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Reuse of Wastewater and Solid Waste Management Module for a Household Unit

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Abstract *India considered to be world's seventh largest and world's second most populated country. India right now is facing a major problem of water scarcity problems. Water scarcity leads to many problems such as decrease crop cultivation resulting in food shortage which indeed will decrease the economic condition of country as most of the economic growth depends on the farming and other cultivation processes. On domestic level we should recycle domestic greywater and reuse in daily lives as it helps in reducing the exploitation of water resources, hence saving them. This paper contains review on the different recycling methods of grey water. Suitable recycling techniques should have ability to achieve excellent removal of organics, solids and surfactants. Greywater reuse is one of the main alternatives of reducing fresh water consumption in households, industries and commercials infrastructure. Grey water, a mixture of waste water from laundry, bathroom and kitchen can be treated and reused for activities like landscape irrigation, toilet flushing and ground water recharge. Thus, the reuse of treated greywater can help us with saving the freshwater resources. Solid-waste management is a major challenge in urban areas. Without an effective and efficient solid-waste management program, the waste generated from various human activities, both industrial and domestic, can result in health hazards and have negative impact on the environment. The objectives of the study are to determine different types of solid waste generated by the households, to assess handling methods at household level, to ascertain common challenges associated with waste management systems.*

Keywords- **Wastewater, Greywater, Blackwater, Solid waste, BOD, COD.**

1. INTRODUCTION

Reuse of Domestic Wastewater treatment is becoming an important field of research in a global context of increasing water scarcity and inadequate sanitation. In developing world, insufficient water supply and poor sanitation facilities cause thousands of deaths each day.

Two types of wastewater which are created in household are:

A. Greywater

Greywater is wastewater from non-toilet plumbing fixtures such as showers, taps and basins, etc.

B. Blackwater

Blackwater is water that has been obtained from the toilet. Blackwater is the water obtained from urine and flush water and/or dry cleansing materials.

The easiest and most efficient way for reducing fresh water use is to conserve water by using less of it. Water conservation is an easy way to save water. However, many people are going beyond conservation by using greywater in place of fresh water for subsurface irrigation, toilet flushing, fighting fires, washing cars, and other possible uses. Source separation of domestic wastewater is a strategy for simplifying the wastewater treatment and reuse process.

Fig 1: - Household water consumption

Solid waste is the unwanted solid materials generated from combined residential, industrial and commercial activities in an area. It can be categorized on the basis of its origin (domestic, industrial, commercial, construction or institutional); according to content (organic material, glass, metal, plastic paper etc.) or according to hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc.). Solid waste creates significant health problems and a very unpleasant living environment if not disposed of safely and appropriately. If not correctly disposed of, waste may provide breeding sites for insect-vectors, pests, snakes and rats that may increase the l of disease transmission.

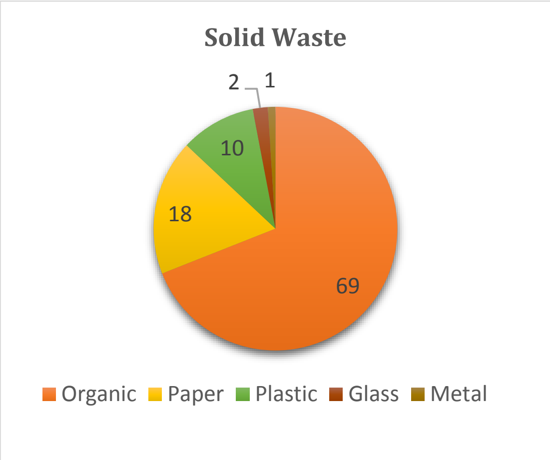

Fig 2: Composition of solid waste generated in house

1.1 Aim

1. To improve the wastewater quality, making it suitable for reuse.

2. To utilize solid waste generated in house.

1.2 Objectives

1. To improve quality of wastewater by eliminating pollutants and organic materials.

2. To make wastewater reusable for flushing and gardening.

3. Determination of different types of solid waste generated by households and its conversion in compost.

2 LITERATURE REVIEW

Glenda Emmerson (1998) [1], concluded that alternative source of water is grey water. Grey water is the water that comes from domestic bathroom and laundry drains. If this water is used for relatively safe applications such as flushing, irrigation, then a family can reduce their usage around 30-50 percent.

Vasudevan Rajaram (2010) [2], presented a consolidated approach to manage the water and wastewater and it had concluded that every drop of wastewater in rural and urban India should be reuse. So that it does not contaminate our drinking water supplies and conserve water resources for satisfying the thirst of the entire nation.

Javed Alam (2012) [3], proposed the concept of using grey water in various possible fields thus, making fresh water demand with in control. The use of grey water in India is in the beginning stage. Though, many developed countries are already using this new water after some preliminary treatments depending upon the type of use.

Krishna Kumar (2013) [4], proposed that the grey water treatment by the process of bio-remediation, where dirt water from bathroom and sinks are treated using effective micro-organism solution and filtered by use of sand filter. The author concluded that by this method effective treatment of grey water form bathroom and basins can be achieved.

Kamal Rana (2014) [5], introduced some efficient, cheap and sustainable grey water treatment system for households the authors discussed processes to identify the best suited processes at household and community level. Septic tank, constructed wetlands and intermittent sand filter are identified as the most suitable processes for decentralized treatment due to the simple operation and maintenance facilities.

Saroj B. Parjane et al (2011) [6], presented greywater reuse system developed for small college campus in rural areas. The greywater treatment setup had a combination of natural and physical operations such as aeration, primary settling with poured water flow, filtration and agitation, hence called as hybrid treatment setup. Performance of the setup was investigated for the recycling of grey water from bathrooms, laundries and basins from the hostel in the college campus. The grey water treatment setup was designed for around 180L per hour capacity and comprised of primary settling tank with cascade flow of capacity 20 litres, agitation tank with the capacity of 15 litres, aeration tank with a capacity of 15 litres and a filtration unit with capacity of 20 litres.

Krupa Naik et al (2016) [7], in this paper the author has proceeded with an experiment in a small village Raju Pura in Gujarat with a population around 900 people. In the text she shows that the greywater was directly dumped in the rivers whereas the blackwater was directly transferred to the septic tank. Instead dumping greywater in the rivers, it can have treated onsite using treatment plant and can be reused in domestic application like toilet flushing. It was found that total usage of fresh water was around 135 litres per capita per day. Paper also shows that greywater produced is around 60% of the fresh water supplied. After calculating it was found that the amount of greywater produced in the village was around 72900 litres per day. She proposed that we can recycle the greywater collected and can be reused in various domestic households. The paper presents both mechanical and aerobic system for treatment of the greywater. During the preliminary tests it was noted that the greywater in the village had a higher value of BOD that is 274mg/litre and high total solids around 1080mg/litre which should be 30mg/litre and 100/litre respectively as per Indian standards for inland water standards. In the test a treatment model was made to reduce the BOD and total solids in the water. The model contained sand filtration process in which thickness layer of the sand had to be varied for the water to come according the Indian standards. It was seen that after filtration the BOD had dropped down to 35mg/litre and total solid had dropped to 104mg/litre. From the experiments they carried out they concluded that greywater treatment is cheaper than the wastewater treatment. Mainly most of the wastewater contains 50-80% of greywater therefore cost of waste water treatment can be reduced by proposing greywater treatment plant. They concluded that the recycled greywater can be reused for further irrigation and the exploitation of natural water resources can be reduced.

Shaikh, Sk Sameer, Sk Younus et al (2015) [8], proposed grey water reuse in Pusad City in Maharashtra, India in this grey water was collected from the bathrooms, basins of the residential area of Pusad city, Maharashtra, India. Total 08 samples of grey water were taken at first day of morning and evening of every week and the performances of system were investigated for these 08 samples of grey water at steady state conditions. Laboratory scale integrated grey water system was designed for 100 lit/hr capacity restricted five components such as storage tank with 100 litres capacity, sedimentation tank has 40 litres capacity, Filter-I (Gravel + Sand) has 40 litres Filter-II (Coconut shell coal + Charcoal) unit of 40 litres capacity and Disinfection Tank has also 40 litres capacity. Parameters such as pH, total dissolved solids (TDS), Total suspended solids (TSS), chemical oxygen demand (COD), turbidity, chloride content in Grey water were determined for each sample.

3. METHODOLOGY

3.1 Model Description

3.1.1 Model Jar 1

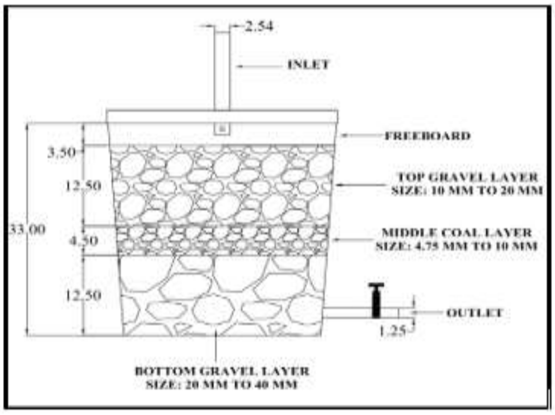

Fig 3: Model jar 1 details (All Dimensions are in cm)

Model Jar 1 is made of a simple plastic jar and is divided in to three compartments i.e. bottom gravel layer, middle coal layer and top gravel layer with both top layer and bottom layer having a depth of 12.5 cm, middle layer having a depth of 4.5 cm and a freeboard of 3.5 cm. Height of the model is 33 cm, the upper diameter is 31 cm, bottom diameter is 26 cm, inlet diameter is 2.54 cm and the outlet diameter is 1.25 cm.

The total capacity of the model is 20 L. The gravel size at the bottom layer is 20 mm – 40 mm. The coal size at the middle layer is 4.75 mm to 10 mm and the gravel size at the top layer is 10 mm – 20 mm. Between top layer and middle layer and between middle layer and bottom layer a gunny bag is placed. The retention period for the process is 1 day.

3.1.2 Model Jar 2

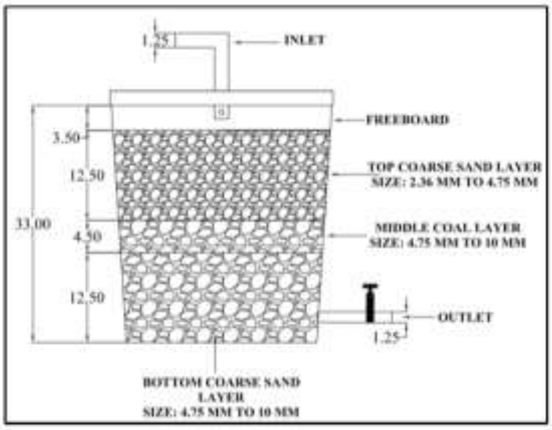

Fig 4: Model jar 2 details (All Dimensions are in cm)

Model Jar 2 is made of a simple plastic jar and is divided in to three compartments i.e. bottom coarse sand layer, middle coal layer and top coarse sand layer with both top layer and bottom layer having a depth of 12.5 cm, middle layer having a depth of 4.5 cm and a freeboard of 3.5 cm. Height of the model is 33 cm, the upper diameter is 31 cm, bottom diameter is 26 cm, inlet diameter is 2.54 cm and the outlet diameter is 1.25 cm. The model jar 2 is connected to model jar 1 through a rubber pipe.

The total capacity of the model is 20 L. The coarse sand size at the bottom layer is 4.75 mm – 10 mm. The coal size at the middle layer is 4.75 mm to 10 mm and the gravel size at the top layer is 2.36 mm – 4.75 mm. Between top layer and middle layer and between middle layer and bottom layer a gunny bag is placed. The retention period for the process is 1 day.

3.2 Process

3.2.1 Wastewater Treatment

The wastewater is fed through the inlet. The water is evenly distributed over the filter media. As the water percolates through the voids of the filter media layer by layer the wastewater is filtered. In the model jar 1 which is gravel filter, the large suspended particles get removed and the middle coal layer adsorbs the odorous substances from the wastewater along with the organic matter.

The wastewater which is now pre-filtered is now fed to the model jar 2 which is coarse sand filter through a rubber pipe which connects the outlet of gravel filter and inlet of coarse sand filter. In the coarse sand filter the treatment efficiency increases as the size of filter media decreases resulting in larger surface area there by trapping the smaller particles. The role of the middle coal layer is the same as in model jar 1 to adsorb the odorous substances from the wastewater and organic matter. As the wastewater is retained for 1 day and the cycle is continued a bacterial film known as bio film is formed around the particles of filtering media. The colour of this film is greenish. It helps in decomposing the organic matter present in the wastewater there by reducing the organic matter increasing the efficiency of the filter.

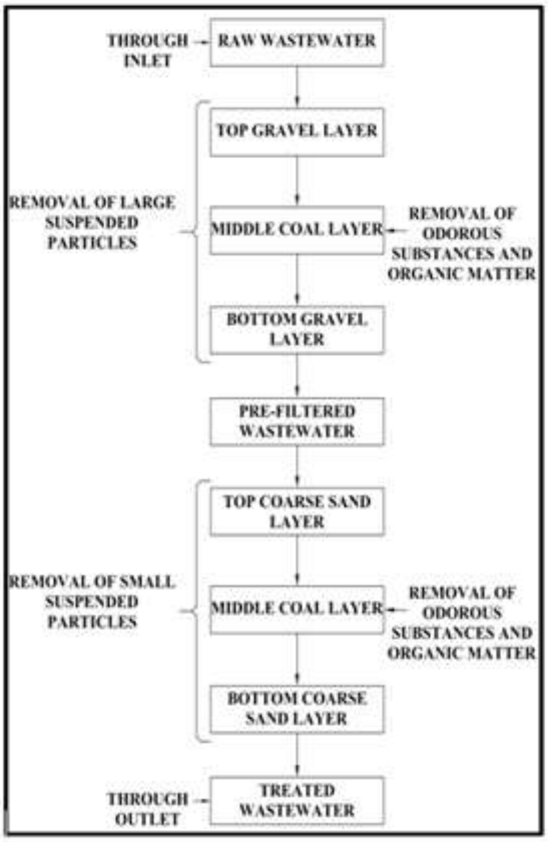

Fig 5: Wastewater treatment process

3.2.1.1 Test carried on Wastewater

SR NO	PARAMETERS
1	BOD (Biochemical Oxygen Demand)
2	COD (Chemical Oxygen Demand)
3	DO (Dissolved Oxygen)
4	TS (Total Solids)
5	Sulphate
6	Ammonium
7	Nitrate
8	Nitrite
9	Temperature
10	pH

1. To determine the BOD, COD and DO parameters APHA (American Public Health Association) Standard Method was used.
2. Determination of TS parameter was done by Weighing Balance Method
3. Sulphate, Ammonium, Nitrate and Nitrite parameters were determined by Aquasol Kit.
4. Temperature and pH parameters were determined by Thermometer and pH Meter respectively.

3.2.2 Solid Waste

Composting is a simple, rewarding way to recycle yard trimmings and food scraps at home while creating compost, a valuable soil amendment for gardens and lawns. Food scraps and yard trimmings, such as leaves, grass clippings, garden debris, and brush, make up over 20% of a typical household's solid wastes.
Where people have their own gardens or vegetable plots, organic waste can be dug into the soil to add humus and fibre. This makes the waste perfectly safe and also assists the growing process.

3.2.2.1 Model Description

The composting bin model is made up of a simple plastic jar. The total height of the model is 29 cm, top diameter is 27cm and bottom diameter is 24 cm. Also, for the inspection purpose a small opening of diameter 6cm is provided at the top of the bin. A tap is provided for the removal of the liquid accumulated during the pickling process.

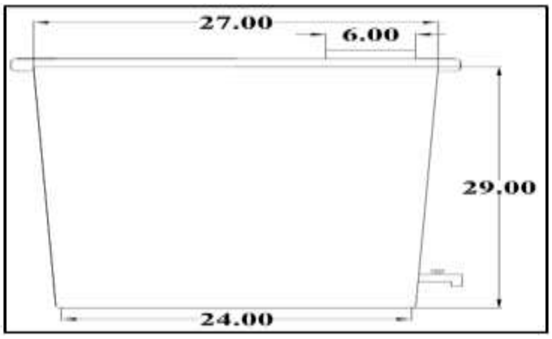

Fig 6: Composting bin model details (All Dimensions are in cm)

3.2.2.2 Process

Add jaggery at the bottom of the bin. Then place the filter [Strainer] in the bin.Take a paper sheet and cover the filter fully. Now add solid food waste. Then add about 2 table spoons of compost maker powder evenly. For every 2 inches of food waste add compost maker powder again. Repeat the steps of adding food waste and compost maker till the bin is completely full. Once the bin is full make sure the lid is closed tight. Do not open the bin for next 15 days.

After 15 days the food waste should be pickled. If lot of white mould is seen then it is a good sign. Bin should have a sour pickle kind of smell. If it has foul smell the something has gone wrong. After the food waste is pickled, compost is made by curing the pickle. Take the coco peat block and place it in any container. Add 4 litres of water, wait for 20 minutes. Break the expanded coco peat block evenly. Now the coco peat powder is ready to mix with the pickle.

Lastly layers of pickled waste and coco peat are to be created. Take a big pot or any container. Add 2 to 3 inches of pickled waste and 3 to 4 inches of coco peat powder. Continue the process till the pickled waste is over. Allow it to cure for next 2 to 3 weeks. Finally, the pickle will become compost in this process.

4 RESULTS

Parameters	Inlet Readings
BOD (mg/L)	92.2
COD (mg/L)	300.8
DO (mg/L)	7.1
TS (mg/L)	3380
Sulphate	427.5
Ammonium	4.5
Nitrate	2.5
Nitrite	50
Temperature	26.12
Ph	7.86

Table 1: Inlet Readings

Parameters	Outlet Readings
BOD (mg/L)	60.91
COD (mg/L)	127.18
DO (mg/L)	5.17
TS (mg/L)	2489.6
Sulphate	110
Ammonium	1.5
Nitrate	0.75
Nitrite	25
Temperature	24.08
Ph	7.57

Table 2: Outlet Readings

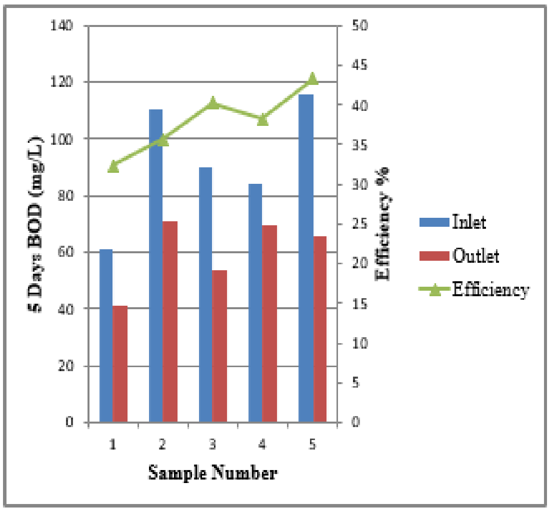

Chart 1: BOD test result graph

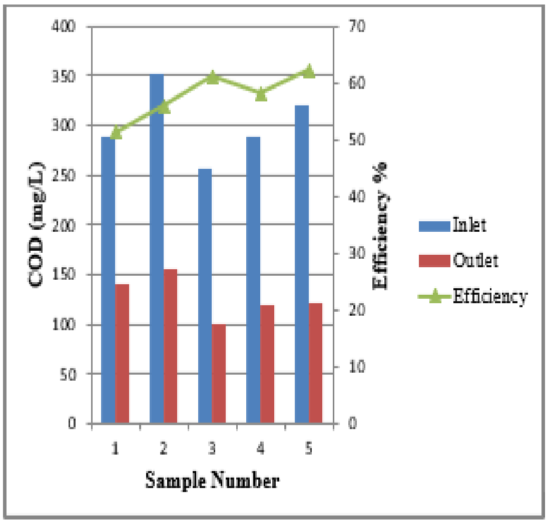

Chart 2: COD test result graph

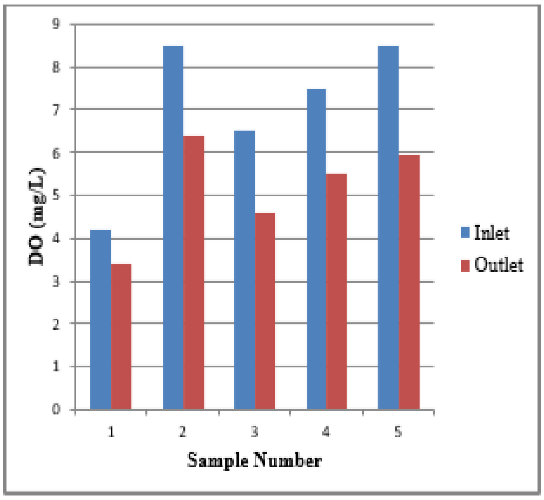

Chart 3: DO test result graph

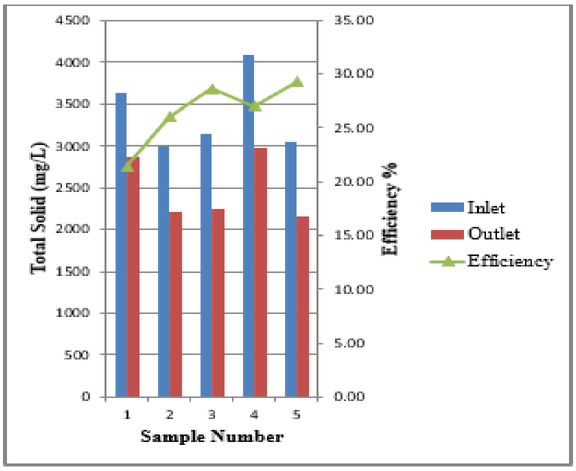

Chart 4: TS test result graph

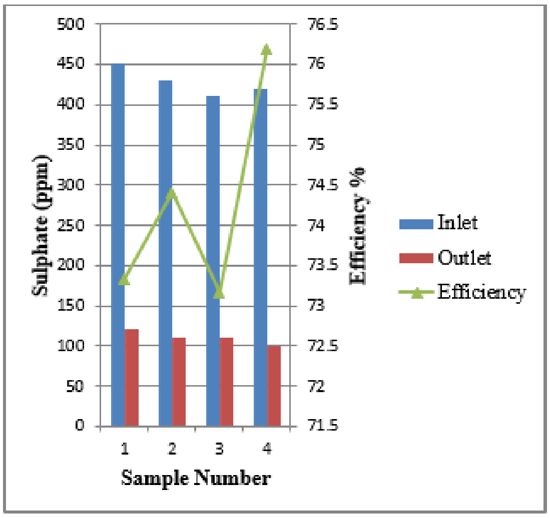

Chart 5: Sulphate test result graph

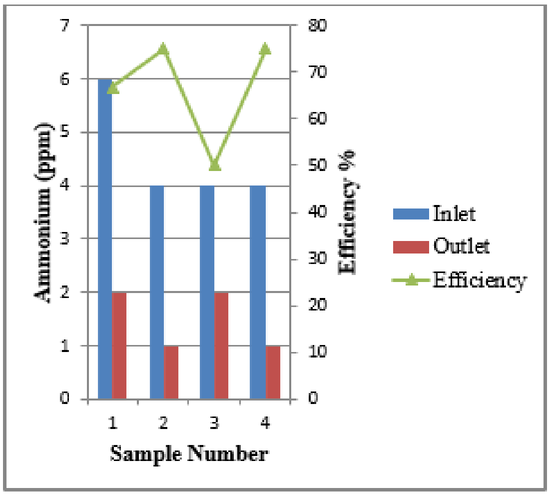

Chart 6: Ammonium test result graph

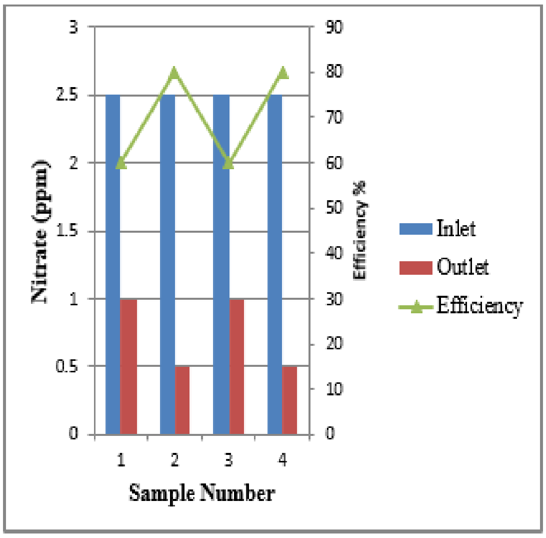

Chart 7: Nitrate test result graph

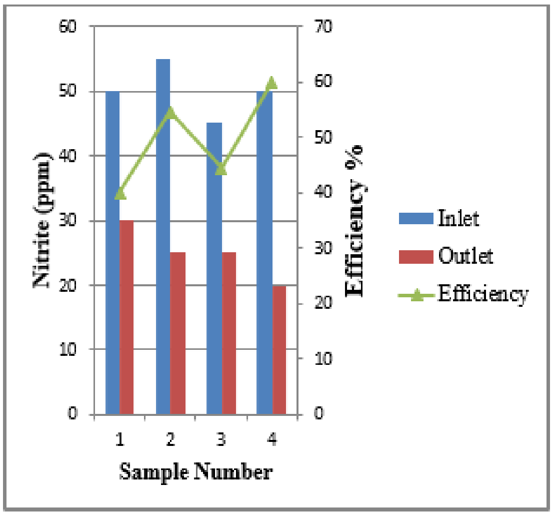

Chart 8: Nitrite test result graph

Sr. No.	Sample No.	Reading of Sample Before Treatment (^{0}C)	Reading of Sample After Treatment (^{0}C)
1	1	23.5°C	20.3°C
2	2	21.4°C	21.1°C
3	3	28.1°C	27.1°C
4	4	29.2°C	26.3°C
5	5	28.4°C	25.6°C

Table 3: Temperature test results

Sr. No	Sample No.	Reading of Sample Before Treatment	Reading of Sample After Treatment
1	1	8.20	7.15
2	2	7.17	7.90
3	3	8.75	8.20
4	4	7.60	7.44
5	5	7.60	7.2

Table 4: pH test results

5. CONCLUSIONS

From the results obtained from the tests for various parameters, all the parameters are within permissible limit suggested by the MPCB except for the BOD parameter. Even though the BOD parameter is not within permissible limit the treated wastewater can be reused by avoiding direct contact for toilet flushing and gardening.

Thus by reusing the wastewater upto 50% - 60% of potable water can be saved daily resulting in the reduction of requirement of fresh water along with the reduction in sewage generation, minimizing its impact on the environment..

For solid waste management by using the composting method mentioned in the above procedure to make compost at reduced time than the convenional method using compost maker powder as an enhancer the compost that will be produced will be upto the quality that it can be used as a fertilizer. By doing this around 60 % - 70% of the solid waste generated from the the households can be efficiently managed thereby minimizing the environmental pollution.

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