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Design of Slow Sand Filter using Waste Material

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ABSTRACT

The improvement of water quality is closely associated with man-environment relationships. There should be a dialogue between all actors and the community when undertaking water and sanitation activities. For positive results and better sustainability, the community should be involved and participate at all stages of water development and environmental sanitation schemes. A combination of safe drinking water, adequate sanitation and hygiene practices like hand washing is a pre-requisite for morbidity and mortality rate reduction, especially among under five years old children in developing countries. To reduce the incidence and prevalence of diarrheal diseases, improvements in the availability, quantity, and quality of water, improved sanitation, and general personal and environmental hygiene are required. The majority of people in developing countries do not have access to piped drinking water and must carry; transport and store water within their homes and in the process the quality of water may deteriorate. Therefore, slow sand filtration has been recognized as an appropriate technology for drinking water treatment in rural areas, and is recognized as a suitable filtration technology for removing water borne pathogens and reducing turbidity. It is capable of improving the physical, chemical, and microbiological quality of water in a single treatment process without the addition of chemicals, and can produce an effluent low in turbidity and free of bacteria, parasites and viruses.

Keywords : Slow Sand Filter, Waste Material

I. INTRODUCTION

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 or attention. 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. Due to this slow rate of filtration, a large land area is required for the filtration basins. Small communities that have plenty of available land are often good candidates for slow sand filtration. Slow sand is a relatively simple filtration process. No chemical addition is required for proper filtration operation. Particle removal is accomplished primarily through biological processes that provide treatment. The biological activity is located primarily in the top surface of the filter known as the “schmutzdecke,” although recent research has indicated 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 for the biological organisms to mature in a new slow sand filter. Slow sand filters are not backwashed like rapid rate filters, but are instead scraped or harrowed periodically when head loss reaches 3 - 4 feet across the filter bed. Typically slow sand filters must be scraped or harrowed every 1 - 12 months depending on water quality. Some facilities with very high water quality can experience even longer filter runs. During scraping, the top 1/8 – 1/2 inch of sand is removed from the filter bed. Eventually, after years of operation, the sand layer must be replaced to restore the depth of the filter bed. In some cases, filters are harrowed to break up the top layer of material and reduce head loss through the filter. Sand is not removed when filters are harrowed, but the top layer of organic material is broken up and floated off the surface of the filter bed using flow up through and across the filter surface. After a filter is scraped or harrowed, the filtered water is typically sent to waste for a period of 1 - 7 days to allow the biological population in the filter to reestablish. The mechanisms of purification vary depending on the type of filter. Proper choice of the filter depth, sand type, sand size and filtration rate affects the pollutant removal performance and purification efficiency of the sand filter (Abudi, 2011). The biological activity is enhanced with increasing filter depths. Microorganisms and other suspended particles have to travel more through the sand, thus, a higher removal efficiency is expected at higher sand depths (Ellis, 1984). The use of slow sand filter to remove bacteria from contaminated groundwater has been an attractive option as a filter system in both developed and developing countries especially in rural communities due to its low cost, ease of operation and maintenance (Nassar & Hajjaj, 2013; Logsdon et al., 2002). Using sand filter for water treatment offers unique advantage for solving water shortage problem. Though the technology is cheap and simple, it is not widely used in the Philippines, perhaps due to lack of expertise for the maintenance and operations of such kind of treatment. With the growing population in the Philippines especially in the urban and suburban areas, potable water demand will increase inevitably and slow sand filtration may address the concern. Moreover, access to safe drinking water is one of the first priorities following a disaster in a local community (Loo et al., 2012). An evaluation of the use of local sand for slow filtration and its eventual use in local water districts for water treatment is an important contribution to water demand of the local population. Thus, this study aimed to investigate the efficiency of slow sand filter in purifying well water using Tons River sand as the filter medium. Turbidity and pH tests were done on water sample before and after the filtration process to determine the percent efficiency of the slow sand filter to reduce turbidity and ph.

II. METHODS AND MATERIAL

2.1 Proposed Model

1. Study Area Selection:
   - Identify suitable locations for conducting the research, preferably in small, rural communities with well water sources.
   - Consider factors such as accessibility, availability of Tons River sand, and willingness of the local community to participate.
2. Experimental Design:
   - Determine the number and size of slow sand filtration units to be constructed for the study.
   - Decide on the specific parameters to be measured, such as turbidity and pH, and establish the sampling frequency.
3. Water Sample Collection and Analysis:
   - Collect representative water samples from the

selected wells before the filtration process.

- Analyze the initial turbidity and pH levels of the water samples using appropriate methods and equipment.
- Ensure accurate and consistent measurement techniques and adherence to quality control procedures.

4. Slow Sand Filtration System Setup:

- Select suitable containers or filtration units for constructing the slow sand filters.

5. Sampling and Testing:

- Collect water samples from the filtered output of the slow sand filters at predetermined intervals.
- Perform turbidity and pH tests on the filtered water samples using standardized methods and equipment.
- Record the data accurately, including the time of sampling and corresponding filtration duration.

6. Data Analysis:

- Analyze the collected data to determine the efficiency of the slow sand filters in reducing turbidity and pH levels.
- Calculate the percentage reduction in turbidity and pH compared to the initial values.
- Consider statistical analysis techniques, such as t-tests or analysis of variance (ANOVA), if applicable, to assess the significance of the results.

III. RESULTS AND DISCUSSION

It was observed that the reduction of turbidity, pH, and electrical conductivity increases at a flow rate of 3.82 x 10^(-7) m^3/sec. For the wastewater treated, initial turbidity was 14 NTU and pH was 8.5. The retention time was 12 minutes and 21 seconds respectively. The results show that there occurs a notable reduction in the turbidity, pH and electrical conductivity of the wastewater treated

TABLE I

OBTAINED RESULTS OF SLOW SAND FILTER

Parameters analysed	Initial	Final	% Reduction Efficiency
Turbidity (NTU)	14	2	86
pH	8.5	7.2	-
Electrical conductivity (μS/cm)	386	85.7	77

IV.CONCLUSION

It was observed that the dirty water filters out and from bottom of the pipe quite clear.

- Grey water color changes to normal tap water.
- Water becomes suitable for drinking purpose.
- It was observed that the reduction efficiency of turbidity is about 70% and the reduction in pH and electrical conductivity is also noticeable. Thus it can be concluded that the slow sand filter is efficient in treating wastewater from a particular source.
- The use of aggregates as filter media is proven to be effective
- Authorized BOD is 30mg/l, respectively, for agriculture. Thus, it can be concluded that the output of the filter is suitable for agricultural use in terms of BOD.

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