Proceedings of the
International Conference on Mechanical Engineering and Renewable Energy 2013
(ICMERE2013) 1 - 3 May 2014, Chittagong, Bangladesh

ICMERE-2013-PI-114

ANALYSIS OF EXTENSION THE SUN-RAY TRAVEL PATH AND DEVELOPED A SOLAR CONTAINER TO DISINFECT FLOOD WATER BY SOLAR HEAT

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Abstract- *The flood affected people of Bangladesh suffer from various waterborne diseases due to lack of drinkable water. It is impossible for them to purify the flood water given their misfortunate situation during the flood. Hence there is a need for an apparatus which would minimize their sufferings by disinfecting the flood water to make it drinkable for them. This paper focuses on developing a solar container, which would be able to raise the temperature of the water to a certain limit to successfully disinfect the waterborne pathogens for flood affected people in Bangladesh. Various shapes were designed for the solar containers such that inside the container the sun ray travels longest path to raise the temperature of water. This study shows that the temperature rise does not change much on the variation of the sun ray travel path inside the solar containers.*

Keywords: Disinfect Flood Water, Sun Ray Travel Path, Temperature Rise, Waterborne Diseases.

1. INTRODUCTION

Water has always been an important and life-sustaining drink to humans and is essential to the survival of all organisms. Drinking water or potable water is sufficiently high quality that it can be consumed or used without risk of immediate or long term harm.

Over large parts of the world, humans have inadequate access to potable water and use sources contaminated with disease vectors, pathogens or unacceptable levels of dissolved chemicals or suspended solids. Such water is not potable and drinking such water leads to widespread acute and chronic illnesses and is a major cause of death in Bangladesh. Reduction of waterborne diseases is a major public health goal in developing countries like Bangladesh [1].

Each year in Bangladesh about 26,000 km^2, (around 18%) of the country is flooded. The flood affected people have no shelter, let alone the necessity of getting drinkable water. So they have to drink the flood water which is contaminated with various types of waterborne pathogens. Various studies have proved that boiling water is a good way of disinfecting, but the flood affected people do not have the opportunity to boil water as they have to stay on roofs or trees. So they need a source of pure drinking water which does not require any conventional energy source. They can utilize the solar energy to their aid by using devices which can disinfect flood water, uncomplicated, which is easy to handle and cheap for poor people. So the need of a setup is felt which can serve these purposes. Researchers have been working in this purifying water sector and able to produce many devices most of which are very complicated and not suitable for the flood affected people to use. If a simple solar container is made which can serve the purpose of disinfecting flood water, the water related diseases can be reduced to a great extent. In this paper, different simple solar containers are developed focusing on different length of the sun ray travel path. In this project, an especial focus is given to develop a design of solar pot that may accumulate solar heat and helps to raise the temperature at a desired level at which maximum infected germs die and the flood water can be drinkable. Three different shape solar pots have been studied and found different temperature rises. It is being observed that in a normal water containing pot, temperature can be risen up to 50°C in perfect sunny condition at summer season. But this temperature is not enough to kill the germs especially bacteria. Bacteria can be killed at a temperature 90°C instantaneously and 20 minutes at 55°C [2]. In conventional way, water can be boiled to rise temperature by using wood, fuel etc, which are not available at flood area. Many researchers like Avery, Edward [3] Gumucio, Ricardo Salcedo's [4], Wetzel [5], Deutsch [6] invented apparatus for water purification. However, these are not satisfying the needs of the population is flood areas. Most of the case these are costly, non-affordable, non-appropriate, for the rural areas in flood affected population of poor countries like Bangladesh. Some of them are toxic while chlorine in used to disinfect.

2. METHODOLOGY

2.1 Water Purification Technologies

The entire world's population needs safe drinking water at low cost and ease of use. The inexpensive portable water disinfect container is a major problem for much of the world's population. It has been estimated that approximately 15to 20 million children under the age of 5 die from diarrheal conditions brought on by infected drinking water every year. This is equivalent to a fully loaded DC-10 crashing every ten minutes every day round the year.

The most effective way of disinfecting drinking water is boiling water by using heat. This heat may come from wood-fuel burning, nuclear power or solar energy. Contrary to population opinion, boiling water for many minutes or even hours is not necessary to successfully disinfect. Numerous investigations have been conducted to demonstrate that temperatures much lower than the sea level boiling point (100°C) can successfully disinfect drinking water. Heat inactivation of micro-organisms is exponential with time. In general, disinfection time can range from instantaneous at 90°C to 20 minutes at 55°C. Using conventional means of heating water such as heating water over an open flamed stove, results an extremely energy-intensive process where as much as 1500 BTU per gallon of water can be required. Moreover, heating water from an ambient temperature to at least 90°C disinfection temperature requires a minimum energy input of approximately 130 BTU per pound of water [2]. This energy is usually wasted because once the disinfection temperature is reached to make the water safe to drink; the heat content of the water is dissipated to the environment before consumption.

Chlorine is another technique, which is mostly known, to disinfect drinking water. However, chlorine is a toxin that must constantly be replenished in order to be effective as a replenishable chemical, there is always a continuing cost incurred.

Other techniques of disinfection such as membranes, resin beds, and the like, require electricity for operation. This source of energy may not be available at the site or be too expensive when compared to this project.

Thus, the need exists for a safe and inexpensive technique for disinfecting drinking water.

This project work, the modified container, is to provide a non chemical, non toxic, simple, efficient, reliable and cost effective method to disinfect flood water using solar heat to disinfecting temperatures.

Collier [2] invented a solar heat exchanger, which is definitely non-portable. Therefore, this may not be feasible for rural areas where people are resting on trees, roofs, etc and such costly instrument is not affordable to have at home to use it only at flood season. Gumucio, Ricardo Salcedo's [4] invention is only for saline water, whereas flood water contains water borne pathogens (germs). Avery [3] invented a water purification apparatus that are costly and needs more personnel to operate and also this apparatus is not workable at flood area.

Wetzel [5] and Deutsch [6] invented a water distillation apparatus, which produces distilled water by means of solar energy. In his apparatus water is to be distilled in a confined internal chamber and subjected to solar energy through a transparent lid. The water that is distilled collects on the interior surface of the lid. This is a very slow process to supply water in a flood affected vast population. Hossain [7] has developed a solar container that could increase the temperature of the water contained upto 65° C and successfully showed that the water pathogens are killed at this temperature.

2.2 Mechanism of Manufacture

Several solar containers were to be designed and manufactured. Very shiny and high reflectable material were to be used as liner on the inside surface. The temperature was to be measured and thereby the travel path of the sun ray inside the container. The main focus was to increase the travel path of the sun rays as to increase the temperature further more.

3. ANALYSIS OF SUN RAY TRAVEL PATH

Three sets of experimental data were chosen for observing the sun ray travel path inside the solar containers.

The sun ray travel path measurement was done by visualizing the solar containers as two dimensional geometrical shapes. For a reference position of the sun, different points in each container were specified. Then by a java based software GEOGEBRA [8], drawings and calculations of the sun ray travel path was completed.

The solar containers were visualized as such for the calculations (Figure 1) and the calculated Travel Path = (7.1+2.02+6.04) = 15.16cm.

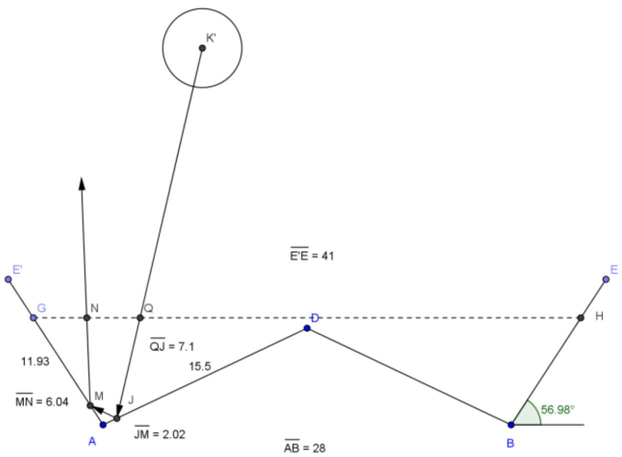


Fig 1: Schematic diagram of a Solar Container

Table 1 shows the comparative state of solar container 1 and 2 in different day time. Depending on the altitude angle (sun position) the lengths of sun travel path are calculated.

Table 1: Comparative Result of Solar Container 1 and 2

Parameter	Solar Container 1			Solar Container 2	
Case	1	2	3	1	2
Time	1500	1600	1700	1200	1300
Altitude angle °	49.55	36.01	22.67	88.52	76.96
Longest Sun Ray Travel Path (cm)	32.89	32.99	120.98	108.41	112.25
Ambient Temperature °C	33.8	35	34	33.2	34.8
Measured Water Temperature °C	32.4	33	33	33.8	34.3
Temperature Difference °C	-1.4	-2	-1	0.6	– 0.5

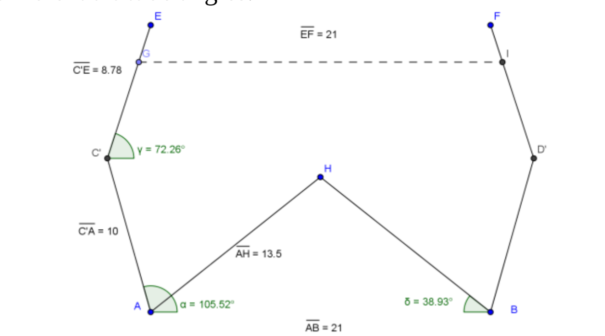
So the sun ray travel path is slightly more for case 2. But as seen from the table 5.2, difference of water temperature and ambient temperature is 0.6°C for case 1 and – 0.5°C for case 2. So despite the sun ray travel path being more, case 2 has lower temperature difference.

The above observations show that, in case of both the containers, the temperature rise associated was completely independent of the sun ray travel path inside the solar container. So the solar container made should not solely concentrate on temperature rising by increasing sun ray travel path.

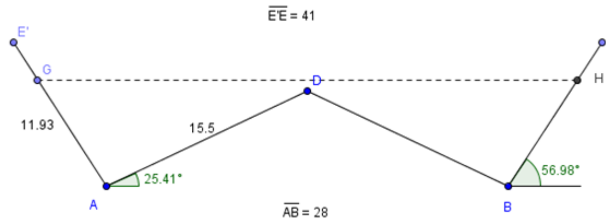
4. DESIGN CONCEPT AND RESULT ANALYSIS

4.1 Design Concept and Manufacture of Solar Containers

Figures 2 (a and b) show the front sectional view of the solar containers. These two designs have chosen as such that it would provide longer sun ray travel paths for different altitude angles.



a



b

Fig 2: Front Sectional View of different solar containers

Considering the sun light travel path, the setups shown in figures 3(a and b) of the solar containers were manufactured. Figures 3 (c-h) are the modification of the figure 3b having different conditions. Very shiny and reflective material was used for these the solar containers.

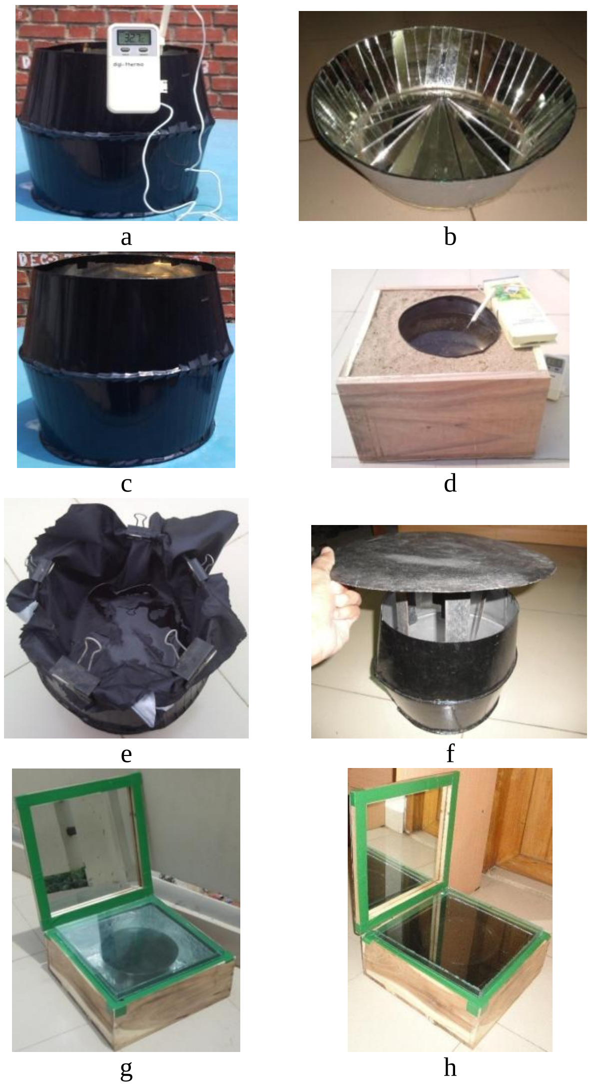


Fig 3: Photographs of different solar containers

Figure 4 shows the temperature gain/loss for different solar containers for different modification of the pots.

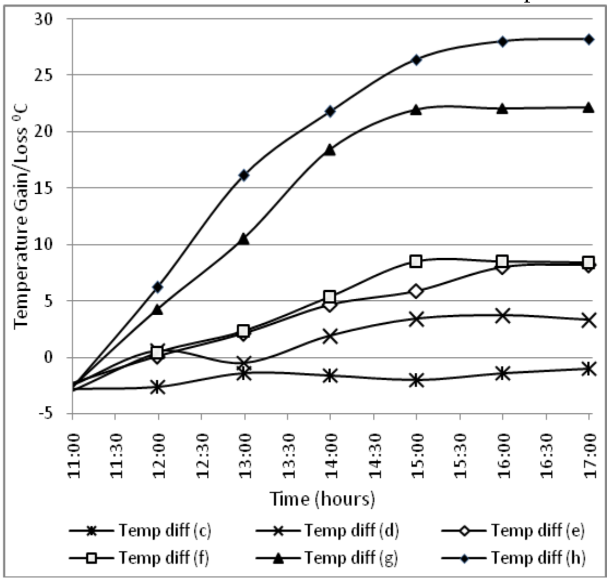


Fig 4: Temperature gain/loss from the ambient conditions for different solar containers

4. RESULT ANALYSIS AND DISCUSSION

To protect heat loss and get more reflective surface black coat at the outside and silver coat at the inside were used for figure 3c, which could increase the temperature slightly (figure 4). Further heat loss was protected by using wood dust filled box and black cloth on top as figures 3 (d-e), which contributes further temperature increase (see figure 4). By using fin (figure 3f) from the top surface another few degrees of temperature would add up but for the case of figures 3(g-h) where extra reflective surfaces were used to accumulate the sunrays would lead satisfactory temperature rise to disinfect the water pathogens and there by flood water will be pure and safe for drinking (Hossain, 2012).

It is also found that travel path along cannot increase the temperature (see fig 4 for c pot) of the water up to the required value. This is because the sun-ray looses heat once it touches the surface of the water and rest of the path traveled by the ray without having any heat rather light. As there is no heat insulation or accumulation of the sun rays for the first three containers (figures 3 a-c), the gained heat is lost due open surface of water.

However, the combination of both absorptivity and reflectivity principles with insulation the solar containers shown in figures 3(d-f) can store more heat as to increase the temperature upto 65°C which is enough to kill the germs (Hossain, 2012).

5. CONCLUSION

The paper shows that the increase of the sun-ray traveled path is not the solution to heat up the water upto a required level as to disinfect the flood water. So more techniques as the combination of both absorptivity and reflectivity principles with insulation the solar containers shown in figures 3(d-f) can be used to heat up the infected water to the temperature upto 65°C.

The first two containers failed to raise the water temperature needed to kill the waterborne pathogens. The advancement of the article followed a systematical approach and thereby it was later discovered that the corresponding rise of water temperature with respect to the ambient temperature does not depend on maximizing the sun ray travel path inside the container. Therefore, the finally developed solar container based on the reflectivity, absorbtivity, and insulation can be much effective in increasing temperature to a required level of the flood affected areas in Bangladesh. Further developments in this solar container are needed for a mass production. In the energy crisis situations, this environment friendly apparatus can come to the aid of flood affected people.

7. REFERENCES

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