EPH- International Journal of Agriculture and Environmental Research
ISSN (Online): 2208-2158
Volume 11 Issue 01 February 2025
DOI: 10.53555/eijaer.v11i1.105

INFLUENCE OF INDUSTRIAL WASTEWATER ON NATURAL SOIL: A REVIEW

Desai Riya[1*], Patel Pratik[1]

[1]*Department of Environmental Science, Faculty of Science, Sarvajanik University, Surat, Gujarat, India.*

Corresponding Author:
Email: *desairiya206@gmail.com*

Abstract:

Waste disposal is a major concern due to rapid urbanization and industrialization. Finding cutting-edge, eco-friendly technology is urgently needed to tackle it. This paper reviews Constructed soil filter beds as engineered model design for wastewater treatment and evaluates the potential of using porous media, like soil rock, stone, gravel and plants in treating different industrial and domestic wastewater. Soil minerals and soil microorganism play important roles in elimination of pollutants from wastewater. This process removes BOD, COD, TSS, and TDS effectively, environment-friendly, cost-effective and in eco-friendly manner with general and natural mechanisms.

Keyword: Soil, Constructed filter beds, Industrial Wastewater.

INTRODUCTION:

No life without water. For the fulfilment of the water crisis dealing with wastewater is essential. Two hydrogen molecules and one oxygen molecule make up the two primary constituents of water. Since these substances are rarely present in pure water, they could be regarded as contaminants. Many of these contaminants are also found in drinkable water, which humans consume daily. Nearly 71% of water covers most of the earth's surface, and only 2.5 percent of fresh water is accessible on the surface. In addition to being a major factor in modern human welfare and the depletion of natural resources worldwide, the rapidly increasing population and industrialization both release enormous amounts of wastewater, Water can be reused using treatment methods. Pollutants in industrial wastewater are almost invariably toxic and they must be treated before they go to any further destination of their disposal. Many countries set their disposal limits for environmental protection. For a better future, one should use natural or environment-friendly materials for the treatment of any waste so that it can reduce further. (Arora & Kazmi, 2015)

Currently, the government and industry use a wide variety of natural and chemical approaches.

The important thing is to choose an appropriate technology for the treatment in considering cost, energy, maintenance, manpower, operation, land, etc. According to various researches conducted, these environmentally friendly and natural processes are simple to implement and cost-effective, yet environmentally beneficial. These methods can be modified and developed by different types of industries to maintain the environment. (Al-Yazouri, 2005). All of these industries emit enormous amounts of wastewater, which when treated with natural methods like constructed soil filter beds can prove to be a vital source of irrigation in pre-urban and urban agriculture.

Natural Treatment Methods:

There are so many chemical and other treatment processes that are carried out but the best method is soil filter bed. One of the key advantages of natural soil is its eco-friendly nature. Soil is a natural filter that can effectively remove pollutants from wastewater through various physical, chemical, and biological processes. Natural soil introduction can be a versatile and adaptable approach for industrial wastewater treatment. Researches shows that natural process can significantly reduce the concentration of pollutants in wastewater Therefore, using and developing eco-friendly methods is a need for the time and future.

A soil filter bed is a treatment for wastewater treatment and works as a trickling filter. Different types of soil, such as sand, clay, and loam, have different properties that can affect their ability to remove specific pollutants from wastewater. Such treatment is effective for the removal of colour, Odor, and other wastewater pollutants. For the success of this filter, the bed is crucial as the media must provide a good environment for the development and growth of microbial population. These technologies permit the treated water with good physio-chemical and bacteriological quality. (Angel Villabona-Ortíz, 2022) there are many studies that have been carried out with different soil and different layers of gravel and other porous material that show the ability to transport and store water with different hydraulic retention times. Many industries have adopted the natural methods for treatment and have obtained good results necessary for the disposal of treated wastewater in natural water bodies (Al-Yazouri, 2005).

Vermi-filtration is an eco-friendly wastewater treatment system that utilizes earthworms and microorganisms to break down organic matter and improve water quality. It operates in dark, humid, and oxygenated environments with porous filtration media (Li et al. 2011), such as soil, sand, and gravel, which facilitate water retention and transport while enhancing pollutant removal (Angel Villabona-Ortíz, 2022). The Hydraulic Retention Time (HRT) significantly impacts the system's efficiency, with longer retention improving reductions in Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).

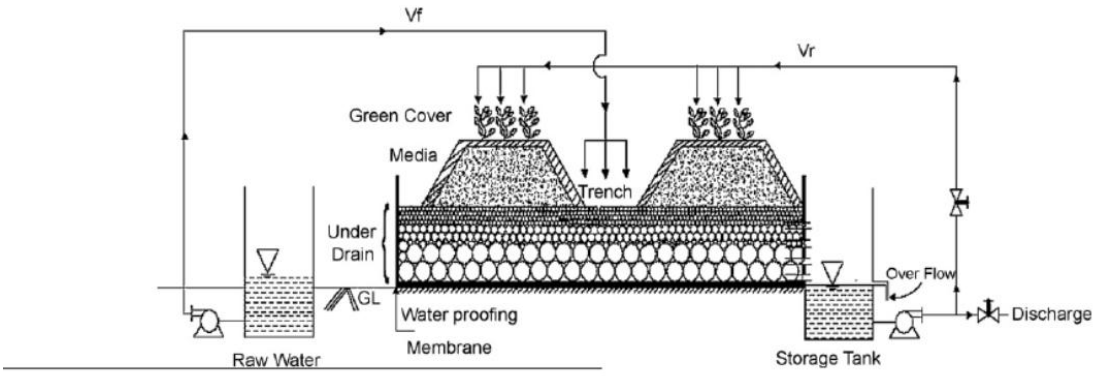
Constructed wetlands are engineered ecosystems designed to treat wastewater, stormwater, or agricultural runoff by mimicking natural wetland processes. They consist of shallow basins filled with soil, gravel, sand, and vegetation, which work together to filter and purify water through physical, chemical, and biological processes. These systems effectively remove pollutants, reduce Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), and improve water quality. Constructed wetlands are sustainable, low-cost, and energy-efficient, offering additional ecological benefits such as wildlife habitat creation, carbon sequestration, and aesthetic enhancement. (Li et al. 2011).

Material and methods:

Selection of the right packing material that has a high porosity, adequate water retention ability, and capacity to hold the microbial community to the chosen support media is crucial for a natural soil filter effectiveness and long-term activity (Das et al., 2019; Kumar). Soils, peat, composts, wood chips and other materials are the primary bed media used in biofiltration. Most process-specific requirements might be met by these materials.

1. Design of treatment plant:

Past researches had generally described that the average dimensions of the proposed model are 25cm × 20cm × 30cm. Model consisted of a filter bed, waste-water storage tank, and a water distribution system. The filter bed design is divided into 4 layers from bottom to top. The bottom layer is filled with large gravel. The second layer is filled with medium sized gravels. The third layer consist of small size gravel and the top layer consists of natural soil. Wastewater is added through gravitational force at various HRT. The design of the model is shown below.



(Fig. 1. Cross-sectional view and layout of CSF showing upper and lower media for processing water) (After Kadam et al., 2009)

2. Model design parameters:

The performance of the model is greatly depended on Hydraulic retention time (HRT) and Hydraulic loading rate (HLR). High HLR causes lower HRT, which could lower the effectiveness of the treatment.

3. Physio-chemical analysis:

Standard parameters assessed mainly were COD, BOD, TSS, pH, and heavy metals. The percentage reduction for the removal can be calculated by the below formula

$$percentage\ reduction\ (\%R) = \frac{\text{Inital concentration} - \text{final concentration}}{\text{Initial concentration}} \times 100$$

4. Microbiological Analysis:

Microbial activity was evaluated in the raw effluent and treated water. The basic parameter for microbial analysis is the most probable number (MPN) method and standard plate count (SPC) technique. (Arora & Kazmi, 2015).

The pathogen removal or bacterial removal efficiency was calculated as log removal value (K) using the following formula:

Log removal value (K) = $LOG_{10}\, C_{in}/ C_{out}$

C_{in} and C_{out} represent the influent and effluent pathogen concentrations, respectively (Arora & Kazmi, 2015).

5. Terrestrial Plants:

In this treatment process, the design can be planted with terrestrial species. Plants can be planted in the basket that was placed in the ditch and filled with filter bed material. (Kaoru Abe, 1997)

Result and discussion:

Natural soil can be a highly effective medium for the treatment of industrial wastewater. It has demonstrated substantial removal of pollutants such as heavy metals, organic contaminants, and nutrients. Natural soil exhibits strong adsorption capacity for a wide range of contaminants. This is attributed to the presence of various minerals and organic matter in the soil. Microbial activity within the soil layer performs important role in the filtration process for the degradation of pollutants. Various results show the filter bed using soil for treatment change pH and remove color and pollutant. Pollutant removal is more than 50% than the loading rate. (Kadam et al., 2009)

Conclusion:

One of the key points is the sustainability of using natural soil for wastewater treatment. Natural soil-based systems are often more environmentally friendly and cost-effective compared to conventional treatment methods. Additionally, the limitation of treatment is extreme pH levels might limit the applicability of natural soil in some industrial contexts. Model emphasized the potential of natural soil-based treatment for fulfil regulatory standards for wastewater treatment. It was noted that monitoring and periodic assessment of the treatment system are crucial to ensure compliance.

References:

1. Abe, K., Ozaki, Y., & Kihou, N. (1997). Introduction of fiber plants to plant bed filter systems for wastewater treatment in relation to resource recycling. *Soil Science and Plant Nutrition*, *43*(1), 35-43.
2. Araya, M., Terashima, M., Takagane, A., Abe, K., Nishizuka, S., Yonezawa, H., ... & Saito, K. (1997). Microvessel count predicts metastasis and prognosis in patients with gastric cancer. *Journal of surgical oncology*, *65*(4), 232-236.
3. Arora, S., & Kazmi, A. A. (2015). The effect of seasonal temperature on pathogen removal efficacy of vermifilter for wastewater treatment. *Water research*, *74*, 88-99.

4. Barbusiński, K., Urbaniec, K., Kasperczyk, D., & Thomas, M. (2020). Biofilters versus bioscrubbers and biotrickling filters: State-of-the-art biological air treatment. In *From biofiltration to promising options in gaseous fluxes biotreatment* (pp. 29-51). Elsevier.
5. Chandra, B. T., & Shankar, H. S. (2018). Effect of heat treatment on dry sand abrasive wear behavior of Al7075-Albite particulate composites. *Materials Today: Proceedings*, *5*(2), 5968-5975.
6. Chen, Z., Hu, S., Hu, C., Huang, L., Liu, H., & Vymazal, J. (2016). Preliminary investigation on the effect of earthworm and vegetation for sludge treatment in sludge treatment reed beds system. *Environmental Science and Pollution Research*, *23*, 11957-11963.
7. Chiarawatchai, N. (2010). *Implementation of earthworm-assisted constructed wetlands to treat wastewater and possibility of using alternative plants in constructed wetlands* (Doctoral dissertation).
8. Das, S., Lee, S. H., Kumar, P., Kim, K. H., Lee, S. S., & Bhattacharya, S. S. (2019). Solid waste management: Scope and the challenge of sustainability. *Journal of cleaner production*, *228*, 658-678.
9. Dipali Patel, Pratik Patel(2023). Constructed wetland system as a natural technology to remediate wastewater. *Journal of Advanced Zoology*,44(4),1281-1288.
10. Lavrnić, S., & Mancini, M. L. (2016). Can constructed wetlands treat wastewater for reuse in agriculture? Review of guidelines and examples in South Europe. *Water Science and Technology*, *73*(11), 2616-2626.
11. Li, H., Li, Y., Gong, Z., & Li, X. (2013). Performance study of vertical flow constructed wetlands for phosphorus removal with water quenched slag as a substrate. *Ecological engineering*, *53*, 39-45.
12. Nemade, P. D., Kadam, A. M., & Shankar, H. S. (2009). Wastewater renovation using constructed soil filter (CSF): A novel approach. *Journal of Hazardous Materials*, *170*(2-3), 657-665.
13. Sinha, R. K., Bharambe, G., & Chaudhari, U. (2008). Sewage treatment by vermifiltration with synchronous treatment of sludge by earthworms: a low-cost sustainable technology over conventional systems with potential for decentralization. *The environmentalist*, *28*, 409-420.
14. Tayim, H. A., & Al-Yazouri, A. H. (2005). Industrial wastewater treatment using local natural soil in Abu Dhabi, UAE. *American journal of environmental sciences*, *1*(3), 190-193.
15. Villabona-Ortíz, A., Tejada-Tovar, C., & Ĺopez-Barbosa, D. (2022). Hydrodynamic evaluation of a filter bed of porous material from stratified sedimentary rocks for the removal of turbidity in surface waters. *South African Journal of Chemical Engineering*, *39*(1), 97-105.