

The Domestic Wastewater Treatment Installation's Performance Study of Technical Aspects in Cahaya Abadi Housing, Palembang City

Jito Bachri¹, Chanel Tri Handoko^{2,3*}, Hendrik Jimmyanto⁴, Susi Susanti⁵

¹Sriwijaya University Professional Engineer Study Program (PSPPI), Sriwijaya University, Indonesia

²Environmental Science Department, Graduate School Universitas Sebelas Maret Surakarta-5716, Indonesia

³Center for Environmental Research, Universitas Sebelas Maret, Surakarta-5716, Indonesia

⁴Department of Civil Engineering, Faculty of Engineering, Tridinanti University, Indonesia

⁵Department of Chemical Engineering, Faculty of Engineering, Universitas Sriwijaya

Received: October 03, 2023 **Published:** March 31, 2024

Abstract

Comprehensive treatment of rural water pollution is being pioneered by developed countries, and many countries now have a variety of waste treatment facilities and process technologies suited to their rural conditions. Domestic waste is handled differently at waste processing facilities in cities than in rural areas. The Indonesian government has launched domestic wastewater treatment initiatives to reduce water pollution from domestic waste. This paper discusses the installation of a domestic wastewater treatment system in the Cahaya Abadi housing complex, located in Palembang City. The method used for this study includes surveying and observing the inlet discharge and outlet discharge of the wastewater treatment system. An analysis was then conducted to calculate the resulting discharge and detention time. The results of this analysis indicate that extensive maintenance is required to ensure that the domestic wastewater treatment and distribution system runs as efficiently as possible. The research was conducted at Cahaya Abadi Housing in Sri Mulya Village, Sematang Borang District, Palembang City. The DWWT Cahaya Abadi processes liquid waste from household activities but despite having a capacity for 169 houses, only 31 houses use it. The findings from the analysis of technical aspects show that the rate of incoming discharge is 9.9 m³/hour, while the outgoing discharge with a pump measures 2.38 m³/hour and without a pump measures 0.26 m³/hour. Based on observations, it has been observed that the water quality of the outgoing discharge is clearer when no pump is used compared to when a pump is utilized. Furthermore, it has been determined that the resulting detention time amounts to 6.51 hours, which does not meet the criteria set by SNI 8455:2017.

Keywords: Domestic sewage, Domestic waste, Flow discharge, Detention time

INTRODUCTION

In comparison to only 18% of people living in metropolitan regions, around 50% of the world's population today resides in rural areas without adequate sanitary services. To fulfill the goal of sustainable development, sanitation facilities still require ongoing research and development, particularly in developing countries (Singh, et al 2019). Water contamination has intensified as a major barrier to rural development in recent years. About 20 million tons of residential sewage from rural areas were directly released daily by 2015. In significant river valleys, a few rural domestic sewage treatment projects have been installed and tested (Cheng, et al 2020). Developed nations led the way in the thorough treatment of rural water pollution, and many nations now have a range of sewage treatment facilities and process technology that are appropriate for their rural characteristics. For instance, Japan established 2000 little rural sewage treatment facilities by the end of 1996. Europe published rural home

* **Corresponding author:** chanel.handoko@gmail.com

Cite this as: Bachri, J., Handoko, C., Jimmyanto, H., Susanti, S. (2023, September). The Domestic Wastewater Treatment Installation's Performance Study of Technical Aspects in Cahaya Abadi Housing, Palembang City. *Enviro: Journal of Tropical Environmental Research*, 25(2), 1-9. doi: <https://doi.org/10.20961/enviro.v25i2.79282>

sewage discharge standards around the turn of the 20th century. Spain has also made it mandatory for villages with 2,000 or more residents to finish building a sewage treatment system by 2005 at the latest, and it has established the specific indicators of sewage discharge. The majority of South Korea's rural population employ tiny, straightforward wetland sewage treatment facilities, and they live in dispersed communities (Xu, et al 2023).

Domestic sewage in rural areas is treated differently than it is in sewage treatment facilities in cities. It is challenging to gather because its drainage points are dispersed. To be processed and released close, the majority of the domestic sewage from rural areas needs to be combined in one or more settlements. Most rural regions still have relatively imbalanced social and economic levels after years of development, and the lack of sewage treatment and disposal poses a severe threat to the rural natural environment (Xiuyun Li, 2021; Cheng, et al 2019). In Indonesia, septic tanks are still often used in local, on-site wastewater treatment systems for homes. Septic tanks are underground buildings that are insulated but not impermeable. The septic tank functions by collecting feces and unclean water from the toilet or latrine and depositing sediment or solids in the unclean water in order to reduce the number of contaminants in the water that exits the septic tank (Jimmyanto, et al 2022). The dirty water that exits the septic tank still contains contaminants and dangerous microorganisms because the septic tank primarily only serves to precipitate the sludge content in domestic wastewater so that it may contaminate soil, ground water, and ultimately lead to surface water bodies (Ghawi, 2017).

To prevent water pollution in places without separate residential waste processing, the Indonesian government has started establishing domestic wastewater treatment (DWWT). According to Emilia et al. (2023), this development takes into account aspects including population density, groundwater depth, and financial capability. Mechanical, biological, and chemical processes can be employed to treat wastewater in the three main categories of wastewater treatment—primary, secondary, and tertiary. The characterization of the wastewater, including daily quantities, flow rates, and associated pollutant load, greatly influences the choice of the treatment system design. The performance requirements for the treatment system, the selection of the most appropriate treatment methods, the design of the system, and its operation all depend on an accurate assessment of the wastewater to be treated (Rarasari, et al 2019; Zihan Li, 2021).

Since then, a number of domestic wastewater treatment systems (DWWTs) that treat domestic wastewater on a residential and regional scale have been operating in Palembang. Previous research conducted by Jimmyanto et al. in 2022 and Candra et al. in 2023 focused on DWWT in the city of Palembang. The findings from these studies highlight the need for various efforts to ensure that the DWWT and its distribution system can operate at peak efficiency, particularly with regard to discharge and detention time. Building upon the work of previous researchers, this paper aims to review the performance of the DWWT system in the Cahaya Abadi housing complex located in Palembang City, specifically focusing on the discharge and detention time it produces.

RESEARCH METHODS

The study is being conducted at the Cahaya Abadi Housing in Sri Mulya Village, Sematang Borang District, Palembang City which has the geographic coordinates 2°56'58.4"S 104°50'06.2"E (Figure 1). Primary data collection for this study was observation, direct measurements made in the field, or the making of observation instrument sheets. Identifying the legal foundation and applicable laws related to activity plans from numerous associated organizations or publications, research journals, and the internet constitutes collecting secondary data from various references. The stages of data analysis carried out are the calculation of existing water discharge (Q existing) and planned water discharge (Q plan) which can be determined by:

$$Q = \text{domestic wastewater discharge} * \text{number of houses} * \text{number of family members in 1 house} \quad (1)$$

The amount of detention time can be determined by the equation:

$$\text{Detention time} = \frac{\text{Volume}}{Q} \quad (2)$$

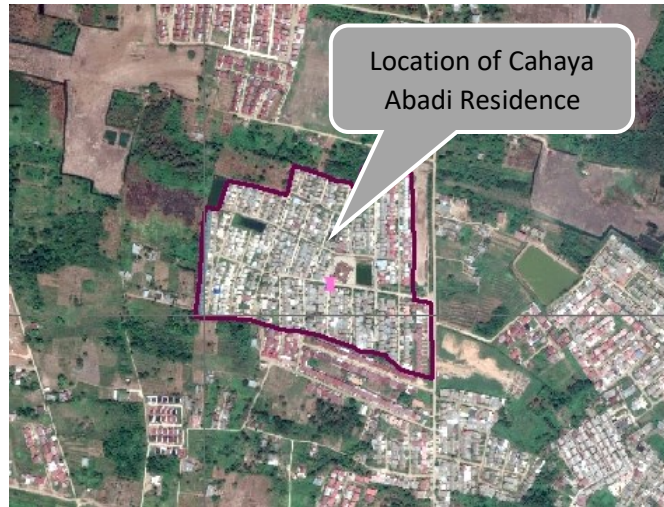


Figure 1. Research location at Cahaya Abadi Housing

RESULTS AND DISCUSSION

Technical considerations, such as the DWWT 's construction, network system, discharge, and detention time, need to be discussed in order to assess its performance. This DWWT 's construction is made of reinforced concrete and includes a number of systems in the form of processing tanks. Anerobic Upflow Filter (AUF) and Anerobic Buffle Reactor (ABR) are used in the Cahaya Abadi Housing DWWT processing system. Wastewater from the second decomposing tank flows into the UAF (Anerobic Upflow Filter) media with a flow from bottom to top. Anaerobic Upflow Filterization (AUF) is a wastewater treatment process that is carried out by flowing wastewater into the first digester tank, then flowing into the second digester tank, where the first and second tanks serve as a precipitator and decomposer as well as a septic tank. A bottom-up flow system will boost processing effectiveness by decreasing the speed of wastewater flow's confined particle motion.

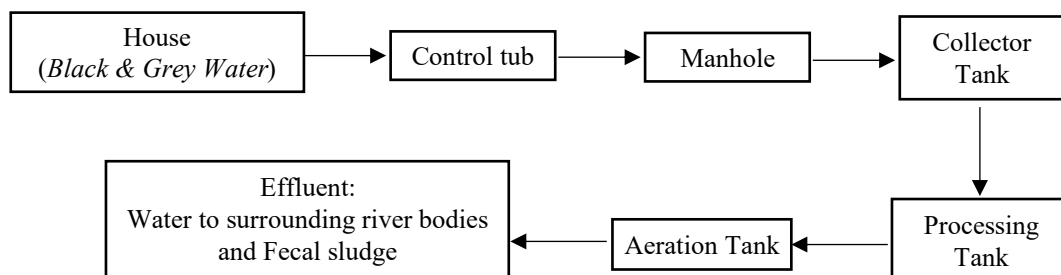


Figure 2. Flow diagram of the wastewater processing process at Cahaya Abadi Housing

The Anerobic Buffle Reactor (ABR), on the other hand, is made up of a settling compartment,

numerous baffle reactors, and many series of sludge blanket reactors that are utilized to direct the upflow of water (Novilyansa, et al. 2020). By interacting with surplus anaerobic microorganisms in the filter media, this anaerobic system processes non-sedimented materials and dissolved solid materials with the aim of decomposing dissolved organic materials and dispersed organic materials in wastewater in an oxygen-free environment (Ding, et al. 2021). The Cahaya Abadi Housing DWWT's processing procedure is shown in Figure 2 the flow chart below, commencing with the home that generates waste from both gray and black water. The waste flow is then directed to the control tank and the manhole, which serves to make pipeline maintenance easier in the event of a blockage. In a collection tank, the waste flow is collected before going into the processing tank. The exact location of the DWWT for the Cahaya Abadi house, which is made up of numerous processing tanks built with reinforced concrete, is shown in Figure 3.



Figure 3. Existing condition of the Cahaya Abadi Housing DWWT

The piping network system is made up of house connection pipes (SR), service pipes (tertiary pipes), branch pipes (secondary pipes), and main pipes (main pipes). These pipes have the purpose of collecting waste water from its sources and channeling it to the DWWT building to be processed so that wastewater effluent is produced in accordance with the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number: P.68/Menlhk/Setjen/Kum.1/8/2016 concerning. In addition, this piping system needs a control tank and manhole that are at least 50 meters apart. The control tank serves as a trap tank for the main pipe, taking in dirty water from the bathroom drain and diverting it there so that when dirt deposits form, the pipe becomes blocked from the drain. Manhole drains and bathroom waste are simple to manage and maintain. Table 1 is data from the DWWT system network at Cahaya Abadi housing along with dimensions and numbers.

Table 1. Cahaya Abadi Housing DWWT Pipeline Network System

Pipe Network System	Information
Control body dimensions	40 cm x 40 cm
Number of control tanks	199 unit
Type of control body construction	Concrete
Distance between control bodies	20 meters
Manhole dimensions	60 cm x 60 cm
Number of manholes	48 unit
Manhole construction type	Construction from concrete
Distance between Manholes	50 meters

Main pipe dimensions	6"
Parcel pipe dimensions	4"

In the event that there is a blockage in the pipeline connecting the control tank and the collection tank in the DWWT processing unit, the manhole serves to facilitate repair. Table 1 gives a quick overview of the pipe network system based on survey findings and observations. When compared to the projected capacity of the DWWT, which was 200 SR (1000 people), the service coverage of the Cahaya Abadi Housing DWWT in 2019 was 169 SR (845 people), suggesting that the underutilized capacity (idle capacity) was 31 SR (155 people). The situation is brought on by the underutilization of the current infrastructure or the presence of operational challenges, resulting in 31 SR of idle water capacity. The lack of distribution or residential connection pipe installations is to blame for this unused capacity. The maximum level of pollutant elements and/or the maximum amount of pollutant elements whose presence is permitted in wastewater that will be discharged or released into water sources from a business and/or activity must not be exceeded by the disposal system from wastewater treatment products to water bodies. Environmental regulations for domestic wastewater are based on South Sumatra Governor's Regulation No. 8 of 2012, which includes the criteria pH, BOD, Suspended Residues, Oil and Fat.

The processing discharge reviewed consists of discharge from the house connection (SR), inlet discharge and outlet discharge. Home connection discharge (SR) is calculated from the amount of waste produced by household activities. Inlet discharge is calculated from the total volume of wastewater entering from the collection tank to the DWWT processing tank, while outlet discharge is calculated from the total volume of wastewater leaving the outlet during a certain time. House connection discharge (Q SR) is calculated by: Q water usage x number of houses x number of occupants with Q water usage = 90 liters/person/day (Technical Guidelines for Implementing SANIMAS Activities) so that the amount of house connection discharge Q SR = 76.05 m³ /day or 3.17 m³/hour.

The inlet discharge (Q_{inlet}) can be determined by dividing the volume of water in the collection tank by the pumping time. Pumping time is the time needed to drain wastewater from the collection tank to the DWWT processing tank. The collection tank has dimensions of 5.5 m long x 3 m wide x 4.5 m high, but the water stored in the tank is only 1.5 m high because the manhole pipe is located at that height, so the volume of wastewater in the tank is amounting to 24.75 m³. The wastewater pumping time at Cahaya Abadi Housing is divided into 2 sessions, namely 06.00 – 08.30 and 15.00 – 16.00 so that the maximum pumping time is 2.5 hours. The amount of inlet discharge (Q_{inlet}) based on the explanation above is 9.9 m³/hour or 2.75 liters/second.

Table 2. Measurement of discharge at the DWWT outlet when the pump is operating at DWWT Cahaya Abadi Housing

Measurement	Volume (liter)	Time (detik)	Discharge (liter/sec)
1	1	1.5	0.67
2	0.8	1	0.8
3	1	2	0.5
Average			0.66
			2.38 m ³ /hour

The discharge collected in the collection tank comes from rainwater, groundwater seepage, and water nearby the DWWT location, as evidenced by the analysis of house connection discharge (Q SR) and inlet discharge (Q_{inlet}), which revealed that the inlet discharge is greater than the house connection

discharge. With a flow of $6.73 \text{ m}^3/\text{hour}$, the increase in discharge that is unrelated to domestic wastewater is about 212%. The DWWT outlet discharge when the pump machine is operating at 06.00 is calculated by measuring the volume that comes out every second using a measuring cup and stopwatch. Based on the results of measuring the discharge at the DWWT outlet 3 times, the average discharge at the DWWT outlet when the pump engine was operating was 0.66 liters/second or $2.38 \text{ m}^3/\text{hour}$ (Table 2). Then another DWWT outlet discharge measurement was carried out at noon at 14.00 when the pump machine was not operating. The discharge produced when the pump engine is not operating is lower than the discharge when the pump engine is operating, namely $0.26 \text{ m}^3/\text{hour}$ or 0.071 liter/second (Table 3).

Table 3. Measurement of discharge at the DWWT outlet when the pump is not operating at DWWT Cahaya Abadi Housing

Measurement	Volume (liter)	Time (detik)	Discharge (liter/sec)
1	1.1	15	0.073
2	1	12	0.083
3	0.5	9	0.056
Average			0.071
			$0.26 \text{ m}^3/\text{hour}$

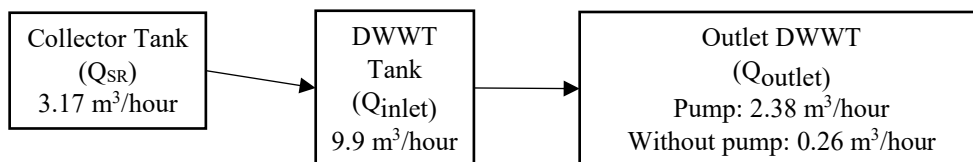


Figure 4. Discharge scheme in DWWT tanks at Cahaya Abadi Housing

Figure 4 shows the discharge flow diagram from the storage tank to the DWWT outlet discharge. where both the inlet discharge at the DWWT tank and the DWWT outlet are greater than the wastewater discharge from residents' homes (SR). This shows that the discharge is reduced at every stage of the DWWT processing. From these findings, it can be shown that the inlet discharge (Q_{inlet}), which has a difference of 97.4% when the pump machine is not working, is greater than the discharge at the DWWT outlet when the pump machine is functioning. These findings suggest that wastewater discharge when moving through the DWWT processing tanks has decreased. The decrease in discharge indicates that a sedimentation process has occurred in the DWWT processing tank over a certain period of time, which aims to reduce BOD and sludge levels in wastewater before it is discharged into water bodies. The time required for the mud or sludge sedimentation process in the DWWT processing tank is called detention time.

In comparison to the discharge when the pump machine is not running, the discharge at the DWWT outlet is very considerable when the pump machine is running. Because there is no detention time or detention time in the DWWT processing tank when the pump machine is operating, a very fast discharge flow results in a lot of undeposited sedimentation, which causes the water quality to be more turbid with a higher BOD value. This is because the processing in the DWWT tank is not optimal. The quality of the water produced is clearer (lower BOD levels) since no sludge is produced, as opposed to a pump machine that is not in operation, which produces a small flow rate, slow flow to the DWWT processing

tank, and has a longer detention time. Figures 5 and 6 display the variations in treated water quality outflow results.



Figure 5. DWWT outlet (a) when the pump machine is operating (b) the pump machine is not operating



Figure 6. Visual results of water quality from the DWWT outlet (a) when the pump machine is operating (b) the pump machine is not operating

Detention time, also known as detention time, is the amount of time that must pass while wastewater and microorganisms are in touch with one another in the wastewater treatment process unit. The calculation of existing detention time can be calculated by:

$$\text{existing detention time} = \frac{\text{volume of tub}}{Q \text{ inlet}} \quad (3)$$

The Cahaya Abadi Housing's DWWT processing tank is separated into 8 processing tanks, as shown in Figure 7. The volume of the DWWT tank can be computed by multiplying the dimensions, length 17.5 m, width 6.55 m, and depth 4.5 m, giving us 515.82 m³, and the detention duration is determined by 515.82/9.9 = 52.10 hour for 8 tubs, so the detention time for 1 tub is 6.51 hours. SNI 8455:2017 suggests there is a correlation between anaerobic microbe contact time with wastewater and the effectiveness of BOD removal. According to SNI 8455:2017, the appropriate detention time for DWWT processing in Cahaya Abadi dwelling is between 7 and 20 hours based on the correlation graph of detention time and BOD removal percentage (Figure 8). The desired BOD removal percentage is 70 to 95%.

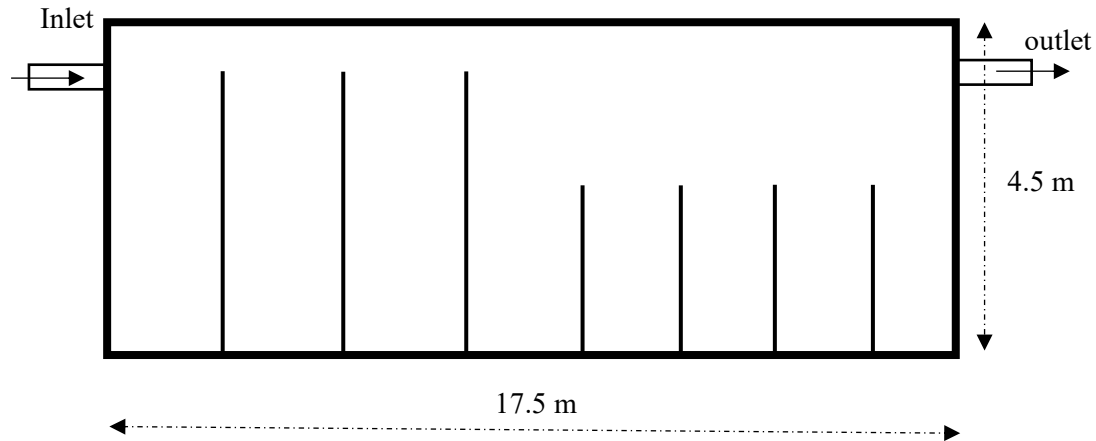


Figure 7. Sketch of the DWWT processing tank for Cahaya Abadi Housing

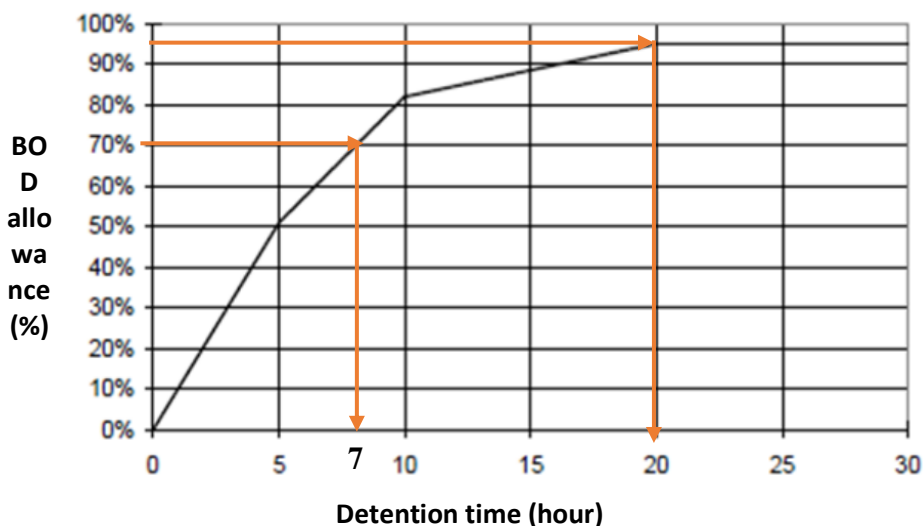


Figure 8. Correlation of detention time and BOD removal percentage

CONCLUSION AND RECOMMENDATION

The research on the technical components of the Domestic Wastewater Treatment (DWWT) study has been completed, and the results of the discussions can be used to draw conclusions. DWWT Cahaya Abadi is responsible for processing domestic liquid waste from household activities, but currently only 31 houses are utilizing it, even though the facility's capacity is able to handle up to 169 houses. As a result, there is unused capacity. The results obtained from identifying technical aspects indicate that the inlet discharge is $9.9 \text{ m}^3/\text{hour}$ and the outlet discharge is $2.38 \text{ m}^3/\text{hour}$ with a pump and $0.26 \text{ m}^3/\text{hour}$ without a pump. Observations have revealed that the water quality of outlet discharge flow without a pump appears clearer compared to when using a pump. Additionally, it was found that the resulting detention time was calculated as 6.51 hours which does not meet SNI 8455:2017 criteria. Therefore, improvements in the processing system are necessary.

REFERENCES

- Candra, E., Permatasari, R., & Kurniati, L. (2023). STUDI KELAYAKAN INSTALASI PENGOLAHAN AIR LIMBAH (IPAL) DOMESTIK KAWASAN BENDUNG KOTA

- PALEMBANG. *Jurnal Teknik Sipil LATERAL*, 1(1), 26-36.
- Cheng, P., Jin, Q., Jiang, H., Hua, M., & Ye, Z. (2020). Efficiency assessment of rural domestic sewage treatment facilities by a slacked-based DEA model. *Journal of Cleaner Production*, 267, 122111.
- Cheng, J., Chen, Y., He, Y., & Hu, H. (2019, December). Research of rural domestic sewage treatment processes in Ningbo. In *IOP Conference Series: Earth and Environmental Science* (Vol. 358, No. 2, p. 022072). IOP Publishing.
- Ding, N., Zhao, L., & Fei, W. (2021, May). Research on Application of Anaerobic Treatment Technology for Domestic Sewage in Rural Areas. In *IOP Conference Series: Earth and Environmental Science* (Vol. 781, No. 3, p. 032049). IOP Publishing.
- Emilia, V. M., & Ilonka, W. A. Optimalisasi Model Ipal SPALD-S dan Ipal SPALD-T (Studi Kasus Kelurahan Pajang, Kota Surakarta). *ENVIRO: Journal of Tropical Environmental Research*, 25(1), 42-51.
- Ghawi, A. H. (2018). Study on the development of household wastewater treatment unit. *Journal of Ecological Engineering*, 19(2).
- Jimmyanto, H., & Iskandar, I. (2022). Feasibility Study of Communal Domestic Wastewater Treatment Plant In Sekanak Area, Palembang City. *International Journal of Engineering Applied Sciences and Technology*, 7(2), 08-15.
- Li, Z. (2021). Treatment and technology of domestic sewage for improvement of rural environment in China-Jiangsu: A research: <https://doi.org/10.52152/spr/2021.146>. *Science Progress and Research (SPR)*, 1(4), 305-314.
- Li, X. (2021). Rural domestic sewage treatment technology application in Conghua district of Guangzhou under the rural revitalization strategy. In *IOP Conference Series: Earth and Environmental Science* (Vol. 621, No. 1, p. 012097). IOP Publishing.
- Novilyansa, E., Anwar, A., & Cambodia, M. (2020). Analisis Kebutuhan Instalasi Pengolahan Air Limbah Domestik (Ipal) Dengan Variasi Jumlah Sambungan Rumah (Sr). *Teknika Sains: Jurnal Ilmu Teknik*, 5(1), 27-34.
- Rarasari, D. M. G., Restu, I. W., & Ernawati, N. M. (2019). Efektivitas Pengolahan Limbah Domestik di Instalasi Pengolahan Air Limbah (IPAL) Suwung-Denpasar, Bali. *Journal of Marine and Aquatic Sciences*, 5(2), 153-163.
- Singh, R. P., Kun, W., & Fu, D. (2019). Designing process and operational effect of modified septic tank for the pre-treatment of rural domestic sewage. *Journal of Environmental Management*, 251, 109552.
- Xu, W., & Liu, Z. (2023). Evaluation on the Current Situation of Integrated Treatment of Rural Sewage in China: A Case Study of Anhui Province. *Water*, 15(3), 415.