Determination of Efficiency of Roughing Filter for Grey Water Treatment

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***Abstract* — India is facing a serious water crisis and it is estimated that India's population will be suffering from severe water scarcity by 2025. Groundwater and surface water sources are becoming increasingly vulnerable to anthropogenic pollution. The best cost-effective process to reduce water scarcity is the reuse of grey water. The total grey water fraction has been estimated to account for about 75% volume of the combined residential sewage. Grey water typically breaks down faster than black water and has lower levels of nitrogen and phosphorus. Hence Grey water management aims on using treated grey water in applications which do not require drinking water quality. These non potable reuse applications include industrial processes, irrigation, toilet flushing and laundry washing depending on the technologies utilized in the treatment process. Hence the need for a separate treatment system right on the premises of the house or an apartment block or hotel, from which the water comes, and where the treated water would then be used would be the sensible solution to combat water crisis. In this paper, the design of laboratory scale roughing filter using different filter media to treat grey water generated is presented. The performance of laboratory scale grey water treatment was investigated using roughing filters and the efficiency was analyzed.**

Keywords—Grey water, Roughing Filter, filter media, water crisis.

I. INTRODUCTION

Where there is water, there is life. Life exists around numerous uses of water which makes it important for survival and luxury. It is an essential resource to sustain life. A lack of water to meet daily needs is a reality today for one in three people around the world. Because of this, water should be conserved to sustain our domestic needs for the future. As world population is constantly growing, the demand of water increases each and every day. According to experts, conservation is one way of making use of the available water in an effective and efficient manner. Nowadays, technology has developed to the point that waste water can be cleaned into water fit for irrigating, laundry and safe for drinking. One such way to treating waste water is "Grey Water Treatment". Grey water is slowly gaining importance in the management of water resources. The benefits of well-organized grey water management is that it offers a tool for coping with water scarcity and reduces the amount of pollution to enter the hydrological cycle.

A. Grey Water

Grey water is defined as wastewater without any input from toilets which means that it corresponds to wastewater produced in bathtubs, showers, handbasins, laundry machines and kitchen sinks. It contains far less nitrogen than black water. Nine-tenths of the nitrogen contained in combined wastewater derives from toilet wastes. Grey water typically breaks down faster than black water and has lower levels of nitrogen and phosphorous. It decomposes much faster than black water.

B. Objective of Project

The objective of the project is to analyse the performance of the roughing filter and to determine its efficiency in treating grey water. This project has been aimed to reuse the grey water in an effective way for our domestic purposes according to the characteristics of grey water and feasibility of the adopted filter, so that the amount of water that is left unused is collected and treated for the purposes like gardening, cleaning, and laundry purposes. This can minimize the usage of water consumption for various domestic activities.

II. METHODOLOGY

A. Grey water Treatment

The increasing need for water paved way for the newest simpler treatment. It is a multistage process Grey water treatment is a process in which the solids, organic matter, hardness is removed. The treatment process is classified as:

- Preliminary Treatment

Preliminary Treatment was carried out to separate the large size floating particles like vegetable matters, food particles, leaves, hairs etc and also settleable inorganic solids

- Filtration Process

The filter used in this study is Roughing Filter. Roughing Filtration can be considered as a major pre-treatment process for wastewater, since they efficiently separate fine solid particles over prolonged periods without addition of chemicals. They mainly act as physical filters and reduce the solid mass. However, the large surface area large filter surface area available for sedimentation and relatively small filtration rates also supports absorption as well as chemical and biological processes. Therefore besides solid matter separation , roughing filters also partly improve the bacteriological water quality and to a minor extent , change some other water quality parameters such as colour or amount of dissolved organic matter.

B. Assembly and Testing of the Treatment System

The aim of the testing was to see that the treatment system is operating without any difficulties when water is pump into the system. For this the roughing filter was fabricated as per the design considerations of 5 person equivalent and it was tested for leakage before filling the

filter media. Four Different types of filter materials were selected in four different chambers as follows:

TABLE I. TYPES OF FILTER MATERIALS

Chamber	Size (mm)	Materials
Chamber -1	300x300x300	Corse Gravel (40-60 mm)
Chamber -2	300x300x300	Gravel (20-40mm)
Chamber -3	300x300x300	Activated Charcoal
Chamber -4	300x300x300	Fine Sand (125-250 µm)

The selected filter medias were collected, washed and dried. It was then filled in the appropriate filter chambers. Testing was one with tap water which was allowed to run through the whole system for various cycles in order to get rid of the impurities in the filter media. Before starting to test all the components such as inlet and outlet along with it, regulators were installed. The inlet and outlet was attached in order to send the water in and out. The smaller containers were placed on a floor in order to collect the treated water and the inlet chamber was placed in such a way that it maintains a secure smooth flow.

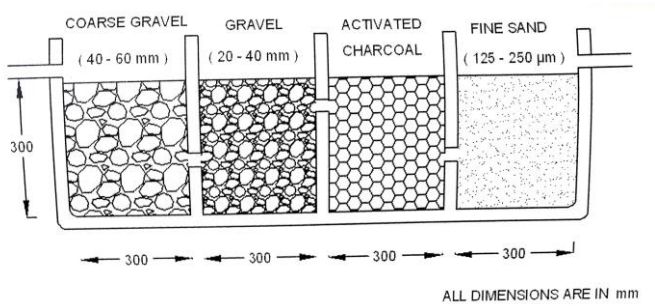

Fig. 1. *Assembly of Roughing Filter*

C. Roughing Filter Data

- Size of the Roughing Filter = 1200x300x310 mmm3
- Size of Each Chamber= 300 mm
- Capacity of the Filter before filling the filter media = 108 litres
- Capacity of the Filter after filling the filter media = 52 litres
- Hydraulic Flow Rate: 1.8 litres/ hr
- Filtration rate of Roughing Filter = 1.5 m/hr
- The flow maintained in the roughing filter was continuous
- The head was maintained constant for having continuous flow.

D. Working of Roughing Filter

The water to be treated was led into the roughing filter's chamber 1 containing gravels of large size which helps in reducing the turbulence level of sample and then it was led into the next chamber of decreasing gravel size where it also works on the parameter of turbidity. Then the water from chamber 2 was allowed unto the chamber 3 where Activated charcoal was filled and due to its higher specific area, the minor contaminants gets absorbed to its surface and finally the water is sent to the chamber 4 where the filled fine sand acts as biofilms which improves the water quality by treating it completely. Finally the efficiency of roughing filter was determined.

III. RESULTS AND DISCUSSION

A couple of problems occurred while combining the components together. Yet the system functioned well when tested with the water flow. In order to monitor the quality of the outlet water, parameters like total solids, turbidity, Ph, dissolved oxygen, BOD, COD, Nitrates, Sulphates were compared between inlet and outlet water. The efficiency of roughing filter was determined to be 92.8% in removal of suspended solids, 33% in removal of hardness , 26.3% in chloride removal, 88% in nitrated removal, 63% in sulphates and 90.05% in removal of phosphates.

TABLE II. OBSERVATIONS OF TESTING

Parameters	Inlet	Outlet			
		Day 1	Day 2	Day 3	Day 4
Ph	5.62	6.58	6.65	6.57	6.45
Turbidity (NTU)	64.51	1.67	0.79	0.54	0.48
Total Dissolved Solids (mg/l)	687	577.7	559.42	531.7	510.8
Hardness (mg/l)	593.2	412.67	404.78	401.23	400.97
Chlorides (mg/l)	346.72	264.12	260.32	259.17	257.56
DO (mg/l)	7.92	1.2	1.8	1.7	1.3
Nitrates (mg/l)	5.45	1.772	1.15	0.443	0.41
Sulphates (mg/l)	140	56	54.2	53.9	53.1
Phosphates (mg/l)	4.79	0.5	0.54	0.5	0.6

Parameters	Inlet	Outlet			
		Day 5	Day 6	Day 7	Day 8
Ph	5.62	6.87	6.95	6.99	7.05
Turbidity (NTU)	64.51	0.21	0.2	0	0
Total Dissolved Solids (mg/l)	687	496.06	482.5	474.4	460.52
Hardness (mg/l)	593.2	399.12	395.47	382.89	378.41
Chlorides (mg/l)	346.72	254.01	251.04	249.34	247.21
DO (mg/l)	7.92	1.8	1.7	1.7	1.4
Nitrates (mg/l)	5.45	0.354	0.329	0.311	0.306
Sulphates (mg/l)	140	50.7	48.6	47.1	46.4
Phosphates (mg/l)	4.79	0.5	0.5	0.5	0.5

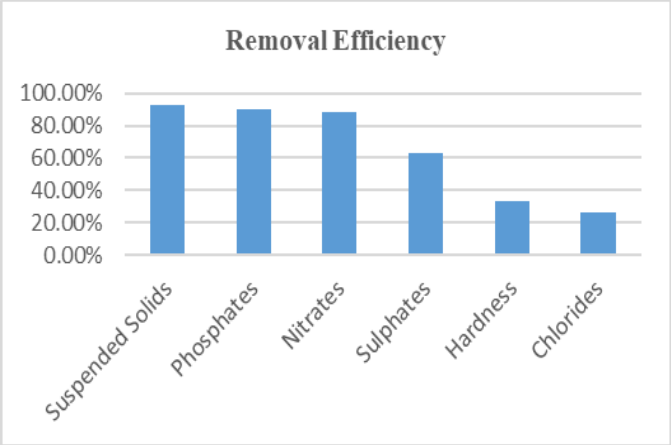

Fig. 2. *Removal Effeiciency of Roughing Filter*

IV. CONCLUSION

With regards to water crisis, decline in rainfall and draught threat throughout numerous countries, by applying self reliant processes which are economically important, the mentioned process such as roughing filtration must be studied to provide healthy refreshing water to developing countries. Filtration efficiency of a horizontal roughing filter was estimated with a laboratory developed filter model with screening as pre treatment.

The Efficiency of the filter was determined by the comparison between the values of mentioned parameters in inlet and expected outlet results. Significant reduction in physico chemical parameters of grey water was achieved . Achieved results in this study shows that roughing filtration may be considered as a packed, low-cost and efficient treatment process. Therefore this treatment may be posed as a total treatment system in which treated water exited from the filter may be sent to distribution network after simple post chlorination.

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