Domestic Wastewater Treatment using Phytorid Technology

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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 using Iris Pseudacorus (Yellow Iris) plants and natural source for the treatment without affecting the ecosystem. The Chrysopogonzizanioides is to increase the pH value and to reduce the nitrogen, phosphorous content. The coagulation and flocculation process is done by alum to have a turbidity and to remove the suspended solids. This method is more advantageous of cost effective, negligible operation and maintenance with minimum electricity, smaller footprint. The main focus of the project is to avoid the scarcity of the irrigation water and to avoid the odor in the treated water and to enhance the quality of the water to prevent ground water pollution by analyzing the nominal water parameters that need to be satisfied for reusing the treated water with the references of IS 3025 code book**.

keyword: Phytorid Technology, Ecosystem, ground water pollution, irrigation water, Chrysopogon zizanioides , alum , yellow iris.

I. INTRODUCTION

The Earth is called the blue planet, since freshwater is a scarce resource available in earth. Only 2.5% of all water resources are freshwater, of the 2.5% which are freshwater, nearly 70% is not accessible, because it is bound in snow and ice, thus only 0.5% of the total water on earth is accessible for drinking and other freshwater uses. Primary water source is polluted to a great extent through the 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. In addition to this, the effects of the globe warming has increase the water source in one side and scarcity in the other part in major uses such as agriculture.

The above facts highlight the need to find improved water treatment to meet the problem of food security, water availability and use of water efficiently. It is beyond any doubt that energy will be main concern of the nation in coming years. Identification and adoption of appropriate technology to overcome these pressures is therefore absolutely essential. There were many techniques and methods used in the wastewater treatment but the technique which use the nature for the nature prevention is Phytorid Technology. The phytorid technology is a effective and safe method of treating wastewater using the plants based on principle of natural wetlands. The technology utilizes wetlands plants, gravel/ porous stone and their associated microorganisms to mimic natural wetland ecosystem processes for the treatment of wastewater.

The phytoridtechnologywas 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.

II. OBJECTIVE

In order to overcome the groundwater pollution by the treated water used in irrigation field.

To avoid the foul odor and no mosquito nuisance.

Easy to maintain and skilled manpower not required

Facilitates recycle and re-use of water (re use of grey water upto 95%).

III. TREATMENT MECHANISM

Phytorid Technology System 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 physic-chemical processes such as sedimentation , absorption and precipitation at the water-sediment, root-sediment and plant-water interface. 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 biofilm that attached on plant roots systems and surrounding media by diffusion process. It leads to reduction in BOD as well as COD. Suspended solid are removed by filtration and gravitational settlement. Although plant uptake may be substantial, the sorption of phosphorus by anaerobic reducing sediment appears to be the most important process. Pathogens are removed mainly by sedimentation, filtration and absorption by biomass and by natural die-off and predation. Evapotranspiration slows water flow and increases contact times, where rainfall, which as the opposite effect, wills cause dilution and increased flow.

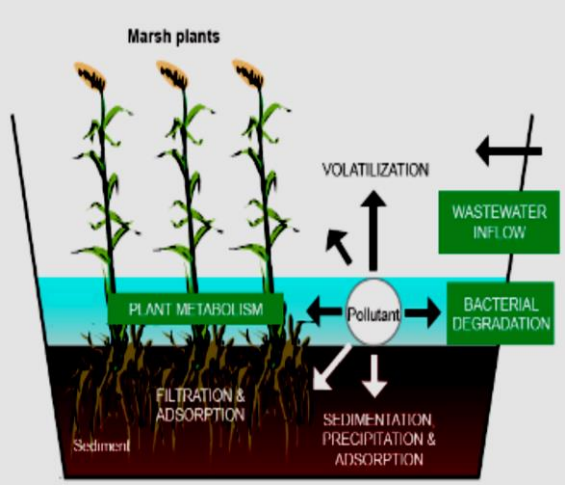


Fig. 1 Treatment mechanism

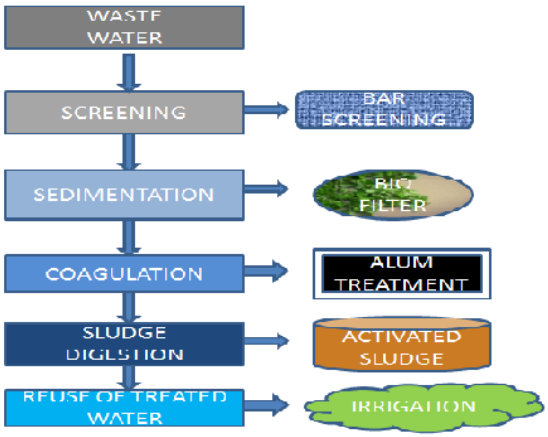
IV. METHODOLOGY

The plants were transplanted into the biofiltertanks which is filled by the layers of porous stone and latterite stone. The water is allowed to pass through the biofilter tank and gone through the reaction. The water after phytoremediation process involves in coagulation process using alum and sludge digestion is done by vetiver powder.

V. MATERIALS USED

A. Commonly used plants:

There are different kinds of the plants that can be grown in the fresh water, grey water, brackish water, waste water were taken into account for the wetland process which has specified characteristics of removing the nutrients of the pathogens and reducing the odor and preventing the insects breeding etc. some of the plants are listed below:



Cannaindica (Indian Shot)
Colocasiaesculenta(Green Taro)
Cyperusalternifolius(Umbrellapalm)
Iris Pseudacorus (Yellow Iris)
Juncusbufonius (Toad Rush)
Pennisetumpurpureum (Purple Fountain Grass)
Scirpusvalidus (Softstem Bulrush)
Strelitziareginae (Bird of Paradise)
Zantedeschiaaethiopica (Calla Lilly)
Lythrumsalicaria (Purple Loosestrife)

B. Iris Pseudacorus:

Iris Pseudacorus commonly called as "Yellow Flag" or "Yellow water iris" found in wetlands, along riverbanks and near ponds. It will grow in freshwater or shallow water which can tolerates submersion, low pH, and anoxic soil. It has ability to take up the heavy metals through its roots. Rhizomes in its acts the biofilter to absorb the BOD,COD, nitrogen and other organic compounds in wastewater. It avoids the odor from the waste water and it is pest resistance.

C. Alum:

Alum coagulation and flocculation are common process used to remove the turbidity and NOM(Natural Organic Matter).when the alum is added to water, it dissolves into its component ions according to the following reaction

$Al_2(SO_4)_3.14H_2O \rightarrow 2Al(OH)_3 + 6H^+ + 3SO_4^{2-} + 8H_2O$

The total concentration of dissolved aluminum is functions of the pH neutralize the charges on the colloidal particles in the raw water, thus bringing the particles closer together to allow a floc to begin to form. This results in removal of turbidity, colour and chemical oxygen demand reduction.

D. Chrysopogon zizanioides:

Chrysopogon zizanioides commonly known as Vetiver is an herbal plantthat has been widely used for medicinal purpose,soilerosion,water conservation etc. It absorbs dissolved nutrients, such as N and P, and is tolerant to salinity, magnesium, aluminium and manganese. It also Absorbs dissolved heavy metals from polluted water, tolerates As, Cd, Cr, Ni, Pb, Hg, Se and Zn. Commonly vetiver is used as an fragrant this also helps in reducing the odor from the treated water.

VI. TYPICAL DESIGN FEATURES

Phytorid system is proposed for the treatment of sewage or domestic wastewater which will consists of a basin or a channel with barrier to prevent seepage, but the biofilter tank contains a suitable depth of a porous materials. A primary treatment facility would be constructed along with basic for effective removal of solids and thus reduces the marginal BOD and oil/grease using the stone. The porous media also supports the root emergent vegetation.

Fig2. Typical section of the biofilter tank

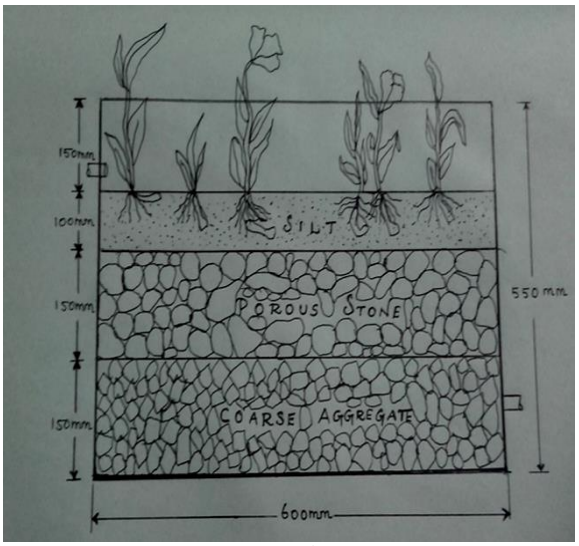


Fig 3. Dimension of the prototype

VII.TREATMENT PROCESS

A. Primary treatment:

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

B. Secondary treatment:

Pre-treated wastewater flows 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, plant absorbs contaminants and store in above-ground shoots and the harvestable parts of roots/rhizomes. Roots and their exudates immobilize contaminants through absorption, accumulation, precipitation within the root zone, and thus prevent the spreading of contaminants. Plant enzymatic breakdown of organic contaminants, both internally and through enzymes. Plant root stimulates soil microbial communities in plant zones to break down contaminants. Contaminants taken up by the roots through plants to the leaves and are volatized through stomata where gas exchange occurs.

$$\text{Organic matter} + O_2 \rightarrow CO_2 + NH_3 + H_2O$$

$$NH_3 \rightarrow NO_3^- \text{ (nutrient)}$$

By this phytoremediation process, the BOD, COD and the heavy metals contaminants where removed. It is a process which can be done both aerobic and anaerobic method. The retention time for the phytoremediation 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 sends to the next container for the sludge digestion process.

C. Tertiary treatment:

The treated water from the biofilter may contain some suspended and the nitrogen, phosphorous constituents in it. These will be reduced/ removed by sludge digestion process using the Chrysopogonzizanioides. The vetiver powder thus mixed with the secondarily treated water and allowed to settle down for 15mins. After this process,the water is undergone coagulation and flocculation process using the alum by the jar test. From the above process, the water is obtained in white colour without any foul odor.

VIII.PERFORMANCE OF THE TREATMENT

The performance of the treatment is obtained by undergoing series of tests in different parameters and analyzing the capability of the process to change the characteristics of the water accordingly with their reaction.

Biochemical oxygen demand	= 90-95%
Chemical oxygen demand	= 85-95%
Total suspended solids	= 90-95%
Total nitrogen	= 60-85%
Phosphate	= 50-80%
Turbidity	= 80-90%
pH	= 70-85%
Colour and odor	= white and no odor

IX. RESULT

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.

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