JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Pilot-Scale Floating Treatment Wetlands for Decentralized Hospital Wastewater Treatment: A Review

[1]Mr.Sushant S. Kurhe, [2]Dr.Dipak K, Chandre,[3]Mr.Rahul D. Patil,[4]Ms.Gaytri R. Roham,

[1]Assistant Professor,[2]Assistant Professor,[3]Assistant Professor, [4]Lecturer

[1]Chemical Engineering Department,

[2]Chemical Engineering Department,

[3]Chemical Engineering Department,

[4]Department of Physics

[1]Sir Visvesvaraya Institute of Technology, Nashik, Maharashtra

[2]SirVisvesvaraya Institute of Technology, Nashik, Maharashtra

[3]SirVisvesvaraya Institute of Technology, Nashik, Maharashtra

[4]Institute of Agriculture & Dairy Science, Loni

Abstract: Hospital wastewater is a complex mixture of pharmaceuticals, disinfectants, heavy metals, and pathogenic microorganisms. Conventional wastewater treatment plants are often insufficient to completely remove pharmaceutical residues, leading to environmental and health risks. Floating treatment wetlands (FTWs) have emerged as an innovative, sustainable, and low-cost solution for decentralized hospital wastewater treatment. This review highlights the design principles, mechanisms of pollutant removal, performance of pilot-scale FTWs, and challenges associated with their implementation.

I. Introduction

The increasing consumption of pharmaceuticals and chemicals in healthcare facilities has resulted in hospital effluents becoming a major source of environmental contamination. Decentralized treatment systems, such as floating treatment wetlands (FTWs), can provide cost-effective and eco-friendly alternatives to centralized wastewater treatment plants. This review focuses on the potential of FTWs for treating hospital wastewater at a pilot scale.

II.Mechanisms of Pollutant Removal

FTWs utilize aquatic plants, microbial biofilms, and substrate interactions to remove contaminants. The primary mechanisms include:

- Phytoextraction and phytodegradation of pharmaceuticals
- Rhizodegradation by root-associated microbes
- Sedimentation and filtration of suspended solids
- Adsorption of pollutants onto root surfaces and substrates
- Phytovolatilization of volatile organic compounds

III.Suitable Plant Species

Commonly used plants in FTWs include water hyacinth (*Eichhorniacrassipes*), duckweed (*Lemna minor*), cattail (*Typhalatifolia*), and vetiver grass (*Chrysopogonzizanioides*). These species are selected for their high growth rate, tolerance to contaminants, and ability to support microbial communities.

IV.Performance of Pilot-Scale FTWs in Hospital Wastewater Treatment

Pilot-scale studies have demonstrated significant removal efficiencies for pharmaceuticals, antibiotics, and organic matter. Reported removal rates include:

- 60–95% for antibiotics (ciprofloxacin, sulfamethoxazole)
- 50–90% for analgesics (paracetamol, ibuprofen)
- 70–98% for nutrients (nitrogen, phosphorus)
- 80–99% for pathogens (E. coli, enteric bacteria)

V. Advantages of FTWs

- Low capital and operational costs
- Decentralized applicability in hospitals and rural healthcare centers
- Aesthetic and ecological benefits
- Potential biomass reuse for bioenergy or composting

VI. Challenges and Limitations

- Variable treatment performance depending on plant species and climate
- Risk of secondary pollution from harvested biomass
- Limited scalability compared to large centralized systems
- Seasonal variation in plant growth affecting efficiency

VII. Future Prospects

Future research should focus on:
- Integrating FTWs with advanced treatment technologies (e.g., ozonation, nanomaterials)
- Exploring native plant species for pharmaceutical removal
- Long-term monitoring of pilot and full-scale systems
- Techno-economic analysis and life cycle assessment for large-scale adoption

VIII. Conclusion

Pilot-scale floating treatment wetlands offer a sustainable solution for decentralized hospital wastewater treatment. They provide effective removal of pharmaceuticals and pathogens while being cost-effective and environmentally friendly. However, further studies are needed to optimize design parameters, ensure consistent performance, and address challenges related to biomass management and scalability.

IX. References

[1] Ilyas, H., &Masih, I. (2020). Pharmaceuticals' removal by constructed wetlands: a review. Journal of Water and Health, 18(3), 253–277.
[2] Verlicchi, P., &Zambello, E. (2014). How efficient are constructed wetlands in removing pharmaceuticals from untreated and treated urban wastewaters? Science of the Total Environment, 470–471, 1281–1306.
[3] Gallegos-Castro, E. et al. (2025). The Removal of Acidic Drugs from Domestic Wastewater Using Constructed Wetlands/Stabilization Ponds. Water, 17(8), 1192.