IJARASEM

ISSN: 2395-7852

International Journal of Advanced Research in Arts, Science, Engineering & Management

Volume 10, Issue 3, May 2023

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 6.551

+91 9940572462 +91 9940572462 ijarasem@gmail.com www.ijarasem.com

Bioremediation of Polluted Water by using Different Herbs

Mr. Nikhil Atram [1], Prof. Rohit Deshmukh [2], Prof. Rajesh Ingole [2]

[1] PG Student, Civil Engineering Department, Swaminarayan Siddhanta Institute of Technology, Nagpur, Maharashtra, India

[2] Assistant Professor, Civil Engineering Department, Swaminarayan Siddhanta Institute of Technology, Nagpur, Maharashtra, India

ABSTRACT- In the developing technologies and growing environment, the usage of the water source plays a vital role and its been needed and used in large amount. Insufficient management of municipal and wastewater in immense environmental problems and increasing hygienic risks for the growing urban population thereby hampering poverty alleviation and a sustainable development of Indian society. But now days, the waste water is converted into a source for various purposes in different aspects by the use of phytorid technology. phytorid technology is a patented technology and being very effective in water pollution treatment it leads one step forward to sustainable treatment of wastewater in safe manner. In view of rising concern about pollution of water bodies due to discharge of waste in them, it is necessary to initiate alternative thinking as conventional methods through STPs (Sewage treatment Plants) have had limited success. In recent years the application of specifically designed Phytorid technology (popularly known as wetland based technology) for treatment of wastewater- municipal, urban and agricultural, is becoming widely acceptable. Phytorid technology is a type of constructive wetland system developed by, National Environmental Engineering Research Institute (NEERI), CSIR In 2005. This technology used the type of decentralized waste water treatment approach for the treatment of wastewater. It can be used for the treatment of domestic, agricultural, slaughter house, fish pond water etc. If sufficient land area is available it is preferable for pre-treated sewage. The technology utilizes wetlands plants, gravel/ porous stone and their associated microorganisms to mimic natural wetland ecosystem processes for the treatment of wastewater.

KEYWORDS- Phytorid Technology, Wastewater, Natural Wetlands, Wetlands Plants, NEERI

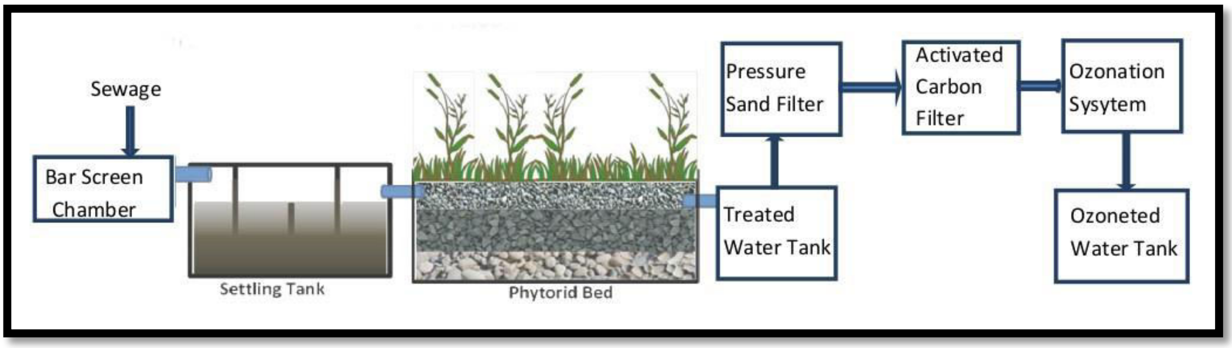
I. INTRODUCTION

1.1 OVERVIEW

In developing countries, especially in India, a large proportion of the population does not have access to safe water. 'Phytorid Technology' is a patented technology and being very, effective in water pollution. It is useful for secondary and tertiary treatment of municipal wastewater, management of sludge, treatment of industrial or agricultural effluent as well as for the treatment of landfill leachates. Indian cities and their suburbs contribute immensely to the deterioration of water quality of nearby water bodies mainly because of the population explosion, industrialization and changing lifestyle of urban people. Many of the cities have been provided with wastewater treatment systems but municipalities have not been able to maintain and run the system properly leading to deterioration of nearby water bodies used as a sink for wastewater of the towns and cities. More recently, it has been estimated that most of the developing countries will run out of water by 2050. Conventional methods of wastewater treatment particularly in urban areas is constrained by availability of space and infrastructure, therefore constructed wetlands are natural alternative to technical methods of wastewater treatment. The phytorid technology was developed by NEERI (National Environmental Engineering Research Institute) and patented in Indian, European and Australian countries. The advantages of this technology is compensate and offset the rate of existing wetland loss, improve wetland quality provide flood control. The phytorid technology is a subsurface flow type wherein water is applied to the cells/beds filled with porous media such as gravel and stones. The hydraulics is maintained in such a manner that water does not rise to the surface retaining a free board at the top of the filled media. These systems may include a wide variety of foliage in the form of aquatic, marsh, ornamental, herbs, grasses and also terrestrial plants known to grow in water logged condition. The system is based on use of specific plants normally found in natural reed with filtration and treatment capability. This system can be utilized for a wide variety of applications. It can be used for secondary and tertiary treatment of municipal wastewater, sludge management, treatment of industrial or agricultural effluent as well as for the treatment of landfill leachates. The phytorid technology is a effective and safe method of treating wastewater using the plants based on principle of natural wetlands. The 'Phytorid Technology' is a combination of the physical, chemical and biological processes which resulted into ultimate treatment for the waste water. This particular technology works without electricity, minimum maintenance, less manpower and importantly self sustainable.

1.2 PHYTORID TECHNOLOGY

'Phytorid Technology' is being very, effective in water pollution control as it functions as "pollutant" sinks for sediment, nutrients, and metals. There are different mechanisms plays an important role in treating waste water in the wetland, principal measures are sedimentation,bacterial action, filtration, decomposition, nutrient uptake and vegetative system. The system comprises of a sequence of two independent cells.Advanced Filter Cell (AFC), that supports a permutation of different sizes of stones and gravel wherein anaerobic digestion occurs Phytorid Treatment Cell (PTC) made up of different layers of life supporting media (Gravel) as in AFC, planted with wetland plants. 'Phytorid Technology' can treat the wastewaters by naturally without the addition of chemicals. It has been accomplished with the use of aquatic or semi aquatic plants along with their associated biota. 'Phytorid Technology' is an improved wetland ecosystem for treatment of wastewater. It involves proper utilization of biological treatment capacity with optimized engineering parameters.The filterable wetland will be sown with aquatic and/or semiaquatic plants where wastewater will flow in through vertical and horizontal specially designed units for better hydraulics and adequate retention period. These units will be designed and evaluated for its efficiencies with regard to removal of BOD/COD, suspended solids, phosphorous, nitrogen and fecal coliforms. It is useful for secondary and tertiary treatment of municipal wastewater, management of sludge, treatment of industrial or agricultural effluent as well as for the treatment of landfill leachates.



(Fig.1.1: Phytorid Water Treatment Technology)

1.2.1 Components of the treatment system

- Sewage Collection Tank
- Settler/Screening Chamber
- Phytorid Bed
- Treated water Storage Tank

1.2.2 Phytorid technology has been used in treating variety of wastewaters Domestic wastewater

- Open Drainage
- Cleaning of nallah water
- Agriculture wastewater
- Dairy wastewater
- Municipal landfill leachate
- Pre treated industrial wastewater

1.2.3 Commonly used plants species in Phytorid systems

- Reeds (Phragmites Spp)
- Elephant grass (Pennisetum purpurem)
- Cattails (Typha Spp.)
- Cana Spp
- Golden dhuranda

- Bamboo
- Nerium
- Colosia

1.2.4 Major benefits of adopting Phytorid technology

- Cost effective
- Operation of Phytorid is based on gravity rule, so less electricity required.
- Operation and maintainance expenses are low/negligible.
- The treated water is reused in various operation facilitating Zero liquid dischage.
- Able to endure the situation of variation in temperature, pH and flow rate of the sewage treated.

1.2.5 Pollutant Removal processes occur during treatment process

- Sedimentation
- Filtration
- Adsorption
- Precipitation
- Decomposition
- Microbial degradation
- Nutrient uptake

1.3 NATURAL WETLANDS

A natural wetland is an area of ground that is saturated with water, at least periodically. Plants that grow in wetlands, which are often called wetland plants or saprophyte, have to be capable of adapting to the growth in saturated soil. Natural wetlands are ecosystems that are either permanently or temporarily saturated in water, providing a natural habitat for biotic organisms and supporting conditions that promote the development of wetland soils. The structure of a natural wetland is shaped due to its surrounding abiotic conditions and these may be classified as: marshes, swamps, forested wetlands, bogs, and wet meadows, as well as coastal wetlands such as mangroves. The ability of wetlands to retain large volumes of water, which they release slowly, makes them significant for combatting extreme weather conditions such as flood control and drought mitigation, that occur more frequently as a result of climate change. Additionally, wetlands contribute to water purification, water regulation, biodiversity, aesthetics and recreation. Within the natural wetlands many biological activities occur, therefore these are known to be as “biological supermarkets”. Natural wetlands endowed shelter to many species by providing huge quantity of food for their survival. The life cycle in the natural wetland ecosystem shows similarity as in other ecosystems. For example, in wetlands, bacteria degrade the dead decay matter of plants and animals into organic form as they do in other ecosystems.

1.4 HISTORICAL BACKGROUND

Treatment of wastewater is a relatively modern practice. While sewers to remove foul smelling water were common in ancient times. It was until the late 19th century that the large cities began to understand that they had to reduce the amount f pollutants in the used water they were discharging to the environment. Despite large supplies of fresh water and the natural ability of freshwater to cleanse itself over time, populations had become so concentrated by late 1850 that outbreaks of life threatening diseases were traced to bacteria in the polluted water. Since that time the collection of wastewater and treatment has been developed and perfected, using some of the most technically sound biological, physical, chemical and mechanical techniques available. As a result, public health and water quality are protected better today than ever before.

At a typical water plant, several million gallons of wastewater flow through each day. The amount of wastewater handled by the treatment plant varies with time of day and with the season of the year. A treatment plant uses a series of treatment stages to clean up the water so that it may be safely released to the lake, stream or river.As the time passes, the mode of treatment changes from one to one and finally to the most economical one called phytorid technology which treat the water without effecting the ecosystem.

Austria; The total number of constructed wetlands in Austria is 5,450 (in 2015).[24] Due to legal requirements (nitrification), only vertical flow constructed wetlands are implemented in Austria as they achieve better nitrification performance than horizontal flow constructed wetlands.

United States of America; The Arcata Marsh in Arcata, California is a sewage treatment and wildlife protection marsh.

Australia; The Urrbrae Wetland in Australia was constructed for urban flood control and environmental education. At the Ranger Uranium Mine, in Australia, ammonia is removed in "enhanced" natural wetlands (rather than fully engineered constructed wetlands), along with manganese, uranium and other metals.

1.5 OBJECTIVES OF THE STUDY

- Natural Treatment of Wastewater
- Low Cost & Eco-Friendly to Environment
- Waste stabilization and nutrient removal
- In order to overcome the groundwater pollution by the treated water used in irrigation field
- To avoid the foul odour and no mosquito nuisance
- East to maintain and skilled labour not required
- Facilitate re-use and recycle of water (re-use of grey water up to 95%)
- Constructed wetlands (Phytorid technology) and natural water treatment systems aim to control and optimize the ability of a wetland to remove or transform wastewater pollutants

II. LITERATURE REVIEW

Table 1.2: Historical developments of wetland treatment technology

Types	Flow	Year	Location	Application	References
Free water surface	Horizontal	1952- 1970s	Plon, Germany	Removal of Phenols and dairy wastewater treatment with bulrush plants	Seidel, 1966
		1980s	California	Urban storm water treatment	Chan et al., 1982
		1990-2000	USA Norway China Canada	For the treatment of Landfill leachate, industrial, stormwater and mine drainage	Vymazal, 1998
		2000 onwards	Canada USA Argentina Kenya, Greece Australia Spain UK, Sweden, Zambia New Zealand	For the treatment of Landfill leachate, pulp and paper, mine drainage, swine, dairy, domestic and industrial wastewater	Hadad et al., 2006
	Horizontal	1960s	Germany	Various type of wastewater	Seidel, 1966
		1970s	Germany	Treatment of municipal sewage	Kickuth, 1978
		1980s	Germany, Australia	Treatment of municipal sewage and piggery effluent	Kickuth, 1981 Finlayson et al, 1987
		1990s	Worldwide, UK, USA, Australia, Slovenia, Germany China New Zealand Denmark Canada,	For the treatment of municipal/ domestic, industrial, agricultural, run off and Landfill leachate wastewater	Robinson et al., 1999

			Switzerland, Norway		
		2000 onwards	UK, USA India Italy, Spain, Portugal, Kenya, Canada, Slovenia, Mexico Australia South Africa Lithuania Thailand, Germany France Taiwan, Poland	For the treatment of municipal/ domestic, industrial, agricultural, run off and Landfill leachate wastewater	Bresciani et al., 2007
	Vertical	1965	Germany	CW with vertical flow was used as pretreatment units before wastewater treatment in horizontal flow bed	Seidel, 1965
		1990s	Germany, Netherlands	For the treatment of municipal/ domestic, special organics, herbicides, dairy,and cheese dairy wastewater	Kern and Idler, 1999
		2000 onwards	Portugal, Canada, Australia Germany France Pakistan	For the treatment of municipal/ domestic, special organics, leachate, and refinery wastewater	Aslam et al., 2007
	French - Hybrid	1979	France	The use of this system, developed by the CEMAGREF (now IRSTEA) in the early 1980's Used for treatment of raw sewage	Liénard, 1987
Subsurface	Hybrid	1965-1975	Krefeld, Germany		Seidel, 1965
		1990-2000	UK Nepal	Sewage wastewater, hospital	Burka and Lawrence, 1990; Laber et al., 1999

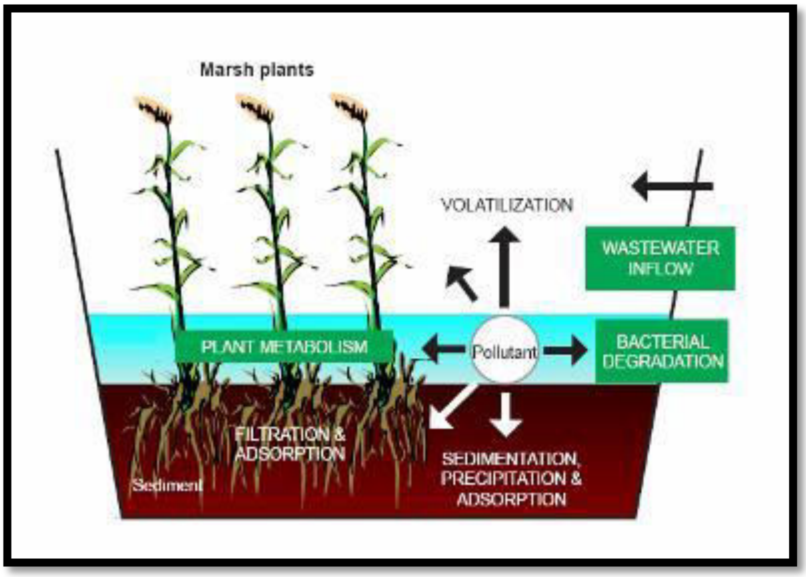
III. PROPOSED METHODOLOGY

3.1 TREATMENT MECHANISM

Phytorid Treatment Systems have been found to be effective in treating BOD, TSS, N and P as well as for reducing metals, organic pollutants and pathogens. The principal pollutant removal mechanisms in treatment systems include biological processes such as microbial metabolic activity and plant uptake as well as physico-chemical processes such as sedimentation, adsorption and precipitation at the water-sediment, root-sediment and plant water interfaces.

- Microbial degradation plays a dominant role in the removal of soluble/colloidal biodegradable organic matter in wastewater.
- Biodegradation occurs when dissolved organic matter is carried into the biofilms that attached on plant root systems and surrounding media by diffusion process.
- Suspended solids are removed by filtration and gravitational settlement. A pollutant may be removed as a result of more than one process at work.

- Conversion of nitrogen compounds (Nitrification / Denitrification) occurs due to planned flow of wastewater through anaerobic and aerobic zones.
- Phosphorus is present in wastewaters as Orthophosphate, Dehydrated Orthophosphate (Polyphosphate) and Organic Phosphorus.
- Although plant uptake may be substantial, the sorption of Phosphorus (Orthophosphate P) by anaerobic reducing sediments appears to be the most importantt process. Pathogens are removed mainly by sedimentation, filtration and absorption by biomass and by natural die-off and predation.

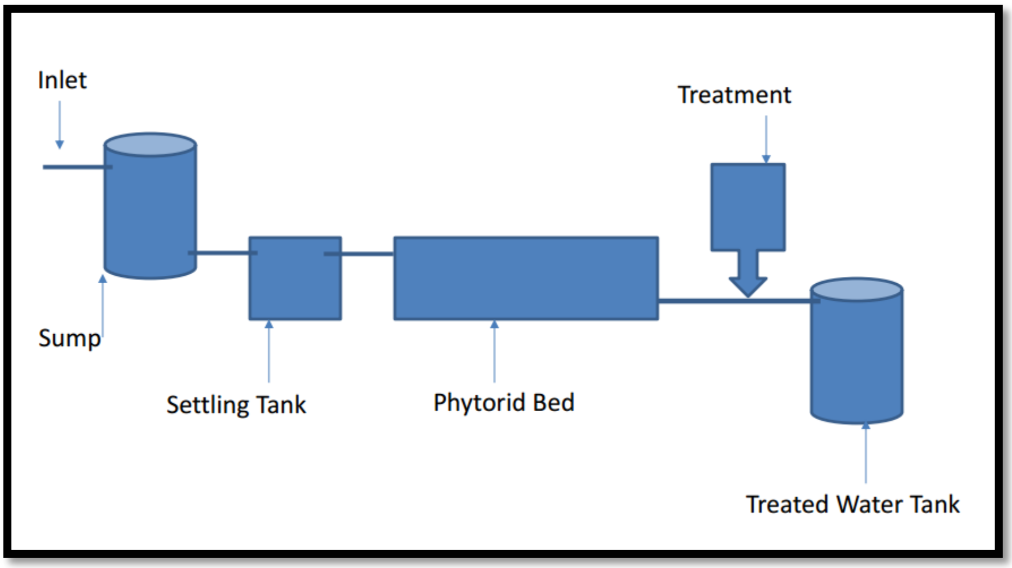


(Fig.3.1: Treatment mechanism)

3.2 METHODOLOGY

The system includes intake well, settling chamber, treatment bed, and collection tank. If the water is to be treated with any dosing treatment then additional treatment dozing tank may be proposed. Wastewater from screening chamber flows into primary settling chamber by gravity. Solid waste has been separated in screening chamber by gravity and digested in anaerobic manner. Next bed is called Phytorid which is the heart of the system. Wastewater from primary settling chamber further flows into Phytorid bed by gravity. Phytorid bed is provided with different gradation of gravel/stone aggregate and hydrophytes type plants. The Phytorid bed is divided into compartments of baffle walls provided in such a way that the flow of wastewater is in sinusoidal manner. The unique design provides both the anaerobic and aerobic zones in the same Phytorid bed. Aerobic zone is near roots of plants, as plants transport oxygen from air to the roots and intern into water for biochemical oxidation. A specially design culture media helps in carrying biochemical oxidation in Phytorid bed. The flow of sewage is few inches below the gravel top layer and therefore no sewage is exposed leading to avoiding mosquito problems.

- After the Phyroid bed clears the water, it has been treated with chlorine or other dozing
- material to clear the bacterial or smell in water. This can be done by UV rays by natural
- ways without using any mechanical or electrical machineries at project.



(Fig.3.2: Steps involved in Phytorid Technology)

3.3 TREATMENT PROCESS

3.3.1 Primary treatment: Primary treatment consist of removal of the heavy particles and the oil grease from the waste water collected. This is processed in container where the wastewater is collected and passed through the grid mesh for the removal of large particles such as vegetables waste, plastics etc and the screened water is allowed to flow on the latterite brick stone which will absorb the oil/grease present in wastewater.

3.3.2 Secondary Treatment: Pre-treated wastewater f lows slowly through the porous medium under the surface of the bed in a horizontal path until it reaches the outlet zone. From the stagnant water, plants absorb contaminants and store in above ground shoot and the harvestable part of roots. Roots and their exudates immobilize contaminants through absorption, accumulation, precipitation with in the root zone, and thus prevent the spreading of the contaminants. Plant enzymatic breakdown of organic contaminants, both internally and through enzymes.Contaminants taken up by the root through plants to the leaves and are volatized through stomata where gas exchange occurs.

$$\textbf{Organic matter}+O_2=CO_2+NH_3+H_2O$$
$$NH_3=NO_3\ \textbf{(Nutrient)}$$

By this phytoremidiation process, the BOD, COD and the heavy metals contaminants where removed. The retention time for the phytoremidiation process is approximately 24 hours by the continues flow of the water in the bed. the secondary treated water is collected through the outlet and and sends to the next container for the sludge digestion process.

3.3.3 Tertiary treatment: The treated water from the biofilter may contain some suspended and the nitrogen, phosphorous,. The vetiver powder thus mixed with the secondary treated water and allowed to settle down for 15 min. After this process, the water is undergone coagulation and flocculation process using the alum by jar test. From the above process, the water is obtained in white colour without any foul odour.

IV. ROLE OF PLANT SPECIES

- The most significant functions of plant species in relation to water purification are the physical effects brought by the presence of the plants.
- The plants provide a huge surface area for attachment and growth of microbes. The physical components of the plants stabilize the surface of the beds, slow down the water flow thus assist in sediment settling and trapping process and finally increasing water transparency.

- Plants play a vital role in the removal and retention of nutrients and help in preventing the eutrophication of wetlands. A range of plants has shown their ability to assist in the breakdown of wastewater. Cattail (Typha spp) are good examples of marsh species that can effectively uptake nutrients. These plants have a large biomass both above (leaves) and below (underground stem and roots) the surface of the substrate.
- The sub-surface plant tissues grow horizontally and vertically, and create an extensive matrix, which binds the particles and creates a large surface area for the uptake of nutrients and ions. Hollow vessels in the plant tissues enable oxygen to be transported from the leaves to the root zone and to the surrounding soil.
- This enables the active microbial aerobic decomposition process and the uptake of pollutants from the water system to take place.
- Macrophytes stabilize the surface of plant beds, provide good conditions for physical filtration, and provide a huge surface area for attached microbial growth. Growth of macrophytes reduces current velocity, allowing for sedimentation and increase in contact time between effluent and plant surface area, thus, to an increase in the removal of Nitrogen.
- Hydraulic conductivity is improved in an emergent plant bed system. Turnover of root mass creates macropores in a system allowing for greater percolation of water, thus increasing effluent/plant interactions.
- Decomposing plant biomass also provides a durable, readily available carbon source for the microbial populations.
- Plant species mediate transfer of oxygen through the hollow plant tissue and leakage from root systems to the rhizosphere where aerobic degradation of organic matter and nitrification will take place. The plant species have additional sitespecific values by providing habitat to make wastewater treatment systems aesthetically pleasing.

(Fig.4.1: Cattails (Typha Spp.))

V. CONSTRUCTION OF PHYTORID SYSTEM

5.1 SELECTION OF SITE

- The suitability of a site for constructing a treatment wetland may depend on the condition of one or more factors such as substrate, soil chemistry, hydrology/geomorphology, vegetation, cultural/socioeconomic impacts including environmental justice issues, the surrounding landscape, land use/zoning considerations and potential impacts to safety and health.
- A distance of 5 to 10 m from the residential building in case of domestic sewage is recommended, depending on the type of pretreatment.
- In case of industrial effluents, site-specific plan from residential areas is required.
- The location is to be selected in such a manner that drinking water sources are not impaired.
- As far as possible, the site must be safe from flooding.
- The selected site should be protected from unauthorized access.
- It must be possible to dispose of the treated effluent at the selected site as per standards set by the concerned regulatory agency.

(Fig.5.1: Phythorid Bed structure)

(Fig.5.2: Plants Fixing Work)

(Fig.5.3: Pump House for inlet Raw Sewage Water)

(Fig.5.4: Weir)

VI. RESULTS

The treatment results in the reduction of the BOD, COD, total suspended solids, heavy metal constituent and there is improvement in the pH level and decrease rate of the turbidity and hardness which satisfies the standards of the irrigation water needs and thereby the nutrients needed for the plant growth is obtained in the water is in specified rate that does not affect the growth and efficiency of the product. Thus, the Phytorid technology is economical, less area required, maintenance, easy construction and the energy is efficiently used with the sustainable ecology condition. There is no impact to the environment by the odor or the quality of the water which is turn result in less ground water pollution with effective irrigation.

Table 6.1: Removal efficiency of Phytorid System

Water Parameters	Removal rate (%)
Biochemical oxygen demand (BOD)	85-95
Chemical oxygen demand (COD)	85-95
Total nitrogen	60-70
Phosphate	30-40
Total suspended solids	75-95
Faecal Coliform	90-95

VII.CONCLUSION

It is concluded that phytorid technology is one of the efficient way of decentralized treatment of water, requiring negligible operational and maintenance cost. But more land area for higher volume of sewage. Hence, it can be adopted in local institutions and societies. Moreover institution should be further made to improve the quality and efficiency of the phytorid system. The studied wetland plants can reduce the level of Turbidity, COD, BOD, TS, TSS, Phosphate and Nitrate to different degree in waste water. Since the technology is low cost, environmentally friendly and simple, the use of constructed wetland in municipal wastewater treatment is a promising technology which could be adopted by the developing countries where limited resources are available for the installation of high tech treatment plants.

REFERENCES

1. Anonymous, 2005. Phytorid technology: A natural technique for municipal and industrial waste water treatment, International patented technology, Technical folder, National Environmental Engineering Research Institute, Nagpur.

2. Alknanda Technologies, Designing & Implementation of a Sewage Treatment Plant Using Phytorid Technology, 2012.
3. Chandramani Bhimrao Patil , Dr. Arif Khan, 2020, Sustainable Solid Waste Management; Case study of Nagpur, India, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 09, Issue 11 (November 2020)
4. Gobinath.R1, S.Aravind, AshiSudhakar.P.K, A.Sathya Singh, M.Swathi,, " Color and Odor Removal from Tannery Waste Water using Natural Coagulant and Locally Available Commercial Grade Lime, Scholars Journal of Engineering and Technology (SJET) ISSN 2321-435X Sch. J. Eng. Tech., 2013; 1(3):133-139
5. Kokyo Oh, Tiehua Cao, Tao Li, and Hongyan Cheng, "Study of Application of Phytoremediation Technology in Management and Remediation of Contaminated Soil", Journal of CleanEnergy Technologies, Vol. 2, No. 3, July 2012.
6. Maria, A. (2003), 'The Costs of Water Pollution in India', paper presented at the conference on Market Development of Water & Waste Technologies through Environmental Economics, 30–1 October 2003, Delhi.
7. Snehal Bhaskar Thamke , Dr. Arif Khan, 2021, Constructed Wetlands – Natural Treatment of Wastewater, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 10, Issue 06 (June 2021)
8. Narendra Sukhdevrao Naik , Dr. Arif Khan, 2020, E-Waste Management with respect to Indian Scenario, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 09, Issue 11 (November 2020)
9. Md Shahjada Alam , Dr. Arif Khan, 2020, To minimize Vehicular Emissions of Nagpur, India, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 09, Issue 11 (November 2020)
10. Md Shahjada Alam, Dr. Arif Khan,2020, The Impact Study of Vehicular Pollution On Environment, International Journal for Science and Advance Research In Technology (IJSART) Volume 6 Issue 12 –DECEMBER 2020.
11. Mayur Ambarlal Humane , Dr. Arif Khan, 2020, A Case Study on Sanitation Conditions in India, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 09, Issue 11 (November 2020)
12. V.S.Ghorpade, Dr. P.G. Sonawane, Study of Performance Evaluation of Decentralized Wastewater Treatment Systems to treat domestic wastewater, Internal Journal of Engineering and Technical Research(IJETR),November 2015.
13. SarwokoMangkoedihardjo,ShintaAlbetaLaila, "Compost On Evapotranspiration Bed Planted With Yellow Flag For Treatment Of Wastewater Containing Anionic Surfactant", Journal of Applied Sciences Research, 8(3): 1630-1633, 2012.
14. Swapnil S. Navaghare, Vipul A. Kadam, Suraj T. Sawant, SaurabhSwamy and Prof. Archana N. Mahajan," New invention on Reuse of Sewage and Wastewater by Phytorid Technology", International Journal on Recent and Innovation Trends in Computing and Communication.
15. AnuradhaManikraoPatil, SagarGawande," Implementation of Sewage Treatment Plant by using Phytorid Technology", IJIRT 143750 International Journal of Innovative Research in Technology.
16. V.T. Deeptha, J.S. sudarsan and G.Baskar, " Performance and cost evaluation of constructed wetland domestic waste water treatment", journal of Environmental Biology 2014.
17. Sanjay MurlidharKarodpati, Alka Sunil Kote, " Energy-Efficient and Cost-Effective Sewage Treatment using Phytorid Technology, International Journal of Advanced Technology in Civil Engineering, ISSN: 2231 –5721, Volume-2, Issue-1, 2013.
18. N.Abdel-Raouf , A.A. Al-Homaidan I.B.M. Ibraheem," Microalgae and wastewater treatment,Saudi Journal of Biological Sciences (2012) 19, 257–275
19. Rajesh B. Biniwale, Decentralised wastewater treatment including reuse and recycle- role of constructed wetlands, Jaipur, February 7, 2013
20. Phytorid technology for sewage and industrial wastewater treatment & reuse by Go Green Solutions Pvt.Ltd.