

# Comparative Analysis of Wastewater Generated from Homoeopathic Hospital, MRMC Medical College, and Government College

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**Abstract** — Wastewater generated from healthcare and educational institutions contains various physical, chemical, and biological pollutants that may create environmental and public health problems if discharged without proper treatment. In the present study, wastewater samples collected from a homoeopathic hospital, MRMC medical college, and government college were analyzed and compared to evaluate pollution characteristics and wastewater quality. Important parameters including pH, turbidity, total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chlorides, nutrients, and microbial contamination were examined using standard laboratory procedures. The experimental results revealed noticeable variations in wastewater quality among the selected institutions. Wastewater generated from MRMC medical college showed comparatively higher organic and microbial pollution because of hospital activities, laboratory discharge, and sanitation systems. Elevated BOD and COD values indicated significant organic contamination, while higher TDS and TSS concentrations reflected the presence of dissolved and suspended impurities. The study highlights the importance of proper wastewater treatment and monitoring in healthcare and educational institutions to minimize environmental pollution and protect public health. The findings may assist environmental engineers and institutional authorities in planning sustainable wastewater management systems.

**Keywords:** Wastewater Analysis, Institutional Wastewater, Medical College Wastewater, BOD, COD, Wastewater Treatment, Environmental Pollution

## I. INTRODUCTION

Rapid urbanization and institutional development have significantly increased wastewater generation from healthcare and educational establishments. Hospitals, medical colleges, hostels, laboratories, and educational institutions consume large quantities of water for sanitation, washing, laboratory activities, and maintenance operations. As a result, considerable amounts of wastewater containing physical, chemical, and biological contaminants are discharged into the environment.

Wastewater generated from healthcare institutions is generally more hazardous than domestic sewage because it may contain pharmaceutical residues, laboratory chemicals, disinfectants, pathogens, organic matter, and suspended solids. Educational institutions also generate wastewater from classrooms, laboratories, canteens, hostels, and sanitation facilities. Improper disposal of untreated institutional wastewater may lead to water pollution, groundwater contamination, foul odor generation, eutrophication, and public health risks.

Medical college wastewater often contains higher concentrations of organic pollutants due to hospital

discharge, laboratory activities, and sanitation systems. Parameters such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), and microbial contamination are important indicators used to evaluate wastewater quality and pollution strength.

Wastewater characterization plays an important role in selecting suitable treatment technologies and monitoring environmental safety standards. Analysis of physicochemical and biological parameters helps environmental engineers understand pollution levels and treatment requirements before wastewater discharge or reuse.

The present study focuses on the comparative analysis of wastewater generated from a homoeopathic hospital, MRMC medical college, and government college. Wastewater samples collected from the selected institutions were analyzed for parameters including pH, turbidity, TDS, TSS, dissolved oxygen, BOD, COD, chlorides, nutrients, and microbial contamination. The study aims to evaluate wastewater quality, compare pollution levels among institutions, and highlight the importance of proper wastewater treatment and environmental management practices.

## II. LITERATURE REVIEW

Several researchers have studied the characteristics and treatment requirements of wastewater generated from healthcare and educational institutions. Institutional wastewater contains organic matter, suspended solids, nutrients, detergents, pharmaceutical residues, laboratory chemicals, and pathogenic microorganisms that may create environmental and public health concerns if discharged without proper treatment.

Zhang et al. investigated hospital wastewater characteristics and reported that healthcare wastewater contains higher concentrations of organic pollutants, suspended solids, disinfectants, and pharmaceutical compounds compared to domestic sewage. The study emphasized the importance of biological treatment and advanced filtration systems for effective pollutant removal [1].

Kaur and Sharma analyzed wastewater generated from educational institutions and hostel facilities. Their research identified detergents, food residues, suspended solids, and microbial contamination as major pollutants present in institutional wastewater. The authors recommended decentralized wastewater treatment systems for reducing environmental pollution [2].

Ahmed et al. studied wastewater generated from healthcare institutions and reported the presence of antibiotics, laboratory chemicals, pharmaceutical residues, and pathogenic microorganisms. The study highlighted that untreated medical wastewater may affect groundwater quality and contribute to microbial resistance [3].

Patel and Mehta carried out a comparative analysis of wastewater generated from medical colleges and educational institutions. Their results showed higher BOD, COD, and microbial contamination in medical college wastewater because of hospital discharge and laboratory activities [4].

Reddy et al. investigated physicochemical characteristics of institutional wastewater and observed elevated turbidity, suspended solids, nutrient concentration, and organic pollution levels. The researchers recommended proper wastewater monitoring and biological treatment systems for pollution control [5].

Singh and Verma evaluated wastewater generated from government colleges and hostels. The study identified organic pollutants, detergent residues, and microbial contamination as major contributors to wastewater pollution. Biological treatment systems such as activated sludge processes and aeration systems were found effective for organic pollutant removal [6].

Johnson et al. conducted microbial analysis of hospital wastewater and reported the presence of pathogenic microorganisms including coliform bacteria and harmful pathogens. The study emphasized the importance of disinfection methods such as chlorination and ultraviolet treatment for reducing microbial contamination [7].

Previous studies mainly focused on wastewater generated from individual institutions such as hospitals or educational campuses. Limited research is available on comparative analysis of wastewater generated from homoeopathic hospitals, medical colleges, and government colleges under similar environmental conditions. Therefore, the present study aims to compare wastewater characteristics among selected institutions and evaluate pollution levels based on physicochemical and biological parameters.

### III. MATERIALS AND METHODOLOGY

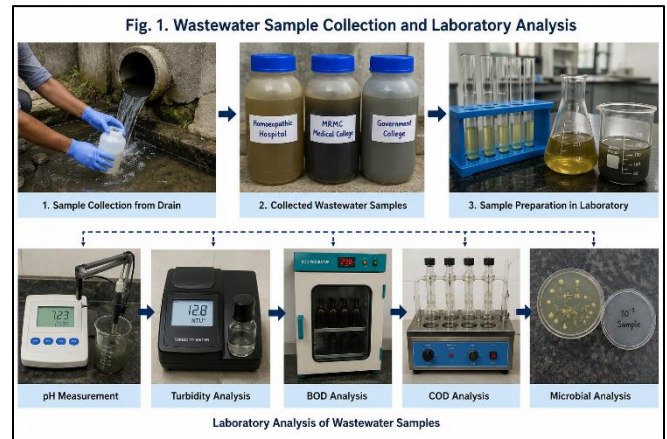
#### A. Study Area

The present study was conducted using wastewater samples collected from selected healthcare and educational institutions including a homoeopathic hospital, MRMC medical college, and government college campus. These institutions generate significant quantities of wastewater from hospital activities, laboratories, hostels, canteens, sanitation facilities, and cleaning operations.

#### B. Wastewater Sample Collection

Wastewater samples were collected from major discharge points such as laboratory outlets, drainage channels, hostel wastewater lines, sewage collection systems, and sanitation discharge locations. Clean and sterilized plastic containers with airtight lids were used for sample collection to avoid contamination.

The samples were collected during regular operational hours to obtain representative wastewater characteristics. After collection, all samples were labeled properly and transported immediately to the laboratory for analysis under controlled conditions.



#### C. Parameters Analyzed

The collected wastewater samples were analyzed for important physical, chemical, and biological parameters to evaluate pollution characteristics and wastewater quality. The parameters analyzed during the study included:

- pH
- Turbidity
- Total Dissolved Solids (TDS)
- Total Suspended Solids (TSS)
- Dissolved Oxygen (DO)
- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Chlorides
- Nutrients
- Microbial contamination

Parameter	Homoeopathic Hospital	MRMC Medical College	Government College
pH	Near Neutral	Slightly Variable	Moderate
Turbidity	Low	High	Moderate
TDS	Moderate	High	Moderate
TSS	Low	High	Moderate
BOD	Low	High	Moderate
COD	Moderate	High	Moderate
Microbial Contamination	Moderate	High	Moderate

Table I: Comparative Wastewater Characteristics

#### D. Laboratory Instruments Used

Standard laboratory instruments were used for wastewater analysis. A digital pH meter was used for pH analysis, while turbidity measurements were carried out using a turbidity meter. TDS values were determined using a digital TDS meter. Dissolved oxygen was measured using a DO meter. BOD analysis was performed using a BOD incubator, and COD analysis was carried out using COD digestion apparatus.

#### E. Experimental Procedure

The collected wastewater samples were analyzed using standard laboratory procedures. Physical parameters such as color, odor, turbidity, and suspended solids were examined initially. Chemical analysis was carried out to determine pH, TDS, DO, BOD, COD, and chloride concentration.

Biological analysis was performed to identify microbial contamination present in wastewater samples.

The experimental observations and laboratory readings obtained from different institutions were recorded systematically and compared to evaluate pollution levels and wastewater characteristics.

#### F. Comparative Analysis

The results obtained from wastewater analysis were compared among the selected institutions to identify variations in pollution strength and wastewater quality. The analysis helped evaluate the environmental significance of wastewater generated from healthcare and educational establishments and highlighted the need for proper wastewater treatment systems.

### IV. RESULTS & DISCUSSION

The wastewater samples collected from the homoeopathic hospital, MRMC medical college, and government college were analyzed to evaluate their physical, chemical, and biological characteristics. The experimental results indicated noticeable variation in wastewater quality and pollution levels among the selected institutions.

#### A. pH Analysis

The pH values observed during wastewater analysis ranged from slightly acidic to moderately alkaline conditions. Wastewater collected from MRMC medical college showed comparatively higher pH fluctuations due to the presence of laboratory chemicals, cleaning agents, and hospital discharge. The wastewater from the homoeopathic hospital and government college remained closer to neutral conditions.

#### B. Turbidity and Suspended Solids

Turbidity analysis revealed the presence of suspended particles and organic impurities in all wastewater samples. MRMC medical college wastewater exhibited comparatively higher turbidity and Total Suspended Solids (TSS) concentration because of laboratory discharge, hospital waste, and sanitation activities.

Government college wastewater showed moderate suspended solids concentration mainly due to hostel wastewater and domestic sewage discharge. Lower turbidity values were observed in homoeopathic hospital wastewater.

#### C. Total Dissolved Solids Analysis

The Total Dissolved Solids (TDS) analysis indicated the presence of dissolved salts, detergents, and chemical substances in wastewater samples. Higher TDS concentration was observed in MRMC medical college wastewater because of laboratory activities and cleaning operations.

Moderate TDS values were recorded in government college wastewater due to domestic wastewater generation and canteen discharge.

#### D. Dissolved Oxygen Analysis

Dissolved oxygen analysis showed comparatively lower oxygen concentration in wastewater samples containing higher organic pollution. MRMC medical college wastewater exhibited lower dissolved oxygen levels because microbial

decomposition consumed available oxygen during organic matter degradation.

The homoeopathic hospital and government college wastewater samples showed comparatively higher dissolved oxygen concentration.

#### E. BOD and COD Analysis

Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) analysis indicated significant organic pollution in institutional wastewater. MRMC medical college wastewater showed comparatively higher BOD and COD values because of hospital discharge, laboratory waste, and sanitation systems.

Government college wastewater showed moderate organic pollution mainly due to hostel and canteen wastewater. The homoeopathic hospital wastewater exhibited comparatively lower pollution strength.

Higher BOD and COD values indicate greater oxygen demand for decomposition and oxidation of pollutants present in wastewater samples.

#### F. Microbial Analysis

Microbial analysis confirmed the presence of coliform bacteria and pathogenic microorganisms in wastewater samples. MRMC medical college wastewater showed comparatively higher microbial contamination because of healthcare-related activities and hospital discharge.

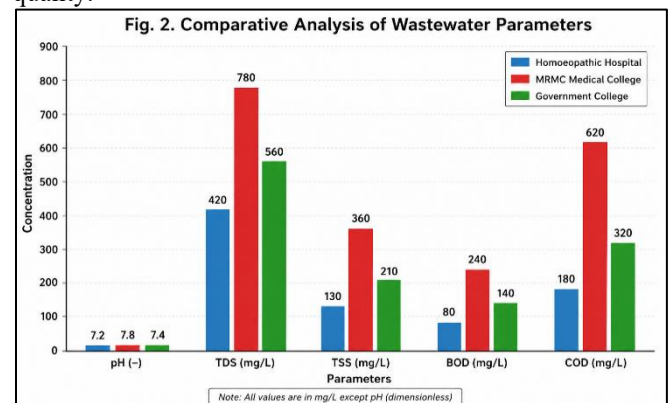
The presence of pathogenic microorganisms indicates potential environmental and public health risks associated with untreated wastewater disposal.

#### G. Comparative Wastewater Assessment

Comparative analysis of wastewater parameters revealed that MRMC medical college wastewater contained the highest pollution load among the selected institutions. Elevated turbidity, TDS, TSS, BOD, COD, and microbial contamination levels were observed because of laboratory activities, hospital waste, and sanitation discharge.

The homoeopathic hospital wastewater showed comparatively lower pollution levels, while government college wastewater exhibited moderate pollution characteristics similar to domestic sewage.

The experimental results highlight the importance of proper wastewater treatment and continuous monitoring before environmental discharge. Biological treatment, sedimentation, filtration, and disinfection processes are necessary to reduce pollution load and protect environmental quality.



## V. CONCLUSION

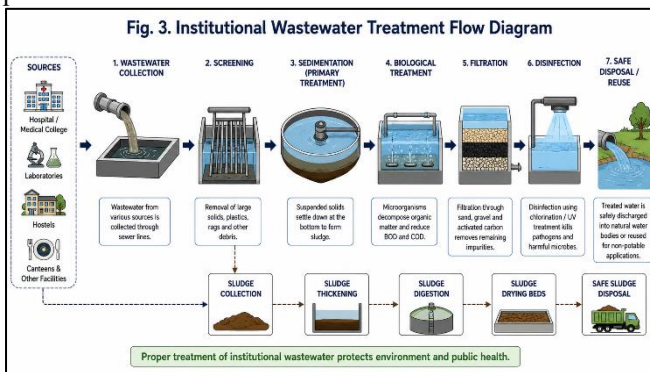
The present study focused on the analysis and comparison of wastewater generated from a homoeopathic hospital, MRMC medical college, and government college. Wastewater samples collected from the selected institutions were analyzed for important physical, chemical, and biological parameters including pH, turbidity, TDS, TSS, dissolved oxygen, BOD, COD, chlorides, nutrients, and microbial contamination.

The experimental results revealed significant variation in wastewater characteristics among the selected institutions. Wastewater generated from MRMC medical college exhibited comparatively higher pollution levels due to hospital discharge, laboratory activities, sanitation systems, and medical waste generation. Elevated BOD and COD values indicated strong organic pollution, while higher TDS, TSS, and microbial contamination reflected the presence of dissolved impurities, suspended solids, and pathogenic organisms.

Government college wastewater showed moderate pollution characteristics mainly associated with hostel wastewater, domestic sewage, and canteen discharge. The homoeopathic hospital wastewater exhibited comparatively lower pollution strength but still contained organic and microbial contaminants requiring proper treatment before disposal.

The study highlights the importance of regular wastewater monitoring and implementation of efficient treatment systems in healthcare and educational institutions. Proper treatment processes such as sedimentation, biological treatment, filtration, and disinfection are essential for reducing pollution load and protecting environmental quality and public health.

The overall findings demonstrate that institutional wastewater management plays an important role in environmental sustainability and safe wastewater disposal practices.



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