



# PURIFICATION AND DISINFECTION OF WATER BY SOLAR ENERGY

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## Abstract

**Water pollution is one of the main problems of Environmental issues, which is creating nuisance to the environment and also the cause of many water borne diseases that shows effects on the living kind. Many people die because of drinking contaminated water as they don't have accessibility for filtered water or their economical conditions does not afford for filtered water and also the disinfection techniques. This is the main criteria of choosing this compact filter, which is very cheap that poor people can afford and drink filtered water which is free from maximum pollutants which intend to cause diseases. In this paper, an investigation report of compact filter has given which is cost effective for developing countries and ease of maintenance. A solar water disinfection system has arranged that improves the water quality (free from microbial activity) of drinking water at household level. By using this technique of filtration method in the compact filter which contains natural filter bed, 20 Liters of water is purified within 30 minutes. This filter helps to remove turbidity as well as physical, chemical contaminants. Pathogenic organisms in water are removed by solar hybrid system or disinfection chamber, which is the cheapest way of using renewable energy.**

**Index Terms: Compact filter, Filtration, Turbidity, Solar hybrid system or Disinfection chamber.**

## I. INTRODUCTION

Water is the most important natural resources available in the world and it is one of the very

important aspects to keep living beings alive. It is more essential to use the filtered water more efficiently. The safe drinking water supply is one of the most challenging issues in terms of economic aspects. Now a days, filtration of water is the uneconomical aspect. The cheapest form of filtering water is by using natural materials, forming layers of beds such as gravel, charcoal, brick chips, and the major portion of layer of bed is mostly comprising of sand constitutes. Drinking water is one of the basic needs of life and is essential for survival. Still more than one billion people all over the world do not have ready access to an adequate and safe drinking water supply and more than 800 million people of those are unsaved lives in rural areas. In India, ground water is being used as raw water for 85% public water supply. Water supply varies widely in terms of region and country. In 1970s, approximately 2.5 billion people are in developing world, out of which only 38% has safe drinking water. At the beginning of the 1980s, water supply coverage was 75% in urban areas and 46% in rural areas. In developing countries, 75% of the population had access to water supply. So they are always prone to loss of their lives or cost a big toll to save themselves from the occurrence of different water-borne diseases. Water disinfection is one of several interventions that can improve public health. Water contamination due to pathogenic agents, chemicals, heavy metals, pesticides, water disinfectants, and thereby product as a consequence of industrial and agricultural activities, leaching from soil, rocks, and atmospheric deposition and other human activities has become a hazard to human health in several regions of world. In general, the

methods which are used to treat water include physical processes such as filtration. We can also treat the water which is used. The reuse of water has been doubled as the greatest challenge of the 21st century (Asano, 2002), and, as such, great emphasis is being put into the development of new technologies for the treatment methods such as sedimentation and distillation, biological processes such as slow sand filters or biologically active carbon, chemical processes such as flocculation and chlorination and the use of electromagnetic radiation such as ultraviolet light. The aim of this study is to design a simple and low cost panel of hybrid technology for utilizing solar energy efficiently towards water purification and disinfection system, and to utilize waste materials for the house hold purification system.

Objectives:

- To prepare low cost water filter
- To prepare a economical disinfection chamber
- To make filtered water available in remote areas
- To conduct various tests on quality of water sample obtained

## **II. MATERIALS AND METHODS**

Mechanism of Water Purification and Disinfection:

This entire purification of water is mainly divided into two stages

1. First stage is filtration of water using compact filter and
2. Second stage is disinfecting the filtered water using disinfection chamber.

The water purification and disinfection system is divided into two steps. First is the compact filter preparation and second is the solar collector preparation. In this system, the water is filtered by using physical process of filtration as well as solar energy. At first the water is filtered by using the compact water filter. Then the pure water is reserved in an aluminum cylinder surrounding with the square glass, which is connected with the solar flat plate solar collector. The solar collector consists of aluminum cane that absorbs the solar heat energy and passes through the aluminum cylindrical chamber. The solar collector is an air tight chamber in which glass is used as surface cover. Then the reserve chamber obtained heat either directly from the sun or the solar collector so that no significant

effect on the disinfection of *E.coli* bacteria. From this, water gets heated up killing the bacteria which is considered as pure water. There are many parameters of measuring water are tested by different instruments after and before treatment. Finally we not only get the pure drinking water but also hot water from this system.

**Compact Filter:**

Compact filter is related to slow sand filters which is most economical when compared to other types of filtration methods. In this type of filtration initial cost is low and the cost for filtration of water is nil. Filtration is commonly the mechanical or physical operation which is used for the separation of solids from fluids (liquids or gases) by interposing a medium through which only the fluid can pass. The compact filter is consists 5.00 cm layer of coarse gravel, 16 cm fine gravel, 5 cm brick chips, 4.00 cm wood charcoal and plastic container.

**Plastic Container:**

A circular plastic container of height 30cm and width 25cm is taken and placed on the dispenser vertically down ward. Now the bottom part of the plastic container becomes the top part, this part of 5cm is to be cut for easy insertion of compact filter. Compact filter is the main system of eliminating physical and chemical impurities, the different layers of compact filter are taken as follows.

**Fine Aggregate Layer:**

The fine aggregate (sand) layer is the bottom layer of height 16cm which the sand is passing from 1.18mm size sieve and the sand retaining on 0.6mm size sieve is taken , below this a 200 micron sieve is placed as support membrane.

**Brick Chips Layer:**

The brick chips are used because of its high porous nature , bricks chips are of from broken bricks passing through the sieve of 12.5mm and retaining on 10mm size sieve with a height of 5cm and a sieve of 300 microns sieve is placed on the brick chip layer.

**Charcoal Layer:**

The charcoal layer is placed on the top of brick chip layer and the size used is the charcoal chips is passed through 12.5mm size sieve and retained on 10mm size sieve is used with a height of 4cm

and a 300 micron sieve is placed on the top of the charcoal layer.

**Dispersion Plate:**

An aluminum plate of 20cm diameter and 1mm thick circular plate is taken and made four strips of 5cm is cut and bent down for dispersing the water that is poured on the gravel layer without disturbing the layer.

**Solar Dis-Infection Chamber:**

Solar water disinfection is a type of portable water purification system that uses solar energy to make biologically-contaminated (e.g. bacteria, viruses, protozoa) water safe to drink. The filtered water is treated by solar energy in order to remove the rest pathogens, microorganisms, some viruses and bacteria. It also kills germs. Here the water is heated by an aluminum cylinder sheet containing 12 inch height with 7 inch diameter and a capacity of containing 5 liters of water. It is surrounded with the rectangular box which consists of glass sheet having 25cm depth, 25cm wide and 50cm height. The rectangular box is attached to the solar collector which is composed of columns of painted black aluminum can, a frame to house the columns and ventilation for the heat transportation. Solar thermal water disinfection chamber uses heat from the Sun to heat water to 40-50 °C for a short period of time.

**III. EXPERIMENTAL PROCEDURE**

**Filtration Process:**

A typical filtration system consists of the following components

1. Filtration of water through compact filter.
2. Disinfecting the water by disinfection chamber.

The river water is collected and poured in compact filter, which the raw water passes through different layers of natural filter beds such as gravel, sand, charcoal, brick chips. In this process, the physical solids get trapped in and the turbidity of water is removed completely, this water is called palatable water and the water contains only bacteria, microscopic organisms. This water is transferred to disinfection chamber where water is heated up by using sun rays, this heating process kills the bacteria and microorganisms which are present in water. Now we get purified water which is safe to drink.

**Working:**

**Filtration:** The PET (Polyethylene terephthalate) water tin of 20 liters capacity with dispenser attached with tap at bottom is taken. A plastic pipe of diameter 1cm is taken and attached to the dispenser tap, so as transfer the palatable water to the disinfection chamber. Now PET tin is cut opened at the bottom above 5cm and placed inverted on the dispenser making the opening portion for inlet of raw water, then a 300 microns wire mesh is placed in the PET tin as the base layer. Now sieved and washed sand of size 600 microns is placed at the bottom layer with a height of 16cm and a wire mesh of size 300 microns is placed above the sand layer as a barrier, Put 4cm of wood charcoal layer is placed and again 300 microns wire mesh is placed as a barrier and for easy cleaning purpose and brick chips of 5cm height are placed and again mesh is placed above the brick chips layer. Since at the top the gravel layer of height 5cm is placed evenly distributing on all sides equally and compressed using hand, above the gravel layer a dispersion plate is made with 4 projections of 5cm length and at the bottom of the plate an elevation of 4cm is made for easy flowing of water and easy dispersion of water without disturbing the gravel layer. A top lid on the PET tin is made of aluminum of diameter 31cm is placed and at the center a wire mesh of 400microns is placed to obstruct the larger sized physical impurities.

**Disinfection:** An aluminum container of height 30cm and diameter 15 cm is prepared by attaching a tap at the bottom of the container for collection of purified water. Here the aluminum container is painted black color for absorbing more heat than the emitted sun rays (IS 427: 2005) for paints. Now an air tight chamber should be made for eliminating the external bacteria found in air and to allow sun rays completely without obstruction, a transparent float glass of requirements of IS 14900: transparent float glass of 6mm size is taken and made in a rectangular shape of height 50cm and width 30cm is placed as a cover on the aluminum container. A hole of 1 cm is made at top of the glass to make inlet for the filtered water pipe of diameter 1cm.

IV. RESULTS

Table.1 Physical Parameters of water before and after filtration and disinfection

Parameter	Raw Water	Filtered Water	Disinfected Water	IS 10500 Standards	Remarks
Hardness (mg/l)	840	380	370	300 - 600	Fit for drinking
Alkalinity (mg/l)	530	290	240	200 - 600	Fit for drinking
Sulphates (mg/l)	NIL	NIL	NIL	200 - 400	Fit for drinking
Acidity (mg/l)	23	25	28	20 - 40	Fit for drinking
pH	7.5	7.3	7.0	6.6 - 8.5	Fit for drinking

IMAGES



Fig.2 Compact filter



Fig.3 Plastic Container



Fig.4 Charcoal Layer



Fig.5 Fine Aggregate Layer



Fig.6 Dispersion Plate



Fig.7 Brick Layer



Fig.8 Coarse Aggregate

**V. CONCLUSIONS**

The main conclusions of the study are given below:

1. Efficiency of filter for removing physical impurities is 100%.
2. Efficiency of filter for removing chemical impurities is 80%.
3. The compact filter is biologically perfect since the water is disinfected.
4. The Rate of filtration is 30 L/hr.
5. It is the cheapest method of water purification and disinfection since the filtration cost of water is 1paise per liter.
6. Its initial cost is low and suggestable for the people from poorer backgrounds.

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