A LABORATORY SCALE ANALYSIS OF GREYWATER USING DRAWER COMPACTED SAND FILTER

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Abstract

Water is an important natural resource to maintain human and animal life. Due to rapid industrialization, development and increasing population there is an increase in demand of water. So we need to search for alternatives to reduce the consumption of freshwater. One of such alternative is greywater treatment. Sand filtration has been considered as one of the effective and economical methods for water and wastewater treatment. One of such sand filtration technique is Drawer Compacted Sand Filter (DCSF), which is a modified design for sand filter. This paper presents the performance analysis of Drawer Compacted Sand Filter (DCSF), carried out on the basis of its first cycle. It was found that DCSF is efficient in removal of COD, TSS and turbidity with removal percentage of 95.83%, 80.76% and 89.71% respectively. It is easy to maintain, flexible, requires less area, effective and less expensive.

Key Words : Synthetic greywater, Drawer Compacted Sand Filter.

1. Introduction

Water is a very important and an essential need of every human being and animal to survive. The area of earth's surface covered with water is about 70%, but the quantity of fresh water is very less. The distribution of water over the globe is uneven; the oceans contains about 97% of total amount of water present on earth, freshwater's share is only 3 %, in which 79% is trapped in ice caps and glaciers, groundwater is 20% and accessible surface freshwater is only 1%. The accessible surface water has 52% of its water in lakes, 1% in rivers, 1% in living organisms, 8% as water vapours and remaining 38% as soil moisture [1]. From this we can observe that amount of freshwater available is very less and it is decreasing day-by-day due to human activities. Due to rapid industrialization, development and increasing population there is an increase in demand of water. According to World Water Development Report 2015, it is expected that demand of water for manufacturing will increase globally upto 400 percent between 2000 and 2050. Around 700 million people in 43 countries suffer today from water scarcity. It is estimated that by 2025, two-thirds of the world's population could be living under water stressed conditions and 1.8 billion people will be living in regions with absolute water scarcity [8]. So we need to search for alternatives to reduce the consumption of freshwater. One of such alternative is greywater (GW) treatment. Greywater can be defined as any domestic waste water produced, excluding sewage. In other words residential greywater can be defined as a mixture of wastewater discharges from household including kitchen sinks, laundry waste water, bathroom sinks and

bathtubs[6]. The quantity of greywater is around 60%-70% of total wastewater produced in a day [5]. The benefits of greywater recycling includes, less fresh water extraction, less impact on septic tank and treatment plant infrastructure, reduced energy use, ground water recharge, increased plant growth, greater quality of surface water, protection of ground water, maintain soil fertility, protection of land and vegetation and protection of the community against possible disease transmission [3]. There are various methods by which greywater can be treated. Sand filtration has been considered as one of the effective and economical methods for water and wastewater treatment since ancient times. One of such sand filtration technique is Drawer Compacted Sand Filter (DCSF), which is a modified design for sand filter in which sand layer is broken down into several layers. The depth of these sand layers may be 5 to 10 cm each and placed in movable drawers separated by 5 to 10 cm space each. As the drawers are spaced at distance oxygen movement is facilitated, which maintain aerobic condition, no anoxic conditions, thus no unpleasant odors [9]. It is easy to maintain, flexible, requires less area, effective and less expensive.

2. Materials Used in Study

A. Sand and Gravel

In DCSF, sand was used as a major filtering medium. Sand could remove large extend of impurities from water. Three draws of DCSF were filled with different grades of sand. The sand was obtained from YCCE's Concrete lab, that is brought from Bhandara district. The gravels were

obtained from this stock sand. The sand and gravel were sieved according to the sieve analysis method and different grades of sand and gravel were obtained.

Fig. 1 : Sand

Fig. 2 : Gravel

B. Coconut shell activated charcoal

Charcoal that is processed to increase its porosity and surface area to increase its adsorption capacity is called as activated charcoal [10]. In DCSF, coconut shell activated charcoal which is in granular form has been used.

Fig. 3 : Coconut shell activated charcoal

3. Methodology Adopted

A. Prepration of synthetic greywater and Characteristics The characteristics of real greywater were observed and synthetic greywater was prepared. The composition of synthetic greywater prepared in lab is shown in table 1 and characteristics of this synthetic greywater after testing are shown in table 2.

Table 1
Composition of Synthetic Greywater

Component	Concentration (g/l)
Tap water	1 lit
Washing powder	0.16 g/l
Coconut oil	0.1 g/l
Dish washing solution	0.16 g/l
Handwash	0.16 g/l
Body wash	0.16 g/l

Table 2
Characteristics of synthetic greywater

Parameter	Unit	Concentration
COD	mg/l	240
TSS	mg/l	78
TDS	mg/l	628.1
Turbidity	NTU	24.3
Conductivity	$\mu\text{S/ppt}$	1.362
pH	-	8.5
Hardness	mg/l	168

B. Experimental Setup

a) Drawer Compacted Sand Filter (DCSF) Fabrication:- A DCSF unit of iron framework was fabricated and seven plastic drawers with dimensions of 36 cm x 25.5

cm x 7 cm were obtained and placed on the frame. Out of the seven plastic drawers one drawer was used for distribution of synthetic greywater over the gravel bed uniformly. It was connected to a storage container which contains synthetic greywater, placed besides DCSF unit.

Fig. 4 : Schematic diagram experimental set up

b) *Design Parameters of the Laboratory DCSF* :- For lab study, the drawers used have dimensions 36 cm x 25.5 cm x 7 cm based on the availability.

Table 3
Design Parameters of the Laboratory DCSF

Drawers	Filter medium
Drawer 1	Distribution of Synthetic GW
Drawer 2	Gravels; effective size=4.75
Drawer 3	Sand; effective size=2.36
Drawer 4	Sand; effective size=1.3
Drawer 5	Sand; effective size=0.6
Drawer 6	Activated charcoal
Drawer 7	Collection of effluent
Depth of media	5 cm in each drawer
No. and size of Perforation in each drawer	12 and 3 mm

C. *Operating conditions and procedures*:- Drawer compacted sand filter with gravel, sand and activated charcoal were fed with synthetic grey water. It was operated under room temperature and after each treatment the effluent was tested for pH, COD, Hardness, turbidity, TSS, TDS and conductivity.

D. *Mechanism of treatment in DCSF* :- The synthetic grey water was pumped using a submersible pump and transferred via distribution tray placed over the upper surface of the gravel layer of drawer number 2. The water then percolates through the filtering media placed in drawer number 2 to drawer 3 and one by one passes through each filtering media in all drawers at a flow rate of

4 lit/hr. The treated greywater thus obtained from the last drawer is then collected and tested.

4. Results

Performance analysis of drawer compacted sand filter was carried out and the results are reported as below.

Table 4
Experimental data of DCSF

Parameter	Unit	Influent Concentration	Effluent Concentration	% Removal Efficiency
COD	mg/l	240	10	95.83%
TSS	mg/l	78	15	80.76
TDS	mg/l	628.1	554.4	11.73%
Turbidity	NTU	24.3	2.5	89.71%
Conductivity	μS/ppt	1.362	1.135	20%
pH	-	8.5	8.5	-
Hardness	mg/l	168	152	9.52%

High COD removal efficiency can be seen in DCSF. Because, DCSF works fully under aerobic condition as the sand layers are divided into several layers it gives air space between each layer, which allows oxygen to diffuse easily and thus enhance the treatment of greywater and increase the treatment efficiency.

Aerobic bacteria requires oxygen for their survival. They use this oxygen in the metabolism of biodegradable components, inactivation and consumption of pathogens. The decrease in this quantity of oxygen will give rise to anaerobic condition along with the production of ammonia, hydrogen sulphide and other substances which produce bad odors [2].

5. Conclusion

From the above analysis, carried out on the basis of first cycle of DCSF it was found that DCSF is efficient in removal of COD, TSS and turbidity with removal percentage of 95.83%, 80.76% and 89.71% respectively. With further analysis better results can be obtained. DCSF is easy to maintain, flexible, requires less area, effective and less expensive. This paper concludes that, as land footprints of DCSF is small it is suitable for dense urban areas where land availability is a huge problem and as it is convenient to use and requires low maintenance, it can be used by wide range of people without any problem.

6. Future Scope

This paper provides preliminary perspective of DCSF. Further investigation is required to be carried out to check the performance of DCSF by using different media depth, different filter media with different sizes, responses to different hydraulic and organic loads and finding out the mechanism of water movement through each drawer and also its impact on the bacterial removal mechanism.

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