A PERFORMANCE STUDY OF A DUAL MEDIA FILTER FOR SURFACE WATER TREATMENT

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Abstract**—** All traditional water treatment facilities use the highly successful technique of rapid sand filtration. The fundamental issue is stratification, which prevents the full application of the sand bed utilized. Additionally, a lot of the fast sand filters are plagued by issues including mud ball development, subpar effluent, and a high backwash water requirement. The limitation of quick sand filters can be overcome by dual media and multimedia filters. In contrast, higher filtering rates might even be attained. However, due to the scarcity of filter materials other than sand and coconut shell in India, the application of such methods is restricted. The performance of existing fast sand filters could be improved by covering them with coconut shells. The method of capping involves covering the filtration media with stability caps, such as crushed coconut husks, anthracite coal, and bituminous coal. By using coconut shell as a capping material in a small scale study, an attempt is made to test the effect of capping a fast sand filter. A comparative analysis revealed that a greater filter run and higher quality rate of filtration are both feasible, as are lower backwash requirements.

Keyword—wastewater treatment plant, dual media filter, wastewater.

I. INTRODUCTION

A typical method for eliminating tiny particles from water is filtration. Sand filters are used in almost all typical surface water treatment facilities and some ground water treatment methods. In the treatment of used surface water, the quick sand filter is nearly often utilized. Some pre-treatment of the raw water is normally required, such as sedimentation. The majority of water treatment facilities have undergone changes as a result of rising demand, which is highlighted by a greater filtration rate. Higher filtration rates can be attained or this sand filter constraint can be managed using dual media filters. However, due to the scarcity of filter materials other than sand and coconut shell in India, such methods are not widely used. An appropriate cap, such as crushed coconut shells, bituminous coal, or anthracite coal, is placed over the filtration media during capping. A portion of the sand is also replaced during capping.Coconut shells will be used in the proposed work as a capping media since they are readily available, help to outfit some additional head loads, and enhance the filtration of bacterial measures.

I. 1.1 NECESSITY OFTREATMENTOFWATER

Surface water that is made available for public use must be transportable and suitable for drinking from the perspectives of its chemical, physical, and biological qualities. Drinking water needs to be portable and come from an unpolluted source. However, the raw water typically available from surface water isn't directly fit for drinking. Producing drinkable water that is mobile and safe is the goal of water treatment.

For a person to survive, there must always be access to clean water. Before being made available to the general public for residential or other usage, the available raw waters must first be cleaned and cleansed. The treated water needs to be made secure, pleasing to the eye, and appealing to the taste and tongue of people. Any water supply plan's main goal is to provide enough clean water in a timely manner. Clay and suspended solids at high concentrations are the main obstacle to using surface water as a source of water supply. The most popular technique for removing clay and suspended particles is filtering. In the filtering process, suspended particles are retained in the water after it passes through a bed of pervious material. Rapid and slow sand filters are frequently employed in surface water filtration to remove clay and suspended particulates from the water. Rapid sand filtration is the most often used method of surface water treatment for municipal water supply because it requires less space, has a higher output, and is more flexible. Coagulation-flocculation, filtration is the most economical technology for treating low turbid surface water since it is simple to operate and requires little upkeep.In this procedure, the added chemicals flocculate the suspended solids before sending them to the filter. Many complex mechanisms work together to deeply integrate and maintain the suspended solids in the liquid. After some period of use, the filter medium clogs and the flow rate drops as a result. Backwashing, which utilises 2-5% of the total filtered water, is required to clean the filter bed when it clogs up. The typical water treatment procedure, which involves aeration, chemical coagulation, flocculation, sedimentation, filtration, and disinfection, must be changed due to the wide variations in the quality of the raw water available in India. Sludge and back wash water from water treatment facilities offer environmental problems when disposed of. The improvement of chemical dosing and filter runs will lead to a decrease in rejects from water treatment facilities. Finding the most practicable method for assuring proper drinking water production with the fewest possible rejects and managing it also necessitates looking into the operational status of the water treatment facilities.

OBJECTIVES

The main goal of this study is to keep the water quality within reasonable bounds.

- To make delivering clean water more affordable.
- To compare the properties of pre- and post-treated water.

III. **MATERIALSANDMETHODALOGY**

- The filter's components are:
- Sand
- Gravels
- Crushedcoconutshell

- *SAND*

The ideal effective sand the cleaned and sun-dried stock sand was sieved to prepare the size and homogeneity coefficient. Sand utilized had an effective size of 0.6mm and a coefficient of homogeneity of 1.7mm.

The following qualities should be present in filter sand:

- It was mined from quartz, basalt, and other hard rocks.
- It is devoid of organic matter, lime, clay, and loam.
- It is a constant size and kind.
- It is tough and resistant.

- *GRAVELS*

The supporting media for the sand layer has been sieved gravel that is retained on 4.75mm. Before being used as the supporting filter media layer, gravel was properly cleaned and dried in the oven. A loose collection of rock fragments is known as gravel. Sedimentary processes lead to the natural occurrence of gravel across the planet. Commercial crushed stone production also produces gravel in significant amounts.

- *CRUSEDCOCONUT SHELL*

- The materials for the capping will be the crushed coconut shell. Given that fine sand particle settling velocity is greater than that of cappinng medium particle settling velocity, the size of crushed coconut shell was calculated. By crushing and screening coconut shells, the desired size and consistency can be achieved. Before use, the crushed coconut shell received a charge by heating.

METHODLOGY

In the filtration unit, a 20 cm thick gravel bed, a 15 cm thick sand layer, and a 20 cm thick layer of crushed coconut shells were spread out as the dual filter layer. A sizable container holds the river water for a holding duration of roughly three to four hours. The fast sand filter was used to filter the water that remained after the sedimentation process. A 20-liter capacity dispenser that is positioned high above the fibre unit supplies influent water to the filter.Throughout the test period, a 10 cm head of water was kept above the filter medium in the filtration unit. A dispenser positioned above the filtering unit continually fed raw water into the system. Each hour, an effluent sample was collected. Turbidity, pH, total solids, and BOD levels are measured in this sample. It took up to 8 hours to complete the experiment. To test the water sample in the lab, the following techniques were used.

- **Dissolved solids**: Filtering the sample water and weighing the dry residue left in the filter paper allows one to calculate the amount of dissolved particles in water. The BIS code specifies 500 mg/l and 2000 mg/l as the acceptable and ideal limits for dissolved solids, respectively.
- **pH:**The logarithm of the reciprocal of the hydrogen ion concentration in the water is shown by the pH value. It serves as a gauge for the water's acidity or alkalinity. While lower pH values indicate higher hydrogen ion concentrations in acidic solutions, higher pH values indicate lower hydrogen ion concentrations in alkaline solutions. So, water will be alkaline if the pH value is greater than 7, and acidic if the pH value is lower than 7. However, the BIS guideline specifies that the acceptable pH range for public supply may be between 6.5 and 8.5.
- **Hardness:** When such hard waters are combined with soap, their hardness is what prevents adequate leather or foam from forming. It typically results from the presence of calcium and magnesium salts in water, which react with soap to generate scum. Because they could result in increased soap usage, boiler scaling, pipe corrosion and incrustation, tainted food, etc., hard waters are not ideal. The acceptable and desired limits of water hardness in accordance with BIS code are 300 mg/l and 600 mg/l, respectively.
- **Chloride:** Sodium chloride, or table salt, is a common type of chloride that is present in water. Chloride levels over normal in river or stream waters may be an indication of water contamination from sewage and other industrial or human wastes. Chloride levels in treated water that is made available to the general population should not go above an acceptable level of roughly 250 mg/l. The BIS code specifies that a maximum of 1000 mg/l of chloride may be present in drinking water.
- **Nitrate:** Nitrogen in water is a sign of organic matter and can take one or more of the following forms: free ammonia, albuminoidal or organic nitrogen, nitrites, and nitrates. Free ammonia levels for potable water should not be more than 0.15 mg/l since their presence indicates the existence of un-decomposed organic materials. Potable water should contain no more than 0.3 mg/l of organic nitrogen. While officially a disease called "mathemoglobinemia" (often known as "blue baby disease"), the presence of too much nitrate in water may negatively impact the health of infants. The BIS regulation states that the ideal nitrate level in home water supply is typically no higher than 45 mg/l.
- **Turbidity:** Water will appear muddy, hazy, or turbid if there is a significant amount of suspended matter present, such as silt, clay, or other finely divided organic compounds. Even if the clay or other inert suspended particles might not be unhealthy, they should be removed or minimized for aesthetic and psychological reasons. The acceptable and desired limits of turbidity in drinking water are 5 NTU and 10 NTU, respectively, according to IS-10500.

IVFILTERDIMENSION

Filter media is needed for the model and is specified in the design as follows:

Gravel use overall in the study using the dual media model was as follows:

L= Length=45cm

B=Breadth=45cm

D=depth ofthe gravelpacking=10cm

Total quantity of Sand use in the dual media model study:-

L= Length45cm

B=Breadth 45cm

D=depth=15cm

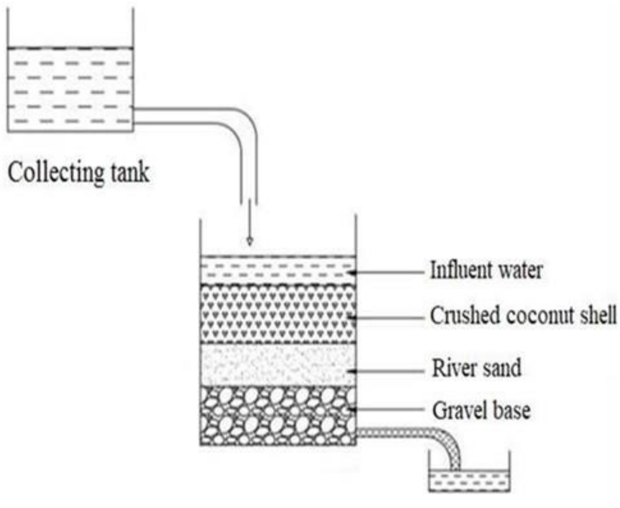
Totalquantityofcoconutshell:-

L=Length= 45cm

B=Breadth= 45cm

D= depth= 10cm

EXPERIMENTALSETUP



V. TESTSCONDUCTEDONWATERSAMPLE

- **pHTest:**

The term pH refers to a measurement of the amount of hydrogen ions in a solution and is defined as the negative log of the amount of H+ ions in water and waste. Acidic conditions range from a pH value of 0 to less than 7, while basic conditions range from a pH value of 7 to 14 or higher. It is said to have a neutral pH when the concentration of H+ and OH- ions is equal.

- **TURBIDITYTEST:**
It is brought on by the presence of colloidal and suspended particles in the water. The type of water sample will determine the type and level of turbidity.

1) Turbidity metres often come in two varieties:

- Relies on visual perception (bare eye)
- Determined directly (from a metre reading)

HARDNESSINWATER:

Divalent metallic cations are responsible for hardness. Calcium, magnesium, strontium, ferrous, and manganese cations are the main hardness-inducing ions. These cations are primarily accompanied by the anions sulphates, carbonates, bicarbonates, chlorides, and nitrates. Significant regional differences exist in the hardness of water. Water on the surface is typically softer than water underneath. The type of geological formations that have come into touch with the water have an impact on its hardness. $CaCO_3$ at 300 mg/l is the IS value for drinking water.

DETERMINATIONOF CHLORIDE:

- When the concentration of chloride linked with sodium exceeds 250 mg/l, the flavour is salty. Chloride does not pose any risks to human health, but it corrodes concrete because it produces hydrochloric acid, which is also very corrosive and problematic for suckers, when calcium is extracted from water in the form of calcite ($MgCl_2$), or magnesium chloride.

DETERMINATIONOF NITRATE:

- In the presence of an alkaline media, the nitro derivative that is created when nitrate and phenol disulphonic acid react turns yellow. According to Beer's law, the amount of nitrate present in the sample directly correlates to the colour produced.

BIOCHEMICALOXYGENDEMAND:

The biochemical oxygen demand, or BOD, is the quantity of dissolved oxygen required by aerobic organisms to decompose organic compounds present in a given water sample at a particular temperature over a certain time period. BOD is also known as biochemical oxygen demand.

VI RESULTANDDISCUSSION

The following is an outcome of the sampling:
Influent and effluent water samples were examined for a number of parameters during the filtration process, including turbidity, pH, BOD, hardness, nitrate, and chloride. Effluent samples were taken and examined throughout the filtration process.

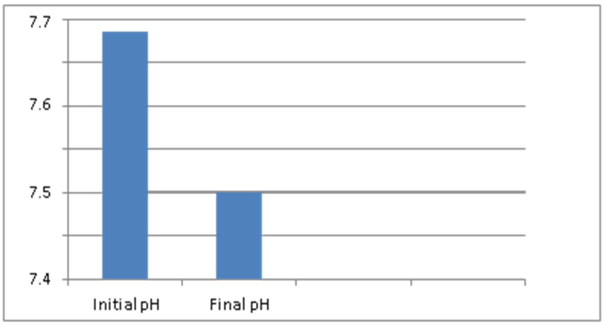


Chart1:TypicalgraphofInfluentandEffluent

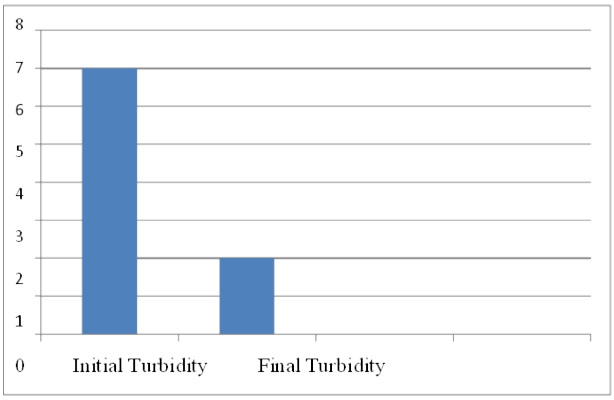


Chart 2: Typical Graph of Influent and Effluent turbidity(NTU).

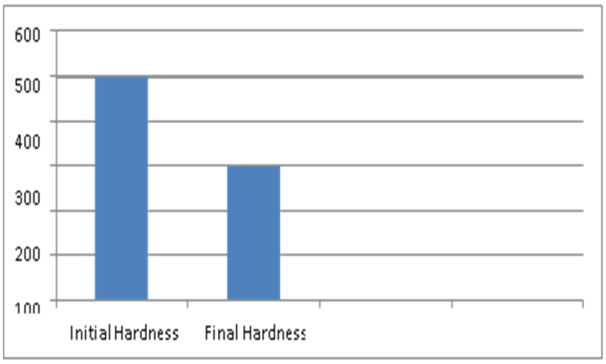


Chart 3: Typical Graphof Influent and Effluent Hardness(mg/l).

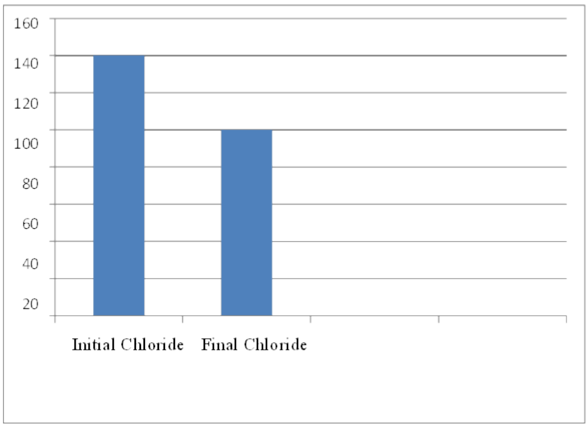


Chart4:TypicalGraphInfluentandEffluentBOD(mg/l).

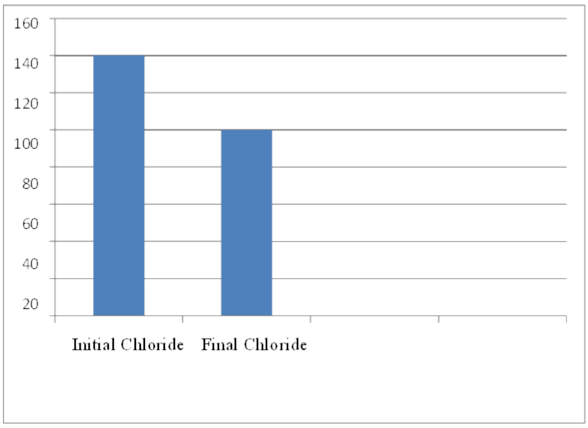


Chart5:TypicalGraphofInfluentandEffluentChloride(mg/l).

CONCLUSION

1. The filtration procedure works well when crushed coconut shell is employed as the filter material.
2. The considerable decrease in turbidity, total solids, pH, and BOD.
3. The colour intensity significantly decreased.
4. Turbidity has decreased by up to 72%.
5. The reduction in BOD demonstrates the effectiveness with which coconut shell can remove organic compounds.

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