Grey Water Treatment by Phytoremediation Technique-A Comparative Study using Vetiver Grass and Lemon Grass

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***Abstract*—Rapid urbanization and industrialization, population exploitation etc. are the main sources of surface and subsurface water pollution. Now the water consumption is more and the clean water demand is also high. Recycle and reuse of wastewater is the solution to solve these problems. The main objective of the present study was to find out the effectiveness of vetiver and lemon grass in the pollutant removal from grey water in constructed wetlands.**

Keywords*— Vetiver, lemon grass, phytoremediation, grey water, wet land.

I. INTRODUCTION

One of the major threats that our earth is facing is environmental pollution, increasing with every passing day and causing grave and irreparable damage to the environment. Pollution of soil and water with waste waters of different characteristics is a common practice. Waste water treatment before disposal is the only remedy for this problem. Grey water is used water from our bathroom, sinks, showers, tubs, washing machines, etc. which is not contact with black toilets, urinals. It may contain waste food, traces of dirt, grease, hair, and other household cleaning products. It may be contaminated with a range of soluble and particulate substances such as soaps, detergents, skin, saliva, dirt etc... Each type of contaminant, whether it is detergent/surfactant, organic, microbial or particulate, must be treated separately. Grey water makes up around 30 to 50 % of wastewater discharged into the sewers. If this grey water is recycled at its source or make some arrangement separately, it will reduce the load on sewage treatment plants and also reduces the demand of water. For the treatment of these waste water rich in nutrients and other toxic chemicals has been done using conventional wastewater treatment methods such as activated sludge and biological nutrient removal technologies or several chemical methods. These methods are very expensive and dependent on electrical energy and skilled workers or impossible to carry out, as the volume of contaminated material was too large.

Vegetations are very useful for all types of phytoremediation applications, either in soil or in wetlands. The scientific research conducted in the last ten years has clearly demonstrated that vetiver grass (Vetiveria zizanioides L. Nash) and lemon grass (Cymbopogan flexuosus) are s one of the most effective and low- cost naturmethods of environmental protection. Vetiver grass is a versatile hardy plant having stuff and erect stems, deep, extensive, fast growing and penetrating root systems and are highly tolerant to adverse climatic and highly tolerant to elevated levels of heavy metals, herbicides, pesticides. Lemon grass acted as a potential metal-tolerant plant as its metal tolerance index is greater than 100%.

II. OBJECTIVES

The main objectives of this project are

- To analyze the physical parameters of collected greywater, such as pH, acidity, alkalinity, chloride content etc.
- To compare the efficiency of phytoremediation technique in greywater using two plants (vetiver grass and lemon grass).
- To make an alternative water resource for purposes of irrigation,toilet flushing etc.
- To reduce daily water supply demand.
- To minimize the amount of waste water entering into sewer.
- To enhance the quality of food crops.
- To save fresh water, money, energy resource.

III. MATERIAL USED

A. GREYWATER

Blackwater means water containing faces, urine, toilet water, and toilet paper. Greywater, on the other hand, is the water that generates from human activities like washing dishes, laundry and bathing which is not contact with black toilets, urinals. It may contain waste food, traces of dirt, grease, hair, and other household cleaning products.

One of the basic materials we have used for the study is grey water. The greywater is collected from household units and treated in near site. We are taking 200 liters of wastewater for treatment. wastewater from bathroom, kitchen, sink, laundry etc. are collected through pipe system. Lots of contaminants like acidic and alkaline substances, suspended and dissolved solid particles, oil, fats and grease, heavy metals, pathogenic organisms and synthetic chemicals are likely to be present in grey water.

B. VETIVER GRASS

Chrysopogon zizanioides, generally known as vetiver and khus, is a perennial grass of the family poaceae. It is a densely tufted bunch grass which can be easily established in both tropics and temperate areas of the world. It grows to 150 centimeters high and forms clumps as wide. It can reach 3m in height under favorable conditions. The stems are tall and leaves are long, thin, and rather rigid. The flowers are brownish-purple.Unlike most grasses, which form horizontally spreading, mat-like root systems, vetiver's roots grow downward, 2 meters to 4 meters in depth.

C. LEMON GRASS

Lemon grass (Cymbopogan flexuous) is a tropical perennial plant (family: Poaceae) which grows in many parts of tropical and sub-tropical East Asia and Africa. In India, it is cultivated along Western Ghats (Maharashtra, Kerala), Karnataka and Tamil Nadu states besides foot-hills of Arunachal Pradesh and Sikkim.

D. SAND

Sand is the fine aggregate used as the basic component of filter media. Sand is used for the removal of suspended matter, floating and sinkable particles. The wastewater flows through a fine bed of sand and gravel. Particles are removed by way of absorption. When excessive pressure loss on the filter exists, it must be rinsed. The yield varies between 50 and 99.9%. COD, BOD, organically bound nitrogen and phosphate, and undissolved metals are also removed from the waste water. The effective size of sand used in the range of 0.15 – 0.35mm.

D. GRAVEL

The gravel in a filter system has several functions. It supports the sand, permits the filtered water to move towards the underdrain and, in the case of a rapid filter, facilitates a uniform flow distribution. Sand and gravel layer remove the bacteria and other practical from wastewater. Gravel filters are effective in removing sediment and heavy metals from waste water and less effective in removing dissolved nutrients. The aggregates used are of size 6mm size.

E. FILTER MEDIA

Gravel and sand are the most commonly used growth media in phytoremediation processes. Here slow sand filtration process was used. Slow sand filters are used in water purification process for treating raw water to produce a potable quality product. Filters are typically 1 to 2 meters deep, rectangular / cylindrical in cross section and are used to treat surface water. The length and breadth of the tanks are determined by the flow rate desired by the filters, which typically have a loading rate of 200 to 400 liters per hour per square meter.

IV. METHODOLOGY

Vetiver grass and lemon grass are selected as plant material for phytoremediation. Then greywater treatment is done using 3 chambered processes. The raw wastewater is laboratory tested before and after the treatment. The comparative study of both grey water before treatment and after treated with vetiver grass and lemon grass where discussed. Also, here studied which plant will give more effective result.

A.DESIGN OF FILTER BED

Here slow sand filtration design for designing the filter bed was used. It is highly efficient as it can remove 98-99percent bacteria.it removes suspended solids, odour and taste. It can remove turbidity only up to 50 mg/l. Rate of filtration = 100 to 200 liter/hour/m^2.

B. FILTER MEDIA

- Sand - 90 to 110cm thick.
- Sand should be of uniform size. If different size is present, thencoarsest size at the bottom and finest size at the top.
- Effective size = 0.2 to 0.5 mm.

C. DESIGN OF CHAMBER

Generally, 135 lpcd of domestic water supply is required for average Indian cities as per Indian standards and after utilization generates 80% waste water; which includes 70% grey water. For this design of phytoremediation units 70% of waste water generatedis considered.

D.DESIGN RESULTS

Table 1. The designed values of remediation tank

	By design	Reduced Scale
Length	0.6m	0.4m
Breadth	0.3m	0.2m
Depth	0.3m	0.2m
Total area	0.18m2	0.08m2
Grey water	448litre	192litre

E. EXPERIMENTAL SETUP

The total span of filter bed was 40cm, width was 20cm and the depth was 20cm. The first layer was 6mm gravel with 10cm depth. The top layer was fine aggregate of size 0.3 to 0.5 mm with 5cm e depth. Then the Freeboard of 5cm height is provided.

Settling tank: Opaque plastic drum with top opening with lead was used and has provided with provisions for sludge outlet. It has a capacity of 200 liters. Experiment set up shown in figure 1.

Phytoremediation chamber: Coarse aggregates of angular size are provided in which plants are supported to stand. The total span of filter bed was 40cm, width 20cm and

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the depth 20cm. The first layer was 6mm size thick gravel with the depth 10cm. Then the top layer was fine aggregate of size 0.3 to 0.5 mm.

Figure 1. Three chambered treatment system

thick. The depth of sand is 5 cm. Then the free body of 5cm height is provided. Sub-surface flow of waste water is provided from about 0.05m below the top surface of aggregate level.

Collecting tank: Water after phytoremediation was collected in the collecting tank. This remediated water was tested in laboratory for the result.

V. TREATMENT

The complete process took 24 hours after settling of sludge. The first processing unit consist of sedimentation tank where raw water from kitchen sinks, bathrooms, cloths and utensils washing was collected. The raw water was allowed to remain still, so as to settle down the larger particles, in the form of sludge. The duration for settlement of particles was 24 hrs. After 24 hours, water was released in phytoremediation chamber. This chamber contains 15 cm thick layer of coarse aggregate in which vetiver grass and lemon grass were planted, which acts as treatment unit. Then water was released to another tank after 24 hours. The raw water sample and the treated sample of the same batch were tested in the laboratory.

VI. RESULT AND DISSCUSION

A. LABORATORY TEST REPORT

Grey water sample and treated grey water sample are laboratory tested to determine the chemical as well as physical impurities present in water. Collected Greywater before treatment is shown in figure 2. and treated greywater from vetiver grass and lemon grass is shown in figure 3.

Figure 2. Greywater before treatment

(a) (b)

Figure 2. Greywater after treatment (a) vetiver grass and (b) lemongrass

The analysis report of various physical and chemical characteristics of greywater before and after the treatment are given in Table 2. Table 3 shows effectiveness of vetiver grass and lemon grass.

Table 2. Physical and chemical characteristics of greywater before and after the treatment

Sl No	Parameters	Unit	Test method APHA	Result		
				Grey water before treatment	Greywater after treatment	
					Vetiver grass	Lemon grass
1	pH	NIL	400H+B	7.9	7.81	7.78
2	Electrical conductivity	µS/cm	2510B	972	946	953
3	Turbidity	NTU	2130B	120	19	20
4	Total alkalinity	Mg/L	2320B	272	249	246
5	Chloride	Mg/L	4500Cl-B	116	101	103
6	Total hardness	Mg/L	2340C	384	373	367
7	Calcium	Mg/L	3500CaB	82.4	78.3	76.6
8	Magnesium	Mg/L	3500MgB	43.6	42.1	41.4
9	Total solids	Mg/L	2540B	953	876	889
10	Total dissolved solids	Mg/L	2540C	610	569	573
11	Total suspended solids	Mg/L	2540D	256	89	97
12	Ammonia asN	Mg/L	4500 NH3 F	7.41	6.08	6.27
13	Total phosphorous	Mg/L	4500P E	6.15	5.2	4.99
14	Iron	Mg/L	4500FeB	0.58	0.43	0.46
15	Sulphate	Mg/L	4500 SO4 E	50.7	45.8	43.9
16	BOD (3 days at 27OC)	Mg/L	5210B	137	78.4	75.35
17	COD	Mg/L	5220C	448	147	152

Table 3. shows effectiveness of vetiver grass and lemon grass.

Removal efficiency (%)				
	Contaminants	Vetiver grass	Lemon grass	Better performance
1	pH	1.26	1.51	Lemon grass
2	Electrical conductivity	2.67	1.95	Vetiver grass
3	Turbidity	84	83.33	Vetiver grass
4	Total alkalinity CaCO3	8.4	9.55	Lemon grass
5	Chloride	12.93	11.2	Vetiver grass
6	Total hardnessas CaCO3	2.86	4.42	Lemon grass
7	Calcium	4.97	7.76	Lemon grass
8	Magnesium	3.44	5.04	Lemon grass
9	Total solids	8.18	6.71	Vetiver grass
10	Total dissolved solids	6.72	6.06	Vetiver grass
11	Total suspended solids	65.23	62.1	Lemon grass
12	Ammonia as N	17.94	15.38	Vetiver grass
13	Total phosphorous	15.44	18.86	Lemon grass
14	Iron	25.86	20.68	Vetiver grass
15	Sulphate	9.66	13.41	Lemon grass
16	BOD (3 daysat 27OC)	42.77	45	Lemon grass
17	COD	67.18	66.07	Vetiver grass

VII. CONCLUSION

The main benefits of grey water recycling were to reduce use of freshwater, less strain on septic tanks and treatment plants, effective purification, feasibility for sites unsuitable for a septic tank, reduction in use of energy and chemicals, groundwater recharge etc. and the challenge is to find a low-cost, user friendly methods. According to the results from our project it is found that phytoremediation is a promising technology for grey water treatment. This treatment shows remarkable reduction in BOD, COD, turbidity and TSS. The concentration of pH, electrical conductivity, turbidity, total alkalinity, chloride, total hardness, calcium, magnesium, total solids, total dissolved solids, total suspended solids, ammonia, total phosphorous, iron and sulphate content are reduced. Commonly available wetland plants such as lemon grass and vetiver plants shows high efficiency to treat the greywater. Both chambers show efficiency in purifying the grey water. Also, vetiver and lemon grass have sufficient phytoremediation property. In this study the treated grey water reaches the required quality for land irrigation (CPCB Effluent standards 1995). So, the treated water by phytoremediation will be suitable for irrigation purposes. Greywater treatment by phytoremediation technique using vetiver and lemon grass is found as a highly efficient, cost effective and ecofriendly method. The treatment capabilities of the plant depend on different factors like climate, contaminants of different concentrations, temperature, root and shoot length of plant etc. The plant growth rate and hydraulic retention time can influence the reduction of contaminants.

VIII. REFERENCES

[1] Girija, Maya M Nair, S. Lakshmi, Soumya S Pillai, “Phytoremediation Potential of Vetiver Zizanioides: A Green Technology to Remove Pollutants from Pampa River by Hydroponic Technique”, October 2016.

[2] Randhir Bute, Ekta Waghmare, Ajay Sarode, Amit Chandekar, Abhijit Sawwalakhe, Kailash Bondre, “Treatment of Grey Water Using Technique Of Phytoremediation”, March 2017.

[3] Dhanya D, Jaya D.S, “Pollutant Removal in Wastewater by Vetiver Grassin Constructed Wetland System” December – 2018.

[4] Sheena K.N, Harsha P,” Feasibility Study of Phytoremediation in Wastewater Treatment”, International Journal of Science and Research(IJSR), August 2018.

[5] Joice K Joseph1, Amrutha Haridasan, Karunakaran Akhildev and Pradeep Kumar AP (2017) ‘‘Applications of Vetiver Grass (Chrysopogon zizanioides) in Eco System Based Disaster Risk Reduction - Studies from Kerala State of India’’, J Geogr Nat Disast, an open access journal, Volume 7, Issue 1, 1000192, ISSN: 2167-0587.

[6] Edgard Gnansounou, Catarina M. Alves, Jegannathan Enthori Raman (2017) “Multiple Applications of VetViver Grass-a review”, International Journal of Environmental Science, ISSN: 2367-8941, Volume 2.

[7] Adithya Vikram Chopra, Umang K Shah and J S Sudarsan, “Waste Water Treatment by Phyto-Remediation Technique”, June2016.

[8] Paul Truong, Tran Tan Van and Elise Pinners Vetiver System Applications, CreateSpace, (10 April 2008).