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Research Article

AN EXPERIMENTAL ANALYSIS ON GREY WATER TREATMENT USING DRAWER SAND FILTERS

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ABSTRACT

Environmental pollution is a global concern because of the harmful effects on public health and the environment. In present scenario, the availability of water is a major challenge. Alternative water sources available include rainwater, sea and brackish water, grey water and domestic or municipal waste water. Among these, grey water represents the most profitable sources in terms of its reliability, availability and raw water quality. In this research a cost effective system to meet the water requirements is established. From the experimental results we found that grey water can be treated by using drawer sand filter and the treated grey water can be reused for domestic purposes. The paper concludes that DCSF(Drawer Compacted Sand Filters) would be appropriate for use in dense urban areas as its footprint is small and appropriate for a wide range of users.

INTRODUCTION

Water covers 70% of the globe's surface, but most is saltwater. Fresh water that is available for human consumption comes from rivers,lakes, underground sources and aquifiers. These sources together account for only 1% of all water on the Earth. Water scarcity currently affects many regions in the world, As human population increase, the need for water also increases in domestic, agricultural, industrial and urban sectors, Consequently, water or blue gold is widely predicted to be a critical resource. In water scarce environment, wastewater reuse and reclamation are often considered as a viable option for increase water resources availability, grey water and domestic or municipal waste water. Among these, grey water represents the most profitable source in terms of its reliability, availability and raw water quality. Grey water reuse has played a major role in meeting domestic and irrigation demands(Guidance manual, NEERI, 2007).

Jamarah et al. 2008 says that greywater reuse is a sustainable and attractive option to cope with global water shortages. It can save 40-70% of freshwater by reusing it for toilet flushing and irrigation. (Rodgers, *et al*., 2004; Almoayed, 2011; Abdel, 2013) has devised Drawer Compacted Sand Filter (DCSF) through dividing the sand depth into several layers and allowing air space between layers would ease the diffusion of oxygen between different layers so that the filter will function with fully aerobic conditions,

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thus enhancing the aerobic biological treatment of greywater. Maintaining aerobic conditions in sand filter is considered one of the crucial factor to achieve high treatment efficiency, which according to (Kamal, *et al*., 2014; Karabelnik, *et al*., 2012; Karnapa, 2016; Leverenz, *et al*., 2009) could be maintained through unsaturated conditions and aeration between doses.

METHODOLOGY

The project on grey water treatment by drawer sand filters is done by collecting grey water from our home kitchen, office buildings, etc., and treating it economically. The Drawer Compacted Sand Filter (DCSF) is a modified design for a sand filter in which the sand layer is broken down into several layers, each of which is 10 cm high and placed in a movable drawer separated by a 10 cm space. It involves the following steps:

i.Collection of grey water

ii.Laboratory investigation of grey water before treatment

iii Treatment of grey water using drawer sand filters

iv. Laboratory investigation of treated water

v. Reuse of treated water

Laboratory investigation of grey water before treatment

Grey water or sullage is the waste water generated in household, offices and other buildings. Sources of grey water include sink, shower, water from washing machine and dish washers. To check the characteristics of grey water tests were conducted on alkalinity, hardness, temperature, pH, TDS, COD and BOD and the test result are as given in Table 1.

RESULTS AND DISCUSSION

Design of drawer sand filter

A drawer sand filter unit for testing and optimizing the design under laboratory condition was constructed. A metal framework of 70 cm × 32 cm × 70 cm was designed and fabricated. Five plastic drawers with dimensions of 35 cm × 28 cm × 6 cm were obtained and placed on the frame as shown in (Fig. 1). Each draws of DCSF was filled with different grades of sand (Lukas, 2015; Nimala, *et al*., 2016; Rodgers, *et al*., 2004; Winward, *et al*., 2008). The purity of water increases with fineness of sand. Each drawer except the lowest drawer (number 5) – was perforated with holes. Pump was used to pump synthetic greywater from a small storage tank placed next to the drawer sand filter. Table 2 shows all design details of the laboratory drawer sand filter.

Table 1. Laboratory tests and results

Laboratory Test	Result
Alkalinity	449 mg/l
Hardness	378 mg/l
Temperature	29.8 C
Total dissolved solid	540 mg/l
pH of sample	9.1
BOD	232 mg/l
COD	120 mg/l

Fig. 1 Schematic diagram for DCSF unit.

Table 2. Design parameters of the laboratory drawer sand filter dimension of each drawer 35 × 28 × 6 mm

Drawer 1	Gravels retained in the sieve 4.75 mm
Drawer 2	Sand retained in the sieve 2.36 mm
Drawer 3	Sand retained in the sieve 1.18 mm
Drawer 4	Sand retained in the sieve 600 micron
Drawer 5	Sand retained in the sieve 300 micron
Depth of media	40 mm (for each drawer)

Small gravels and silica sand, of two different sizes, were used as treatment materials.

Treatment system

Grey water systems that involve storing grey water must treat the grey water to reduce the other micro-organism that can multiply in stagnant water. Physical and chemical grey water treatment system primarily utilizes disinfection and filtration to remove while biological treatment uses aeration and membrane bio reactors. In DCSF unit sand is placed in movable drawer and is exposed to air from above and below; this facilitated oxygen movement within and between the sand layers, thus oxidation occurs in all layers with no chance of oxygen depletion.

The grey water was pumped using a submersible pump and transferred via well-designed manifold

Table 3. Performance of DCSF

Parameters	hydraulic loading rate ($l/m^2/day$)	Effluent concentration	% Removal
	70	42	65
COD	100	60	50
(mg/l)	130	80	28.33
	70	32	86.08
BOD_5	100	30	86.95
(mg/l)	130	26	88.69
	70	7	24
pH	100	7.2	21.73
	130	7.5	18.4
	70	240	36.6
Hardness	100	270	28.6
(mg/l)	130	290	23.4
TDS	70	360	33.3
(mg/l)	100	370	31.48
	130	381	29.4
Alkalinity	70	344	23.2
	100	300	33.03
(mg/l)	130	320	28.5
Temperature	70	30.6	2.2
	100	31	4.02
(°C)	130	31.2	4.69

lines placed over the upper surface of the sand layer of drawer number 1. The water then percolates through the filtering media placed in drawer number 1 to drawer 2 and passively passes through the filtering media in all drawers. The DCSF was operated under varying hydraulic loading rate of 70,100,130 $l/m^2/day$. The water, which comes out from the last drawer, is accumulated to be sampled and tested.

Laboratory investigation of treated water

The performance of the drawer compacted sand filter DCSF in the grey water treatment was studied and the results of the study are reported are given in Table 3.

From the above analysis it was found that slight difference was noticed in terms of overall filter efficiency between different loads for all parameters. The highest percentage removal of maximum number of parameters was at the hydraulic loading rate of 70.

CONCLUSION

The DCSF unit designed in this project was found able to overcome the problems associated with conventional sand filter design adopted, such as clogging and also which requires a large land area to house the filter. From the experiments carried out, it was found that slight difference was noticed in terms of overall filter efficiency between different loads for all parameters. The analysis result showed that most of the parameters of grey water are above permissible limits for reuse. This new compact design would allow sand filters to be used in locations where space is at a premium, such as dense urban areas, and the low maintenance requirements mean that a wide range of users could easily operate a DCSF.

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