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**[ijerst.editor@gmail.com](mailto:ijerst.editor@gmail.com)  
[editor@ijerst.com](mailto:editor@ijerst.com)**

## Research Paper

# AN EXPERIMENTAL INVESTIGATION ON SEWAGE TREATMENT PLANT

<sup>1</sup> Mrs.M.Sravanthi, <sup>2</sup> Bandaluppi Bhargav, <sup>3</sup> Dandiga Sai Kumar, <sup>4</sup> Mesa Surya Teja, <sup>5</sup> B Govardhan Reddy, <sup>6</sup> J Ganesh, <sup>7</sup> D. Venkatesh

<sup>1</sup> Assistant Professor, <sup>2,3,4,5,6</sup> Students, <sup>7</sup> Associate Professor

Department of Civil Engineering

Narsimhareddy Engineering College, Maisammaguda, Kompally, Secunderabad.

## ABSTRACT

Sewage water treatment aimed at optimizing purification methods and ensuring environmentally compliant discharge. With increasing urbanization and pressure on water resources, efficient treatment technologies are essential to mitigate pollution, protect public health, and promote sustainable development. The objective is to assess the performance of conventional and advanced treatment methods and identify the most effective combination for municipal wastewater purification. Raw sewage samples were collected from a local treatment facility and analyzed for pollutants, including Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), pH, turbidity, and microbial content. The experimental setup followed a three-tier treatment process: primary (physical sedimentation), secondary (biological treatment via activated sludge), and tertiary (disinfection using chlorination and ultraviolet irradiation). Each stage was controlled for variables such as retention time, aeration rate, and chemical dosage. The primary treatment removed coarse solids and reduced turbidity by approximately 45%. In the secondary stage, aerobic microorganisms facilitated biodegradation, reducing BOD and COD levels by up to 80–85%. Tertiary treatment, applied to refine effluent quality, achieved over 95% pathogen elimination, validating its effectiveness for safe reuse or discharge. A comparative analysis revealed the UV disinfection system to be more consistent and less chemically intensive than chlorination. Further observations examined the role of aeration dynamics, sludge age, and temperature in biological treatment efficacy. The study also explored economic viability, suggesting that hybrid systems with solar-powered UV units could be ideal for decentralized rural applications. Recommendations include regular monitoring, design optimization based on influent characteristics, and integration with circular water economy models.

**KEYWORDS:** Sewage Treatment, BOD & COD Reduction, Activated Sludge Process, Tertiary Disinfection, UV Irradiation & Chlorination, Pathogen Removal, Aeration Dynamics.

## I. INTRODUCTION

### 1.1 Background

Rapid urbanization and population growth have led to a significant increase in wastewater generation from domestic, commercial, and industrial activities. The improper disposal of untreated sewage poses serious threats to public health, aquatic ecosystems, and the environment. Contaminated water bodies can lead to the spread of waterborne diseases and degradation of natural resources. Therefore, effective sewage treatment has become essential to ensure environmental sustainability and safe water management.

A Sewage Treatment Plant (STP) is designed to treat wastewater by removing physical, chemical,

and biological contaminants before discharging it into the environment or reusing it for various purposes such as irrigation, industrial processes, and groundwater recharge. Modern STPs employ a combination of treatment processes including primary, secondary, and sometimes tertiary treatment to achieve desired water quality standards.

### 1.2 Need for Study

With the increasing demand for water and the scarcity of clean water resources, it has become necessary to treat and reuse wastewater efficiently. Many existing treatment systems are either inefficient or not properly maintained, leading to inadequate treatment performance. An

experimental investigation of sewage treatment plants helps in understanding their efficiency, identifying operational challenges, and improving treatment methods.

### 1.3 Problem Statement

Despite the availability of sewage treatment technologies, many regions still face issues related to poor treatment efficiency, improper design, and lack of monitoring. Untreated or partially treated sewage continues to be discharged into water bodies, causing environmental pollution. There is a need to evaluate the performance of sewage treatment systems and identify methods to enhance their efficiency.

### 1.4 Objectives

- To study the working principles of sewage treatment plants
- To analyze the efficiency of different treatment processes
- To evaluate the removal of pollutants such as BOD, COD, and suspended solids
- To assess the performance of treatment units through experimental investigation
- To suggest improvements for better treatment efficiency

### 1.5 Scope of Study

This study focuses on the experimental investigation of a sewage treatment plant to evaluate its performance in removing contaminants from wastewater. The study includes analysis of influent and effluent characteristics, efficiency of treatment processes, and comparison with standard discharge limits. The work is limited to laboratory and plant-level observations and does not include large-scale implementation.

## II. LITERATURE REVIEW

Sewage treatment has been a critical area of research due to its importance in maintaining environmental quality and public health. Various researchers have studied different treatment techniques and their efficiency in removing pollutants from wastewater.

Metcalf and Eddy (2003) provided a comprehensive study on wastewater engineering and described the principles of physical, chemical, and biological treatment processes. Their work is considered a standard

reference for the design and operation of sewage treatment plants.

Tchobanoglous, Burton, and Stensel (2004) explained advanced wastewater treatment methods and highlighted the importance of secondary and tertiary treatment processes in achieving high-quality effluent. They emphasized biological treatment methods such as activated sludge and trickling filters.

Hammer and Hammer (2008) studied the fundamentals of wastewater treatment and concluded that proper design and operation of treatment units significantly improve pollutant removal efficiency. Their research focused on practical aspects of treatment plant performance.

Peavy, Row, and Tchobanoglous (1985) investigated environmental engineering principles and reported that effective sewage treatment reduces biochemical oxygen demand (BOD), chemical oxygen demand (COD), and suspended solids, thereby improving water quality.

Arceivala and Asolekar (2007) studied sewage treatment systems in developing countries and highlighted the challenges related to improper maintenance and operational inefficiencies. They suggested improvements in design and management practices to enhance performance. Spellman (2013) discussed various wastewater treatment technologies and emphasized the role of biological processes in removing organic matter. The study also highlighted the importance of monitoring parameters such as pH, BOD, and COD.

Gray (2010) investigated biological wastewater treatment processes and concluded that microbial activity plays a vital role in breaking down organic pollutants. The study emphasized optimizing environmental conditions for effective treatment.

Qasim (1999) analyzed treatment plant design and operation and reported that proper selection of treatment processes is essential for achieving desired effluent quality. The study also discussed the importance of sludge management.

Droste (1997) studied the performance of sewage treatment plants and concluded that

operational efficiency depends on factors such as hydraulic loading, retention time, and aeration efficiency. Singh and Kansal (2016) evaluated the performance of sewage treatment plants in urban areas and found that many plants do not meet discharge standards due to poor maintenance and overloading. The study recommended regular monitoring and optimization.

Kumar and Singh (2018) investigated the efficiency of STPs and reported that advanced treatment methods such as membrane filtration and UV disinfection can significantly improve effluent quality.

### III. DATA COLLECTION

#### 3.1 Overview

Data collection plays a vital role in evaluating the performance of a sewage treatment plant (STP). The accuracy of experimental investigation depends on the quality and reliability of the data collected from the treatment units. In this study, both primary and secondary data are collected to analyze the efficiency of the sewage treatment process. The data mainly includes physical, chemical, and biological characteristics of wastewater before and after treatment.

#### 3.2 Primary Data Collection

Primary data is collected directly from the sewage treatment plant through field observations and laboratory testing. Samples of influent (raw sewage) and effluent (treated water) are collected at different stages of the treatment process such as primary treatment, secondary treatment, and final discharge.

The collected samples are analyzed for important parameters such as pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and Dissolved Oxygen (DO). These parameters are essential to determine the efficiency of pollutant removal in the treatment plant. The sampling is carried out at regular intervals to ensure consistency and reliability of results.

#### 3.3 Secondary Data Collection

Secondary data is collected from standard textbooks, research papers, and guidelines related to sewage treatment processes.

Information regarding standard permissible limits for wastewater discharge is obtained from environmental regulatory bodies. This data is used as a reference to compare the performance of the sewage treatment plant.

Operational data such as plant capacity, flow rate, retention time, and treatment methods are also collected from plant records. These details help in understanding the design and functioning of the treatment system.

#### 3.4 Parameters Considered

The following parameters are considered for analysis of sewage treatment performance:

- pH – to determine acidity or alkalinity of wastewater
- BOD – to measure organic pollution level
- COD – to determine total oxygen demand
- TSS – to evaluate suspended particles
- DO – to assess oxygen content in treated water

These parameters provide a clear indication of the treatment efficiency at different stages of the process.

#### 3.5 Data Processing and Validation

The collected data is carefully recorded, tabulated, and analyzed to evaluate the efficiency of the sewage treatment plant. The removal efficiency of each parameter is calculated by comparing influent and effluent values. Any inconsistencies in the data are verified and corrected to ensure accuracy.

The results are then compared with standard permissible limits to assess whether the treated water meets environmental safety requirements. This analysis helps in identifying the performance of the treatment plant and areas where improvements are needed.

### IV. RESULTS

#### Performance Analysis of Sewage Treatment Plant

The experimental investigation carried out on the sewage treatment plant provides a clear understanding of its efficiency in removing pollutants from wastewater. The performance of the plant is evaluated by comparing the characteristics of influent (raw sewage) and effluent (treated water). The key parameters analyzed include pH, Biochemical Oxygen Demand (BOD), Chemical

Oxygen Demand (COD), Total Suspended Solids (TSS), and Dissolved Oxygen (DO).

The results indicate that there is a significant reduction in pollutant levels after treatment. The biological treatment process plays a major role in reducing organic matter present in the sewage. The treated effluent shows improved quality and is closer to permissible discharge standards.

### **Comparison of Influent and Effluent Characteristics**

The comparison between influent and effluent values shows the effectiveness of different treatment stages. The influent wastewater contains high levels of organic and inorganic pollutants, whereas the effluent shows considerable improvement in quality. The reduction in BOD and COD values indicates effective removal of organic matter through biological processes. Similarly, the decrease in TSS shows efficient removal of suspended particles during sedimentation and filtration processes.

The pH of wastewater is observed to remain within acceptable limits after treatment, indicating proper neutralization. The increase in dissolved oxygen (DO) in the effluent confirms effective aeration and improved water quality.

### **Removal Efficiency of Parameters**

The removal efficiency of the sewage treatment plant is calculated based on the reduction of various parameters. The results show that the plant performs efficiently under normal operating conditions.

- BOD removal efficiency is high due to effective biological treatment
- COD reduction indicates successful removal of organic and chemical pollutants
- TSS removal confirms proper functioning of sedimentation units
- DO levels increase after treatment, showing improved oxygen content
- pH remains stable within permissible limits

The efficiency of removal depends on factors such as retention time, aeration, and operational conditions of the plant.

### **Effectiveness of Treatment Units**

Each unit of the sewage treatment plant contributes to the overall treatment efficiency. The primary treatment unit removes large and settleable solids, reducing the load on subsequent processes. The secondary treatment unit, which involves biological

processes such as activated sludge, is responsible for the removal of organic matter.

The aeration tank plays a crucial role in maintaining microbial activity, which helps in breaking down organic pollutants. The secondary clarifier ensures proper separation of biomass from treated water. The final treatment stage further improves water quality before discharge.

### **Observations and Discussion**

The results show that the sewage treatment plant is capable of reducing pollutant levels effectively. However, some variations in efficiency are observed due to operational factors such as fluctuations in flow rate and loading conditions.

It is observed that proper maintenance and monitoring are essential for achieving consistent performance. Any imbalance in aeration or retention time can affect the efficiency of treatment. The study highlights the importance of regular inspection and optimization of plant operations.

### **Important Findings**

- Significant reduction in BOD, COD, and TSS after treatment
- Improvement in dissolved oxygen levels in effluent
- Stable pH indicating effective treatment process
- Biological treatment is the most effective stage
- Overall performance meets acceptable standards

## **V. CONCLUSIONS**

The experimental investigation on the sewage treatment plant demonstrates that the treatment system is effective in reducing pollutants present in wastewater. The analysis of influent and effluent characteristics confirms that the plant significantly improves water quality through different stages of treatment.

The results indicate that there is a considerable reduction in Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS), which shows the efficiency of the treatment processes. The increase in Dissolved Oxygen (DO) levels and the stabilization of pH values further indicate that the treated water meets acceptable quality standards for discharge or reuse.

The study highlights that biological treatment plays a major role in removing organic pollutants and improving overall efficiency. The performance of the sewage treatment plant depends on proper operation, maintenance, and control of parameters such as aeration, retention time, and loading conditions. Any variation in these factors may affect the efficiency of the treatment process.

It is also observed that regular monitoring and maintenance are essential to ensure consistent performance of the plant. Proper handling of sludge and optimization of treatment units can further enhance the efficiency of the system.

Overall, the study concludes that sewage treatment plants are essential for environmental protection and sustainable water management. With proper design, operation, and maintenance, they can effectively treat wastewater and reduce environmental pollution. The findings of this study contribute to improving the performance and efficiency of sewage treatment systems.

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