Urban Wastewater Treatment using Phytorid

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Abstract— The process of design, construction and operation of sewage treatment plant (STP) requires multi-disciplinary approach. Many conventional methods are available for design of sewage treatment plants. The process involved in these treatments is either aerobic, anaerobic or combination requiring number of mechanical and electrical items thereby requiring large amount of energy. The ever growing need of energy makes the design, operation and maintenance of STP a challenging task. The conventional method of sewage treatment can be made efficient by advanced technologies and intelligent supervision but this in turn increases the total cost. However, Phytorid technology developed by National Environmental Engineering Research Institute treats the sewage by plant. It is found from the study carried out on nine STPs at various locations in Pune and Mumbai in Maharashtra (India) that the sewage treatment by Phytorid technology uses only 20% of the energy as compared to conventional sewage treatment plants and also it is very effective in comparative many treatment methods. It is thus concluded that Phytorid technology is the future for sewage treatment.

Key words: Phytorid, Wastewater Treatment

I. INTRODUCTION

Water covers 71% of the Earth's surface it is vital for all known forms of life. On Earth, 96.5% of the planet's crust water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, 0.001% in the air as vapor, clouds (formed of ice and liquid water suspended in air), and precipitation. Only 2.5% of this water is fresh water, and 98.8% of that water is in ice (excepting ice in clouds) and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies and manufactured products. A greater quantity of water is found in the earth's interior.

The average daily amount of water consumed by a person in India is near about 150 lpcd. and water consumed by industry is 35 $km^{3/}$year, and the consumption of water in agricultural is about 70%. The waste water generation from above is nearly 85% of water consumption.

Primary water source is polluted to a great extent through discharge of harmful substances. It is estimated that every 1m^3 of contaminated water once discharged into water bodies will contaminate further 8 to 10 m^3 of pure water. Out of the 31 diseases that are major cause of death in developed countries, as many as 21 are due to contaminated water. The above facts highlight the need to find improved water treatment to meet the problems of food security, water availability and use of water efficiently. It is beyond any doubt that energy will be the main concern of the nations in coming years. Identification and adoption of appropriate technology to overcome these pressures is therefore absolutely essential. The object of sewage treatment is to stabilize the organic matter present in sewage so as to produce an effluent liquid and sludge, which can be disposed-off into the environment without causing health hazard or nuisance. The endeavor should be to adopt modern and cost- effective technologies and equipment to achieve value for money and maximum user satisfaction. The septic tanks which treat the sewage by pure anaerobic process can be considered as preliminary STP. The requirement for better treatment of sewage coupled with development of technology lead a way forward towards aerobic process. This requires pumping and blower operation which is energy consuming. Thus conventional STP requires energy for achieving better results .The aerobic process requires oxygen to be provided to the bacteria. Chong et al. discussed the recent developments in photo catalytic water treatment technology. The ability of this advanced oxidation technology has been widely demonstrated to remove persistent organic compounds and micro-organisms in water. Novak and Horvat discussed the structured mathematical models which combined the use of oxygen electrode and biological waste water treatment to optimize the position of electrode in the bio-reactor for efficient transfer of oxygen. The ever- growing need of energy makes the design, operation and maintenance of STP a challenging task. Poch et al. deliberated on improvement of conventional wastewater treatment through an intelligent integrated supervisory system. Recently developed concept of treating the sewage by root zone technology provides aerobic and anaerobic treatment simultaneously in one tank. Yang used phyto-remediation for treating contaminated site and concluded that it is an efficient, economical, and environment friendly eco- technology. Besides these advantages, phyto- remediation has considerable potential for environmental restoration of contaminated sites. Pawaskar has suggested modification in root zone technology that overcomes the limitation of huge area requirement for application of constructed wetland (CW). The modified CW can be effectively used within the nallah area to treat incoming waste water with techno-economical feasible option. Vymazal discussed that horizontal sub-surface flow constructed wetlands in the Czech Republic are designed to take an advantage of many of the same processes that occur in natural wetlands. The results of the observations by the author also indicate that constructed wetlands can be used as tertiary treatment systems to polish organics and suspended solids. Zhang et al. carried out comparison between the cost of a conventional wastewater treatment processes and CW. The results showed that the CW does not have any advantage in construction cost. However, it has advantage in operation and maintenance cost. The operation and maintenance cost of conventional plant was found to be Rs 16/m3 whereas CW was Rs 1/ m3. The main objective of this study was to identify energy-efficient design parameters for a conventional STP and comparison of construction, operation and maintenance cost of STPs vis-à-vis sewage treatment by Phytorid technology. Based on the different systems and technology, three STPs were visited for the study. The emphasis was on construction cost along with operation and maintenance aspects. Since natural water resources are limited and a large gap exists between available water supply and the amount required for intensive cropping, appropriate use of wastewater of domestic origin can help in meeting a part of the increased demand of water. Wastewater reuse for agriculture presents not only a low cost appropriate disposal medium but also an opportunity to manage wastes with minimum adverse environmental effects, as the treatment requirements prior to land application are less rigid than those for disposal into water bodies. It has been observed that in states, such as Haryana, the NO3 concentration has exceeded the permissible limits (Maria 2003). Application of sewage, sludge and municipal wastewater on land has been practiced since time immemorial.

II. Methodology

The visits to the STPs having different capacities and different systems were made to study and compare the construction, operation and maintenance costs. The study included (i) process employed (ii) initial cost of construction (iii) maintenance costs and (iv) usage of treated waste water. The emphasis was given to maintenance cost considering electrical load and chemicals used. The norms and guidelines of Central Pollution Control Board were taken into account during the study. Energy efficiency parameters were identified and comparisons made to arrive at the best fit solution. The visits to the STPs and material received have helped in deducing the following energy-efficient design parameters which dictate the energy requirements:

A. Pumps

The aerobic, anaerobic or any other combination system of STPs require pumps for operation. Besides there is a requirement to run the pumps continuously either for raw sewage, sludge or filter water, etc. Thus the main consumers of electricity are pumps.

B. Blowers

The maximum energy is consumed by blowers since they are of higher ratings and run 24 hrs. (iii) Diffusers-These are the network of pipes laid in the tanks having holes of various sizes and alignments. The efficiency of the system depends on the matrix of holes which in turn dictates energy consumption.

C. Media

The consumption of energy and efficiency in STP depends on the surface area and typical media used for bacterial growth. Moving media bio-reactor will use less energy compared to activated sludge.

D. Chemicals

These are required for flocculation, coagulation and disinfection. The use of chemicals contributes towards cost.

E. Advanced Oxidation Process

Employs ultraviolet radiation for efficient oxidation but requires substantial electricity consumption.

F. Automation

It achieves intelligent supervision for efficient operation and maintenance of sewage treatment plant.

G. Operator

The human element is irreplaceable. However systems like Phytorid requires less supervision.

A tank of glass of 1ft. 6 inch. length, 1ft. width and 1ft. height has been taken into consideration as a filter media which the waste water collected form inlet of STP and a river in Pune is passed through it to remove turbidity as well as SS particles present in water.

Equal layers of aggregates, sand and coal would act as a basic filter. After filtration a second tank is taken as a sedimentation tank of 2ft. length, 1ft. width and 1ft. height. Including baffle walls. In this tank a sludge is separated from water which is lately used as a fertilizer in agricultural. After it a final stage of phytorimediation is done in Phytorid bed which is 3ft. length, 2ft. width and 2ft. height. The layers is this bed is of equal layers of pebbles, aggregate and soil with cowdung. Above all Phytorid plants like Elephant grass, Nerium, cattail, Colosia plant (Alu)[7] and Alfalfa etc. would be used as the major purifying factors in this Phytorid process.

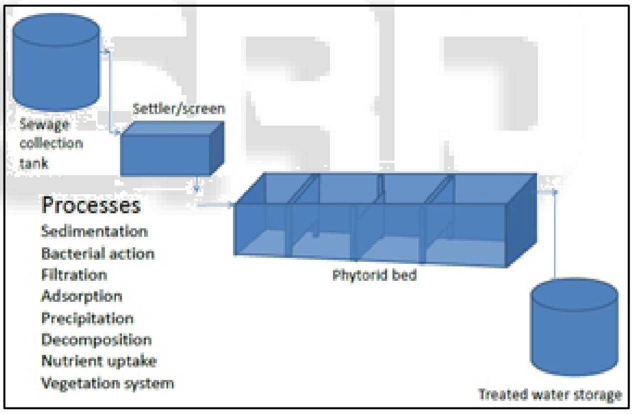

Fig. 1: Components of Phytorid

As these plants survive and flourish on nutrients in sewage, they absorb oxygen from atmosphere and send down to sewage from their roots thus increasing oxygen content eventually purifying sewage in clean water. An opening would be given from glass tank to a container where clean water would be discharged after a specific detention time of 1 hours. Plants which act as a purifier in this topic are some-times readily available in our surroundings such as "Indian Shot" etc. but due to its incomplete know how such useful plants are wasted.

Fig. 2: Colosia Plant (ALU)[7]

One of the most important aspects regarding implementation of this project is not a single labor was used for any of the works. Considering right from sewage handling to laying of aggregates or preparation of semi portable Phytorid bed to pouring layer of cow dung over soil on the bed which acts as a filter media

III. Advantages of Technology

The waste water treatment with Phytorid Technology is easy, efficient; require less manpower, and totally sustainable method to the all conventional methods.

Technology is cost effective and efficient in the removal of faecal coliforms, BOD, COD, nutrient are up to 95 percent, which is higher than traditional methods.

The system used natural vegetation and the plant specific associated micro biota, as leads to eco-friendly sewage treatment technology. The area occupied by the treatment system also improves the aesthetic of the surrounding area.

The subsurface flow treatment is totally free of mosquitoes and odour nuisance. The treated water can be used for enhancement of environmental architecture such as road side fountains.

The effluent can also be used for irrigation, gardening, toilet flushing etc.

The treated water achieves the permissible limit for sewage discharge in the fresh and marine water body Prepare Your Paper Before Styling

IV. Treatment Efficiency

The 'Phytorid Technology' being natural method, the treatment efficiencies for removal of different pollutants are given in Table 1. The tabulated efficiency will be achieved after the system is stabilized which may require a period of one month after commissioning.

Parameter	Inlet sewage quality	Treated water quality	Standards for inland surface water	Standards Land Irrigation
pH	7.1 to 7.5	7.2	5.5-9.0	5.5-9.0
Biochemical Oxygen Demand (mg/L)	40 to 130	<5	30	100
Chemical Oxygen Demand (mg/L)	130 to 350	< 12-18	250	Not Specified
Total Suspended solids (mg/L)	80 to 90	< 15	100	200
Fecal Coli Farm (MNP/100ml)	10^6 to 10^7	<20	---	---
Nitrogen (mg/L)	10 to 50	4-5	5	Not Specified
Phosphate (mg/L)	10 to 50	1-4	5	Not Specified

Table 1:

V. Operation & Maintenance

The technology is natural treatment system, as the result operation is mostly passive and requires little operator intervention. Maintaining uniform flow across the treatment cells through inlet and outlet adjustment is extremely important to achieve optimum treatment performance. Sampling of inlet and outlet will be carried out for a period of 6 months for every month.

VI. Conclusion

- The cost of construction of STPs of various technologies is almost same.
- However, the maintenance cost varies significantly among aerobic, anaerobic and Phytorid technology. Sewage treatment by Phytorid technology uses only 20% of the energy as compared to conventional sewage treatment plants.
- The details gathered and enumerated in table of comparisons points to clear choice of Phytorid technology as the STP of future.
- Phytorid technology system offers a range of low cost to high tech sanitation options which are hygienically safe, comfortable to use, environmentally friendly and often more economic than conventional systems. In addition, they ideally enable a complete recovery of nutrients in household wastewater and their reuse in agriculture.
- This system not only conserves vital resources which are otherwise simply wasted but also creates employment opportunities. In spite of the fact that it requires minimum maintenance as compared to other prevalent systems.

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