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Effectiveness of Wastewater Treatment Plant (WWTP) on Domestic Wastewater Parameters at the Colonel H.M Syukur Regional Mental Hospital, Jambi

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Abstract
Introduction: *Wastewater management at the Colonel H.M. Syukur Jambi Regional Mental Hospital is a crucial concern for maintaining environmental sustainability and public health. This is based on the quality standards established by the Minister of Environment and Forestry Regulation No. 68 of 2016.* ***Objective:*** *analyzing the effectiveness of the wastewater treatment plant (WWTP) at the Colonel H.M Syukur Jambi Regional Mental Hospital and examining the relationship between inlet and outlet wastewater parameters using the product moment correlation test.* ***Method****: Data was obtained from periodic laboratory testing and secondary data from the hospital, using descriptive analysis as the method.* ***Results and Discussion:*** *The wastewater treatment plant (WWTP) at the Kol. H.M. Syukur Regional Mental Hospital in Jambi is quite effective, with a value of 80-89% in reducing pollutant levels, with some parameters meeting the established quality standards. Correlation tests show a relationship between COD and BOD, and oil and fat parameters with ammonia.* ***Conclusion:*** *there is a significant relationship between the inlet and outlet that supports the success of the processing process*

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Introduction

Globally, healthcare facilities generate significant volumes of waste. Approximately 85% of this total waste is classified as domestic waste, while the remaining 15% is hazardous medical waste that is potentially infectious, contains chemicals, or is radioactive (Elvania & Purwaningrum, 2024); (Saputro & Dwiprigitaningtias, 2022). The management and handling of liquid waste in hospitals has received international attention, as emphasized in the agendas of international conferences such as the High-Level Meeting on Environment and Health of Southeast and Eastern ASEAN Countries, which also covered household and medical waste management. At the national level, Indonesia faces significant challenges in healthcare waste management. According to the 2021 Environmental Health Activity Performance Report, the national average for healthcare facilities that manage medical waste according to standards is only 28.23%. This figure indicates that most facilities still do not meet established standards (Sukadewi, Astuti, & Sumadewi, 2020); (Maharani & Prakoso, 2023); (Alfianti, Rismawati, & Latifah, 2025); (Syahjiah & Latifah, 2025); (Putri et al., 2024)

The situation in Jambi Province is even more alarming. Data shows that only 13.2% of healthcare facilities in Jambi Province have successfully achieved medical waste management standards, far below the national average. This situation indicates significant gaps in compliance and waste management infrastructure in Jambi Province. The low level of compliance with hazardous medical waste management in Jambi indirectly points to broader systemic weaknesses in the overall waste management infrastructure. If a region struggles to handle more regulated and hazardous medical waste, it's likely that domestic hospital waste, considered "non-hazardous," also receives inadequate attention or is processed by suboptimal systems. This highlights fundamental weaknesses in environmental health management in Jambi Province, which require in-depth research at the local level.

While medical waste is inherently hazardous and requires special handling, the larger volume of domestic liquid waste from hospitals also carries potential risks. This waste originates from routine activities such as the kitchen (washing equipment, food scraps) and laundry (washing linen). Although it does not contain hazardous chemicals like medical waste, domestic liquid waste still has the potential to contain pathogenic microorganisms due to the high level of human activity and the diverse range of patient illnesses in the hospital environment. Inadequate treatment of domestic liquid waste from hospitals can have serious consequences for the environment and public health. Water pollution from hospital waste can cause various waterborne diseases, such as diarrhea, cholera, and hepatitis (SAPUTRA, ARJITA, SYUHADA, & ADNYANA, 2024); (Kurniajati, Purnama, & Yulianto, 2023). This aligns with Said (2012)'s opinion that hospital waste is all waste generated by hospital activities and other supporting activities. Given the potential impacts, appropriate management efforts are needed to treat domestic waste that meets environmental hygiene standards.

Furthermore, the decomposition of untreated organic waste can produce unpleasant odors that disrupt the comfort and quality of life of the community surrounding the hospital. Broader impacts include contamination with emerging contaminants (such as pharmaceutical residues and antibiotic-resistant bacteria or ARB) that cannot be effectively treated by wastewater treatment plants. The presence of these contaminants can contribute to the spread of antibiotic resistance and have harmful effects on aquatic ecosystems. Therefore, the urgency of this research lies not only in the management of

ordinary domestic waste, but also in the management of potentially highly contaminated waste streams that, if not properly treated, pose significant public health risks and environmental damage.

Given these risks, national regulations mandate that every hospital must have a Wastewater Treatment Plant (WWTP) that meets standards (Dirgahayu et al., 2024). Key regulations underlying this requirement include Law No. 44 of 2009 concerning Hospitals, Minister of Health Regulation No. 147 of 2010 concerning Hospital Licensing, and Minister of Health Decree No. 1204 of 2004 concerning Hospital Environmental Health Requirements. Failure to comply with these regulations can result in severe sanctions, including temporary suspension of operations or revocation of the hospital's permit, as stipulated in Article 27 (INDONESIA, 2009)

This research specifically focuses on the Colonel H.M. Syukur Jambi Regional Mental Hospital (RSJD), the only mental hospital in Jambi Province. This unique location makes its waste management practices crucial for public health and environmental protection in the region. It is located on Jl. Dr. Purwadi, Km 9.5, Aur Kenali Village, Telanaipura District, Jambi City. In addition to treating and curing patients with mental disorders, like ordinary hospitals in general, the Colonel H.M Syukur Regional Mental Hospital also has the potential to cause negative impacts resulting from health service activities.

The Colonel H.M. Syukur Regional Mental Hospital (RSJD) in Jambi has experienced a significant increase in patient visits, with inpatients increasing by 24% in 2023. This increase in patient numbers is directly correlated with an increase in the volume of liquid waste generated from various hospital activities. The amount of wastewater generated by a hospital depends on several factors, including the number of beds, the availability of common services (such as kitchens and air conditioning), the type of ward or unit, and management policies. This increase in operational load has important implications for wastewater management capacity. Wastewater treatment plants are designed for specific loads. A significant increase (24% in one year) means the wastewater treatment plant (WWTP) is operating under conditions that potentially exceed its design capacity or optimal operating range.

Wastewater management at the Colonel H.M. Syukur Regional Mental Hospital in Jambi is a critical concern for maintaining environmental sustainability and public health. Wastewater from the Colonel H.M. Syukur Regional Mental Hospital can contain hazardous chemicals, pathogens, and other substances that have the potential to pollute the environment and endanger human health. Therefore, analyzing the effectiveness of the Wastewater Treatment Plant (WWTP) of the Colonel H.M Syukur Jambi Regional Mental Hospital is crucial in ensuring that the wastewater has been properly treated before being discharged into the environment. This study will specifically examine the parameters of TSS, TDS, pH, BOD, COD, Oil and Grease, Ammonia, Detergent as MBAS, and Coliform. Each of these parameters was chosen because they directly reflect important aspects of the WWTP's performance and its ability to address the unique characteristics of hospital wastewater, especially under increased operational loads.

Method

The type of research used in this study is a quantitative research method with a descriptive type of research that aims to obtain the results of the analysis of the effectiveness of the wastewater treatment installation (WWTP) of the Colonel H.M Syukur Regional Mental Hospital, Jambi. This research was conducted in December

2024. This research was conducted at the Colonel H.M Syukur Regional Mental Hospital, Jambi. Secondary data required in writing this final assignment include: inlet laboratory analysis, outlet laboratory analysis. Based on the data obtained from the field study to the WWTP of the Colonel H.M Syukur Regional Mental Hospital, Jambi, each parameter will be analyzed based on existing theories in the literature. This analysis includes calculating the effectiveness of the performance of the wastewater treatment unit of the Colonel H.M Syukur Regional Mental Hospital, Jambi, which is characterized by the percentage of pollutant removal. Evaluation of the effectiveness of this WWTP will be based on the percentage of removal and a comparison of the outlet quality with the permitted quality standards based on PERMEN LHK-RI No. 68 of 2016 concerning Domestic Liquid Waste.

Results and Discussion

pH

Based on the environmental quality standards stipulated by the Minister of Environment and Forestry Regulation No. 68 of 2016 concerning domestic waste, it is stated that the degree of acidity (pH) of wastewater that is safe to be discharged into the environment is in the pH range of 6-9.

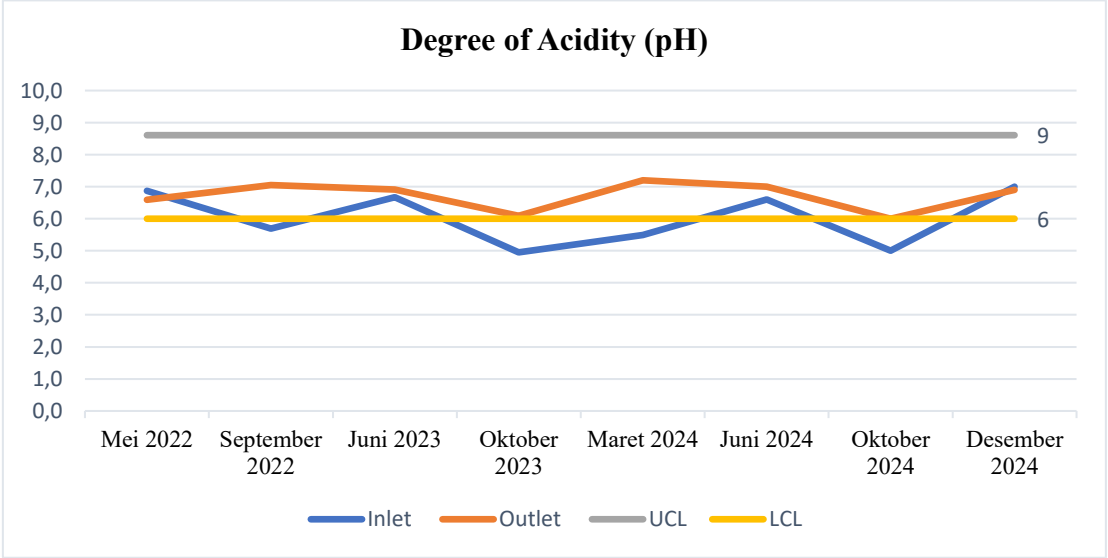

Figure 1. pH parameters

Based on the image above, it can be seen that the pH of the wastewater from the Colonel H.M Syukur Jambi Regional Mental Hospital fluctuates between 5 and 7 with an average of 6.4 which still meets the quality standards of the Minister of Environment and Forestry Regulation No. 68 of 2016. According to Maulana et al., (2025), high pH values can also be influenced by the activity of microorganisms that degrade organic matter (Maulana, Retnawaty, & Fitri, 2025). In line with research by Sattuang et al., (2020), the increase in the pH value of domestic wastewater is thought to be caused by an increase in the amount of dissolved oxygen originating from the diffusion of air into the water.

TSS (Total Suspended Solids) Parameter Analysis

Table 1
Calculation of % Removal TSS parameters

Period Sampling	Parameter TSS			Quality standards
	Inlet	Outlet	% Removal	
Mei 2022	17 mg/L	16 mg/L	5.8%	30 mg/L
September 2022	88 mg/L	20 mg/L	77.27%	
Juni 2023	620 mg/L	5 mg/L	99.19%	
Oktober 2023	353 mg/L	3,28 mg/L	99.07%	
Maret 2024	129 mg/L	32 mg/L	75.19%	
Juni 2024	134 mg/L	8 mg/L	94.02%	
Oktober 2024	278 mg/L	9 mg/L	96.76%	
December 2024	298 mg/L	12 mg/L	95.97%	
	Average		**80.41%**	

Based on the table above, the TSS removal percentage for the May 2022 sample was 5.8%, indicating ineffective TSS removal. Two other samples, from September 2022 and March 2024, were also categorized as less effective. According to Butler et al. (2022), the decrease in TSS values can be influenced by the sedimentation process in the samples over 24 hours. During this sedimentation process, heavy suspended solids will settle to the bottom of the sedimentation tank. The decrease in TSS values during the processing process is influenced by filtration by the media used (Butler, Suyasa, & Negara, 2022).

TDS (*Total Dissolved Solids*)

Table 2
Calculation of % Removal of TDS parameters

Period Sampling	Parameter TDS			Quality standards
	Inlet	Outlet	% *Removal*	
Mei 2022	137 mg/L	126 mg/L	8.02%	2000 mg/L
September 2022	268 mg/L	156 mg/L	41.79%	
Juni 2023	161 mg/L	127 mg/L	21.11%	
Oktober 2023	424 mg/L	24 mg/L	94.33%	
Maret 2024	196 mg/L	158 mg/L	19.38%	
Juni 2024	472 mg/L	182 mg/L	61.44%	
Oktober 2024	220 mg/L	156 mg/L	29.09%	
December 2024	364 mg/L	248 mg/L	31.86%	
	Average		**38.38%**	

Based on Table 2 above, only the sample in October 2023 had a removal percentage categorized as effective with a removal percentage of 94.33%. Seven of the eight samples showed below 80%, which means less effective. The relatively high TDS concentration is due to the presence of dissolved solids smaller than suspended solids. If the amount is excessive, it will increase turbidity which can inhibit the entry of sunlight into the water and disrupt the process of photosynthesis (Nurhidayanti, Setiawan, & Nurahmad, 2022). According to Wibowo (Manyullei et al., 2022), high TDS levels in wastewater at the beginning of treatment are caused by the large number of dissolved organic and inorganic compounds, minerals, and salts in the water body. Because the results of the wastewater laboratory analysis of the Colonel H.M Syukur Jambi Regional Mental Hospital still refer to the Minister of Environment Regulation No. 5 of 2014, Appendix XLIV, where TDS is one of the wastewater quality standard parameters.

This is different from the Minister of Environment Regulation No. 68 of 2016, where TDS is not included in the wastewater quality standard parameters. For the standard TDS parameter, the standard is in accordance with the Minister of Environment Regulation No. 5 of 2014, Appendix XLIV, which is 200 mg/L.

BOD (*Biological Oxygen Demand)*

Table 3
Calculation of % Removal BOD parameters

Period Sampling	Parameter BOD			Quality standards
	Inlet	Outlet	% *Removal*	
Mei 2022	9 mg/L	19 mg/L	-52.63%	30 mg/L
September 2022	162 mg/L	38 mg/L	76.54%	
Juni 2023	801 mg/L	11 mg/L	98.62%	
Oktober 2023	280 mg/L	7,045 mg/L	96.61%	
Maret 2024	323 mg/L	17 mg/L	94.75%	
Juni 2024	222 mg/L	25 mg/L	88.73%	
Oktober 2024	65 mg/L	14 mg/L	79.68%	
December 2024	182 mg/L	25 mg/L	86.26%	
	Average		**71.07%**	

In the inlet sample, it is seen that it still exceeds the quality standard, but after the processing process at the BOD WWTP, it complies with the quality standard of the Minister of Environment and Forestry Regulation No. 68 of 2016. In the samples of June 2023, October 2023, March 2024, June 2024, and December 2024, it has an effective percentage in wastewater treatment on the BOD parameter. The effectiveness of BOD treatment occurs because the decomposition process of organic materials contained in wastewater takes place continuously, both from aerobic and anaerobic processes (Rarasari, et al., 2019).

COD (*Chemical Oxygen Demand)*

Table 4
Calculation of % Removal COD parameters

Period Sampling	Parameter COD			Quality standards
	Inlet	Outlet	% *Removal*	
Mei 2022	22 mg/L	40 mg/L	-81.81%	100 mg/L
September 2022	299 mg/L	82 mg/L	72.57%	
Juni 2023	1704 mg/L	23 mg/L	98.65%	
Oktober 2023	492 mg/L	20,8 mg/L	95.77%	
Maret 2024	694 mg/L	32 mg/L	95.38%	
Juni 2024	506 mg/L	55 mg/L	89.13%	
Oktober 2024	142 mg/L	38 mg/L	73.23%	
December 2024	404 mg/L	56 mg/L	86.13%	
	Average		**66.13 %**	

The COD removal calculations for June 2023, October 2023, March 2024, June 2024, and December 2024 showed effectiveness in reducing COD, resulting in effluent levels far below the standard quality standards based on the Minister of Environment and Forestry Regulation No. 68 of 2016, which is 100 mg/L. The removal percentage calculations for September 2022 and October 2024 were still considered less effective in reducing COD parameters. According to Paputungan et al. (2020), the decrease in COD

levels was due to the aeration process, which is the second stage of processing (Paputungan, Sondakh, & Umboh, 2020).

Ammonia

Table 5
Calculation of % Removal Ammonia parameters

Period Sampling	Parameter Ammonia			Quality standards
	Inlet	Outlet	% *Removal*	
Mei 2022	0,498 mg/L	0,107 mg/L	78.51%	
September 2022	1,95 mg/L	0,317 mg/L	83.74%	
Juni 2023	0,291 mg/L	0,101 mg/L	65.29%	
Oktober 2023	1,76 mg/L	0,395 mg/L	77.55%	10 mg/L
Maret 2024	24 mg/L	2,6 mg/L	89.16%	
Juni 2024	24 mg/L	2,3 mg/L	90.41%	
Oktober 2024	30 mg/L	2,1 mg/L	93%	
December 2024	29 mg/L	2,2 mg/L	92.41%	
	Average		**83.76%**	

The effectiveness of the ammonia parameter of 5 out of 8 samples showed an effective removal percentage. This indicates that the WWTP of the Kol. H.M Syukur Jambi Regional Mental Hospital is quite good at reducing ammonia levels. According to Mariyana, et al. (2015), the decrease in ammonia levels is caused by the provision of variations in chlorine doses. The more variations in the chlorine dose given, the higher the ammonia levels are reduced. Strengthening the statement from Mariyana et al., according to the statement of Sukadewi et al., (2020) the decrease in ammonia occurs in the aerobic contractor tank where microorganisms decompose organic substances present in wastewater and grow and attach to the surface of the media. This process is called contact aeration.

Detergent as MBAS

Table 6
Calculation of % Removal parameter of Detergent as MBAS

Period Sampling	Removal parameter of Detergent as MBAS			Quality standards
	Inlet	Outlet	% *Removal*	
Mei 2022	0,117 mg/L	0,028 mg/L	76.06%	
September 2022	0,683 mg/L	0,117 mg/L	82.86%	
Juni 2023	0,47 mg/L	0,075 mg/L	84.04%	
Oktober 2023	0,993 mg/L	0,122 mg/L	87.71%	10 mg/L
Maret 2024	0,26 mg/L	0,193 mg/L	25.76%	
Juni 2024	12,09 mg/L	0,334 mg/L	97.23%	
Oktober 2024	0,293 mg/L	0,202 mg/L	31.05%	
December 2024	2,64 mg/L	0,114 mg/L	97.30%	
	Average		**72.75%**	

Calculation of detergent removal parameters as MBAS, 6 of 8 samples showed effective criteria in reducing detergent removal. This indicates that most of the wastewater treatment systems used at the Colonel H.M. Syukur Jambi Regional Mental Hospital are able to reduce detergent concentrations according to quality standards. In the study by Premananda & Primajana (2023), the use of an anaerobic-aerobic biofilter WWTP system was very effective in reducing MBAS concentrations (Premananda & Primajana, 2023).

Oils and Fats

Table 7
Calculation of % Removal of Oil and Fat Parameters

Period Sampling	Oils and Fats Inlet	Oils and Fats Outlet	% *Removal*	Quality standards
Mei 2022	2,3 mg/L	4 mg/L	-73.91%	
September 2022	10 mg/L	3 mg/L	70%	
Juni 2023	10 mg/L	3 mg/L	70%	
Oktober 2023	7,49 mg/L	4 mg/L	46.59%	5 mg/L
Maret 2024	0,263 mg/L	0,056 mg/L	78.70%	
Juni 2024	0,124 mg/L	0,084 mg/L	32.25%	
Oktober 2024	0,140 mg/L	0,103 mg/L	26.42%	
December 2024	0,124 mg/L	0,098 mg/L	20.96%	
	Average		**33.88%**	

The oil and fat parameters from wastewater treatment are also influenced by routine maintenance every 1-2 weeks to reduce the risk of contamination and comply with environmental regulations such as the Minister of Health Regulation No. 5 of 2018 concerning Hospital Waste Management.

Correlation analysis between wastewater parameters in the effectiveness of the WWTP of the Colonel H.M Syukur Jambi Regional Mental Hospital

Table 8
Correlation between parameters

		pH	TSS	TDS	BOD	COD	Ammonia	Detergent	Oil & Fats	Coliform
pH	Pearson Correlation	1	.580	.562	.600	.456	.164	.115	-.230	.077
	Sig. (2-tailed)		.132	.147	.116	.256	.697	.787	.584	.856
TSS	Pearson Correlation	.580	1	.237	.402	.283	.351	.000	-.261	-.503
	Sig. (2-tailed)	.132		.572	.323	.498	.395	.999	.532	.204
TDS	Pearson Correlation	.562	.237	1	.530	.498	.533	.206	-.681	.673
	Sig. (2-tailed)	.147	.572		.177	.209	.173	.625	.063	.067
BOD	Pearson Correlation	.600	.402	.530	1	.983**	.089	.133	-.170	.185
	Sig. (2-tailed)	.116	.323	.177		.000	.835	.753	.688	.661
COD	Pearson Correlation	.456	.283	.498	.983**	1	.089	.165	-.180	.236
	Sig. (2-tailed)	.256	.498	.209	.000		.0834	.695	.670	.573
Ammonia	Pearson Correlation	.164	.351	.533	.089	.089	1	.702	-.949**	.243
	Sig. (2-tailed)	.697	.395	.173	.835	.834		.052	.000	.563
Detergent	Pearson Correlation	.115	.000	.206	.133	-165	.702	1	-.714	.302
	Sig. (2-tailed)	.787	.999	.625	.753	.695	.052		.047	.467
Oil & Fats	Pearson Correlation	-.230	-.261	-.681	-.170	-.180	-.949**	-.714	1	-.415
	Sig. (2-tailed)	.584	.532	.063	.688	.670	.000	.047		.306
Coliform	Pearson Correlation	.077	-.503	.673	.185	.236	.243	.302	-.415	1
	Sig. (2-tailed)	.856	.204	.067	.661	.573	.563	.467	.306	

Based on the table above, it is known that there is a significant correlation between the parameters analyzed at the IPAL outlet of the Colonel H.M. Syukur Jambi Regional Mental Hospital. This indicates that changes in one or more parameters can have an effect on other parameters. pH parameters with other parameters all significance values are above 0.05 indicating no statistically significant correlation. With the level of relationship in the TSS, TDS, and COD parameters are categorized as moderate (0.40-0.599), while the parameters of Ammonia, Detergent, Oil and Fat, and Coliform are categorized as very low (0.00-0.199). Only BOD is categorized with a high level of relationship, namely 0.600.

The relationship between pH and BOD is not always linear because it can be influenced by other factors such as temperature, the presence of nutrients and the type of microorganisms present, but in general a pH close to neutral (6-9) usually supports optimal microorganism activity, thus producing more accurate BOD measurements. This is in line with the statement of Ramadani et al., (2021), good microorganism activity because the pH is not less than 6 or not too acidic and not more than 9 or too alkaline. According to Naillah et al., (2021), there is no significant correlation between pH and the number of coliforms. Therefore, changes in pH in an environment do not directly and significantly affect the number of viable coliforms.

The TSS parameter in the correlation table above shows that the TSS parameter has a significance value above 0.05 with other parameters, indicating that H0 is accepted, meaning there is no relationship between the raw wastewater parameters. The correlation between pH and BOD is categorized as moderate (0.40-0.599), while the other parameters are categorized as low or very low. The TDS parameter in the correlation table above shows that the TDS parameter has a significance value above 0.05 with other parameters, indicating that H0 is accepted, meaning there is no relationship between the raw wastewater parameters. The correlation for Coliform is categorized as high (0.673), while pH, BOD, COD, and Ammonia are categorized as moderate with a coefficient range of 0.40-0.599. Detergents, Oils, and Fats have low or very low correlations with TDS.

The BOD parameter showed a correlation with the COD parameter with a significance value of 0.000, indicating that H1 was accepted, namely a relationship between the raw wastewater parameters, with the correlation level categorized as very high (0.983). The COD results were nearly identical to the BOD parameter, with a correlation with the BOD parameter. This aligns with the statement by Maudy et al. (2024), which states that BOD has a close relationship with other water quality parameters, especially COD. In this study, the decrease in BOD was accompanied by a decrease in COD, indicating a relationship between organic matter decomposition and oxygen demand in wastewater. A decrease in COD is usually followed by a decrease in BOD, as the two are interconnected in the organic matter decomposition process. The ammonia parameter had a very low correlation with the oil and fat parameter (-0.949). Therefore, the low correlation level indicates that changes in ammonia concentration do not consistently predict changes in oil and fat concentrations, and vice versa. This negative value may indicate a very weak inverse relationship. According to the research by Maudy et al. (2024), ammonia levels have a close relationship with water quality parameters, especially BOD and pH (Dirgahayu et al., 2024).

Conclusion

The conclusion obtained from this study is that the wastewater treatment process at the Colonel H.M Syukur Regional Mental Hospital in Jambi begins with the collection of liquid waste into the inlet tank, where the wastewater will be processed through several stages of treatment before finally being discharged into the environment. The study shows that the wastewater treatment plant (WWTP) system functions according to the design, with supervision carried out to ensure the smooth running of the process. The effectiveness analysis shows that the WWTP at the Colonel H.M Syukur Regional Mental Hospital in Jambi can carry out its function well in treating wastewater. The study also found a significant correlation between the parameters analyzed at the WWTP outlet of the Colonel H.M Syukur Regional Mental Hospital in Jambi. This indicates that changes in one or more parameters can have an effect on other parameters, so it is important to monitor.

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