International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 02 | Feb 2020 www.irjet.net p-ISSN: 2395-0072

SOLAR SEWAGE TREATMENT

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ABSTRACT ---In present scenario the main problem we are facing is the lack of purified water in rural area and urban area. The demand for safe, pure drinking water is growing rapidly. Application of solar thermal energy for sewage water treatment has shown to have the least negative impacts and costs. These waste treatment methods uses the customized Evacuated type solar collector without consuming power and also the natural filtration of sewage water using agricultural waste. Activated carbon which is an excellent adsorbent is used in natural filtration to remove water contaminants from sewage water. Thus the main objective of this project is to treat and purify the water and reuse it for textile mills, dying plants, industrial utilisation, gardening and flushing purpose using solar energy. The approach we have opted is done by evacuated tube type collector which can heat the water up to the maximum of 80 .Purification process is done to maintain Potential of Hydrogen and Total Dissolved Solids indicating neutral character. It can be seen that the water that had been treated can be used for the drinking purpose.

Keywords **-** Waste Water, Agricultural Waste, Solar Collector, Total Dissolved Solids, Drinking water.

I. INTRODUCTION

Water is the most important and essential need for human life and is being polluted by human activities, urbanization and industrialization. The ground water is often over exploited to meet the increasing demand of the people. Less than 1% of earth's water is being used for human consumption and people still have no access to safe drinking water. Safe drinking water is the basic need of human beings. Lot of energy resources are getting depleted day by day at a very alarming rate. Continuous research is going on around the world to harness energy from other renewable sources. While we think of the word Renewable, the very first thing that comes to our mind is Solar. We have abundant sunshine throughout the year and solar drying is used even today for food preparation but this has not been used for sewage water purification. If kept in direct sunlight for 4 hours, water is purified by the radiations of the sun and by the increase in temperature. World Health Organization and other agencies worldwide are working towards spreading the importance of solar energy for lower income groups who are particularly susceptible to water borne diseases. Conventional boiling distillation consumes more electricity for every gallon of water, while solar collector uses only the free pure power of the sun. Solar collectors are devices that are used to harness the energy from the sun, convert the income solar radiation into useful heat energy, being the key element in solar energy utilization Systems. Evacuated tube solar collector system is better option for the environment and public utilization because of its simplicity and low cost than flat plate collectors. Ion filtration and distillation systems are even more expensive to purchase and use and will not totally purify the water by removing all contaminants. There are low cost water purifying devices which include Reverse Osmosis and Ultraviolet based water purifiers. However these devices suffer from problems like periodic replacement, wastage of water (in case of Reverse Osmosis) and unavailability of electricity in rural areas for Reverse Osmosis and Ultra-Violet based systems. Solar Sewage treatment includes two aspects; first aspect is sediment and contaminant removal using natural filter then, pathogen elimination in the manifold due to heat generated by natural convection in solar collectors. Initial filtration is carried by natural filter. Natural filtration is a method of filtering that uses a bed of agricultural waste like corn husk, rice straw and adsorbents like vettiver and activated carbon. Corn husk and rice straw obtained from agricultural lands are employed. Vettiver and activated carbon removes the contaminants and impurities using chemical adsorption. After this filtration process, water is passed through the evacuated solar tubes for further purification. The filtered water is stored in underground storage tank. When the need for water arises, it can be delivered. The existing systems have many disadvantages as mentioned above. Thus we have our proposed system for future use which can be easily adopted and utilized for recycling as well as for drinking purposes.

II. OBJECTIVE

The main objective of solar sewage treatment is to improve the rate of water purification by harnessing the solar thermal energy and to remove the sediments and other aesthetics like colour and odour from water using natural filter. This filter is used to remove contaminants and impurities by using agricultural wastes like corn husk and rice straw which is an excellent sediment

removal. Activated carbon is most effective at removing chlorine, volatile organic compounds, taste and odor from water. The water from filter is heated using solar collector to kill or inactivate water borne pathogenic bacteria, viruses, helminthes and protozoa. The purified water, which can be used for various purposes, is stored in storage tank. The water is pumped and stored in overhead tanks. The recycled water is used to meet the water demands of various urban and rural areas. The whole solar sewage treatment process replaces Reverse Osmosis treated water predominantly used nowadays which is not good for human as it causes different mineral deficiency in the human body. The wastewater released from different textile industries, hospitals and other organizations including the chemical industry is treated, purified, recycled and used for cleaning and other daily use purposes.

III. FILTRATION PROCESS

The sewage water is allowed to pass through the natural filter bed containing a layer of corn husk, rice straw, sand filter, vettiver, alum and activated carbon. Alum is used to remove the colour and turbidity from sewage water. The alums are important in many industrial purposes and processes and have been used since antiquity. The most widely used alum is potassium alum. It is used as flocculants to clarify the unwanted turbid liquids, as a mordant in dyeing, and in tanning. Vettiver has the capacity to purify water which can absorb magnesium, heavy metals, nitrogen and is most plentiful and important agricultural waste and aids for sediment removal. It does not lose its properties for a long time which is a great advantage in the filtration process. As they are porous, they can be used as water filtrates. Rice straw is used as an efficient adsorbent material for the removal of phenol and other compounds from waste water and also the pollutants. Sand filter bed acts as a purifying layer and is a type of centralised or semi centralised layer which effectively removes turbidity and pathogenic organisms in a single step in the filtration mechanism. This water filtration produces high quality water without the use of chemical aids. The larger particles are unable to pass through the sand and the water passes through the sand much easily. Once the debris and other particles have been filtered out by the sand, the clean water is obtained. Activated carbon is an effective adsorbent because it is a highly porous material and provides a large surface area to which contaminants may adsorb. Activated carbon is soaked in hydrochloric acid to make it activated. It is used to absorb natural organic compounds, taste and odour compounds and synthetic organic chemicals in water treatment. In addition heavy metals such as lead can also be removed with activated carbon. It also removes biological stabilization and turbidity. The efficiency of this filter is high when compared to the existing system or any other filtration processes. The adsorption capacity and the efficiency of the carbon used depend on the nature of activated carbon used, the water composition, and the operating parameters. In this process, excellent scientific principle of adsorption is used where dangerous pollutants are trapped on the surface of the activated carbon, forming a waste outer layer coating and purify the water of the contaminants. The water obtained after the filtration process has less Total Dissolved Solids when compared to the sewage waste water and also the rate of water purified is increased rapidly. The filtered water obtained is then passed into the evacuated tube solar collector for further purification.

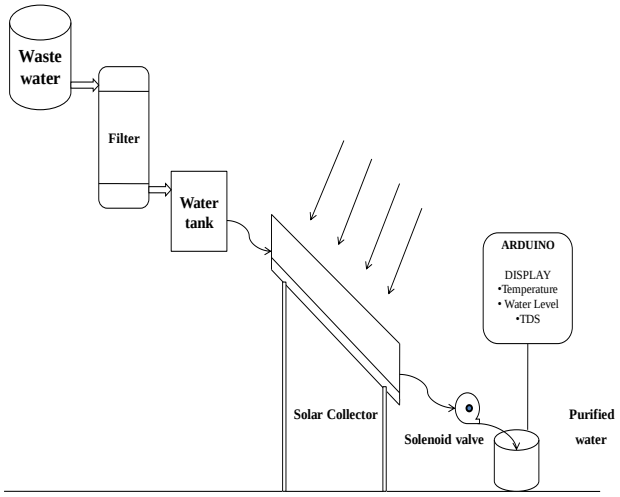

Figure: (a) –Block Diagram

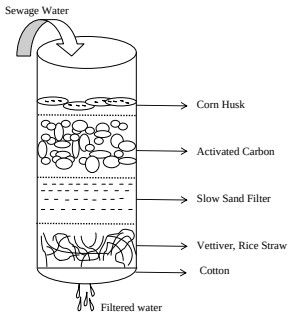

Figure: (b) –Natural Filter Bed

IV. SOLAR PURIFICATION

Energy resources are getting depleted nowadays. Solar energy is a free renewable energy and is abundant in nature. Solar radiations from sun play an important role in water purification which is not implemented in large scale. Solar collectors are used to trap the radiations from the sun. They are highly cost effective and have low maintenance cost.Solar collectors transform solar radiation into heat and transfer that heat to a medium

(water, solar fluid, or air).Research says that evacuated tube solar collectors are highly conducting compared to other types of collectors.Glass evacuated tubes are the key component of the Evacuated Tube Heat Pipe solar collectors. Evacuated (or Vacuum) Tubes are built to reduce convective and heat conduction loss. Each evacuated tube consists of two glass tubes. The outer tube is made of extremely strong transparent borosilicate glass. The inner tube is also made of borosilicate glass, but coated with a special selective coating, which features excellent solar heat absorption and minimal heat reflection properties. The inner tube is filled with water and the heat is transferred to the water by thermo siphon circulation. The chamber between outer and inner glass tubes is evacuated and permanently sealed off. This vacuum acts as the best insulation which allows sunlight to pass through the glass tubes. Due to the surrounding vacuum, heat loss by convection is significantly reduced. The glass tubes are connected with the manifold part and the stainless steel placed inside the manifold. In between the manifold and stainless steel, there is a puff insulation preventing the steel from rusting and the heat loss. The manifold is heavily insulated with a 2" thickness of pre-formed rock wool to keep the heat in and the outer layer of glass wool to prevent heat loss. The stand to hold the manifold is made of mild steel. The water inside the collector can reach the temperature to a tip of 250 and more(i.e.to the pasteurization temperature of water)to kill or deactivate all classes of pathogens including protozoan cysts that have shown resistance to chemical disinfection and viruses that are too small to be removed by microfiltration. As the water heats due to the radiation from sun, the increased temperature will kill or inactivate an important part of commonly water borne pathogenic bacteria, viruses, helminthes and protozoa at a temperature between 45 and 55,thus making the water drinkable. Hence the water from evacuated type solar collector is pure, meeting the drinking water requirement.

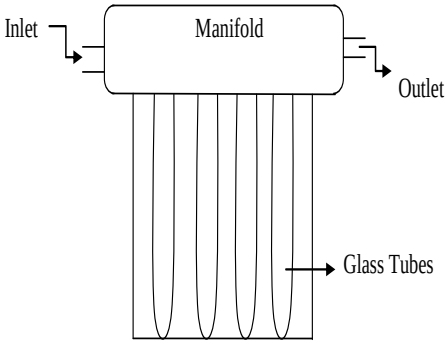

Figure: (c)– Evacuated Type Solar Collector

V. ARDUINO

The purified drinkable water thus obtained from collector is collected in a storage tank automatically, when the temperature inside the evacuated tube solar collector reaches about 50. The water proof temperature sensor which is fitted inside the collector is employed for sensing the temperature of water inside the solar collector. The temperature sensor is used to send the signal to the solenoid valve to open once the temperature of the water reaches 50. Thus the valve opens automatically and the water is sent out to the storage tank. Once the storage tank is filled, the solenoid valve is turned off automatically which is being controlled and interfaced by the arduino program.

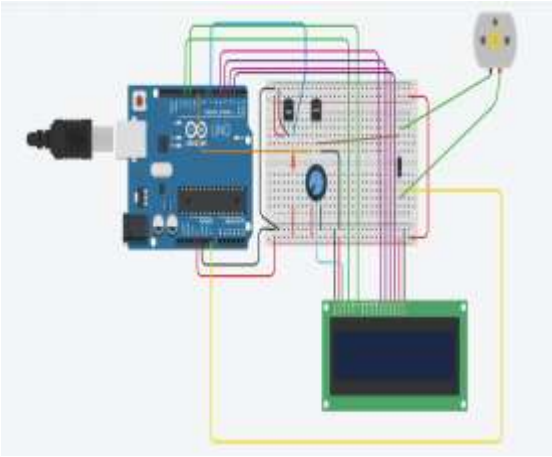

Figure: (d) – Arduino Connection

VI. COMPARISION BETWEEN EXISTING SYSTEM AND PROPOSED SYSTEM

In existing system, chemicals (Ferrous chloride and lime soda) are used to remove sediments. Membranes are soaked in resins to remove odour, colour which is dangerous to health. Reverse Osmosis filters used to reduce the Total Dissolved Solids level below the

drinking water level set by World Health Organization standards and thus Reverse Osmosis filters causes deficiency of minerals in human body. There are no methods available to kill or inactivate water borne pathogenic bacteria, viruses and protozoa. While proposed system uses agricultural wastes such as corn husk, vettiver and rice straw to remove pollutants and harmful chemicals. These agricultural wastes are not soaked in any resins or chemicals. They are used directly in the filter bed without soaking in any chemicals and therefore not dangerous to health. Activated carbon removes odour, colour which is a good adsorbent. Natural filters reduce the Total Dissolved Solids level, which is disinfectant. Evacuated solar collectors, which is used to heat the filtered water inactivates water borne pathogenic bacteria, viruses and protozoa.Also the present system needs frequent replacement of RO membranes soaked in resins. While the proposed system doesn't require frequent replacement, since the carbon is activated by soaking it in hydrochloric acid to make it activated. Existing system needs electricity to carry out the process, hence increased cost and less efficient than the proposed system. But proposed system harnesses only solar energy, hence cost effective and also very efficient.

VII. RESULTS

Total Dissolved Solids value of Sample Sewage Water Taken = 2178 parts per million

The sample sewage water taken has the Total Dissolved Solids value of 2178 parts per million which is not fit for drinking water. The natural filtration using natural filter bed reduces the Total Dissolved Solids level gradually and the Potential of Hydrogen value is obtained to be neutral. The tests were performed for each layer separately to know how the level of contaminants reduces in each layer. After the complete filtration and heating process, the Total Dissolved Solids level reduced largely to 504 parts per million which is said to be the drinking water level set by World Health Organization standards. Hence we have tested the Total Dissolved Solids and Potential of Hydrogen of various layers and came to a conclusion that our proposed project is well suited for the purpose of filtration.

TABLE – 1: Analysis of Total Dissolved Solids test in filtration process

Sl.No	Materials Taken for filtration	Before Treating (parts per million)	After Treating (parts per million)
1.	Vettiver	2178	1975
2.	Rice Straw	1975	1691
3.	Fine Sand	1691	1506
4.	Activated Carbon (Raw Carbon)	1506	909
5.	Activated Carbon (Hydro Chloric Acid soaked)	909	698
6.	Corn Husk	698	504

Figure: (e) -- Final Setup

VIII. CONCLUSION

The water obtained from filter has comparatively less Total Dissolved Solids than waste water and the water is free from impurities, odour, taste, dissolved solids and turbidity. The water received from solar collector is pure. This method can also be further extended to provide formers with clean water for their agricultural lands and irrigation facility to plants by drip irrigation. The water has no hardness due to the carbonates and bicarbonates of calcium and magnesium. The fact that the water can also be used for purifying, flushing and cleaning purpose is an additional advantage. This method of treatment using natural filter and solar collector does not need frequent replacement when compared to the other systems of water treatment .The activated charcoal used in filter is cheap, easily available,

and has high degree of purification. The density and large surface area available for adsorption is an important factor. 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.

IX. FUTURE SCOPE

The natural filtration method used in this project can be widely used in many rural areas and also in the regions where there is a demand of pure drinking water. The filtration process used is natural which does not cause any damage to human health and hence have a large scope in future of this project. It can also be implemented in large scale for the industrial purposes for filtering the dye water released out as waste from many textile companies and industries. This system also plays a major role in agricultural uses for feeding the agricultural lands with pure water.

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