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Treatment of Sewage by Phytotechnology and Comparing with Gravel Bed Reactor

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Abstract - *Sewage is the waste water generated from every community in every sector. Usually sewage is treated with the help of conventional treatment plant before disposed it to river, land or reuse. Construction of conventional treatment plant and its maintenance for small sectors like Hotels, Hospitals, and Hostels, Schools, Colleges found to be very expensive due to which sewage treatment most neglected in our country. Now a day's advance treatment of sewage with low cost of construction with less maintenance and an eco friendly method is phytotechnology. In this method physical, chemical and biological treatment of inlet waste water occurs. The wastewater treatment carried out using roots of plants, gravels, pebbles which is completely natural process and free from electricity and chemicals. This method has very high efficiency of treating wastewater characteristics like neutralization of PH reduction of BOD, COD, Alkalinity, Hardness, Total Solids, Suspended Solids, Dissolved Solids, TN and TP.*

Key Words*: *PH, EC, COD, BOD, DO, TS, DS, TN, TP

1. INTRODUCTION

It is the wastewater generated from the water closet and contains human excreta, which is grey in colour at fresh state and turns black in colour later due to anaerobic decomposition. If proper treatment has been not carried out then there will be unhygienic condition, nuisance smell. Sewage generates from every community like residential buildings, shopping malls, theatres, bus stations, railway stations, airports, fire station, hospitals, schools, colleges, hostels, etc., The quantity of sewage depends on the standard of living of the population. Higher the standard of living more will be the sewage. The time of the day also plays an important role in generation of sewage. Wastewater characteristics also depend on time variation. Hourly variation affects the sewage generation. Mornings will generate more quantity as compared to afternoons and nights. Sewage generated at the bathrooms and water closets, after flushing goes to the septic tank and then to the underground drainage leading to the municipal wastewater treatment plant. The government insists on wastewater treatment before being disposed to water bodies or land. Different units of treatments are made use of to satisfy the government norms before disposal in to the water bodies or land. In water carriage system, sewage contains mainly 99.9 % of water and 0.1% of solids. The main parameters which are analysed for sewage are its pH, Electrical Conductivity, BOD, COD, Chloride, Nitrates, Hardness, Phosphorus, Alkalinity, Solids, and Chlorine.

Table 1.1 Quantitative Characteristics of Raw Domestic Sewage.

Characteristics	Range
pH	6.7 – 8
Total Solids(mg/l)	700 – 1350
BOD(mg/l)	250 – 400
COD(mg/l)	450 – 800
Alkalinity(mg/l)	100 – 250
TN(mg/l)	35 – 60
TP(mg/l)	4 – 15

Table 1.2 Irrigation standard values (As per Indian Standards IS:2296:1992)

parameters	Irrigation standards as per ISI:2296:1974	units
pH	5.5 – 9	
BOD	3	mg/l
COD	125	mg/l
DO	0	mg/l
Total solids	2000	mg/l
Alkalinity	162	mg/l
Hardness	96	mg/l
Total nitrogen	10-15	mg/l
Total phosphorus	10-12	mg/l

1.1 Phytotechnology

In a conventional treatment plant, large amount of electricity is used for pumping the wastewater. Also in aeration process, huge pumps are used. It also needs skilled labours, huge maintenance and there will be odour nuisance. Sludge disposal is also a problem. Phytotechnology is an advanced method of application of artificial ecology to effectively treat the municipal and industrial wastewater. Phytotechnology is defined as "The use of vegetation to contain, sequesters remove or degrade organic and inorganic contaminants in soil, sediments, surface water, and ground waters". This is also known by the name '*Reed bed system*'. It also called '*Root zone system*' and sometimes '*Wetland treatment method*'.

We can also overcome limitations of conventional sewage treatment plant with Phytotechnology. Phytotechnology can be implemented even in every house, community, etc., for sewage as well as sullage treatment purpose. In this method, plants play a very important role in treatment of wastewater. Phytotechnology reactor effectively reduces the total solids and suspended solids due to physical action by gravels, pebbles, of uniform size which act as a mechanical filter. There will be an increase in dissolved oxygen due to respiration action by plants and aerobic bacteria which grow on outer periphery of stem of plant. This will carry out biological degradation process of the organic matter. There will be a chemical action and precipitation also take place. In this project a reactor of proper size has been fabricated. It is filled by gravel mixture of river bank side pebbles and aggregates of uniform size. Specific plants are planted after detail study. The inlet will be the effluent of the septic tank and the treated water will available from outlet after proper discharge rate, detention time and process.

Fig -1: Phytotechnolgy reactor.

2 OBJECTIVES

1. Analyse and characterise the sewage generated from boy's hostel.
2. Construction of artificial ecology in campus area.
3. To investigate the feasibility of applying a phytotechnology to treat the sewage.
4. To determine the efficiency of outlet effluent of phytotechnology.
5. Compare the phytotechnology effluent characteristics with gravel bed filters and wastewater reuse for irrigation standards.

3 MATERIALS AND METHODOLOGY

3.1 Construction of gravel bed reactor

1. Based on literature review and earlier research work on Reed bed system and from Bhopal Ekanth garden project design it is found that about 100 liters of waste water can be treated in 1 m^2 area of root zone treatment technology

2. To increase the retention time, reduce the flow of velocity and to increase wastewater contact surface area for filter bed, roots of plants; Baffle walls are attached at reactors inner surface area.

3. The subsurface horizontal flow has been adapted to both reactors. In this type of flow liquid enters the reactor from inlet pipe which is placed just below to top layer of bed filter due to this method flow there will absence of nuisance odor and complete free from flies, mosquitoes and there will be flow of water sample in horizontal direction includes vertical flow also, due to gravity.

4. There are chances of leakage of inlet wastewater in the weak zones of reactors at jointing of reactor box; it is eliminated by sealing Inner surface that is completely covered by impermeable plastic layer of thickness 0.001m.

5. Pebbles, gravels, aggregates of different grades are collected separately from construction site area, riverbank and road construction site. All stones are well washed to remove impurities attached to stones. Stones are arranged in reactor with respect to their size, such as higher grade pebbles placed at bottom and smaller size at top due to which there is partial fill of holes in large size stone and behaves as a gravel bed filter.

3.2 Construction of phytotechnology reactor

For construction of phytotechnology above five steps are repeated and after

1. After complete surveying of Belgaum Taluq it has been observed and concluded that cannas Indicia and Alocasia are commonly available in all area so recently sprout plants of two different species which are available abandoned in Belagavi Taluq are collected safely and cleaned and wash by pure water to remove attached soil particle, immediately plants are planted in reactor.

2. For 10 days continuously pure water supplied to planted reactor at a rate of 100 liters/day and next 20 liters of septic tank effluent diluted to 100 liters

and supplied to phytotechnology reactor; similarly sewage quantity increased at a rate of 20 liters in 3 days. finally 100 liters of sewage supplied to reactor at 25th day, every day all treated inlet water are disposed of directly from outlet this whole procedure has been carried out to adjust the plants to new environment with new water supply and it has been found that they are adjusted to sewage by its growth that they are perfectly adopted to new artificial Ecology.

3. After about 200 liters of wastewater i.e. sewage or septic tank outlet has been collected from boy's hostel septic tank effluent with full of safety and transported. The collected sewage is stored in two equalization tanks of size 100 liters.

The main application of equalization tank is maintenance of constant discharge as per designed, settling of settable particles, neutralization of temperature and ph variation and equalization of wastewater concentration.

Fig -1: Constructed Phytotechnolgy reactor.

4 RESULTS AND DISCUSSIONS

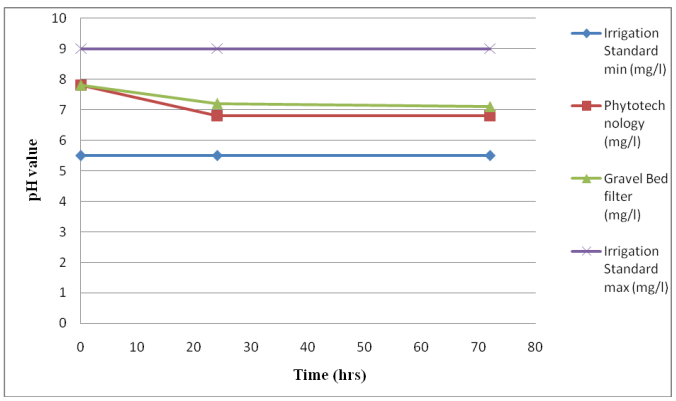

Chart -1: variation of pH at different retention time.

The collected sample lies within the limitation values of irrigation standards (IS:2296:1992) that is 5.5 to 7.8. Phytotechnology reactor and Gravel bed reactor also maintain almost same pH value that is 6.82, 7.2 at 24 hours and 6.86, 7.1, at 72 hours respectively. It is near to neutral. The pH value of wastewater sample and treated water sample are found to be near to neutral because of use of huge quantity of water usage in water carriage system and there is almost no addition of alkaline or acidic solvents in sewage.

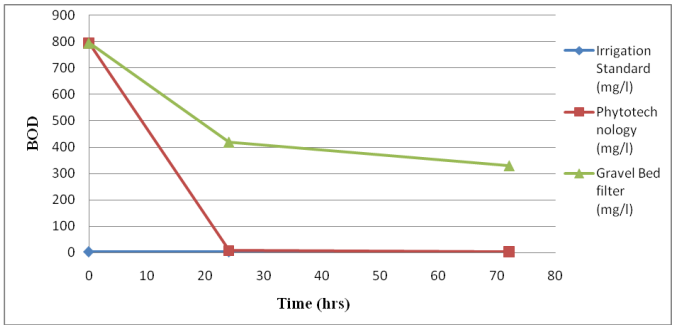

Chart -2: variation of BOD at different retention time.

The BOD of raw sample was 796mg/l and it reduced to 7.96 mg/l and 419 mg/l in Phytotechnology reactor and Gravel bed filter reactor respectively at 24 hours retention time. It reduced to 3 mg/l and 329 mg/l in Phytotechnology and Gravel bed filter respectively at 72 hours retention time. The BOD reduction efficiency in the Phytotechnology reactor and Gravel bed reactor for 24 hours is 99%, 47.36% respectively. Similarly, at 72 hours it is 99.6% and 58.6 6% respectively. The BOD reduction in Phytotechnology is mainly due to both aerobic and anaerobic microbial action where microorganisms develop on the surface of the roots. There will be a certain amount of reduction occurred in gravel bed reactor due to anaerobic microbial action and settlement of colloidal and settable particles.

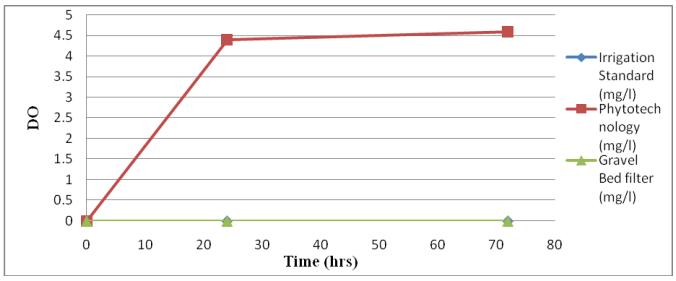

Chart -3: variation of DO at different retention time.

There was complete absence of DO in the raw sample but it has been increased to 4.4 mg/l and 4.6 mg/l in 24 hours and 72 hours respectively at Phytotechnology reactor. There is no change in DO percentage in Gravel bed reactor. Increase

in the DO at Phytotechnology reactor is due to bio-pump process by plants. As per the Irrigation standard (IS:2296:1992) the DO maximum limit required is 0 mg/l.

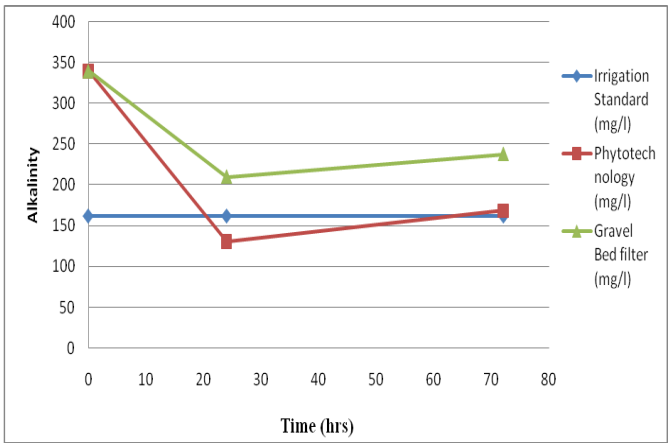

Chart -4: variation of Alkalinity at different retention time.

As per the Irrigation standard (IS:2296:1992) the Alkalinity maximum limit required is 162 mg/l. The BOD of raw sample was 340 mg/l and it reduced to 130 mg/l and 210 mg/l in Phytotechnology reactor and Gravel bed filter reactor respectively at 24 hours retention time. It reduced to 168 mg/l and 238 mg/l in Phytotechnology and Gravel bed filter respectively at 72 hours retention time. About 50.8% and 29.4% reduction at 24 hours retention time and 50 6.67% 30% at 72 hours by Phytotechnology and Gravel bed reactor respectively.

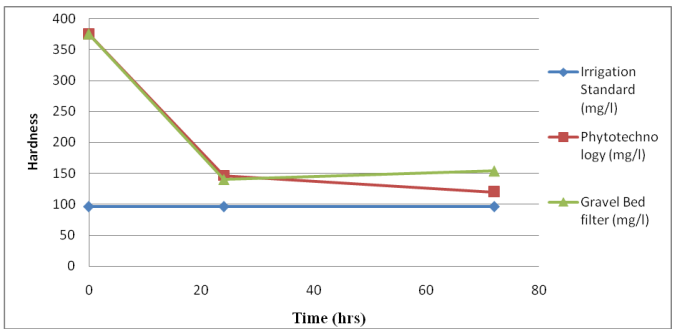

Chart -5: variation of Hardness at different retention time.

As per the Irrigation standard (IS:2296:1992) the Hardness maximum limit required is 96 mg/l. The Hardness of raw sample was 375 mg/l and it reduced to 146 mg/l and 140 mg/l in Phytotechnology reactor and Gravel bed filter reactor respectively at 24 hours retention time. It reduced to 120 mg/l and 153.75 mg/l in Phytotechnology and Gravel bed filter respectively at 72 hours retention time. About 61% and 69% of hardness is reduced at 24 hours retention time in Phytotechnology reactor Gravel bed reactor respectively. 68% and 59% of hardness is reduced at 72 hours retention Phytotechnology reactor, Gravel bed reactor respectively.

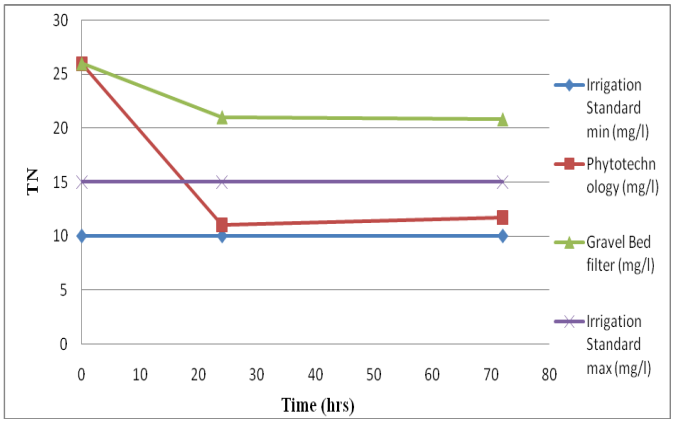

Chart -6: variation of TN at different retention time.

The TN of raw sample was 26 mg/l and it reduced to 11 mg/l and 21 mg/l in Phytotechnology reactor and Gravel bed filter reactor respectively at 24 hours retention time. It reduced to 11.7 mg/l and 20.8 mg/l in Phytotechnology reactor and Gravel bed filter reactor respectively at 72 hours retention time. The reduction of total nitrogen in Phytotechnology reactor is 58% and 55% at 24 hours and 72 hours respectively and about 19%, 20% of Nitrogen reduces by Gravel bed reactor at 24 hours and 72 hours respectively. As per the Irrigation standard (IS:2296:1992) the TN maximum limit required is 10 mg/l.

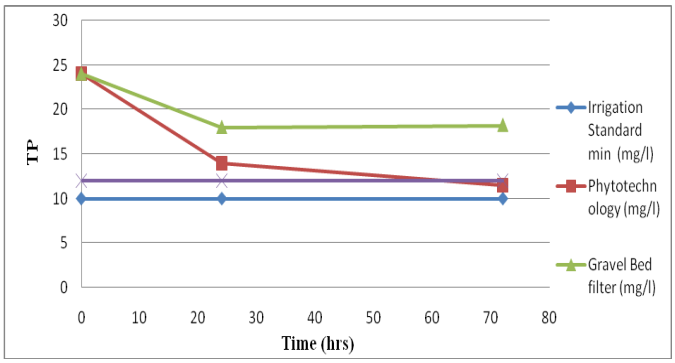

Chart -7: variation of TP at different retention time.

The TP of raw sample was 24 mg/l and it reduced to 14 mg/l and 18 mg/l in Phytotechnology reactor and Gravel bed filter reactor respectively at 24 hours retention time. It reduced to 11.52 mg/l and 18.24 mg/l in Phytotechnology reactor and Gravel bed filter reactor respectively at 72 hours retention time. in Phytotechnology reactor that is 42% and 52% at 24 hours and 20 hours respectively. Gravel bed reactor reduces total phosphorus at percentage of 25% and 24% at 24 hours and 72 hours respectively. As per the Irrigation standard (IS:2296:1992) the TP maximum limit required is 10 mg/l. For 24 hours retention time, the total phosphorus content did not meet the irrigation standards for both the reactors. For 72 hours retention time only Phytotechnolgy reactor could meet the irrigation standard.

5. CONCLUSIONS

- This study demonstrated that subsurface horizontal flow phytotechnology system could be used for treatment of AITM boy's hostel wastewater it is also an effective treatment method for treatment of campus wastewater.
- In this process the plants are very important role in the treatment regarding performance achieved it is able to reduce future level of main physicochemical pollution parameters.
- The experiment results shows that the treated wastewater from phytotechnology can easily reach required water quality standard for irrigation.
- By comparing the phytotechnology with gravel bed reactor we can conclude easily that plant plays very important role in treatment of wastewater.
- The phytotechnology can be independently adopted to completely treat the waste water from different domestic factors.
- The treatment efficiency of wastewater depends on size of reactor, number of plants, growth of plants, quality and quantity of waste water inlet discharge to phytotechnology adoption of type of plant and retention time of wastewater in reactor.

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