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DESIGN OF WATER FILTRATION SYSTEM

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ABSTRACT

Water scarcity has become one of the most serious problems nowadays. The recycling of water from sources like rain water harvester, ponds, rivers, discharge from industry are very crucial to combat water scarcity. Testing were conducted to find out different impurities present in the raw water. The filter materials and disinfectant were selected based on the different impurities present in the raw water. Test results of raw water filtered with the device showed remarkable decrease in bacterial presence and other impurities. The proposed water filtration system is portable, modular and easy to maintain.

KEYWORDS: Water Filter, Activated Carbon, Silica Sand, Recycling Of Water, Chrysopogon Zizanioides.

INTRODUCTION

Water is a clear, tasteless, odourless, and nearly colourless chemical substance, which is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most life forms. It is vital for all life forms. Water consists of two hydrogen and one oxygen atom. Water covers nearly 71% of the earth's surface. Water has wide range of applications like drinking, cooking, producing energy, extinguishing fire etc. Huge population rise, climate change and indiscriminate use of water resource, has caused scarcity of water resources in many parts of the world. Water scarcity affects more than 2.8 billion people over the world. 1.2 billion individuals lack access to clean drinking water [12] United Nations, UN defines water scarcity as the scarcity in availability due to physical shortage, or scarcity in access due to the failure of institutions to guarantee a normal supply or because of an absence of sufficient framework. Many of the water systems that keep ecosystems thriving and feed a growing human population have become stressed. Rivers, lakes and aquifers are drying up and are becoming too polluted to use. More than half the world's wetlands have disappeared. Agriculture consumes more water than any other source and wastes much of that through inefficiencies. Climate change is altering patterns of weather and water around the world, causing shortages and droughts in some areas and floods in others. It is predicted that by 2025 two-thirds of the population will face water scarcity. Figure 1 depicts water scarcity in India. Most of the water filtration systems that are available in today's market are costly hence not affordable for poor people and depends hugely on electricity.

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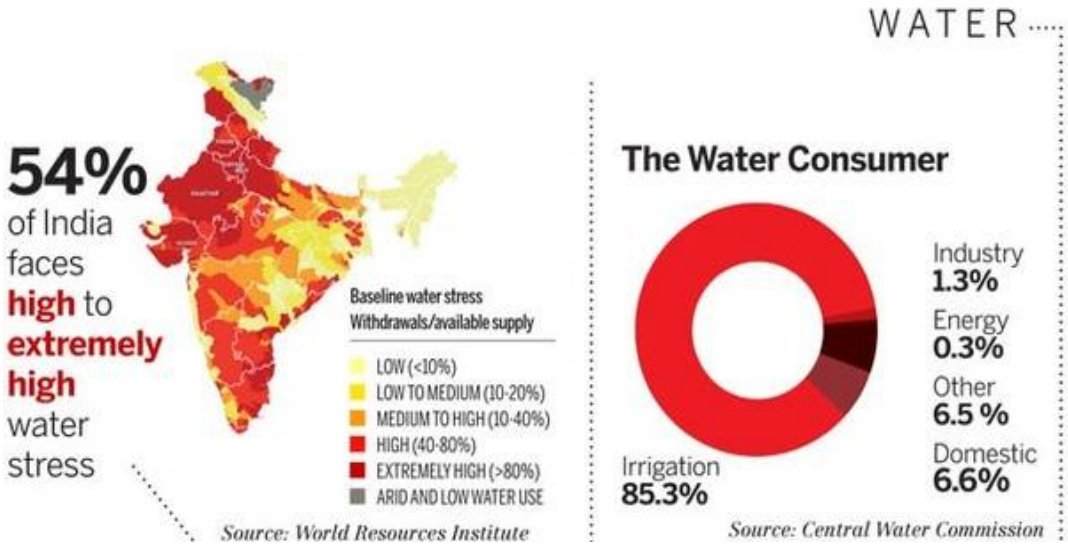

Figure 1.Water scarcity in India [10]

In the past wars have been fought for natural resources like oil, minerals etc but it is widely speculated that world war 3 is going to be fought because of water scarcity. From this it could be understood that recycling of water is highly important. [14]

The design of the water filtration system is based on modularity, which aims at ease of use, compactness, maintenance and replacement of filters. The water filter is automated with the help of an Arduino board. Disinfection is provided to kill the bacteria present in water. At the end user can obtained clean drinking water which meets various standards and free of any impurities. It is highly important to disinfect water. Every year around a million people die because of diseases like cholera, diarrhoea which could be easily prevented if water was disinfected. [13]

The section 1 deals with introduction and section 2 deals with literature review. Section 3 depicts problem definition and section 4 gives solution methodology. Finally, section 6 follows section 5 were results are presented.

LITERATURE REVIEW

The literature consider study on various natural filter materials that are locally available. The material study also includes cellulose membranes, other high fibre materials, and activated carbon.

Various natural Filters/ Membranes that can be used for water filtration are

- Silica activated carbon composite-to remove heavy metals like Ni, Cd, Cr, etc
- Ultra cellulosenanofibers-to remove virus, ultra cellulose nanofibers have shown higher LRV, Log Reduction Value against bacteria and viruses when compared to commercially available filters. It was found through experiments that they can be used at higher flow rates and for long period of time. [11]
- Rice husk-to improve color, turbidity and odor. Rice husk is thrown away as waste, instead it can be carbonized and used for water filtration. By doing this waste can be reduced. [5]
- Natural fibers like cotton-small particles can be removed.

Other fibers like high flux fibrous membranes can be used which have high water flux, that is, the rate at which water permeates through a membrane.

- High flux Nano fibrous membranes-to remove virus
- High flux micro fibrous membranes-for removal of bacteria.
- Derived from natural sources like cotton and wood pulp. [11]

Lignocellulose materials like pine cone, sugar beet pulp, lemon, leaves, grass, barley straw, soybean straw, bagasse and paper that are modified by citric acid-can be used to remove heavy metals from aqueous solution. Thus, remove water hardness (calcium and magnesium cations) [3]

PAC, Plain Activated Carbon

- Taste and odour issues caused by 2-methylisobornoel and geosmin can be removed.
- PAC acts like a sponge. PAC having bimodal pore distribution has optimal adsorption of these compounds. Surface area is proportional to adsorption.
- Low molecular weight PAC has higher adsorption.
- Initial concentration of 2-methylisobornoel and geosmin does not affect its rate of removal by PAC.
- Higher the contact time, higher the efficiency of PAC. [1]

The existing water filter systems are costly and need skilled maintenance. This results in finally throw away process after few years.

PROBLEM DEFINITION

Designing a water filtration system which would be- Affordable, modular, portable, easy to maintain and less dependent on electricity. As water source getting scarce it is essential to purify waste water, rain water to meet daily needs. The filter system aims to purify water from various sources and make it drinkable.

SOLUTION METHODOLOGY

The design of water filter system using natural and reusable fibers is depicted. The various compartments of the proposed system are shown in figure.3. Filter materials used for filter cartridge are wide variety of natural materials like silica sand, activated carbon etc. The disinfection tank and filter cartridge assembly are shown in Figure 3.Exploded view of filter cartridge is shown in Figure 4. The unique feature of the design is the disinfectant unit. Herbal bactericidal reagent is used for disinfection. Figure 2 shows the disinfection tank and spray bottle assembly. The raw water is poured into the disinfection tank and percolate through the following layers until it collects the water at the base.

Automation is achieved with the help of an Arduino board. Automation would take care of stirring of water, actuating spray mechanism to provide dosage of disinfectant, timer to note the time taken for disinfection, transferring water from disinfectant tank to filter cartridge.

DIMENSIONS

- Disinfection tank
- Inner Diameter = 19cm
- Height = 20cm
- Filter modules
- Inner Diameter = 24cm
- Height = 12.5cm

RESULTS

From the test results of water sample form water source, it was found that, amount of bacteria E. coli present in the sample was above the required limit.It is required to include disinfection which would remove bacteria present in water from rain water harvester, ponds etc. Automation is done to ensure filtration of water takes place correctly and the user can get purified water easily.

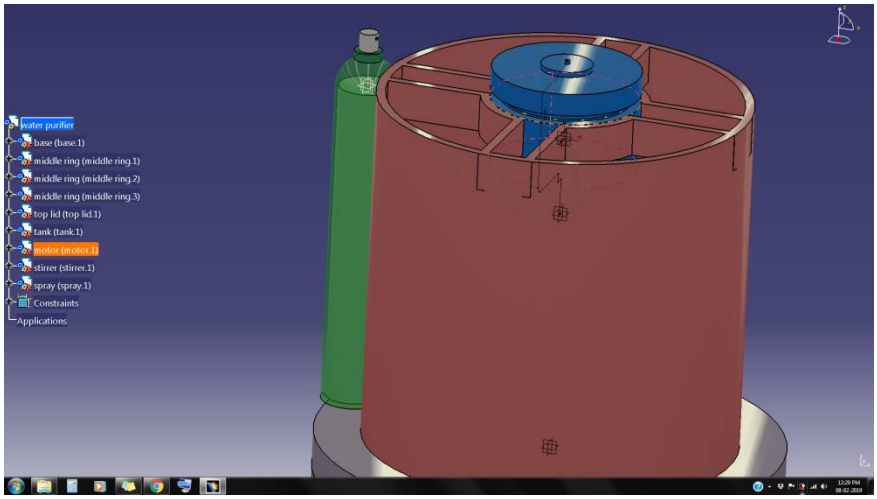

Figure 2.Depicts the side view of disinfectant tank and bottle-spray

A cam connected to a servomotor is can be used to operate the spray to add disinfectant to the raw water. Servomotor is controlled with the help of an Arduino board.

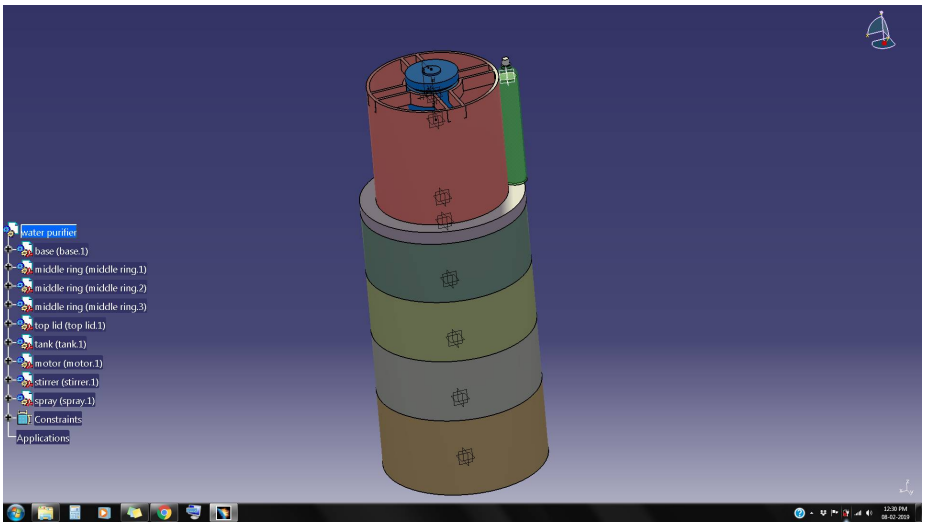

Figure 3.Depicts the side view of disinfection tank connected to filter cartridge

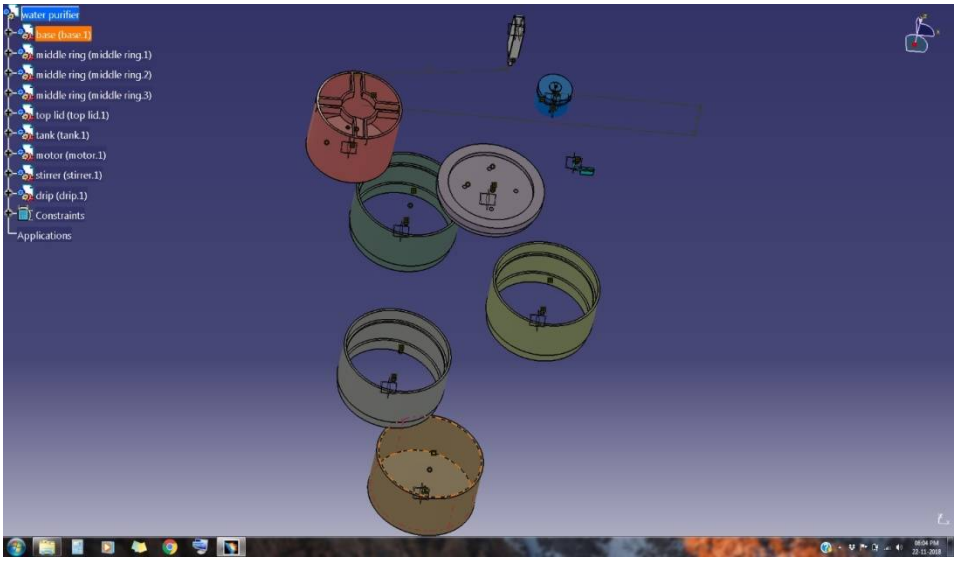

Figure 4.Depicts the exploded view of Filter cartridge

The result of the water sample tested is given in Table 1. To remove the bacteria, the first stage of design consists of a disinfection tank where the disinfection agent would be sprayed to the water and stirred. It will take about 20 minutes for disinfection to get completed. The time required for disinfection is independent of the quantity of water.

After disinfection, a valve is opened such that the water would pass through the filter cartridge and finally to the collection tank from where water could be taken for consumption.

The results are of two types- 1) Water before filtration 2) Water after filtration

Table 1.Water test results from rain water harvest pond at Mar Baselios College of Engineering and Technology

Sl No	Characteristics	Units	Desirable Limit	Raw Water	Filtered Water
1	pH		6.5-8	7	7
2	TOTAL DISSOLVED SALTS	Mg/l	Max 500	170	130
3	TOTAL HARDNESS	Ppm	Max 300	80	60
4	DISSOLVED OXYGEN	Mg/l	Min 10	8.4	9
5	FLUORIDES	Mg/l	Max 1.0	Nil	Nil
6	TURBIDITY	NTU	Max 5	Nil	Nil
7	TOTAL IRON	Ppm	Max 0.3	Nil	Nil
8	TOTAL BACTERIAL COUNT	Colonies	Absent	10^5	10
9	E.COLI	Colonies	Absent	10^3	10

Results shown in Table.1 have led to the development of the present design. The various filter materials include silica sand, activated carbon, gravel and Chrysopogon zizanioides. Further tests will be carried out with time and different water samples.

CONCLUSION

This paper presents a design for a water filtration system with a disinfectant. The proposed system offers several advantages like low-cost, user friendliness, modularity, fully automated and light weight design. Through this work, it is aimed to describe how to design and implement a sustainable water filtration device without unlike costly commercial filters. Since natural materials are used, they can be easily procured at cheap rate.The water obtained after filtration will comply with drinking water standards of WHO, Indian Standards etc and will be fit for consumption. Our approach can produce a promising result to be implemented in a practical water filtration application.

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