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Analysis and Design of Sand Filter by using Capped Coconut Shell and Coal

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***Abstract*: A study was done to determine about sand filter these filters are commonly used in conventional water treatment plants. Problems like mud ball formation and unsatisfactory effluents are affecting sand filter beds. It has been found out that dual media and multimedia filters can overcome the limitations of sand filter. Capping materials such as crushed coconut shell and coal is used as a dual media. Design dual media filters capped with crushed coconut shell proves to be more efficient, economical and durable. Three models having capacity of 10 liter are practiced. All these models consist layers of gravel, sand and capping material of thickness 7cm each. Crushed coconut shell and coal are used as capping material in different models respectively. The water sample was collected from nearby river. The tests which are conducted on sample are pH, Temperature, Total Dissolved Solids, Alkalinity, and Turbidity. The efficiency is based on test results.**

***Keywords*: Sand filter, Coconut shell, Coal, Turbidity, pH, TDS.**

1. Introduction

Water is a basic need of human being; hence the provisions of clean water is an important issue to solve [1].

From hundreds of years there is a technology called slow sand filtration which is used for purpose of the drinking water. This process is well-suited for small, rural areas since it does not need a high degree of operator skill. As its name implies, slow sand filtration is used to filter water at very slow rates. The typical filtration rate is at least fifty times slower than for rapid rate filtration [7]. Due to slower rates of filtrate water, a large area is required for the filtration. Chemicals are not needed for proper filtration operation. Removal of particles is completed primarily through biological processes that provide treatment. The biological activity is located primarily in the top surface of the filter known as the Schmutz decked, although recent research has stated that biological processes throughout the depth of the filter bed may also influence particle removal. A ripening period from several weeks to several months is necessary [7]. So that the biological organisms mature in a new slow sand filter. Purification is always a need from the ancient times [7]. Risk of pollutants should be reduced from. So, the government are taking many efforts to provide adequate and safe drinking water to society by constructing water treatment plants in India. In India sand filter are mostly used to remove the suspended and colloidal particles from water in filtration process for the faster rate. Capping of existing sand filter is the promising method of improving the performance of sand filter [1]. Water purification or drinking water treatment, is the process of removing contaminants from surface water to make it safe and potable for human consumption. We all know that access to clean, fresh water is fundamental to our health and well-being. Most water filters remove harmful Chemicals and bacteria which if consumed can cause diseases.

2. Literature Review

Teena Ann Thomas and K. Mophin Kani. Slow sand filtration is a technology that has been used for potable water filtration for hundreds of years. It is a process well-suited for small, rural communities since it does not require a high degree of operator skill. As its name is, SSF is used to filter water. This water filtrates at very slow rate. It is observed that the typical filtration rate is at least fifty times slower. Due to this slow rate of filtration, a large land area is required for the filtration basins. There is no need of chemical required for proper filtration operation. Removal of particles is completed primarily through biological processes. These also provide treatment. The biological activity is located primarily in the top surface of the filter known as the “schmutzdecke,” Recent studies has stated these biological processes throughout the depth of the filter bed may also influence removal of particle. A “ripening” period from several weeks to several months is necessary for the biological organisms to mature in a new slow sand filter.

Mah, PFRA Canada-Saskatchewan Agri-Food Innovation Fund (AFIF). June 2001. Slow sand filtration has been used successfully in Europe since the early 1900s, and is still a popular method of treating municipal water supplies. Research, and other observations, show that slow sand filtration can effectively remove cysts and coli form bacteria from raw water, and is an innovative, cost effective, low maintenance treatment process. This system works best as part of a multi-barrier treatment approach. A slow sand filter is comprised of a bed of graded sand which is supported by a layer of gravel. This filter media is confined in a box with openings at both ends m allowing water to flow in and out, while operating on a top-

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down, gravity basis. The filtration process a form of natural, biological water treatment is used to remove solids, precipitates, turbidity (muddiness) and in some cases bacterial particles that produce bad taste and odour. Slow sand filtration is well-suited to treat farm water supplies that have reasonable raw water quality.

Sudhir Kapgate, Amol G. Gore, Gaurao S. Kale, Sagar I. Wanjar, Kunal P. Wanode, Rushikesh B. Balpande. Rainwater is an important source to feed the groundwater aquifer, which is done directly or by harvesting and recharging. Purification is always a need from the ancient age of civilization. So the central and state government are taking effort to provide adequate and safe drinking water to society by constructing water treatment plants in India. In India sand filter are mostly used to remove the suspended and colloidal particles from water in filtration process for the faster rate by setting out the different sand beds in constructing it. Designing 'Dual media filter capped with crushed coconut shells' proves to be more efficient, economical and durable.

Abdol Majid Fadaei Department of Environmental Health Engineering, School of Health, Shahrekord University of Medical Sciences, Shahrekord, Iran. Access to safe drinking water has been an important national goal in rural area and other areas. Slow sand filtration (SSF) is one of the oldest water treatment processes used to produce microbiologically safe drinking water. It is shown that safe drinking water was achieved by a combination of a protected and high quality source at the initial point and maintaining quality from the initial supply (source) point through to final consumption. Our study showed efficiency of physical and biological treatment of slow sand filter was relatively desirable but, for water quality improvement it is suggested that a chemistry and microbiology lab in treatment plant be set up. Also filter washing and cleaning should be accomplished on time.

3. Objective of the Project

If you have a Table, simply paste it in the box provided below and adjust the table or the box. If you adjust the box, you can keep the tabl Based on the literature survey the following aims and objectives were decided.

- To construct, design and test the model of slow sand filter capped with coconut shell and slow sand filter capped with coal.
- To compare the performance of slow sand filter capped with coconut shell and slow sand filter capped with coal on the basis of quality of effluent produced which is measured in terms of parameters such as pH, total dissolved solids, alkalinity, hardness, chlorides and turbidity.
- To study and design a sand filter for the removal of pathogen and suspended solids from water using coconut shells, anthracite coal, river sand and gravel for rural area.
- To improve water quality and reduce the cost of providing the clean water and improve ecosystem by maintaining water quality to acceptable levels.
- Improving water system efficiency and resource conservation.

4. Materials and Methodology

In this Paper testing facility, experimental procedures and experimental programs are included. Design of experimental setup is done based on the basic design of sand filter.

A. Material Specification

The materials used for filters are gravel, sand, coconut shell and coal.

Table 1
Materials and specifications

S. No.	Material	Particle Size
1.	River Sand	0.35-0.60mm
2.	Coal	2-3cm
3.	Gravels	4-5cm

1) Gravel

Gravel which retained on 4.75mm has been used as supporting media for sand layer [3]. The depth of gravel layer in the filtration units is 20cm. Gravel was washed and ovendried thoroughly before using as the supporting filter media layer [3].

2) Sand

River sand having uniformity co-efficient 1.7 and effective size 0.60mm is used as filter material [3]. Sand was washed with clean, sun dried and oven dried before using as filter media. The depth of sand layer maintained in the filtration unit is 7cm.

3) Coal

The burned wooden coal is used as capping material above sand layer. The depth of coal layer maintained in the filtration unit is 7cm. The coal is washed and the blackness of the coal is removed and then placed in filter. The strong quality of coal is to decolorize and remove taste from water. With an abundance of larger pores, it attracts certain dissolved chemicals and removes larger particulates. Wastewater treatment plants use it to filter water, while the food industry often uses it to decolorize juices, liquors and other products. Coal is a natural and non-toxic material. The charcoal not only removes impurities it also adds some important minerals such as calcium, magnesium and iron to improve the water quality.

B. Design of Model

We will prepare three models of filters which will have cylindrical shape. The first model will have gravel as a base material, sand as filter media above it and capping of coconut shell at the top. The second model will also contain gravel as a base material but the coal will be used as a capping material between gravel and sand. The third model will again contain gravel as a base material and coal and coconut will be used as a capping material between gravel and sand. All three models will have storage of same capacity and an outlet. So basically, all three models will contain layers of gravel, sand, coconut shells and coal and has drainage attached between top part and bottom i.e. storage. The capacity of the filter is 40 liter in which top part has 30-liter capacity and the storage has 10-liter capacity overall diameter of the filter is 27cm.The fig. 2.B.1

experimental setup of slow sand filter with coconut capping and coal.

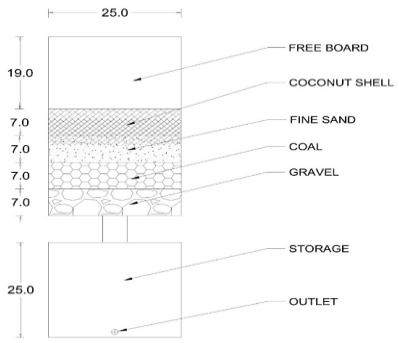

Fig. 1. B.1 schematic model

C. Methodology

In this section, testing facilities, experimental procedures and experimental programs are included. Design of experimental set up is done based on the basic design of slow sand filtration. As per the literature review the design for set-up is done. The following procedure was adopted for conducting the test:

1. Filter layer consisting of gravel bed of 7 cm thickness, sand layer of 7cm thickness and coconut shell layer of 7cm thickness was spread in the filter unit.
2. The water obtained from the lake was stored in a large container for a detention period of about 3-4 hours.
3. Influent water is fed into the filter with the help of a collector of 10 liters capacity has been placed well above the filter unit.
4. A head of water above the filter media in the filtration unit of 19cm was maintained throughout the test period. The raw water was fed to filtration unit continuously through dispenser placed above the filtration unit.
5. Influent and effluent samples were taken at a frequency of every 2 hours. These samples are tested for pH and turbidity. The experiment has been carried out up to 24 hours.

5. Experimental Work

Following test are conducted on water sample**:**

- Temperature Test
- pH Test
- Turbidity Test
- Total Dissolved Solids
- Hardness Test

6. Results

Table 2
Tests result of outlet of SSF capped with coal and coconut shell.

Parameters	Hardness	Ph	TDS	Turbidity	Temp 0^C
1	44.8	7	104.5	3.30	16
2	43.7	7.1	103.9	2.91	16
3	44.2	7.3	104	3.26	17
4	45.1	7.35	105.8	3.45	18
5	44.9	7.46	104.7	2.99	15
6	46.2	7.5	106	3.01	17
7	45	7.56	105.2	3.42	16

7. Conclusion

The following conclusions can be drawn from the project study on different aspects of slow sand filtration.

- Slow sand filters capped with coal having better removal efficiency of Hardness, Total dissolved solids comparing with slow sand filter capped with coconut shell.
- Turbidity and colour removal efficiency decline considerably with higher filtration rates, although the filtrate quality remains reasonably good.
- With less flow rate and the periodic replacement of filter media are the major limitations of the slow sand filters.
- Slow sand filters capped with coconut shell and coal together have shown effective removal of turbidity, Total dissolved solids comparing with slow sand filter capped with coconut shell and slow sand filter capped with coal.

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