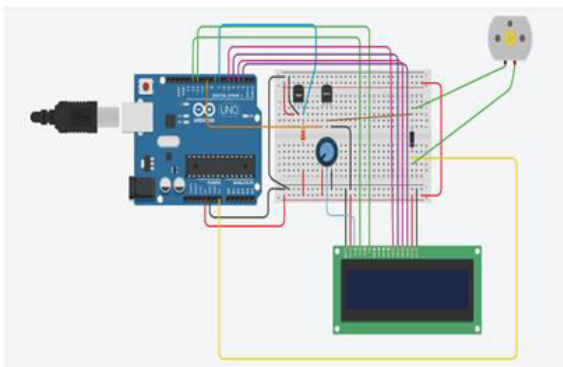


Figure: (e) – Circuit Diagram

Liquid Crystal Display is used to display the temperature of water in the collector. MOSFET used here is IRF540 and it is an N-Channel powered MOSFET. It is also used for amplification process. It helps in controlling voltage.

TEMPERATURE SENSING

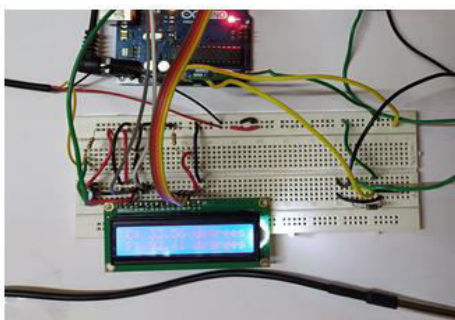


Figure: (f) – displaying both water and room temperature

6. ADVANTAGES

- No chemicals are used in filtration process instead natural materials being used. Thus making the water harmless.
- Sun light is readily available and renewable energy thus it cause no pollution.

- No electricity is used for either filtration process or solar purification thus reducing the consumption of power.
- The resulting level of Total Dissolved Solids obtained falls in the level of Total Dissolved Solids recommended by World Health Organization.
- Less maintenance when compared to other conventional method.
- Usage of electricity is much reduced as compared to other systems.

7. RESULT

The Total Dissolved Solids in the sewage water is around 3000 parts per million but after all the filtration process and solar filtration it reduces to around 650 parts per million. The table shows the value of parts per million in each of the three main treatments such as primary, secondary and tertiary.

TREATMENT	BEFORE TREATMENT (Parts Per Million)	AFTER TREATMENT (Parts Per Million)
PRIMARY TREATMENT	Total Dissolved Solids=3000ppm	Total dissolved Solids=1500ppm
SECONDARY TREATMENT	Total Dissolved Solids=1500ppm	Total Dissolved Solids=700ppm
TERTIARY TREATMENT	Total Dissolved Solids=700ppm	Total Dissolved Solids= 650ppm

TABLE-1: Analysis of Total Dissolved Solids

8. CONCLUSION

The resultant value of Total Dissolved solids are comparatively less than the sample that is being taken. This system also uses natural material for filtration. . The density and large surface area available for adsorption is an important factor. Chemical compounds are avoided in this treatment. Power consumption is greatly reduced as the power is used only for automated system which is used for control of solenoid valve. The materials used for filtration is cheap and readily available on the earth. Agricultural waste can be reused for the filtration purpose. This filtration process and the consequent use of collector have so many advantages and aimed to gain the demands and needs of the present critical situation. To meet out the crisis, this natural filtration method has a good scope and now being increasingly used in developed nations.

9. FUTURE SCOPE

In future, this method can be used in large scale water purification in which the water comes from industries and factories in many rural areas. This system also plays a significant role in agricultural materials used for feeding the agricultural lands with water having less hardness and Total Dissolved Solids.

10. REFERENCE

- [1] Pawar C.D, Kale D.N, Desai A.A, Khan A.H, Chougule V.N, "Development of waste water Treatment Using Solar Energy",IOSR-JMCEe-ISSN: 2278-1684,p-ISSN: 2320-334X pp. 49-54 .
- [2] Nazif Ahmed, Farzana Mollick Ella, "Development and performance test of an evacuated tube solar water heater", *IEEE Renewable Energy Technology*, 2016.
- [3] Aranovitch E, G. Beghi, "Solar thermal collectors. Performance of solar energy converters: thermal collectors", *D. Reidel*, 1981.
- [4] Bruce I Dvorak, "Drinking Water Treatment: Activated Carbon Filtration",Nebguide, University of Nebraska.
- [5] JC Solar Homes, "Concentrators and flat plate collectors" Homes,2015.
- [6] Norton Britan, *Harnessing solar heat*. Dordrecht.ISBN9789400772755.