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Design and Construction of a Filtration System for Water Treatment Using Natural Materials

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Abstract - The design and construction of a filtration system for water treatment using natural materials aim to provide an efficient, low-cost, and eco-friendly solution to water purification. This project explores the use of readily available natural materials such as sand, gravel, activated charcoal, and zeolite, Activated Alumina in a multi-layer filtration system. This system aims to remove any impurities, sediments, and contaminants in water that will make it clean and pure for household and industrial use. The design is simple, cost-effective, and sustainable and thus suitable for rural and underprivileged areas where access to clean water is not possible. The filtration process makes use of a layer of various natural materials targeting different impurities. Gravel and sand remove larger particles, while activated charcoal and zeolite absorb chemical impurities and improve the water's odor and taste. Laboratory tests will be conducted to evaluate the system's efficiency in removing common pollutants such as heavy metals, pathogens, and organic compounds. The outcome of the project may provide a scalable model for communities looking for sustainable water treatment solutions.

I. INTRODUCTION

Water is one of the most vital natural resources on Earth. Of all the water on Earth, 97% is salty and the rest is fresh water found in rivers, streams, and glaciers. Water, which is underground, like that in aquifers, is called groundwater. This groundwater gets recharged, or filled up again, mainly from rain, especially during the monsoon season in India. Irrigation systems, like canals, also help recharge groundwater. While, in India, rainfall alone can naturally recharge approximately 342.43 km. Today, in many Indian cities, water is available just for a few hours daily, and it is quite poor in quality. Low pressure is also another reason for water supply problems, along with irregular supply and inadequate water.

This must be safe and devoid of pathogens, and a regular supply is not enough; waste through leakage and informal connection is another problem. From 1995 to 2006, the water quality tests proved that organic and bacterial contamination of the water source is still a big challenge. This is primarily attributed to the fact that the cities are emitting untreated waste in households into the water sources. In most instances, city governments are overwhelmed with levels of untreated sewage that pass into the water sources. Add this to inadequate clean supply into the water bodies for the dilution of the contaminates.

Thus, the oxygen requirement as well as bacterial contamination within water is increasing that leads towards waterborne illnesses. Water filter purifies the water by the mechanism in which a fine barrier, or a chemical reaction, and also a biological process acts on harmful substances to remove those harmful substances. The water should also be safe, free from harmful microorganisms, and a steady supply is not enough; the issue is with water waste caused by leaks and unauthorized connections. "From 1995 to 2006, water quality tests showed that organic and bacterial contamination in water sources remains a big problem. This is mostly because cities are releasing untreated household wastewater into the water. Most city governments can't handle the growing amount of untreated sewage going into water sources. Also, the water bodies don't have enough clean water to dilute the pollution.".

As a result, it requires oxygen and bacterial contamination in the water, thereby increasing the rate of waterborne diseases. A filter of water removes harmful products by using a fine membrane, chemical reaction, or biological process.

Filters purify water to some extent for applications such as irrigation, making water potable, aquariums in public and private places, and ensuring safety of ponds and swimming pools. Filters employ techniques like sieving, attraction and retention of particles, exchange of ions, transfer of biological matter, and so on to remove unwanted entities from water. A filter will remove very small particles smaller than the holes it lets water pass through, while a sieve or screen would not. Filtration of wastewater is usually the final step in the cleaning process of water, following the first and second cleaning stages and before the disinfection process. As water passes through a filter, residual debris and microorganisms are captured by the filter and removed from free-flowing water. These can occur because of obstruction by physical blockages or biological activity, particles stick to the filter, particle adsorption, or some balance of these factors. Removal of suspended solid particles usually is regarded as the terminal step in a treatment scheme for water.

Many researchers focus their attention on water pollution by using different ways of purifying polluted water, for example, chemical precipitation, biological membrane methods, electrochemical methods, among which the adsorption method of cleaning water using different types of materials is highly demanded because it is very efficient, inexpensive, and environmental friendly. This method mainly uses activated carbon, chitosan, zeolite, and clay minerals as "sponges" from plants and industrial wastes to clean the water.

II. OBJECTIVES

The study aims at making a Filtration System for Water Treatment using natural materials:

- Judging the raw quality of PanchaGanga river water sample
- Design and modeling of filtration unit treating the sample from the panchaganga river
- Comparative analysis of treated water sample with CPCB 2020 standards.

Other goals of this research are:

- Minimize the cost for the entire treatment system.
- To improve the effectiveness of treatment process.
- Raise the quality of raw water.
- On-site treatment of the water produced.
- Reuse and recycle wastewater,.

III. METHODOLOGY

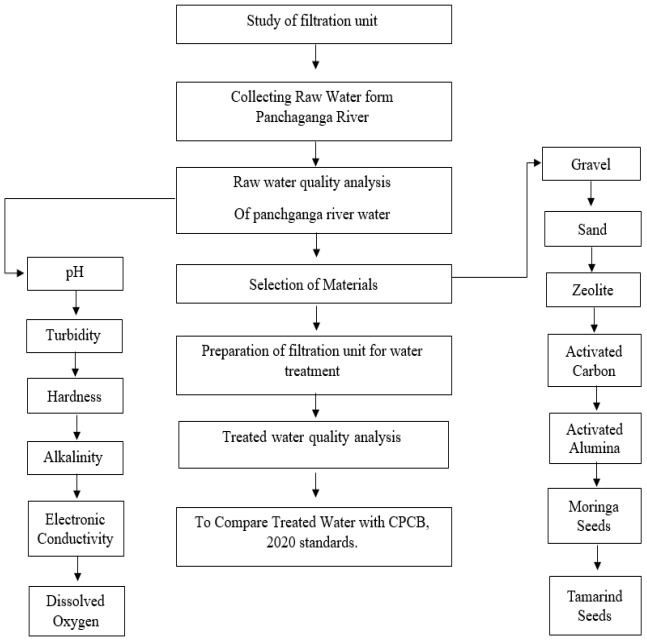


Fig. 1: Model of a filtration system fabricated

Table -1: Flowchart of Filtration system

Sample collect for experimentation purpose. The water samples were collected along the Panchaganga River. Samples sent into the laboratory. Different Experiments on: pH, Turbidity, Dissolved oxygen, Hardness, Electronic Conductivity, Alkalinity Test

IV. Test on raw water sampl

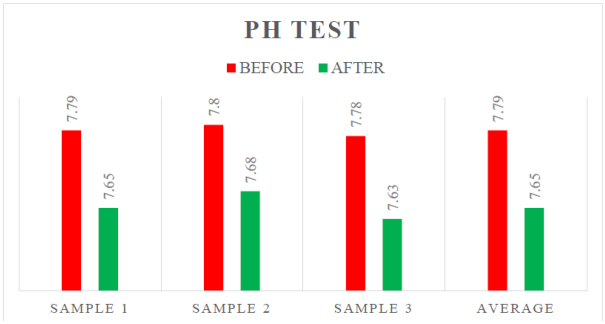


Fig. 2: pH test

pH value can effect on aquatic life and also can change water chemistry.

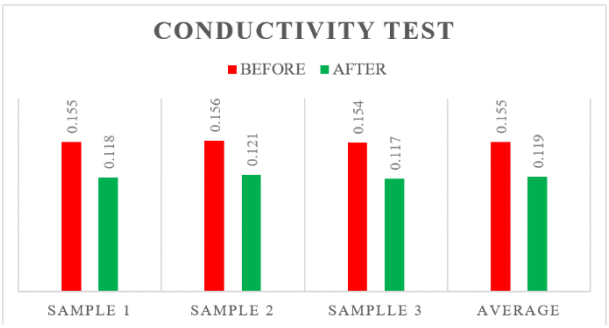
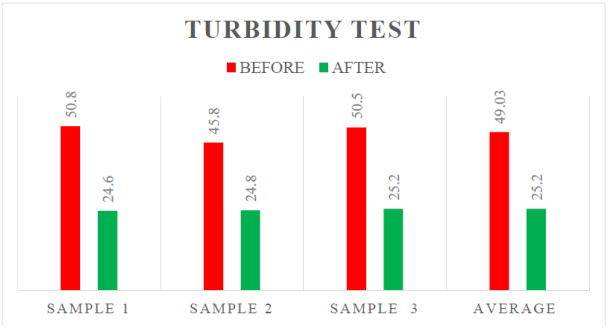


Fig. 2: Conductivity Test

Portable water generally has low conductivity exhibiting the fact that low concentration of TDS polluted and contaminated water generally has more conductivity indicating higher concentration dissolved salts.



Higher turbidity value generally affects they public demand and it reject by the public on aesthetics ground.

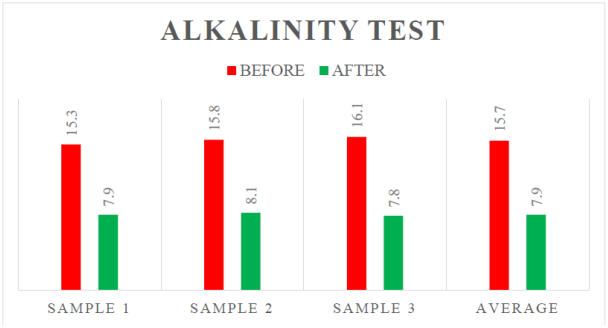


Fig. 2: Alkalinity Test

Higher Alkalinity reflects present of more carbonates and bicarbonates and can change the chemistry of water.

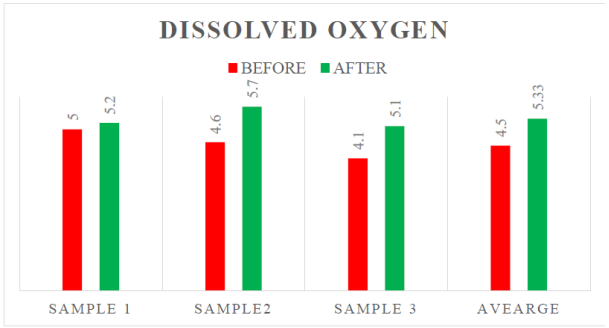


Fig. 2: Dissolved Oxygen Test

Increase the DO is the indication of purity of water however to much of DO is also not desirable test of water mainly depends on the oxygen percentage in water.

Do is the main cause of entire aquatic ecosystem sustainability and survival.

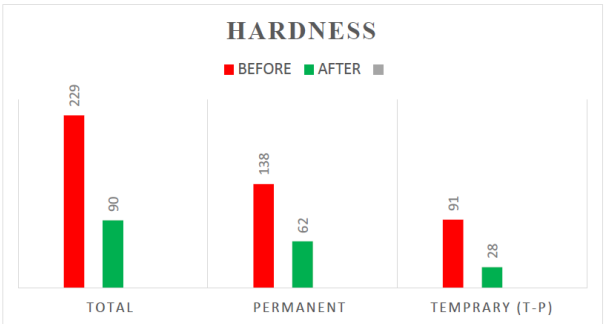


Fig. 2: Hardness Test

Too much of hard water affects industrial water and test of water although people consuming hard water it can affect the health in the long run.

V. CPCB standards for river water 2020

These standards shall provide support in maintaining water quality levels supportive of the health of aquatic ecosystems and human uses. Specific regulatory purposes or local standards would, in fact be best

Parameter	Standard
pH	6.5 - 8.5
Turbidity	≤ 5 NTU
Dissolved Oxygen (DO)	5 mg/L
Hardness	less than 300 mg/L
Electrical Conductivity	less than 1000 µS/cm
Alkalinity	Generally should be less than 200 mg/L (as $CaCO_3$).

indicated in the latest CPCB guidelines or relevant local regulations.

VI. CONCLUSIONS

The experiment was carried out, and it was revealed that the shift in PH value from alkaline to portable range showed affective function of the filter bed electrical conductivity also decreased from 0.155 ms/cm for raw water to 0.119 ms/cm. These clearly indicate improvement in the quality of filtered water compared to raw water further records and values of turbidity reflected appreciable decrease in the concentration total 15.7 mg / liter for raw water 7.9 mg / litre for filter water the study also recorded it improvement do concentration after filtration as per to Raw water. With above observations and recorded values it is clearly that the provided filter it is works efficiency in improve it the water quality the study revealed that the filtered provided can work under any efficiency range up to 45 to 50% this is reflected in the above recorded value

VII. ACKNOWLEDGEMENT

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