International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Natural Way of Treatment of Domestic Waste Water by using Anaerobic Unit and Engineered Wetlands with Phytoremediation - A Review

Vishal Meshram[1], Arif Khan[2]

[1]Swaminarayan Siddhanta Institute Technology, Kalmeshwar, Nagpur, Maharashtra, India – 441501
Email: *vishalmmeshram[at]gmail.com*

[2]Swaminarayan Siddhanta Institute Technology, Kalmeshwar, Nagpur, Maharashtra, India – 441501
Email: *arif3456[at]hotmal.com*

Abstract: ***Fresh potable water for drinking, domestic and agricultural use is life line of human, animals, plants. In present situation most of the countries fight with this scarcity of potable water. And in future situation will be very tuff. Construction of engineered wetlands is concept based on natural wetlands. Processes of engineered wetlands surpass the problems of natural wetlands and will increase the capacity of waste water treatment process. Constructed wetland treated waste water on basis of natural process which is completely non-hazardous, eco-friendly and non-consumption of energy. At in present condition, land is costlier and most of the wetlands vanish due to effective use of lands, hence we found various hazardous changes like ground water depletion, increase of greenhouse gases (Methane, CO2), disturbance/vanishing of bio diversity lived into wetlands. Development of wetland is always cost effective, durable as compare to others conventional waste water treatments and engineered developed waste water treatment plants. Engineered developed wetlands have beautified locality/area and without any kind of odour, smell, nuisance of flying kits etc. Wetlands with pollution absorbent plants create bio diversity and beautified locality.***

Keywords: Anaerobic**,** fermentation, hydrolysis, phytoremediation, wetlands

1. Introduction

Urbanization and growth of society creates the pollution problem and major one is waste water. Now a day, in all over the world water scarcity is most dangerous problem, water require for drinking, farm land, agriculture, industrial use etc. reduced which cause inequality to distribution system. Pollution of water [Goyal 1996] results in change of its physical, chemical, biological and radiological quality leading to its existing, intended or potential uses. Repetitive use and conservation water will solve the various problem related water, it also reduces the energy cost required for transportation of water. Engineered constructed wetland based on the theme of "River has self-cleansing capacity". Located camp, villages have to develop wetland on cluster wise which may develop beauty to locality and increase of ground water with recirculation of same water for washing, plantation, gardening and agricultural works. As considered no space constraint issues, same developed as one kind of individual and combined garden type. Cluster wise developed wetland always cost effective and steady natural flow which have negligible maintenance and highly effective. Decentralized wetlands installation/development has more effectiveness and energy creation (methane) through anaerobic unit. Constructed Wetlands are two types surface and subsurface, it may use depends on locality and practical use. Constructed Wetlands are an effective, environmentally friendly means of treating liquid and solid waste. CWs could bring major economic benefits to developing countries through the provision of biomass and aquaculture. We develop the technology to treat waste water on artificial way but they have disadvantages related to greenhouse gases and ozone layer depletion. The phytoremediation mechanisms include phytoextraction (i.e., phytoaccumulation), enhanced rhizosphere biodegradation, phytostabilization, and phytodegradation (Singh and Jain 2003).

2. Scope of research

Domestic water is common problem and it is directly affected to ground water and surfacing flowing streams. Most of the mine colonies/local villages areas located away from urban area and camp quarters, villages houses connected to conventional type of septic tanks. After some time with in year, those septic tank over flow through outlet pipes. Same condition happens in villages also. As in both localities never think about the future constraint related to environment. Major problem is maintenance and initial cost. As considering the maintenance and initial cost point of view only engineered develop wetlands are useful to domestic waste water treatment work. Our country is developing and cost-effectiveness playing a major role, increase in maintenance cost found to be non-utilisation of sewage treatment plants and by passing work of waste water directly into ground.

Sub surface wetland is avoiding the foul smell, nuisance of flying kits, mosquito's generation and beautified locality. Engineered design anaerobic unit constructed for highly effectiveness to treatment of waste water as well as reducing the treatment load on wetland. Methodology completely based on decentralised process of Screening, sedimentation, digestion through anaerobic process, filtration through wetlands with plants (typha latipholia, canna indica, vetiver, junicus etc.)

3. Research Methodology

The followings are the methods of waste water treatments: Membrane system, Nutrient removal process, Nitrifying removal process, Nitrifying Aerobic process, Aerobic process, Stabilisation ponds, Anaerobic treatment, chemically assisted primary treatment, Primary sedimentation with screen and scum removal, Septic tank and cess pits, Wetlands/ Reeds beds.

Various methods state above, a centralised process of treatment of waste water is always uneconomical and less effective. Such type of independent systems always gives maintenance and regular maintenance on the system means negligence in working, may lead to pollution on environment.

Decentralised system is combination of two or more methods for treatment purpose and basically selection on less energy consumption and low redox potential. The following methodology selected on the basis of available study.

3.1 Anaerobic process

A fermentation process in which organic material degraded and produced mainly methane and CO_2. In this process consumption of oxygen is zero (redox potential is very low). In this process organic matter completely degraded and balance degraded organic matter nearly up to 10 %, may use as organic compost. In this process Compounds like Ammonia, Phosphate, Sodium, and Nitrates etc. lowered from harmful level to acceptable level for environment. This treatment can be adopted at any places of environmental condition. Process is also use to produce the energy through generation of methane gas. As compare to aerobic process for waste water treatment, anaerobic process is always cheaper and maintenance free. Anaerobic degradation are multistep processescontain (i) Hydrolysis (ii) Acidogenesis (iii) Acetogenesis (iv) Methanogenesis (Figure 3.1) (Gujer and Zehnder, 1983). When the first anaerobic treatment systems were developed by the end of the 19th century, the design was not really adequate for good performance, possibly due to the misconception that the settleable solids were the most important sewage component to be removed (McCarty 1982).

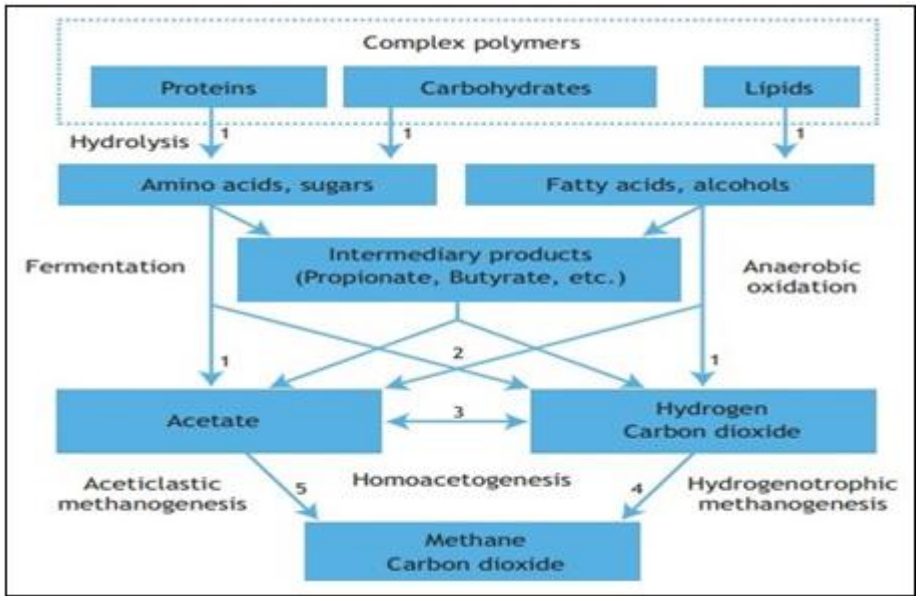

Figure 3.1 : Four Stages of Anarobic reaction including fifth stage of Aceticlastic methanogenes (Gujer and Zehnder, 1983

3.2 Wetlands

Constructed wetlands (CWs) have been proved to be "cost-effective" methods for wastewater treatment. They also provide other landscape and social benefits such as wildlife habitat, research laboratories, and recreational uses (U.S. EPA, 1999). Engineered constructed wetlands (CWs) is natural process of treatment of waste water, which gives high efficiency to removal of pollutants, low maintenance and economical. Wetlands are two type surface and subsurface flow. As per conditions of locality and environment concern selection done of wetland construction. Material use for construction of wetland is always locally available, so that economy should be maintain. Media use for CWs is mostly gravels, coarse sand, and crushed stone. CWs mainly consists of shallow includes the water control structure. Constructed wetlands have efficiency to remove organic as well as inorganic pollutants from domestic/ municipal waste water, mechanism like flocculation, sedimentation, absorption, aerobic and anaerobic reactions and oxidation are the treatment to waste water. Concept of wetland based on the natural cleaning of waste water. Constructed wetlands (CWs) are designed and operated wetlands that are built to imitate unique ecological processes for wastewater treatment. These technologies, that consist principally of plants, substrates, soils, microbes and water, usage various tasks encompassing physical and chemical, including biological, strategies to eliminate multiple pollutants or strengthen the water freshness. Two regulatory sources, Utah Administrative Code R317-3 and U.S. EPA guidelines, are used and R317-3 provides the primary reference for designing of constructed wetland. Eutrophication plays a major role to damage/ major maintenance of wetlands through higher effect of nitrates,

phosphors and potassium in waste water. Waste water influent need primary treatments before waste water enter into the CWs and avoiding the surface flow.

3.3 Phytoremedian

Phytoremediation is the process of removal of pollutants through the use of pollutants fixation plants/ vegetation. Phytoremedian on Constructed wetland gives higher efficiency through the proper use of Phytoremedian plants which is green technology, environment friendly as well as increasing local bio diversity. Use of mix culture always useful in this method and produce high efficiency to remove heavy pollutants. Selection of locally available plants gives durability to survive in local environment as well as high efficiency. In India mostly typha latipholia, Canna Indica, Vativerra, Junicus etc. species are available to treat the waste water on CWs. Use of convectional technique to remediate the soil and water are always uneconomical and not eco-friendly as phytoremediation behave opposite. Phytoremediation is the engineered use of green plants with associated soil beneficial microbes to remove toxic pollutants through degradation and detoxification mechanisms from contaminated soil and water/wastewaters Bharagava *et al*. (2017a); Mukhopadhyay and Maiti (2010); Ali *et al*. (2013).

Nitrogen removal occurs through nitrification, denitrification, ammonification, volatilization and plant uptake. The removal rate in a wetland is 61% through denitrification and 14% through plant biomass, and the remainder is stored in the soil (Matheson, Nguyen, Cooper, Burt, & Bull, 2002). Hence, the nitrification and denitrification processes occurring within the wetland are the major mechanisms for nitrogen removal (Vymazal, Brix, Cooper, Green, & Haberl, 1998). Vegetated zones are anaerobic, because oxygen released by hydrophytic plants is trivial compared to the oxygen demands.Phosphorus is one of the important nutrients that cause eutrophication in the lakes. Plants uptake phosphorus during the growing season, but the phosphorus is released back into the water during decomposition when plants die. But in CWs regular trimming of plants solve the problem of released back into water and trimmed plants use to production of organic fertilizers. The importance of the phytoremediation process is that it is efficient for the removal of toxic organic aromatic pollutants, polycyclic aromatic hydrocarbons (PAHs), explosives (RDX, TNT, HMX), pesticide, landfill leachates, as well as herbicide contamination (Hussein Abdel-Shafy and et al, 2018)

Use of mix culture always useful in this method and produce high efficiency to remove heavy pollutants. Selection of locally available plants gives durability to survive in local environment as well as high efficiency. In India mostly typha latipholia, Canna Indica, Vativerra, Junicus etc. species are available to treat the waste water on CWs. Use of convectional technique to remediate the soil and water are always uneconomical and not eco-friendly as phytoremediation behave opposite. Phytoremediation is the engineered use of green plants with associated soil beneficial microbes to remove toxic pollutants through degradation and detoxification mechanisms from contaminated soil and water/wastewaters Bharagava *et al*. (2017a); Mukhopadhyay and Maiti (2010); Ali *et al*. (2013).

Nitrogen removal occurs through nitrification, denitrification, ammonification, volatilization and plant uptake. The removal rate in a wetland is 61% through denitrification and 14% through plant biomass, and the remainder is stored in the soil (Matheson, Nguyen, Cooper, Burt, & Bull, 2002). Hence, the nitrification and denitrification processes occurring within the wetland are the major mechanisms for nitrogen removal (Vymazal, Brix, Cooper, Green, & Haberl, 1998). Vegetated zones are anaerobic, because oxygen released by hydrophytic plants is trivial compared to the oxygen demands. Phosphorus is one of the important nutrients that cause eutrophication in the lakes. Plants uptake phosphorus during the growing season, but the phosphorus is released back into the water during decomposition when plants die. But in CWs regular trimming of plants solve the problem of released back into water and trimmed plants use to production of organic fertilizers.

4. Phytoremediation Mechanism

Systematic detail shown in following figure 4.1, The phytoremediation mechanisms include phytoextraction (i.e., phytoaccumulation), enhanced rhizosphere biodegradation, phytostabilization, and phytodegradation (Singh and Jain 2003). Mechanisms involved in phytoremedian of trace metal/ metalloids in soil (Memon and Schroeder 2009).

Phytoremediation process involves following steps to remediate the soil/water pollution:

a) Rhizofiltration or Phytofiltration: As shown in figure 4.1. Rhizofiltration is the process of up taking of organic material, metals through roots surface and roots. Contamination up take by plants will harvest after some time with their roots. This process useful for only surface growing plants because they up take large quantity of contamination.
b) Phytoaccumulation or Phytoextraction: In this process plants uptakes the harmful chemicals/metals/ pollutants up to harvestable level i.e., above ground. Plant will harvest after its completion of life span.

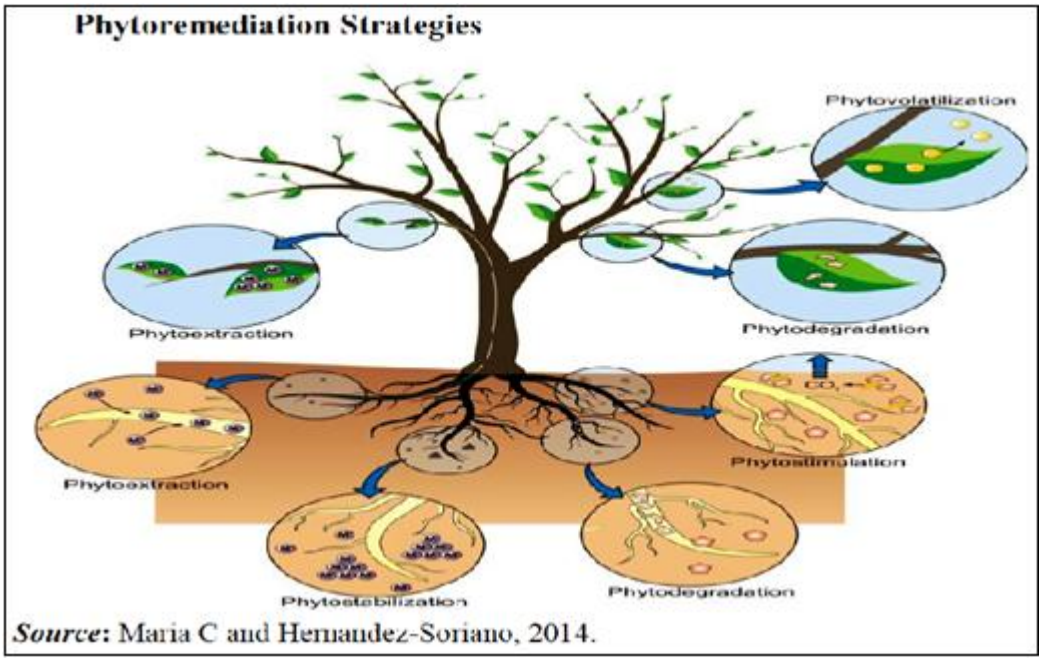

Figure 4.1: Various stages of Phytoremedian strategies

c) **Phytostabilisation:** It is the process of transpiration through root growth that immobilizes the contaminants by reducing leaching activity. It also creates the aerobic environments near the root zone and water passed through it. Phytostabilisation is always effective on vadose zone i.e surface to root zone up to water table. Microbial activity associated with plant roots that degrade the pollutants from water / soil.

d) **Phytostimulation/ Rhizodegradation:** In this process herbicides are remediating the pollutants from water / soil. Herbicides like fungi's, phytopathogens develop through plants minimize the level of pollutants like organic, inorganic, metals, chemicals etc. Microorganism available in to rhizosphere absorbed/adsorbed the pollutants. A systematic figure 4.5 shows the complete representation.

e) **Phytodegradation:** Phytodegradation which is also known as Phytotransformation of breakdown the contaminants taken up by plants through metabolic process with in plants, or break down of contaminants surrounding the plant through the effect of enzymes produced by plant.

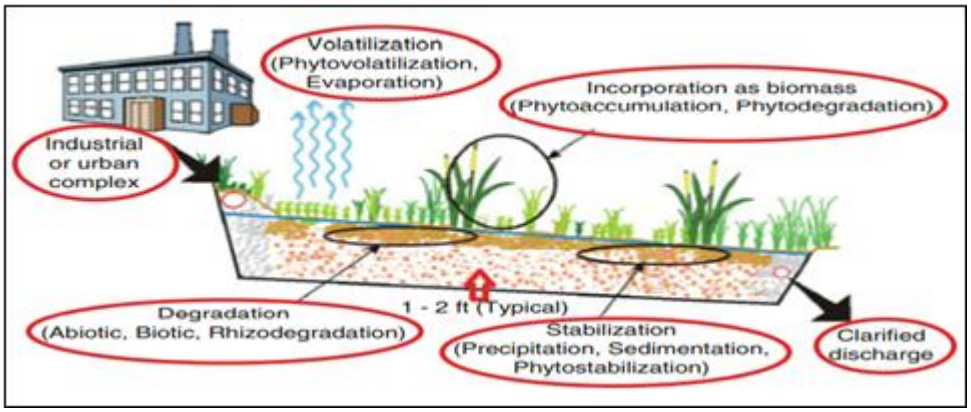

Figure 4.2: Waste water treatment via constructed wetland depicting the various methods of phytoremediation. (ITRC 2009)

f) **Phytovolatilization:** Phytovolatilization is the process of up takes of contaminates through plant roots and its conversion process to gaseous state and release into atmosphere as in organic form, it is also known as evotranspiration. Most of the major pollutants converted into gaseous form as oxides form. Process simply as conversion of inorganic, organic matter in to gaseous state of organic form.

Waste water treatment on constructed wetlands shown in figure 4.2, with all the mechanism of phytoremediation method, rhizodegradation is natural tendency in this method but it causes damage to wetland beds in terms of subsurface flow and reduce it's efficiency.

5. Conclusion

Direct use of wetland was less effective as compare to anaerobic unit but using of phytoremediation plants gives the better results on treated water. Anaerobic treatment with combination Phytoremediation with use multi culture plants like typha and canna gives the appropriate suitable result to treated water may use for agriculture, gardening and washing purpose. This treated water parameter match with

inland drain off. Decentralized system with systematic design of anaerobic units, wetlands with phytoremediation plants gives the economic result with less maintenance and durability to constructed units.

References

[1] Garg K K, and Jain S C 1998 Environment Lessons for common man Published by ESI, Chandigarh, p 39-48.
[2] Amit D, andChhotu R November 2012, Design of Anaerobic digester for waste water treatment, International Journal of Advanced Research in Engineering and Applied Sciences, vol 1Issue 5 p 56-66.
[3] MdEkhlasur R , MohdIzuan E BH , MohdYusoff BAS, Md Kamal U, Khairil M, MohdYunus AS , SitiRozaimah S A, andShamsuzzaman S M 2020 Design, Operation and Optimization of Constructed Wetland for Removal of Pollutant, International Journal of Environmental Research and Public Health vol 17.
[4] Hammer D A 1992,Designing constructed wetlands systems to treat agricultural nonpoint source pollution, Ecological Engineeringp 49–82.
[5] Crites R W, Middlebrooks E J, and Reed S. C. 2006,Natural wastewater treatment systems Boca Raton, FL: CRC Press.
[6] Crites, R W, andTchobanoglous G 1998, Small and decentralized wastewater management systems, New York NY: McGraw-Hill.
[7] Adrianus V H, Mario T K, Paula FF, andLourdinha F 2006,Anaerobic reactor design concepts for the treatment of domestic wastewater, Springer vol 5 p 21-38.
[8] McCarty P L 1964 Anaerobic waste treatment fundamentals Public Works vol 95(9-12) p107-112.
[9] Subbulakshmi G, Sagnika P, Anjali, and Ayush C2020 Phytoremediation: sustainable approach for the removal of Heavy metals from the environment using plants, IOP Conf. Series: Materials Science and Engineering p955.
[10] AbouSeeda M A, Yassen A A, Abou EL-Nour E A A, Gad MM, and Sahar M Z 2020, Phytoremediation of heavy metals principles, mechanisms, enhancements with several efficiency enhancer methods and perspectives: A Review Middle East Journal of Agriculture Research vol 9, Issue 1, p 186-214.
[11] Chandra R,Saxena G, and V.Kumar, 2015 Phytoremediation of environmental pollutants: An ecosustainable green technology to environmental managementCRC Press Boca Raton, p 1–30.
[12] Padmavathiamma P, and L. Li 2009 Phytoremediation of metal-contaminated soil in temperate regions of British Columbia, Canada International Journal Phytoremediation vol 11, p575–590.
[13] Hussein I. Abdel-Shafy and Mona S. M. Mansour 2018,Phytoremediation for the Elimination of Metals, Pesticides, PAHs, and Other Pollutants from Wastewater and Soil, Springer Nature Singapore Pte Ltd.