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MODEL AND FABRICATION OF AN INDIGENOUS WATER PURIFIER

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Abstract - *Even in 21st century millions of people in the developing countries suffer from water-borne disease. Polluted water is causing health problems in the rural areas of India. Here the potential of solar energy to pasteurize the water is investigated. Low cost indigenously available materials have been utilized to design and fabricate a solar pasteurizer having a capacity of nine liters. The designed pasteurizer maintains water temperature in the range of 60°C to 70°C continuously for more than an hour which is enough for deactivation of bacteria. The low cost and operational simplicity of the pasteurizer make it affordable.*

***Key Words*: Pasteurization, Water Purifier, Solar Energy, Water Treatment, Disinfection, Heating.**

1. INTRODUCTION

Polluted drinking water is causing many health problems in the remote areas. Most commonly rural people face huge problem due to unavailability of safe drinking water. In many parts of the world, work is already being carried out to use solar energy for purposes other than cooking. David and Robert (1984) investigated the potential of using solar energy to pasteurize water. They heated water to a temperature of 65oC in a box cooker. Razzak et al. (1985) carried out a direct method for obtaining pasteurization of contaminated water by using solar energy. They designed a solar pipe collector and obtained a temperature of 63 to 78oC. Reddy and Verma (1986) studied the scope of using solar energy in pasteurization of milk. Joyce et al. (1996) reported the thermal effect of equatorial sunshine on water samples contageted with high populations of coliforms. They investigated the feasibility of employing solar disinfection for highly contaminated water. McGuigan et al. (1998) reported a series of experiments to identify the inactivation process in stored water, exposed to sunlight. Safapour and Metcalf (1999) described a simple and reliable method that could be used to pasteurize milk and water with solar energy

To fulfill need of rural people a new design of combine solar pasteurizer cum water filter has been designed. The newly design indigenous water purifier consist of an unique design of solar pasteurizer combine with simple filtration unit. The filtration system consist of two metallic containers placed one at the top of the other one with a ceramic candle filter fitted at the upper containers bottom. Lower container stores the filtered water & to cool the hot water collected from solar pasteurizer, evaporative cooling system is implemented. The whole purifier unit can be placed in suitable support made of wooden table. A funnel is connected with inlet pipe of the pasteurizer. A stop cock is fitted at the outlet connection of first metallic container. Vent holes are provided with collector tank and filter container. A mercury thermometer is fitted at the outlet of water container. In the present work, we report the design of a solar pasteurizer using low cost indigenous material. The efficiency of pasteurizer has been under local environmental conditions.

1.1 Performance Characteristics

1) Latitude of Ahmednagar district, Maharashtra, India: 19.
2) Average intensity of solar radiation in Ahmednagar District, Maharashtra, India**:** 4.8 KW per sq. m
3) Minimum intensity of solar radiation: 1.9 kW per sq. m
4) Maximum intensity of solar radiation: 6.6 kW per sq. m
5) Maximum water temperature attained during winter: 60°C.
6) Maximum water temperature attained during summer: 70°C.
7) Capacity of filtration throughout the day during winter: 9 liters.
8) Capacity of filtration throughout the day during summer: 9 liters +9 liters = 18 liters (water filling and collecting is possible two times).

1.2 Solar Pasteurization and Filtering Unit

The solar pasteurizer unit of improved water purifier is a newly developed solar pasteurizer, which

consists of a square-shaped GI tray, the open side of which is welded at the mid position of a larger size square-shaped G-I sheet (Fig. 1) [7]. The larger sheet is attached on a wooden plate of the same surface area. The outer sides of both GI sheet and inversely fitted tray are painted with dull black paint to absorb solar radiation. The top and sides of inversely fitted tray is worked as upper body of absorber cum storage tank and the bottom sheet is worked as absorber plate at the bottom end of the storage tank. Large surface area of bottom plate of the collector increases the total radiation absorbing area of the collector and thus boosts up the rate of energy collection. The whole collector system is covered by two layers of ultraviolet (UV)-resistant transparent polythene sheets keeping a gap in between. The collector system is to be placed facing south at an angle equal to the latitude of the place (+15° during winter) and the latitude angle (–15° during summer). To boost up the energy collection further, a north facing adjustable reflector made of aluminium foil is provided with the collector system.

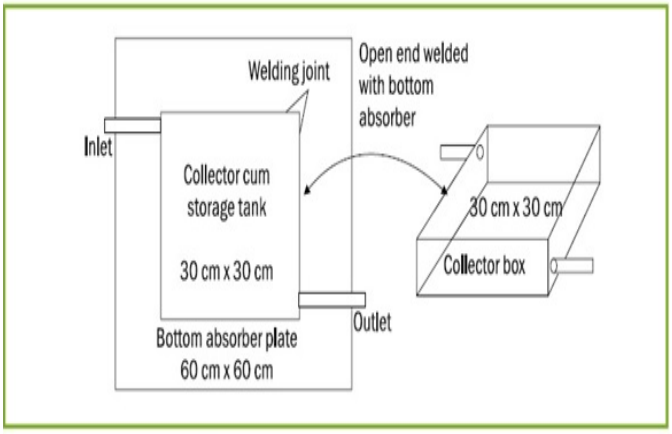


Fig -1 Diagram of Water Tray [7]

The filtration system consists of two metallic containers placed one at the top of the other with a ceramic candle filter fitted at the upper container bottom (Fig. 2) [7]. Lower container stores the filtered water. To cool the hot water collected from solar pasteurizer, evaporative cooling system is implemented. In the system, both top and bottom containers are layered by jute and water from overhead small water container keeps jute pads wet by a drip system through perforated PVC pipes. The whole purifier unit can be placed in a suitable support made of bamboo sticks. A funnel is connected with inlet pipe of the pasteurizer.

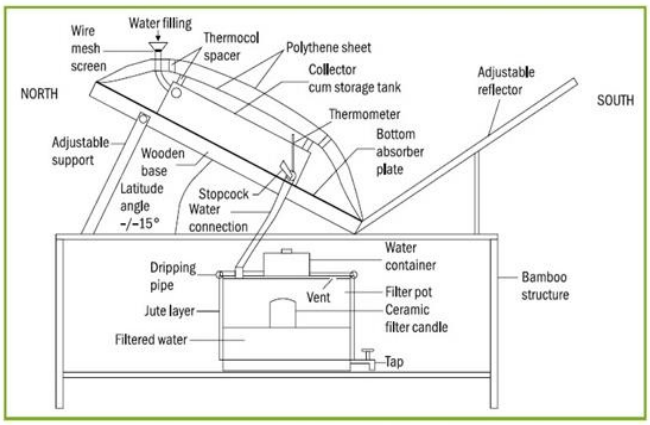


Fig -2 Solar Pasteurization and Filtering Unit [7]

A stop cock is fitted at the outlet connection. Vent holes are provided with collector tank and filter container. A mercury thermometer is fitted at the outlet of pasteurizer.

2. Design of Water Tray (Container)

Dimensions of container:-
Formula: - VOLUME= MASS/DENSITY

$V = M/\rho$
$M = 9$ kg (1 lit = 1kg)
$\rho = 1000$ Kg/m^3
$V = 9/1000 = 0.009$ m^3

But,

VOLUME=AREA×LENGTH
$V = A \times L$

By trial and error method,

The dimensions of container are selected as 30cm×30cm×10cm i.e. length, width, depth is 30cm, 30cm, 10 cm respectively.

1) Solar collector cum storage tank Material: 20 gauge galvanized iron Sheet Dimensions: Length—30 cm, Width—30 cm, Depth—10 cm
2) Bottom absorber plate Material: 20 gauge galvanized iron Sheet Dimensions: Length—60 cm, Width—60 cm
3) Reflector plate Material: Aluminum Sheet Dimensions: Length—60 cm,Width—60 cm.
4) Wooden back of bottom absorber plate Thickness: 12 mm, Dimensions: Length—60 cm, Width—60 cm
5) Filtration Unit Capacity of top and bottom containers: 9 liters each Filtering element: Ceramic filter.

Table -1 Specification of Component

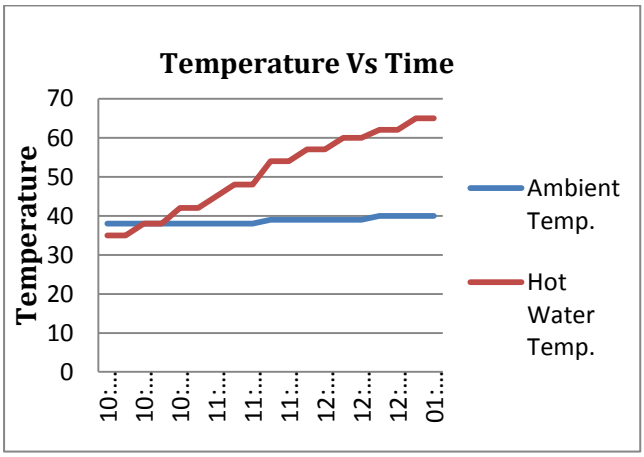
Sr. No.	Component	Specifications	Cost
1.	GI Tray	30cm×30cm	1500
2.	Absorber plate	60cm×60cm	2000
3.	Wooden Table	107cm×60cm	1000
4.	Water Filter	Filter with ceramic candle.	1000
5	Pipe	Plastic pipe	300

3. Experimental Validation

Experimental readings for summer season are taken in two sessions. In first session at ambient temperature of 38 ^{0}c readings are taken from morning 10 am to 1 pm for time interval of 10 min. It is observed that temperature of water increases gradually from 35 ^{0}c to 65 ^{0}c. table no. 2 and graph no. 1 below represents the increase in temperature of water during time period of 3 hours. Total amount of posturized water obtained in this session is 9 liters.

Table -2 Readings in summer 1st session

Time	Ambient Temp (°c)	Hot Water Temp (°c)
10:00	38	35
10:10	38	35
10:20	38	38
10:30	38	38
10:40	38	42
10:50	38	42
11:00	38	45
11:10	38	48
11:20	38	48
11:30	39	54
11:40	39	54
11:50	39	57
12:00	39	57
12:10	39	60
12:20	39	60
12:30	40	62
12:40	40	62
12:50	40	65
01:00	40	65

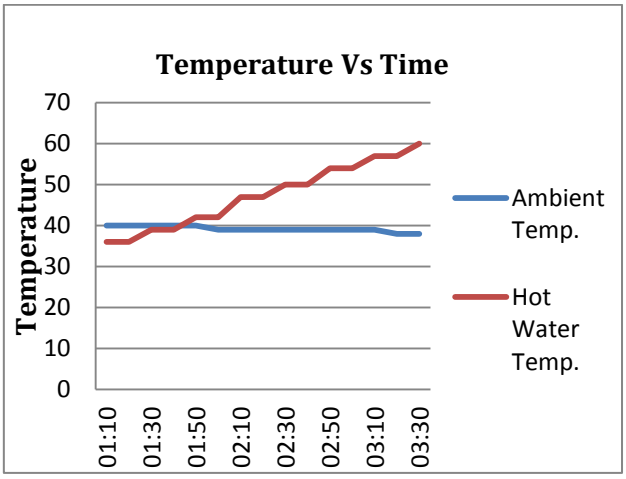


Graph-1 Plot of temp. V/s time for 1st Session

In second session at ambient temperature of 40 ^{0}c readings are taken from 1 pm to 3.30 pm for time interval of 10 min. It is observed that temperature of water increases gradually from 36 ^{0}c to 60 ^{0}c. Table no. 3 and graph no. 2 below represents the increase in temperature of water during time period of 2.30 hours. Total amount of posturized water obtained in this session is 9 liters.

Table -3 Readings in summer 2nd session

Time	Ambient Temp (°c)	Hot Water Temp (°c)
01:10	40	36
01:20	40	36
01:30	40	39
01:40	40	39
01:50	40	42
02:00	39	42
02:10	39	47
02:20	39	47
02:30	39	50
02:40	39	50
02:50	39	54
03:00	39	54
03:10	39	57
03:20	38	57
03:30	38	60



Graph-2 Plot of temp. V/s time for 2nd Session

Fig -3 Model of an Indigenous Water Purifier

3. CONCLUSION

In the indigenous water purifier we enforce to highlight the function of an indigenous water purifier its various aspects and performance. In this uniquely design pasteurizer captures more radiant energy compared to conventional built in collector cum storage type solar water heater. Thus further extensive research and testing can improve the exiting techniques.

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