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Design and Working Model of a Small-Scale Wastewater Treatment Plant for Households

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Abstract

Increasing water demand due to population growth has led to the idea of using wastewater as a resource. The present study has been proposed to design a small-scale grey water treatment plant for households as it contains less organic content. The steps include collection of grey water, designing, setting up the plant, using different methods of treatment and to conduct necessary tests according to BIS/APHA. The performance is showed in terms of reduction in parameters such as Turbidity, TSS, Total Hardness, Phosphates, Nitrates, BOD and total coliform. This project has been carried out using indigenously available materials for economics point of view, the results of the tests on different parameters being within the permissible limits according to CPCB are fit to be reused for different applications such as flushing, street cleaning, irrigation and other non-potable uses and also aiding in reduction of load on the STPs thereby increasing its working efficiency

Keywords: Grey water, Low cost, Reuse, Treatment

Introduction

The present-day scenario of India's sewage generation and treatment capacity is far from being ideal. Every household needs an easy access to the safe and clean water which brings wastewater treatment into consideration**.** Grey water constitutes of about 50-80% of the wastewater generated from households. Currently, Bengaluru generates 1400 MLD wastewater, as per BWSSB's conservative estimates (bwssb.gov.in). The city has total treatment capacity of 721 MLD, but only 520 MLD is getting treated. Hence, treating wastewater is essential to reduce the load on the STPs. Considering this gap, the current project has been taken up, the aim of which is to design and set up a small-scale grey water treatment plants to convey, treat and reuse the grey water from individual houses, temporarily settled communities, rural communities and remote areas and reuse the water for applications like toilet flushing, car wash, ornamental uses in fountains, irrigation, etc.

Methods

Grey water sample for testing is obtained from an apartment in Bengaluru city. Sampling, storage and pretreatment and post treatment characterization are carried out for the parameters pH, TSS, Turbidity, Total hardness, Phosphates, Nitrates, BOD and Coliform as prescribed in **APHA/BIS** (IS 3025-23). Construction of the prototype is carried out using necessary steps described below (fig. 2.1).

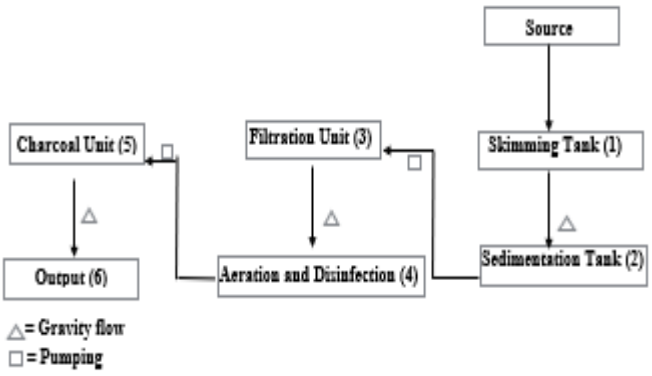

Fig 2.1. Schema of the Treatment plant

Design and working of the prototype

The schema (Fig 2.1) represents the design and setup of the treatment units. Fig 2.1.1 shows the actual design and setup of the prototype model.

1	**Skimming tank**
2	**Sedimentation tank**
3	**Filtration tank**
4	**Aeration tank**
5	**Charcoal filtration**
6	**Collector**

Fig 2.1.1. Working model (Treatment plant)

Discussion

The grey water sample has been subjected as per standard protocols prescribed by BIS/APHA (IS 3025-23) to physical, chemical and biological testing. The raw grey water and treated grey water has been characterized and the results have been tabulated inculcating percentage reduction in efficiency (Table 3.1). In all the cases, analysis of the results provides information that can be used to make decisions or provide re-assurance that conditions are as expected.

Table 3.1. Grey water analysis

Sl. No	**Parameters**	**Raw sample**	**Treated sample**	**% Reduction**
1	Physical	NA	NA	NA
	Colour	yellow	pale yellow	< 100%
	pH	5.86	6.71	NA
	Turbidity, mg/l	428.0	65.5	84.69%
	Total suspended solids, mg/l	0.1	0	100%
2	Chemical	NA	NA	NA
	Total hardness as $CaCO_3$, mg/l	646.9	303.3	53.11%
	Phosphates, mg/l	3.30	0.79	76%
	Nitrates, mg/l	26	24.2	6.9%
	BOD	95.6	20	79.07%
3	Biological Total coliform, MPN/100ml	161	92	57.1%

Table 3.2. Comparison of standard values and results

Sl. No	**Parameters**	**Standard values**	**Treated sample**
1	Physical	NA	NA
	Colour	Colourless	Pale yellow
	pH	6.5-8.5	6.71
	Turbidity, mg/l	1.5	65.5
	Total suspended solids, mg/l	200	0
2	Chemical	NA	NA
	Total hardness as $CaCO_3$	300-600	303.3
	Phosphates, mg/l	0-2	0.79
	Nitrates, mg/l	0-10	24.2
	BOD, mg/l	100	20
3	Biological Total coliform, MPN/100ml	100	92

From the Table 3.1, it can be inferred that the working model is efficient in reduction of different physical, chemical and biological parameters. It has been observed that Turbidity is reduced by 84.96%, TSS has a 100% reduction, Total hardness, Phosphates, Nitrates, BOD and Total coliform are reduced by 53.11%, 76%, 6.9%, 79.09%, 57.1% post treatment respectively. Table 3.2 depicts that all the values obtained are within the limits compared to standard values. However, for the water to be used in flushing the coliform has to be further reduced, in case of irrigation/gardening treated grey water can be used leading to no additional application of fertilizers since it already contains large number of nitrates or can be used generally with improvements in anaerobic treatment to reduce the nitrate content.

Conclusion

The results of the study establish the applicability of the developed methodology. This small-scale grey water treatment plant is a combination of physical and natural operations such as settling, gravity flow, filtration, and aeration. The power supply which is one of the India's major issues was required at minimum. The easy operation, usage of indigenous materials, less maintenance, less power, low operation and maintenance cost contributes to significant and efficient ways of treating and reusing the wastewater in rural communities and small units. This is also proved to be eco-friendly as no toxic chemicals are used in the treatment

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