PERFORMANCE ANALYSIS OF NATURAL AND ARTIFICIAL MEDIA IN HORIZONTAL FILTER FOR GREYWATER TREATMENT

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ABSTRACT

Water scarcity, inappropriate sanitation and wastewater pollution are critically important global issues. Greywater is a sustainable water source for recycling and treatment technologies depends upon the characteristics of greywater and reuse option. Among wide range of the available treatment processes, filtration was selected as it is easy in operation and maintenance, efficient and economical.

In the present study a horizontal flow filter set-up prepared and filled with the low-cost media (jute coir, synthetic fibre and sand of two different size range). Greywater for examination was collected from the girl's hostel of SVNIT on regular basis and allow to settle for 2 hours, before feeding the greywater to the filter.

Filter performance was examined with certain physico-chemical and biological properties of greywater like turbidity, pH, BOD, COD, solids, alkalinity, total and fecal coliform. The filter was run for 93 days including modification and cleaning period. The overall removal was 90.32%, 65.90%, 65.04%, and 16.64% for turbidity, BOD, COD and total solids, respectively. Among the different low cost media used in the reactor, jute coir is showing maximum removal of 66.69%, 11.46%, 35.08% and 33.43% for turbidity, total solids, BOD and COD, respectively. It was also observed that synthetic fibre media is contributing to turbidity and also responsible for clogging of filter.

Keywords: Greywater, horizontal filter, jute coir block, synthetic fibre media

1. Introduction

Water is a basic need not only for human survival but also for socio-economic development. Globally, water use increased six-fold during the twentieth century and by the year 2025 about 1.8 billion people will live under absolute water scarcity conditions. As a consequence, the demand for water will increase in the countries and water availability for irrigation will be a limiting factor for food production.

Household wastewater is composed of blackwater and greywater. Blackwater is the wastewater coming from toilets (faeces, urine, possible toilet paper and flushwater). Greywater is all household wastewater excluding blackwater. This means that greywater includes water from bathtubs, showers, hand basins, kitchen sinks and laundry. Traditionally there is no separation between greywater and blackwater from domestic source and both streams are treated together thus increasing the load on the centralized treatment plant so there must be a decentralized system for the treatment of greywater. The advantages of separate greywater treatment in decentralized systems are to shorten and close the water cycle, to prevent water shortage and to save money.

Safe and sufficient quantity of water is necessary for a healthy growth of human beings. The gap between water demand and available water supply is increasing day by day. Proper sanitation, especially decentralized approach can solve the problem of water supply and wastewater management and that can be done by reuse of greywater as typically from a household, greywater flow is around 2/3 of the total wastewater flow. Also it will reduce the

volumetric load of domestic sewage into the centralized wastewater treatment plan. Hence, greywater has a potential for recycle and reuse.

Greywater reuse methods can range from low cost methods such as the manual bucketing of greywater from the outlet of bathroom, to primary treatment methods that coarsely screen oils, greases and solids from the greywater before irrigation via small trench systems, to more expensive secondary treatment systems that treat and disinfect the greywater to a high standard before using for irrigation. In many countries, reuse of greywater is not practiced due to lack of knowledge of treatment process, stringent reuse standards and the possibility of spreading of disease due to the presence of pathogens in greywater. The issues that are considered in selection of greywater treatment are characteristics of greywater, used standards, technology performance, and cost. Among all the treatment processes, it was found that filtration is one of the feasible options for on-site household treatment of greywater as it is efficient and economical. In the present study, horizontal filter is adopted for treatment of greywater as it is easy in operation and maintenance, and filled with media like jute coir, synthetic fibre and sand.

The main objective of the study is to analyse the performance of different locally available natural and artificial media for the treatment of greywater by horizontal filtration technology.

2. Material and methodology

In the present study, fresh greywater was collected from greywater collection chamber of girls hostel at Sardar Vallabhbhai National Institute of Technology campus, Surat, Gujarat, India. Greywater includes the water coming from bathroom, shower, floor washing, wash-basin, and laundries. Greywater coming from kitchen was not included because of the limitations of plumbing system. The materials used in the study are galvanized iron container, jute coir block which is made up of natural jute fibre available in different forms and sizes locally in the market was washed with clean water several times before using it in the filter. It will provide adequate filtration by retaining particles and allowing water to flow across the media due to its inherent porosity of 48.87%. Coarse and Fine sand was sieve-analyzed and washed several times with tap water until clear water is obtained. The grain size distribution ranged from 1 – 0.600 mm (Coarse sand) and 0.600- 0.125 mm (Fine sand). Synthetic fibre having high void ratio of 95% and above, which will help to entrap the debris and suspended particles easily in the media. Also the advantage of using synthetic material is that there is an electrostatic attraction forces between particles and fibre surface, which can enhance the capture of small particle (<1µm), Perforated galvanized iron sheet separator, mosquito net and PVC pipes and fixtures are used. Performance of the media was analyse by monitoring the physico- chemical properties of greywater like turbidity, pH, alkalinity, BOD, COD, solids and MPN. All analysis was conducted as per Standard method (2012).

Filter setup

Galvanized iron sheet is used to fabricate/Manufacture the filter The filter is divided in five different compartments (one for inlet chamber and others for four different media) which is designed as an open water tight tank to prevent loss due to leakage. mosquito net was used to prevent the mixing and drainage of media. All four media (i.e. jute coir block, coarse sand, fine sand and synthetic fibre) used in the filter as mentioned above are washed properly with clean water and then filled in the filter. Greywater is settled for 2 hours before feeding to the filter. Required filtration rate (0.138 $m^3/m^2/hr.$) was maintained by peristaltic pump and filter is cleaned when filtration rate decreased to 0.084 $m^3/m^2/hr$. After completion of first run (after 21 days) filter was modified by increasing the number of port at the end of each layer in order to study the role of different media in greywater treatment. The filter was operated for the period of 3 months continuously for 21 days run 1 and for 25 days for run 2 and run 3. Daily analysis of effluent as well as influent was done for various physico-chemical tests such as pH, alkalinity, BOD, COD, turbidity, total solids along with the microbiological study.

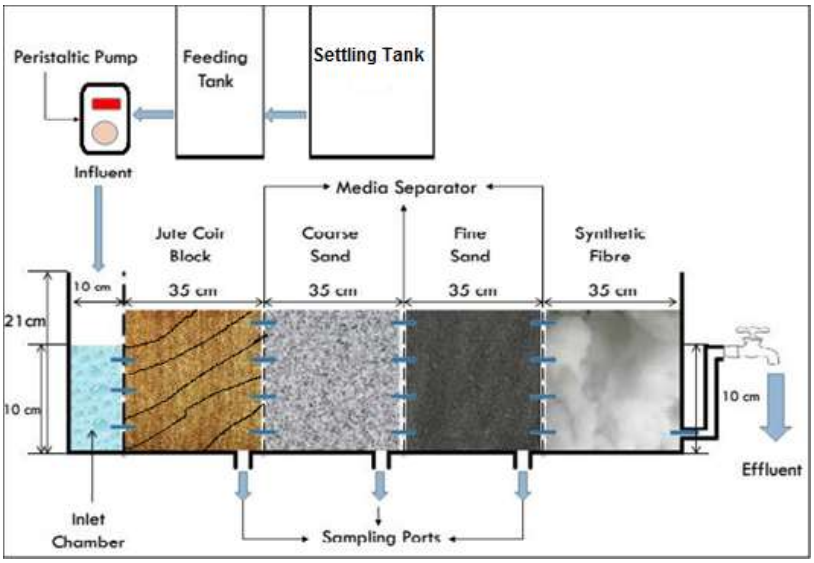

Figure 1: Schematic diagram of filter

3. Results & discussion

The greywater used in this study was treated by two process settling and filtration. The main purpose of settling is to remove the settleable solids from greywater so as to reduce load on filter and provides some degree of purification. Table1 shows the effect of settling for 2 hours on turbidity, BOD, COD, total solids, total dissolved solids, and total suspended solids, respectively. The data for the same shows that turbidity decreases from 88.15± 19.37 to 59.53 ± 16.5 NTU (32.46 % removal) after settling.The variation in BOD and COD of 116.7 ± 21. 93.63 ± 14.37 mg/L (19.76 % removal) and 149.44 ± 16.76 to 115.98 ± 20.55 (22.39% removal) respectively. The reduction in BOD and COD is due to the settlement of organic matter in the settling tank. Abdel-shafy H. *et al*, 2013 reported COD and BOD range of 150 to 258 mg/L and 75 to 140 mg/L, respectively for settle greywater. About 4% of change was observed in total solids, total dissolved solids and total suspended solids.

Table 1: Effect of settling on greywater characteristics

Parameters	**Raw**	**Settle**
Turbidity, NTU	88.15 ± 19.37	59.53 ± 16.5
BOD (mg/L)	116.70 ± 21.98	93.63 ± 14.37
COD (mg/L)	149.44 ± 16.76	115.98 ± 20.55
Total Solids (mg/L)	530.77 ± 77.40	507.88 ± 91.33
Total Dissolved Solids (mg/L)	428.24 ± 76.02	407.78 ± 77.52
Total Suspended Solids (mg/L)	102.53 ± 62	100.1 ± 59.17

Filtration process can remove fine floc particles, colour, dissolved minerals,fine suspended solids and microorganisms. The settled greywater was used as the inlet for filtration unit. Horizontal flow filter set-up prepared and filled with the low-cost media (jute coir, synthetic fibre and sand of two different size range).Table 2 shows the performance of different media used in the reactor for the treatment of greywater.It shows that jute coir block is removing the major portion of all the parameters. It is a very porous material having porosity of 48.87%. Due to its high porosity the formation of schmutzdecke layer is very well and their contribution in removal is high. It is showing maximum removal of 66.69%, 11.46%, 35.08% and 33.43% out of 90.32%, 16.64%, 65.90% and 65.04% of total removal for turbidity, total solids, BOD and COD, respectively.This is because of its mechanical straining property that most of the particles are getting arrested in it and making the media more finer by ongoing procedure arresting more finer particles and this

helps in the formation of slime layer mat on jute coir block which in turn will remove BOD and COD by the biological action. The removal efficiency of turbidity for the biosand filter (sand effective diameter d10=0.35 mm, porosity = 39%) was 89%, (Abudi.Z. 2011). Investigation on the treatment of grey water by an earthen filter observed poor treatment of turbidity with removal 47 % (Hypes et. al.1975). Study on organic material such as bark, wood chips, wheat straw showed reduction of 55 - 99.9% and 51 - 98% for BOD and COD, respectively (Dalahmeh S. *et al* 2011).The removal efficiency of up to 81-89% has been reported for sand filter (Abudi Z. *et al*. 2011).One of the studies conducted on coiled, criss-cross nylon wire pad media showed that 80-90% of COD was reduced in effluent (Deshpande A. *et al* 2012). Horie N. in his study on synthetic fibre media showed the removal of 50 – 80% of suspended solids and 30- 70% of BOD.

Table 2: Percentage Removal by different media

Media/Parameters	Turbidity	Total Solids	BOD	COD
Total Removal	90.32	16.64	65.90	65.04
Jute Coir Block	66.69	11.46	35.08	33.43
Coarse Sand	16.63	0.27	14.39	13.20
Fine Sand	7.58	2.13	7.95	8.52
Synthetic Fibre	-0.58	2.77	8.47	9.88

4. Conclusions

Greywater is important source of water to meet the increasing water demand by reusing after proper treatment. Present study is an attempt to evaluate performance of jute coir block, fine sand and coarse sand and synthetic fibre media as low-cost locally available filter media for greywater treatment. To fulfil the objective fresh greywater was collected from girls hostel without including water used in kitchen. Filter performance was examined with certain physico-chemical and biological properties of greywater like turbidity, pH, BOD, COD, solids, alkalinity, total and fecal coliform. The filter was run for 93 days including modification and cleaning period. The overall removal was 90.32%, 58%, 60%, and 15.44% for turbidity, BOD, COD and total solids, respectively. Among the different low cost media used in the reactor, jute coir is showing maximum removal of 66.69%, 11.46%, 35.08% and 33.43% for turbidity, total solids, BOD and COD, respectively. It was also observed that synthetic fibre media is contributing to turbidity and also responsible for clogging of filter.

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