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Modified Biosand Filter–A Review

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Abstract—*Rapid urbanization all over the world has resulted in an increase in water treatment technologies. But, in rural India, where 70 percent of India's population lives, irregular electric supply and poor economic condition of people are major obstruction for use of now days available advanced water treatment technologies. So Biosand filter is one of the good option. This paper reviews the study of various research works that had been done, in order to modify biosand filter for better treated water quality. This study emphasis on modified biosand filter.*

1. INTRODUCTION

Water has long been understood as a significant pathway for disease [6]. Globally, 1.1 billion people lack access to an adequate water source. Diarrheal disease alone claims the lives of 5000 children every day. Every year, nearly 6, 00,000 children in India die of illnesses associated with unclean drinking water. Inspite of this, 2 out of every 3 households still do not treat their drinking water and half of the rural water supply, where 70 percent of India's population lives, is routinely contaminated with toxic bacteria [7].

The potential for contamination during transport and storage makes the challenge of providing safe drinking water even greater in case of decentralized water distribution system. So points of use (PoU) water treatment technologies are preferred. Commercial purifiers are not affordable to poor people in developing countries like India due to higher capital and operating costs. Dependency of these purifiers on electricity is also a hindrance to the use of such purifiers.

BSF is one of such PoU technologies. It consists of a container with lid and diffuser basin which is filled with layers of sieved and washed sand and gravel. Lid is used to cover the container and diffuser is used to distribute the feed water evenly over entire surface and avoid the disturbance of biolayer. There is a standing water height of 5 cm above the sand layer. A biological layer of microorganisms develops at the sand surface, which contributes to the water treatment. Contaminated water is poured into the top of the filter on an intermittent basis. The water slowly passes through the diffuser, and percolates down under gravity through the biolayer, sand and gravel. Treated water naturally flows from the outlet. The biolayer is the key pathogen removing component of the filter. Without it, the filter is significantly less effective. The water from the filter can be used during the first few weeks while the biolayer is being established, but disinfection is recommended during this time.

2. NECESSITY OF MODIFICATION

The efficiency of current biosand filter (BSF) process is limited to use on raw water with low turbidity. High turbidity water, commonly used as a drinking water source in developing countries, is defined as having turbidity >50 NTU in the Guidelines for Drinking Water Quality(DWQ),[2]. Also the weight of conventional BSF is high. So there is need to modify conventionally used BSF. So this paper reviews the study of various research works that had been done, in order to modify biosand filter for better treated water quality. For convenience their work is divided in following categories and its review is taken in forgoing paragraphs.

3. REVIEW ON WORK DONE

3.1 Operational Changes

A few scientists have attempted the study on surface water and ground water with high turbidity and low turbidity as SWHT, SWLT and GWHT, GWLT respectively [5]. Few of them changes the daily feed volume from 20L to 40 L [1], [2].

3.2 Material changes

A few scientists have attempted the study on modified conventional BSF by introducing a 10cm iron oxide-coated sand (IOCS) layer in the middle of 40-cm sand layer [1]. Few of them modified BSF by inserting 15cm depth of zeolite between coarse sand and fine sand [5]. A 10cm layer of clinoptilozeolite between fine sand and gravel [4].

3.3 Constructional changes

A few scientists have attempted the study on modifying BSF as LPD BSF by inserting, between the diffuser basin and the filter container an additional sand layer of 5 cm and 10cm [3]. Also few of them modified BSF by incorporating 6 cm deep raised upper sand layer and 5 cm deep superfine sand (<0.7 mm) layer [2].

4. REVIEW ON RESULTS

4.1 Operational changes

It was found that Highest turbidity reduction was obtained for SWLT and lowest turbidity reduction was obtained for groundwater samples [5], increased filling frequency led to higher microbial effluent concentrations but also higher microbial removal efficiency [2], Doubling the daily charge from 20 L to 40 L adversely affected the bacterial removal in both filters indicating that operating conditions have a great influence on the filter performance and that volume of water that can be efficiently treated is limited. [1].

4.2 Material Changes

Introduction of IOCS could improve the performance of MBSF by atleast $1\log_{10}$ units and turbidity removal was greater than 90%. Introduction of IOCS is beneficial especially during maturation period and after cleaning operation when the bacterial removal tends to be very low. [1]. When zeolite was used, higher turbidity levels were obtained from samples of SWHT and lower turbidity levels were obtained from samples of GWLT [5]. BSF modified with zeolite showed 93% turbidity removal [4].

4.3 Constructional changes

LPD BSF showed 95% turbidity reduction for both setup with additional 5cm and 10cm sand layer and the total coliform removal was 80%-90 % [3]. BSF incorporated with 6cm deep raised sand layer performed better than BSF incorporated with 5cm deep superfine sand layer for both turbidity and total coliform removal efficiency [2].

5. DISCUSSION

It can be seen from various contributions made in above mentioned paragraphs that, many researchers have identified the issues related with modifying BSF in different ways. Operational, material and constructional changes are the major changes made in conventional BSF in order to modify. From operational changes it is found that volume of water that can be efficiently treated is limited and increased filling frequency led to higher microbial effluent concentrations but also higher microbial removal efficiency. Also the filtered water quality also depends upon raw water turbidity. From material changes it was found that sand coated with Zeolite or iron oxide gives better treated water quality than uncoated sand. From constructional changes it was found that additional biolayer improves treated water quality as compare to single biolayer.

In MBSF during pause period (when filter was not operated), the additional diffuser basin with sand layer in it were kept inside another basin with water. So that the water level would be roughly 5 cm above the sand layer. During operation, these diffuser basins were placed on the filter container. As the upper layer of sand was moved everyday and then placed in a basin of water (creating a backflow of water through the sand) it may be the reason for poor improved performance of the dual sand layer BSFs over the control BSF [3].

For analysis purpose spiked tap water was prepared daily by adding sterilized sewage. Use of sewage for preparation of raw water may not be the true representative of raw water characteristics [1]. The filter was observed to have a higher flow rate which makes it suitable for use by a family for the production of clean water for both drinking and cooking. The BSFZ could be used for the removal of calcium, magnesium and iron. The BSFZ is not recommended for highly turbid water [5].

Effluent quality both in terms of turbidity and microbiological concentrations decreased with pause time shortened from 24 hours to 9 hours [2].Also from literature it is clear that the relationship between various parameters such as flow rate, feed water turbidity and biolayer thickness does not exist. So there is scope to develop such relationship which will help in modifying BSF to meet the drinking water standards.

6. CONCLUSION

In India any of such works haven't dealt with great extent so far, the issue of Modifying BSF is handled by various researchers mostly at foreign countries. Modified BSF should not only be economical but also meet the drinking water standards. It should also be suitable for feed water of high turbidity and withstand the feed water quality variation. It would be helpful to have review of the work done in modifying BSF and apply the results to improvise conventionally used BSF. The study will also create many research avenues in the water treatment in light of Biosand filter.

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