International Journal of Contemporary Sciences (IJCS)
Vol. 3, No. 12, 2025: 579-590

Analysis of the Wastewater Treatment System at Dompu Regional General Hospital, West Nusa Tenggara

Muhamad Yamin
Universitas Qamarul Huda Badaruddin Bagu
Corresponding Author: Muhamad Yamin yaminmuhamad446@gmail.com

A R T I C L E I N F O

Keywords: Wastewater, Anaerobic Biofilter WWTP, Descriptive, Parameters, Effectiveness

Received : 10 October
Revised : 15 November
Accepted: 30 December

A B S T R A C T

Dompu General Hospital as one of the health facilities in Dompu Regency must be able to treat wastewater properly. The hospital' s Wastewater Treatment Plant (WWTP) needs to be evaluated periodically to ensure that its performance is effective and efficient in processing wastewater. This research used is an experiment by conducting observational with a descriptive approach to evaluate the performance of the wastewater treatment plant system and to determine the effectiveness of the Biofilter Anaerobic Aerobic WWTP at Dompu General Hospital. The results of the quality test wastewater sample Biofilter Anaerobic Aerobic WWTP obtained from the parameters of TSS, BOD, COD, Oil and Water parameters and pH, show show figures within the standard for hospital wastewater quality. The results of laboratory tests for the 5 parameters are as follows: Total Suspended Solids (TSS) with a standard of 30 mg/L obtained a waste treatment result is 18.0 mg/L. Biological Oxygen Demand (BOD) test obtained a waste treatment process was 1.47 mg/L. The waste treatment results of Chemical Oxygen Demand (COD) was carried out, 28.9 mg/L. The waste treatment result of Oil & Water was carried out<1,00 mg/L

DOI: https://doi.org/10.55927/ngexj571
E-ISSN: 3047-4078
https://journalijcs.my.id/index.php/ijcs

INTRODUCTION

In providing health services to the public, hospitals play a crucial role as healthcare institutions. However, daily hospital operations also produce liquid waste that has the potential to contain substances hazardous to public health. Hospital liquid waste can contain various pollutants, such as chemicals, drugs, and pathogenic microorganisms, which can negatively impact the environment and public health if not managed properly. Hospitals are healthcare institutions that provide comprehensive personal services, including inpatient care, outpatient care, and emergency services (Ministry of Health No. 340/MENKES/PER/III 2010). (1)

Before disposing of waste, hospitals must have a wastewater treatment system. An effective and efficient Wastewater Treatment Plant (WWTP) can help reduce pollutant levels in liquid waste, thereby preventing it from posing a risk to the environment and public health. Therefore, it is crucial to ensure that the hospital's WWTP is functioning optimally and complies with applicable wastewater quality standards. (2)

Dompu General Hospital, as one of the healthcare facilities in Dompu Regency, also produces liquid waste that must be properly treated. The performance of the WWTP at this hospital needs to be evaluated periodically to ensure its effectiveness and efficiency in processing liquid waste. This evaluation process can help identify existing problems and provide suggestions for improvements to improve the WWTP's work processes.

In recent years, public and government awareness of the importance of proper wastewater management has increased. Stricter wastewater quality regulations and standards are now being implemented to ensure that waste discharged into the environment does not pose a hazard. Therefore, it is important for hospitals to ensure that their wastewater treatment plants (WWTPs) meet the expected quality standards. Therefore, a study on wastewater treatment at Dompu General Hospital is necessary to provide useful information for hospital management to improve WWTP performance (3).

In accordance with Regulation of the Minister of Environment of the Republic of Indonesia Number 5 of 2014, the results of wastewater treatment through a Wastewater Treatment Plant must comply with the following established standards (4):

Table 1. Domestic Wastewater Standards for Hospitals

Parameter	Highest concentration	
Physics	Mark	Unit
Temperature	38	^{0}C
Dissolved solids	2.000	mg/L
Suspended solids	200	mg/L
Chemistry		
Ph	6-9	mg/L
BOD	50	mg/L
COD	80	mg/L
TSS	30	mg/L
Oil and fat	10	mg/L
MBAS	10	mg/L
Ammonia nitrogen	10	mg/L
Total Coliform	5.000	(MPN/100ml)

Descriptive statistics are statistics used to analyze data by describing or depicting the collected data as it is (Husaini Usman, 2013). Descriptive methods use data obtained from a sample to explain or draw conclusions about the sample. Furthermore, descriptive analysis can explain various characteristics of variables, such as size. centralization, plotting, tabular/graphic presentation, and so on (Martias, 2021). (5)

To determine the effectiveness of the wastewater treatment plant (WWTP) at Dompu General Hospital, samples were taken at the WWTP inlet and outlet points, taking into account the resistance time. The effectiveness test was calculated by the percentage of the inlet point to the outlet point. (6)

LITERATURE REVIEW

Hospital Wastewater

Hospital wastewater is wastewater generated from various medical activities, including healthcare services, laboratories, operating rooms, surgical installations, kitchens, laundries, pharmacies, and patient and visitor activities. According to the Ministry of Health (Ministerial Regulation No. 7 of 2019), hospital wastewater is categorized as waste containing pathogenic microorganisms, hazardous chemicals, residual pharmaceuticals, radioisotopes, and organic and inorganic pollutants that have the potential to pollute the environment. Typical characteristics of hospital wastewater are: biological: pathogenic bacteria, viruses, parasites (such as E. coli, Salmonella, Shigella), chemical: detergents, chlorine, ammonia, heavy metals, residual pharmaceuticals, physical: cloudy color, unpleasant odor, high TSS, and higher temperature compared to raw water. These characteristics require more stringent treatment processes than ordinary household wastewater.

Wastewater Treatment Parameters and Quality

Analysis of hospital wastewater treatment systems typically uses water quality parameters such as the following: BOD, to determine how much oxygen microorganisms need to decompose organic matter. Among other things, a high BOD value indicates significant organic pollution; COD, to measure the chemical oxygen demand for the oxidation of organic compounds in wastewater. COD values are often higher than BOD because they include organic matter that is difficult to decompose; TSS, to indicate the amount of suspended solids, which can affect turbidity and the effectiveness of the filtration process; and pH, to indicate the acidity or alkalinity of the wastewater. Biological treatment processes require a neutral pH for the survival of microorganisms. Ammonia and nitrate originate from human metabolic activity or are nitrogen products of organic matter. Hospital wastewater quality standards are stipulated in Minister of Health Regulation No. 7 of 2019 and Government Regulation No. 22 of 2021.

Hospital Wastewater Treatment Systems

a) Equalization Tank (Balance Tank), aims to stabilize the flow and concentration of pollutants before entering the main process. Hospitals experiencing large fluctuations, such as laboratories and emergency units, require this tank to maintain the stability of the WWTP system.
b) Pre-filtration, functions to remove large solids such as tissues, bandages, plastic, and non-hazardous medical waste to prevent damage to pumps and pipes.
c) Anaerobic Process, a process in the absence of oxygen, using an anaerobic tank or anaerobic septic tank to break down organic pollutants. This method is particularly suitable for high organic waste loads.
d) Aeration (Aerobic Biological Process), is a key process in many WWTPs in Indonesian hospitals, such as extended aeration and activated sludge. This aerobic method is effective in reducing BOD, COD, and pathogenic bacteria.
e) Sedimentation (Secondary Clarifier), functions to separate activated sludge from aerated water. Some of the sludge is recycled.
f) Disinfection (Chlorination/UV) This final stage kills pathogenic bacteria. Chlorine (NaOCl) is often used, but UV is gaining popularity because it doesn't produce chemical residues.
g) Sludge Treatment

Sludge treatment can include thickening, drying, and transport to a landfill in accordance with hazardous waste regulations.

Relevant Previous Research

1. Sutrisno (2020) – Evaluation of the efficiency of SBR-type hospital wastewater treatment plants showed a BOD reduction of up to 90%.
2. Wulandari (2021) – Analysis of hospital wastewater treatment plants using MBBR showed a COD efficiency of 85–92%.
3. Hidayat (2019) – Conventional aeration systems are still capable of reducing BOD but are weak bacteriologically without optimal disinfection.

4. Rahman (2022) – Comparison of anaerobic and aerobic processes in hospital wastewater shows that a combination of both methods produces the highest efficiency.

METHODOLOGY

Type of Research

The type of research used is an experiment with laboratory tests according to standard parameters. The test results will then be presented using a descriptive statistical approach to evaluate the system performance and effectiveness (%) of the anaerobic aerobic biofilter wastewater treatment plant (WWTP) at Dompu Regency Hospital. The variables studied are the concentrations of the chemical parameters of the liquid waste, namely:

Table 2. Experimental Variables

Parameter	Unit
Total Suspended Solid (TSS)	mg/L
Chemycal Oxygen Demand (COD)	mg/L
Biologycal Oxygen Demand (BOD)	mg/L
Oil and fat	mg/L
pH rad	-

Then, the TSS, BOD, COD, Oil & Grease concentrations, and pH will be analyzed in a laboratory by taking samples from the inlet and outlet of liquid wastewater at Dompu Regional Hospital.

Laboratory Analysis Stage

Laboratory analysis uses test methods that comply with Indonesian National Standards. The method used in BOD testing is SNI 6989.72-2009. This method determines the amount of dissolved oxygen required by aerobic microbes to oxidize the organic carbon in the sample.

The Chemical Oxygen Demand (COD) test in SNI 6989.2-2009 uses a closed reflux spectrophotometric method.

The principle involves reacting a water sample with a dichromate solution under acidic conditions at a high temperature, followed by measuring the resulting trivalent chromium concentration using spectrometry. This method involves preparing a water sample and a dichromate solution, reacting the sample with the dichromate at 150°C for 2 hours, and then measuring the trivalent chromium concentration using spectrometry at specific wavelengths.
High: 100 mg/L – 900 mg/L at a wavelength of 600 nm; Low: ≤ 90 mg/L at a wavelength of 420 nm. 2 mg/L: estimated Method Detection Limit (MDLest).

Oil is fat that exists in liquid form. To test the oil and fat content in water and wastewater, a solvent extraction method is used. In this analysis, the process

involves extracting oil and fat from a water sample using an organic solvent, then measuring the weight of the extracted oil and fat.

The steps in the analysis are:

a. Collecting and preparing the water sample.
b. Separating the solvent phase from the water phase.
c. Evaporating the solvent to obtain the oil and fat residue.
d. Weighing the oil and fat residue.

Next, the oil and fat content is calculated based on the weight of the collected residue and the volume of the water sample used, followed by direct pH measurement using a pH meter.

The steps are as follows:

a. Calibrate the pH meter using a standard buffer solution.
b. Read the pH value on the pH meter after the measurement is stable.
c. Finally, record the pH measurement results.

The data obtained is then analyzed using a comparison method between the test results of the outlet and inlet parameters to calculate their effectiveness.

Descriptive Presentation of Results

Data presentation in tables is a concise and clear representation of numbers in row and column format. Data in the purpose of using diagrams or graphs is to help make large and complex data easier to understand. They provide a more engaging and informative way of conveying information. An example of a type of graph that can be used is a bar chart, which is used to display discrete data or categorical data. Diagrams and graphs are often found in the output of statistical software such as Excel, SPSS, Spreadsheets, and others.

Effectiveness Data Analysis

The effectiveness value calculation was performed to determine the effectiveness of the Dompu Regency Hospital's Anaerobic Biofilter Wastewater Treatment Plant (WWTP), as follows (Sugiarto, 1987):

Effectiveness (%) =

Where:

A = Parameter level at inlet
B = Parameter level at outlet

RESEARCH RESULT

Descriptive Test Results

The following graph shows a comparison of the inlet and outlet parameter test results for the Aerobic Anaerobic Biofilter Wastewater Treatment Plant (WWTP) at the Dompu Regency Regional Hospital, in accordance with Regulation of the Minister of Environment of the Republic of Indonesia Number 5 of 2014 concerning Liquid Waste Quality Standards for Hospital Activities.

1. Total Suspended Solids (TSS)

The graph of the chemical parameter test results for the Total Suspended Solids (TSS) concentration from the Dompu General Hospital's Anaerobic Biofilter Wastewater Treatment Plant (WWTP) can be seen in Figure 1.

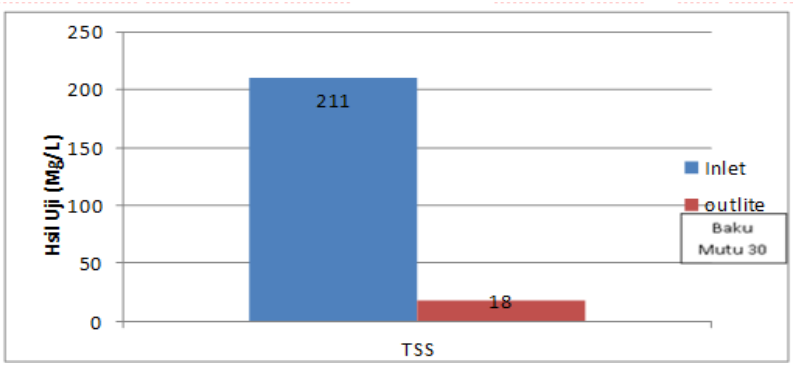

Figure 1. The graph of the chemical parameter test results for the Total Suspended Solids (TSS)

The graph above shows that the TSS parameter value of 18 mg/L is very low. Therefore, the TSS parameter, or suspended solids, meets the specified standards for wastewater quality.

2. Biological Oxygen Demand (BOD)

A graph of the results of the chemical parameter test comparison at the Biological Oxygen Demand concentration from the Dompu Regional Hospital Wastewater Treatment Plant (WWTP) is shown in Figure 2.

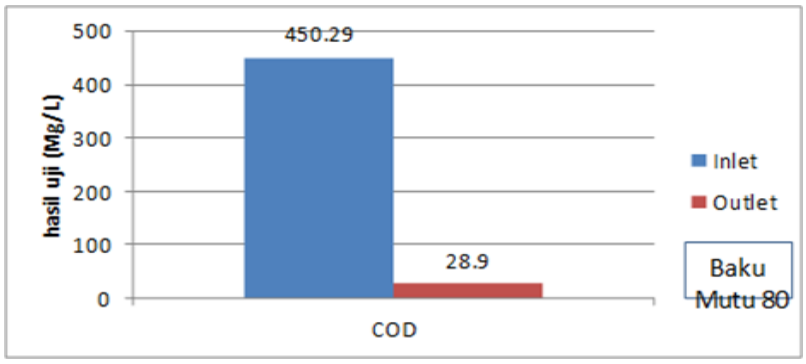

Figure 2. Biological Oxygen Demand (BOD)

The graph above shows that the BOD parameter value is very low, at 1.47 mg/L. Therefore, the BOD (Biological Oxygen Demand) parameter meets the established hospital wastewater quality standard of 50 mg/L.

3. Chemical Oxygen Demand (COD)

Descriptive comparison results of chemical parameter tests at the Chemical Oxygen Demand (COD) concentration of the anaerobic and aerobic biofilter wastewater treatment plants (WWTPs), as seen in Figure 3.

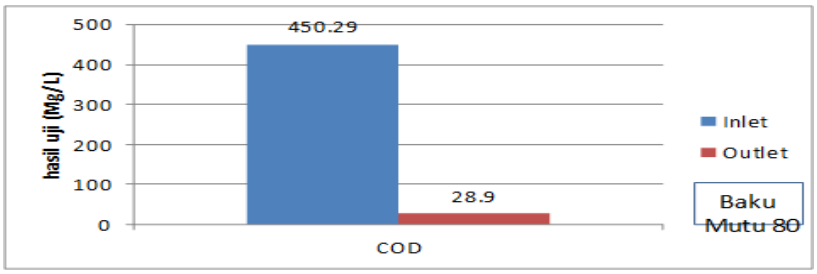

Figure 3. Chemical Oxygen Demand (COD)

The graph above shows that the COD parameter value is very low at 28.9 mg/L. Therefore, the COD or chemical demand parameter meets water quality standards. Hospital wastewater is set at 80 mg/L.

4. Oil and Grease

Descriptive comparison results of oil and water concentration tests from aerobic and anaerobic biofilters are presented in the following diagram.

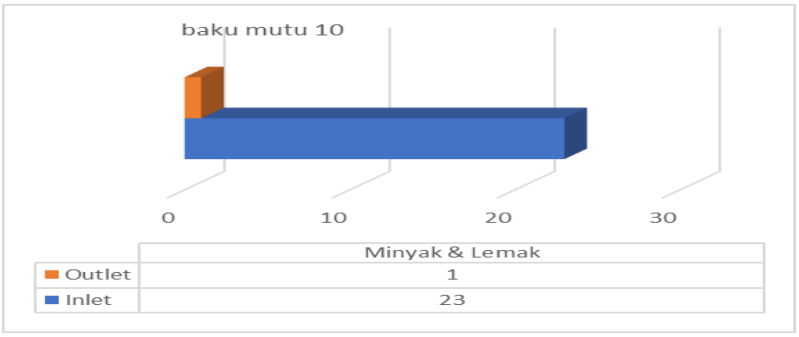

Figure 4. Oil and Grease

The graph above shows that the oil and fat parameter value at 1 mg/L is very low. Therefore, the oil and fat parameters comply with the wastewater quality standard set at 10 mg/L. Water with high oil and fat content can create an anaerobic atmosphere, which can affect aquatic biota.

5. Acidity (pH)

A comparison graph of the pH concentration test of an anaerobic/aerobic biofilter is shown in Figure 5 below.

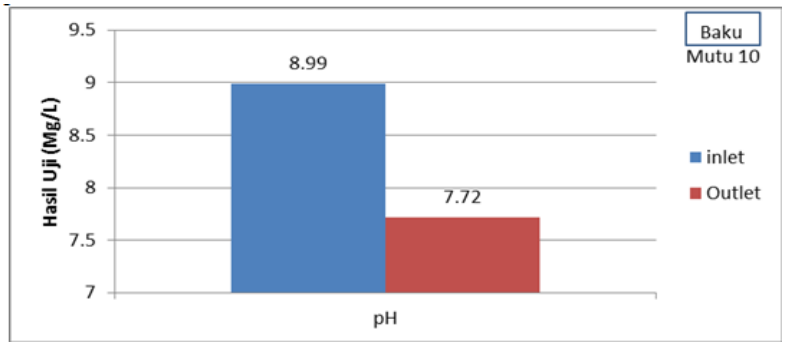

Figure 5. Acidity (pH)

The graph above shows that the pH parameter value is 7.72. Therefore, the pH parameter meets the established hospital wastewater quality standards,

which range from 6.0 to 9.0. The pH of wastewater is greatly influenced by the activity of microorganisms within it and the characteristics of the waste itself. Wastewater also significantly affects the pH value of wastewater. Wastewater with extreme pH values is biologically difficult to treat. Water with a high pH value can be caused by a surplus of ammonia-N, while a low pH value is caused by the presence of excess ammonium-N.

Discussion and Evaluation

The evaluation was conducted by taking water samples from the inlet and outlet of the Wastewater Treatment Plant (WWTP) at the Dompu Regency General Hospital. These samples were then tested at the West Nusa Tenggara Province Health Laboratory Testing and Calibration Center using five parameters: Total Suspended Solids (TSS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Oil and Grease, and pH. The test results from the inlet and outlet samples were then compared with the maximum limits for hospital wastewater quality standards stipulated in Decree of the Minister of Environment of the Republic of Indonesia Number 5 of 2014 concerning Liquid Waste Quality Standards for Hospital Activities. The following table shows the results of the laboratory tests.

Table 3. Results of the IPAL Inlet Sample Test

Parameter	Hasil	Satuan	Baku Mutu
TSS*	211	mg/L	SNI-06-6989.3-2004
BOD*	348,30	mg/L	SNI-6989.72-2009
COD*	450.29	mg/L	SNI-6989.2-2009
Oil and fat	23	mg/L	SNI-06-6989.10-2004
pH*	8,99	-	SNI-06-6989.11-2004

Source: Laboratory Examination Results

The outlet sample test results showed a significant decrease compared to the inlet sample data. Table 3 shows the test results for TSS, BOD, COD, and oil and grease concentrations, which were far below the quality standards.

Tabel 4. Results of the IPAL Outlet Sample Test

Parameter	Hasil	Satuan	Metode	Baku Mutu
TSS*	18,0	mg/L	SNI-06-6989.3-2004	30
BOD*	1,47	mg/L	SNI-6989.72-2009	30
COD*	28,9	mg/L	SNI-6989.2-2009	100
Oil and fat	<1,00	mg/L	SNI-06-6989.10-2004	5
pH*	7,72	-	SNI-06-6989.11-2004	6,0-9,0

Source: Laboratory Examination Results

Based on Tables 3 and 4, the effectiveness value of the Dompu Regional Hospital's wastewater treatment plant (WWTP) performance can be calculated using the formula in equation (1). The calculated results are presented in Table 5.

Table 5. Effectiveness Value Table

Parameter	Baku Mutu	Efektivitas (%)
TSS	30	91,46%
BOD	50	99,57%
COD	80	93,58%
Oil and fat	10	-
pH	10	-

The system effectiveness percentage results averaged above 90%. This indicates that the anaerobic and aerobic biofilter wastewater treatment plant (WWTP) at Dompu Regency Hospital is effective.

Observations and calculations revealed several system components that were damaged, which could potentially impact the hospital's WWTP performance.

DISCUSSION

Analysis of the wastewater treatment system at Dompu Regional General Hospital (RSUD) shows that the wastewater treatment process follows the basic flow of hospital Wastewater Treatment Plants (WWTPs): physical, biological, and disinfection processes. However, treatment effectiveness is still influenced by several factors, including the condition of the WWTP units, daily waste load, and operational and maintenance quality.

CONCLUSIONS AND RECOMMENDATIONS

The performance of the Dompu Regional General Hospital's Aerobic Anaerobic Biofilter Wastewater Treatment Plant (WWTP) system is optimal. This is consistent with the results of the wastewater outlet quality testing of the Aerobic Anaerobic Biofilter WWTP, which showed satisfactory results. Test results for the chemical parameters: TSS, BOD, COD, Oil and Water, and pH, indicate that the concentrations are within the government-established hospital wastewater quality standards. Laboratory test results for these five chemical parameters are as follows:

a) Total Suspended Solids (TSS) with a standard of 30 mg/l. After treatment, the result was 18.0 mg/l.
b) Biological Oxygen Demand (BOD) with a standard of 50 mg/l. After treatment, the result was 1.47 mg/l.
c) Chemical Oxygen Demand (COD) with a standard of 80 mg/l. After treatment, the result was 28.9 mg/l.
d) Oil and fats with a standard of 10 mg/L. After processing, the concentration was <1.00 mg/L.
e) pH (degree of acidity) with a standard of 10. After processing, the concentration was 7.72.

Based on experimental tests and analysis results, the effectiveness of the Aerobic Anaerobic Biofilter Wastewater Treatment Plant (WWTP) at Dompu

Regency General Hospital ranged from 91% to 95%. This level of effectiveness is sufficient for optimal WWTP performance.

Based on the analysis and discussion, several recommendations can be put forward, as follows: optimizing the equalization tank, increasing capacity or improving the flow control system is necessary to stabilize the organic load before it enters the biological process. This is crucial for maintaining consistent aeration performance. Improving the performance of the Aeration Unit includes regularly checking the blowers and diffusers, increasing the number of aerators or replacing them with units with larger capacities, and maintaining DO levels in the range of 2–4 mg/L to ensure optimal microbial performance.

ADVANCED RESEARCH

This research is certainly not perfect and still has many shortcomings, this is because at the time of measurement, a small flow discharge was carried out affecting the velocity analysis on the channel cross-section, so that future research can analyze the rainfall that enters and is accommodated by the lanangga Reservoir so that an analysis of the discharge that comes out of the gate can be carried out so that the analysis results are more optimal, for research to continue and improve.

ACKNOWLEDGMENT

We would like to thank the Director of Dompu Regency Hospital for assisting us and providing access to the data needed for this research. This research was funded by our own funds.

REFERENCES

A study by Putri et al. (2020) found that WWTP efficiency is highly dependent on hydraulic residence time and the type of biological reactor used.

According to Saputra & Widodo (2019), routine maintenance and monitoring of effluent quality are critical factors in maintaining the effectiveness of hospital WWTPs.

Based on the results of a study by Nuraini et al. (2022), hospital management awareness of environmental regulations has increased along with the enforcement of environmental laws.

Handayani et al. (2021) emphasize the importance of periodically evaluating WWTP performance to minimize the impact of water pollution around hospitals.

Lestari, D. (2024). Membrane Technology Innovation for Hospital Wastewater Treatment. Journal of Environmental Engineering, 32(1), 21–29.

Martias, R. (2021). Descriptive Statistical Analysis in Engineering Research. Bandung: Alfabeta Press.

Nuraini, S., Sari, M., & Taufiq, R. (2022). Implementation of Hospital Wastewater Management Regulations in Indonesia. Journal of Law and Environment, 18(3), 301–312.

Putri, A. D., Susanto, B., & Kurniawan, H. (2020). Analysis of Hospital Wastewater Treatment Plant System Efficiency Based on BOD, COD, and TSS Parameters. Journal of Civil and Environmental Engineering, 25(1), 45–53.

Rahmadani & Yusuf (2023) reported that the implementation of an aerated biofilter-based wastewater treatment plant (WWTP) system can reduce BOD levels by up to 90%.

Rahmadani, F., & Yusuf, M. (2023). Application of Aerated Biofilters in Hospital Wastewater Treatment. Journal of Technology and Water, 12(4), 87–95.

Regulation of the Minister of Environment of the Republic of Indonesia Number 5 of 2014 establishes quality standards for domestic wastewater, including hospital wastewater.

Regulation of the Minister of Environment of the Republic of Indonesia Number 5 of 2014 concerning Wastewater Quality Standards. Jakarta.

Research by Rahayu & Sitorus (2018) shows that suboptimal hospital wastewater treatment plant (WWTP) systems can increase BOD and COD levels in the surrounding environment.