



Analysis of Hospital Wastewater Quality Based on Physical and Chemical Parameters at the UPTD RSD dr. H. Soemarno Sosroatmodjo in 2025

Undang Trisnadi¹, Salasiah², Heryanto Saputra³, Yuliaji Siswanto⁴

¹Public Health, Ngudi Waluyo, Indonesia

²Public Health, Ngudi Waluyo, Indonesia

³Public Health, Ngudi Waluyo, Indonesia

⁴Public Health, Ngudi Waluyo, Indonesia

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ABSTRAK

Air limbah rumah sakit mengandung berbagai zat kimia dan mikroorganisme patogen yang berpotensi mencemari lingkungan serta berdampak negatif terhadap kesehatan masyarakat. Penelitian ini bertujuan untuk menganalisis kualitas air limbah di UPTD RSD dr. H. Soemarno Sosroatmodjo tahun 2025. Penelitian ini menggunakan desain deskriptif kuantitatif dengan pendekatan analisis laboratorium. Populasi dalam penelitian ini adalah seluruh hasil uji kualitas air limbah rumah sakit selama periode Juli hingga Desember 2025, sedangkan sampel penelitian berupa data sekunder hasil pemeriksaan laboratorium yang mencakup tujuh parameter utama, yaitu pH, *Biochemical Oxygen Demand* (BOD), *Chemical Oxygen Demand* (COD), *Total Suspended Solid* (TSS), minyak dan lemak, amoniak, serta total coliform. Variabel penelitian meliputi hasil pengukuran masing-masing parameter yang dibandingkan dengan nilai ambang batas baku mutu. Instrumen penelitian berupa lembar hasil uji laboratorium yang telah divalidasi oleh UPTD RSD dr. H. Soemarno Sosroatmodjo. Data dianalisis secara deskriptif kuantitatif, dengan membandingkan nilai hasil uji terhadap standar baku mutu untuk menilai kesesuaian dan efektivitas sistem pengolahan air limbah rumah sakit. Hasil analisis menunjukkan bahwa seluruh parameter masih berada di bawah ambang batas baku mutu, menandakan bahwa sistem pengolahan air limbah di rumah sakit telah berjalan efektif. Namun demikian, fluktuasi nilai COD dan amoniak menunjukkan perlunya pemantauan berkala dan perawatan unit pengolahan limbah secara konsisten.

ABSTRACT

Hospital wastewater contains various chemical substances and pathogenic microorganisms that have the potential to pollute the environment and negatively impact public health. This study aims to analyze the quality of hospital wastewater at UPTD RSD dr. H. Soemarno Sosroatmodjo in 2025 based on physical, chemical, and microbiological parameters compared with the quality standards

stipulated in the Regulation of the Minister of Environment and Forestry (Permen LHK) of the Republic of Indonesia No. 68 of 2016. This research employed a quantitative descriptive design with a laboratory analysis approach. The population consisted of all wastewater quality test results from July to December 2025, while the sample included secondary data from laboratory test results covering seven main parameters: pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), oil and grease, ammonia, and total coliform. The research variables were the measured values of each parameter compared with the quality standard limits. The research instrument was the validated laboratory test report issued by UPTD RSD dr. H. Soemarno Sosroatmodjo. Data were analyzed using quantitative descriptive analysis by comparing each test result with the quality standard thresholds to evaluate the compliance and effectiveness of the hospital's wastewater treatment system. The results showed that all parameters remained below the quality standard limits, indicating that the hospital wastewater treatment system operated effectively. However, fluctuations in COD and ammonia values indicate the need for regular monitoring and consistent maintenance of the wastewater treatment units.

* Corresponding author : yuliajisiswanto@unw.ac.id

1. Introduction

Hospitals, as healthcare institutions, play a vital role in improving public health. However, they can also become a source of environmental pollution if the waste they produce is not managed properly. One type of waste with the greatest potential for environmental impact is hospital wastewater. This waste originates from various medical and non-medical activities, such as treatment rooms, laboratories, operating rooms, nutrition facilities, laundry, and administrative areas. According to (Kurniajati et al., 2023) Hospital wastewater generally contains organic and inorganic materials, heavy metals, chemicals, and pathogenic microorganisms that can cause environmental pollution if disposed of without prior treatment.

Hospital wastewater management remains a challenge in Indonesia (Permenkes RI, 2020) Around 40% of hospitals in Indonesia do not have Wastewater Treatment Plants (WWTP) that meet regulatory standards. This situation increases the risk of groundwater and water body pollution around hospitals,

which can affect public health and aquatic ecosystems. According to the World Health Organization, approximately 80% of wastewater from healthcare facilities in developing countries has not been treated according to environmental standards. This can increase the risk of water-borne diseases, such as diarrhea, skin infections, and gastrointestinal diseases. Therefore, regular monitoring of hospital wastewater quality is necessary to ensure compliance with applicable regulations. Untreated wastewater has the potential to carry pathogenic microorganisms such as *Escherichia coli*, *Salmonella* sp., and *Vibrio cholerae*, which can lead to outbreaks of water-borne diseases, including diarrhea, dysentery, and hepatitis A (WHO, 2024)

In addition to impacting human health, substandard wastewater disposal can also impact environmental quality broadly. Organic substances in wastewater increase Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), which lowers dissolved oxygen levels in water, thus disrupting aquatic life. Meanwhile, high levels of Total Suspended Solids (TSS) and oil and grease can cause water

turbidity and disrupt photosynthesis in aquatic organisms. According to (Rawis et al., 2022) Improperly treated wastewater is a major cause of river quality degradation in urban areas in Indonesia.

Meanwhile, the government's commitment to maintaining environmental sustainability has been outlined in various policies, including Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 68 of 2016 concerning Domestic Wastewater Quality Standards. This regulation stipulates maximum levels of pollutant parameters such as pH, BOD, COD, TSS, ammonia, oil and grease, and total coliform. Hospitals are required to ensure their wastewater meets these standards before being discharged into receiving water bodies. Compliance with this regulation is a crucial part of implementing green hospital principles and sustainable environmental management (Ahmed et al., 2025)

This study was conducted with the aim of analyzing the quality of hospital wastewater based on physical and chemical parameters at the UPTD RSD dr. H. Soemarno Sosroatmodjo in 2025. By comparing the results of laboratory tests against national quality standards, this study is expected to provide an overview of the effectiveness of the hospital wastewater treatment system and become the basis for recommendations for improving sustainable hospital environmental management.

2. Methods

This study employed a quantitative descriptive design with a laboratory analysis approach on hospital wastewater samples. The data used were secondary laboratory test results obtained from the Technical Implementation Unit (UPTD) of Dr. H. Soemarno Sosroatmodjo Regional Hospital (RSD) from July to December 2025. Data collection was conducted through documentation of hospital

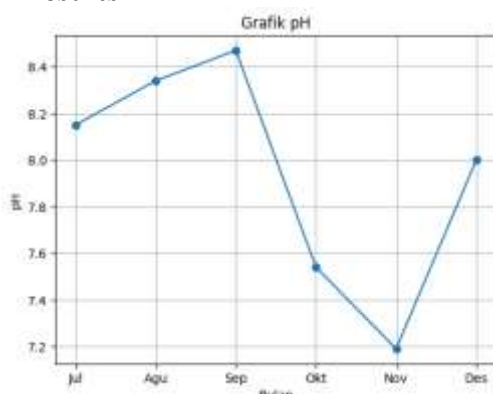
wastewater quality monitoring results analyzed in the laboratory in accordance with applicable Indonesian testing procedures and standards. The parameters analyzed included pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), oil and grease, ammonia, and total coliform. Each parameter was tested using standard methods referring to the Indonesian National Standard (SNI) and compared with the quality standards stipulated in Regulation of the Minister of Environment and Forestry of the Republic of Indonesia (PermenLHK RI) Number 68 of 2016 concerning wastewater quality standards for hospital activities.

The pH measurements were conducted using an electrometric method with a digital pH meter (SNI 06-6989.11-2004) to determine the acidity or alkalinity of the water. BOD parameters were tested using the modified Winkler method with incubation for five days at 20°C (SNI 6989.72:2009), while COD was analyzed using the closed reflux method using potassium dichromate ($K_2Cr_2O_7$) (SNI 6989.2:2019). Total Suspended Solid (TSS) testing was carried out gravimetrically, namely by filtering the sample using 0.45 μ m pore filter paper and weighing the dried residue at 105°C (SNI 06-6989.3-2004). Oil and fat content were analyzed using the n-hexane extraction method and gravimetric weighing (SNI 06-6989.10-2004). Meanwhile, ammonia (NH_3-N) levels were measured using a spectrophotometric method with Nessler's reagent (SNI 06-6989.30-2005) to detect ammonia nitrogen content derived from the decomposition of organic matter.

Total coliform parameters were tested using the Most Probable Number (MPN) method with three series of double tubes according to SNI 6774:2008 or APHA 9221 B procedures to identify the number of coliform bacteria in 100 mL of water samples. Laboratory test results were presented in descriptive tables and graphs, then compared with the threshold values

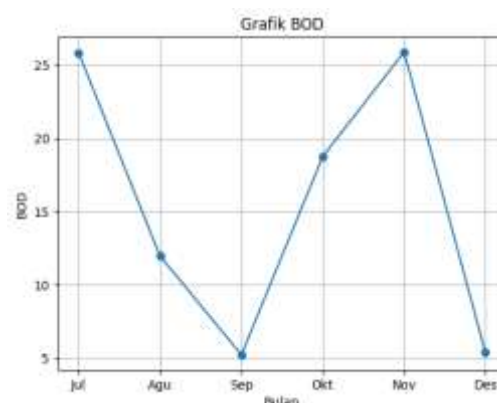
for hospital wastewater quality standards as stipulated in the Indonesian Ministry of Environment and Forestry Regulation No. 68 of 2016. The analysis was conducted descriptively and quantitatively, comparing the test results for each parameter against established standards to assess the level of contamination suitability and quality of hospital wastewater treatment.

3. Results



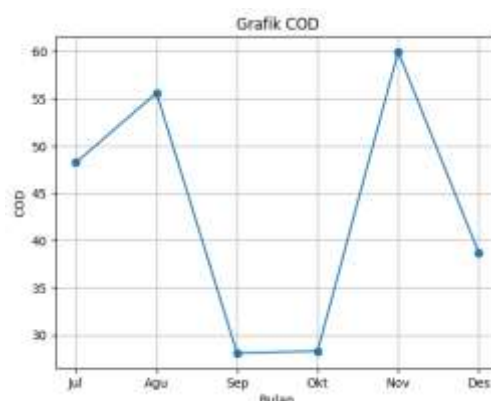
Graph 1. Laboratory Test Results of pH Parameters

Based on the graph, the pH value of the wastewater ranged from 7.19 to 8.47. All of these values are still within the required quality standard range (6–9), indicating that the acidity of the wastewater is relatively stable. This pH value, which tends towards neutral to slightly alkaline, indicates that the neutralization process in the Wastewater Treatment Plant (WWTP) is running well. The small fluctuations that occurred, especially the decrease in November, are still within safe limits and do not have the potential to disrupt the life of aquatic biota. pH stability is an important indicator of the success of chemical processes in wastewater treatment, because extreme pH can inhibit the activity of microorganisms in biological processes.



Graph 2. Laboratory Test Results of BOD Parameters

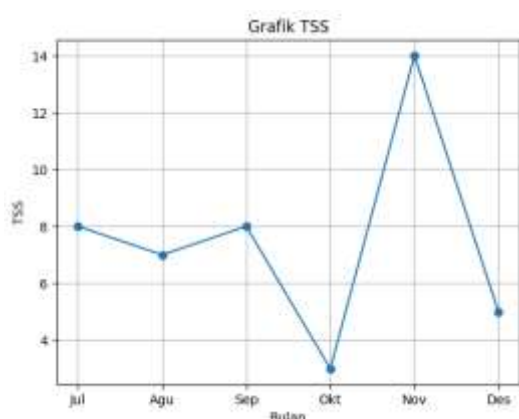
BOD values ranged from 5.23 to 25.89 mg/L, all below the quality standard threshold. This indicates that the biodegradable organic matter content in the wastewater is relatively low and has been effectively degraded through the biological processes in the wastewater treatment plant (WWTP). Significant decreases in September and December indicate optimal aeration efficiency and microbial activity. However, increases in July and November indicate variations in the incoming wastewater load, likely influenced by hospital activities. Overall, the low BOD values reflect the success of the treatment process in reducing potential organic pollution.



Graph 3. Laboratory Test Results of COD Parameters

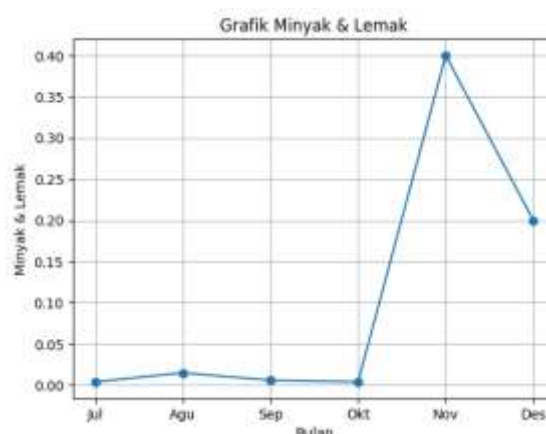
COD values ranged from 28.08 to 59.95 mg/L and remained well below the

established threshold. This indicates that the total organic matter content, both biodegradable and non-biodegradable, remains within the safe range. Fluctuations, particularly the increase in November, indicate variations in the chemical pollutant load. However, the consistently low COD values indicate that the wastewater treatment system is effectively controlling organic matter. The relatively consistent relationship between COD and BOD also indicates that most of the organic matter in the wastewater is biodegradable.



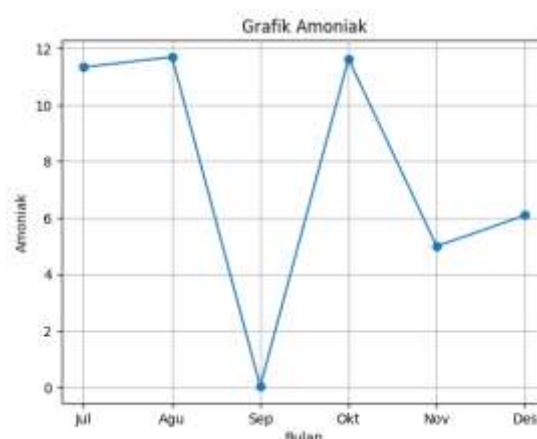
Graph 4. Laboratory Test Results of TSS Parameters

TSS values ranged from 3 to 14 mg/L, indicating very low suspended solids concentrations. This indicates that the sedimentation and filtration processes in the wastewater treatment plant (WWTP) are effective. Low TSS values are crucial for maintaining water clarity and facilitating sunlight penetration into the receiving water body. The increase in November remained within safe limits and was likely caused by increased domestic or medical wastewater activity. Overall, the low TSS reflects the efficiency of the physical processes involved in wastewater treatment.



Graph 5. Laboratory Test Results for Oil & Fat Parameters

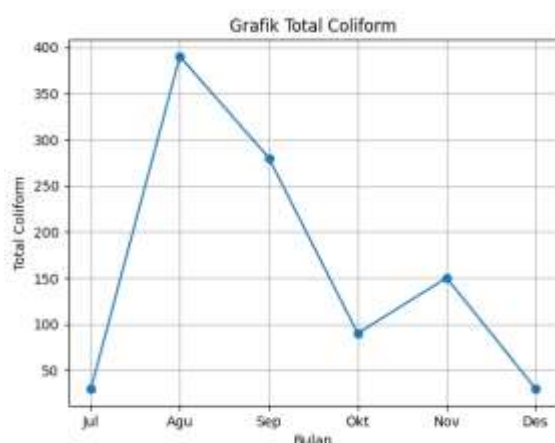
Oil and grease levels ranged from 0.004 to 0.400 mg/L, significantly below the standard quality threshold. This indicates that the oil and grease separation process in the wastewater treatment plant (WWTP) is very effective. These very low values also indicate that waste from kitchens and other activities that produce grease has been properly managed. Although there was an increase in November and December, the values remain within the safe range. Low oil and grease levels are important to prevent disruption of the aeration process and the formation of a film on the water surface.



Graph 6. Laboratory Test Results for Ammonia Parameters

Ammonia parameters showed significant fluctuations, with values ranging from 0.032 to 11.70 mg/L. Several months (July,

August, and October) exceeded the 10 mg/L standard. This indicates an imbalance in the nitrification process in the wastewater treatment plant (WWTP), which converts ammonia into nitrite and nitrate. High ammonia levels can be caused by increased nitrogen-containing wastewater loads, such as urine and organic waste. This situation indicates that although the treatment system is generally effective, optimization of the biological process, particularly in the nitrification unit, is necessary to stabilize ammonia levels and meet standards.



Graph 7. Laboratory Test Results for Coliform Parameters

Total coliform levels ranged from <30 to 390 MPN/100 mL, well below the established threshold. This indicates that the disinfection processes in the wastewater treatment plant, such as chlorination or the use of UV light, were highly effective. Despite an increase in August and September, the values remained within the safe range. Low coliform counts indicate that the discharged wastewater poses a low risk of microbiological contamination, making it safer for the environment and public health.

4. Discussion

The results of wastewater quality monitoring at the UPTD RSD dr. H.

Soemarno Sosroatmodjo show that in general all wastewater quality parameters pH, BOD, COD, TSS, oil and fat, and total coliform are still within the quality standards set in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No. 68 of 2016. This indicates that the hospital's Wastewater Treatment Plant (WWTP) system has worked quite effectively in reducing the pollutant load before being discharged into the receiving water body. The stable pH condition indicates that the neutralization process in the processing unit is running optimally (Anggoro & Mirwan, 2026).

Relatively low BOD and COD values indicate that organic matter is being adequately degraded through the WWTP's biological processes, such as aeration and sedimentation. Low BOD values typically correlate with low oxygen consumption by microorganisms, indicating efficient degradation of organic matter in hospital wastewater (Majumder et al., 2021). Likewise, a stable COD value reflects that most of the organic matter with chemical oxidation capabilities has been decomposed before being released into the environment, thereby reducing the risk of eutrophication in receiving waters (Suraini et al., 2025).

However, despite being within the safe range, fluctuations in parameters such as ammonia in July and August warrant attention. Ammonia is an indicator of inorganic nitrogen, often produced by protein decomposition and urine waste. Ammonia levels that exceed the quality standard could indicate variations in the wastewater load entering the wastewater treatment plant (WWTP) or an imbalance in the nitrification process within the wastewater treatment unit (Majumder et al., 2020). These fluctuations were also reported in other studies that demonstrated the challenges of nitrogen treatment without further steps such as specialized biofilm reactors or anammox processes for nitrogen removal (Suraini et al., 2025).

A consistently low TSS (Total Suspended Solids) parameter indicates that the sedimentation and filtration stages in the wastewater treatment plant (WWTP) are working effectively, allowing suspended solid particles to settle before the wastewater is released into the water body. A low TSS value is important for maintaining water clarity and preventing the obstruction of sunlight penetration, which can damage aquatic ecosystems. These results align with other hospital wastewater monitoring studies that also found that physical sedimentation in WWTPs is quite capable of significantly reducing TSS (Musri S. & Syahlan, 2023). The very low oil and fat content indicates that the separation and reduction of non-polar compounds is also proceeding well, although kitchen waste and hospital service areas can potentially produce these components. High oil and fat content in hospital waste can disrupt the aeration process and cause surface waters to be less efficient in oxygen exchange (Rawis et al., 2022).

A very low total coliform count indicates the disinfection system's success in reducing the risk of microbiological contamination. Total coliform count is often used as an indicator of the presence of pathogenic microorganisms in wastewater. An effective disinfection process, whether through chlorination or UV methods, can reduce coliform counts to below the quality standard threshold, thereby reducing the potential for the spread of water-borne infections (Habibah & Utami, 2025). Compared with other studies in Indonesia, there is variation in the level of compliance with quality standards between health facilities. Some studies even found that at the inlet of the wastewater treatment plant (WWTP), parameters such as BOD, COD, and TSS often exceed environmental standards before treatment, while at the outlet, the

treatment results are more controlled (Islami & Mirwan, 2026).

The implications of these findings confirm that although the UPTD RSD dr. H. Soemarno Sosroatmodjo Wastewater Treatment Plant (IPAL) is generally effective, operational conditions such as seasonal waste load variations, technical problems with the aeration blower, or the need for increased hydro-biological stages still need to be considered to ensure long-term performance stability.

Conclusion

Based on the results of research and analysis conducted on the quality of hospital wastewater at the UPTD RSD Dr. H. Soemarno Sosroatmodjo in 2025, it can be concluded that the overall wastewater treatment system (WWTP) is functioning well and meets the quality standards stipulated by the Indonesian Ministry of Environment and Forestry Regulation No. 68 of 2016. Physical and chemical parameters such as pH, BOD, COD, TSS, oil and grease, and total coliform levels are within the safe range, demonstrating the effectiveness of the hospital's wastewater treatment system. This reflects the hospital's commitment to sustainable environmental management.

However, the finding of increased ammonia levels in July and August indicates fluctuations in wastewater load that require serious attention. This condition may be related to increased medical activity, variations in chemical use in the laboratory, or an imbalance of microorganisms in the WWTP's biological processes. Regular monitoring, evaluation of the treatment unit's performance, and optimization of the nitrification system are necessary to prevent future spikes in ammonia levels. Furthermore, the results of this study also emphasize the

importance of continuous environmental monitoring in healthcare facilities. Hospitals need to strengthen governance aspects l.

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