

Lab-Scale Domestic Decentralized Wastewater Treatment System (DEWATS)

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Abstract—This paper presents the design, development, and testing of a Lab-Scale Domestic Decentralized Wastewater Treatment System (DEWATS) aimed at sustainable wastewater management for small-scale domestic applications. The system integrates three primary units — a Settling Tank, a Baffled Anaerobic Reactor (ABR), and a Planted Gravel Filter (Constructed Wetland). Experimental results demonstrate effective removal of Total Suspended Solids (TSS), Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD), showing the potential for localized wastewater recycling in residential and institutional areas.

Keywords—Decentralized wastewater treatment, DEWATS, Baffled Anaerobic Reactor, Constructed Wetland, Greywater, Environmental Engineering.

I. INTRODUCTION

Rapid urbanization and population growth have increased domestic wastewater generation, overwhelming centralized treatment systems. Decentralized Wastewater Treatment Systems (DEWATS) offer a sustainable alternative by treating wastewater locally, reducing pressure on municipal plants, and enabling water reuse. This study focuses on the design and evaluation of a lab-scale DEWATS model suitable for small residential or institutional applications.

II. LITERATURE REVIEW

Several studies have explored DEWATS and related technologies. Oliveira et al. (2021) demonstrated floating treatment wetlands as efficient decentralized sanitation approaches. Chong et al. (2012) reviewed upflow anaerobic sludge blanket reactors, highlighting their role in reducing organic pollutants. Loubet et al. (2014) analyzed urban water systems emphasizing life cycle impacts.

These findings emphasize DEWATS as a modern, sustainable sanitation framework.

III. METHODOLOGY

The lab-scale DEWATS consists of three main treatment units: Settling Tank, Baffled Anaerobic Reactor (ABR), and Planted Gravel Filter. Each tank was made using 30 L plastic containers. The Settling Tank removes suspended solids via sedimentation. The ABR, divided into three chambers by vertical baffles, supports anaerobic microbial degradation. The Planted Gravel Filter, filled with sand, gravel, and aquatic plants such as Canna and Pothos, provides final polishing by removing nutrients and improving clarity.

IV. EXPERIMENTAL SETUP AND DATA

Influent greywater was simulated using synthetic wastewater. The system operated at a flow rate of 5 L/day. Hydraulic Retention Time (HRT) for the ABR was 6 days. Parameters measured included pH, BOD, COD, TSS, and nitrate levels. Table 1 presents influent and effluent characteristics.

Parameter	Influent	Effluent	Removal (%)
pH	7.4	7.1	-
BOD (mg/L)	300	80	73.3
COD (mg/L)	600	200	66.7
TSS (mg/L)	250	90	64.0
Nitrate (mg/L)	45	18	60.0

V. RESULTS AND DISCUSSION

The DEWATS achieved pollutant removal efficiencies above 60%. The ABR effectively reduced organic loads, while the planted filter

improved nutrient and bacterial removal. The treated effluent met standards for reuse in non-potable applications such as gardening.

VI. CONCLUSION AND FUTURE SCOPE

The Lab-Scale DEWATS proved to be an efficient, eco-friendly solution for small-scale wastewater management. Future improvements may include scaling up, integrating biogas recovery from ABR, and testing different plant species for enhanced nutrient removal.

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