

Monitoring of Domestic Wastewater Treatment PT. Perkebunan Karet (Rubber Plantation Ltd.)

Fajriharish Nur Awan^{1*}, Khairattul Nabila¹, Dewi Erowati²

¹Environmental Engineering Study Program, Institut Teknologi Sumatera, Lampung Selatan, 35365, Indonesia

²Poltekkes Kemenkes Riau, Riau, 28156, Indonesia

*Corresponding author e-mail: fajriharish.awan@tl.itera.ac.id

Abstract

West Sumatera is one of the provinces in Indonesia that has an excellence in agricultural commodities. One of the agricultural products in West Sumatera is natural rubber. In addition to producing rubber, in West Sumatera there are also several rubber plantation processing industries, one of which is PT. Perkebunan Karet (Rubber Plantation Ltd.). In every activity PT. Perkebunan Karet (Rubber Plantation Ltd.) produces liquid waste that comes from domestic activities. The purpose of the research is to identify sources of domestic wastewater, identify liquid waste treatment processes at domestic wastewater treatment plants, identify liquid waste quality before and after treatment and calculate the efficiency of domestic wastewater treatment. The method used is the method of observation and interviews and analysis of data processing using descriptive analysis. The results of this study are the source of domestic wastewater PT. Perkebunan Karet (Rubber Plantation Ltd.) comes from public toilet facilities, company offices, employee mess, control and document center offices, laboratories, dining rooms and canteens. The stages of domestic wastewater treatment include oil and grease traps, sedimentation, filtration, and disinfection. The efficiency of reducing the quality of domestic wastewater on average from January to June for parameters BOD 50.54%, COD 15.79%.

Keywords

PT. Perkebunan Karet (Rubber Plantation Ltd.), Treatment, Quality, Domestic Wastewater

Received: 11 November 2021, Accepted: 19 February 2022

<https://doi.org/10.26554/ijems.2022.6.1.175-180>

1. INTRODUCTION

West Sumatera is one of the provinces in Indonesia that has excellence in agricultural commodities, especially in the availability of fertile land and a sufficient number of workers. One of the agricultural products in West Sumatera is natural rubber, which in 2019 and 2020 produced 186.393 tons of rubber (Badan Pusat Statistik, 2020). Utilization of rubber wood waste is being into liquid smoke through the pyrolysis process which is predicted to produce good quality rubber in accordance with SNI 06-1903-2000 concerning SIR (Vachlepi and Ardika, 2019). In addition to rubber producers, in West Sumatera there are also several rubber plantation processing industries where the company is engaged in the production of crumb rubber and most of its production is exported abroad.

Wastewater treatment work must be eco friendly which not bring damage for the neighborhood. Domestic waste water that is directly discharged into aquatic ecosystems will generally affect the existing water in the receiving ecosystem, even in the end it will result in changing the composition

of the substances contained in it or in other words will result in pollution of the receiving aquatic ecosystem. The results of previous studies show that the impact of domestic wastewater disposal causes river water to become dirty and polluted, namely turning cloudy. Factory activities that discharge liquid waste into rivers greatly affect river ecosystems as well as pollute PDAM water sources (Belladona, 2017). Waste in the long term or short term will make changes to the environment so it is necessary to strive for a waste treatment according to the character of the waste itself (Rarasari et al., 2019). Future planning and designs of wastewater treatment facilities will emphasize techniques to minimize adverse environmental impacts and objections by neighborhood residents. Wastewater treatment plants should conducted planning, design, and operation (Qasim, 2017).

An effective WWTP treatment process is a dimension of sustainable development that has been agreed by 193 countries as Sustainable Development Goals with the aim of ensuring access to water and sanitation for all, as well

as the protection and sustainable use of oceans, seas and marine resources by 2030 (UN, 2016). PT Perkebunan Karet (Rubber Plantation Ltd.) is one of the national private industrial companies engaged in the rubber industry which processes and produces natural rubber into crumb rubber which is generally used as raw material in tire manufacturing plants, so that in each production process it produces waste in liquid form, solid, and gas. In addition to producing waste from industrial activities, also produce waste from household activities (employee mess), offices, laboratories, and canteens. One of the most waste generated from household activities (employee mess), offices, laboratories, and canteens is liquid waste or what is known as domestic wastewater. The domestic waste water of PT. Perkebunan Karet (Rubber Plantation Ltd.) strive to to treat domestic wastewater it produces by treating domestic wastewater produced in a Domestic Wastewater Treatment Plant. Domestic non-toilet/latrine waste water is referred to as gray water, which is domestic wastewater from bathing water, washing water and water from the kitchen. Domestic gray water wastewater from INBIS Domestic IPAL treatment has the potential to be an alternative water source for watering plants (greening) if the processing results are in accordance with quality standards (Husein, 2019).

The purpose of this study is to identify the source of domestic wastewater, identify the wastewater treatment process at the domestic wastewater treatment plant, identify the quality of wastewater before and after treatment, calculate the efficiency of domestic wastewater treatment PT. Perkebunan Karet (Rubber Plantation Ltd.).

2. METHOD

The research design is cross sectional study which wastewater samples were taken at one time and then BOD and COD parameters were measured. The tools and materials used in this study included sample containers (jerricans), ballast bottles, label boxes, and stationery. The materials used in this study were wastewater samples taken from the domestic operations of the factory. This research was conducted at PT. Perkebunan Karet (Rubber Plantation Ltd.). The type of activity carried out is in the form of field study activities in the environmental field which includes liquid waste treatment. The implementation of the research starts on January to June, 2021. The flow of this research starts from the preparation stage, literature study, implementation stage, data collection, data analysis, and report writing. The data collected in the study are primary data derived from field observations, interviews with staff in the handling of liquid waste treatment at PT. Perkebunan Karet (Rubber Plantation Ltd.). The data obtained were then processed and analyzed descriptively.

3. RESULTS AND DISCUSSION

3.1 Domestic Wastewater Source PT. Perkebunan Karet (Rubber Plantation Ltd.)

Domestic wastewater comes from domestic operational activities in the form of water from sinks (kitchens, hands), bathrooms (water tubs/soaking tubs/showers), washrooms (WC, toilets), and so on, which have the main component in the form of materials. organics, and detergents. At PT. Perkebunan Karet (Rubber Plantation Ltd.) have various facilities that can produce domestic wastewater. The domestic wastewater generating facilities consist of public toilets, company offices, employee mess, document control center office, laboratory, dining room and canteen. In previous study, planning for communal septic tanks is a small-scale wastewater treatment plant which is essential to facilitate community sanitation in maintaining the stability of environmental ecosystems. Based on the results of previous studies, the communal septic tank is designed so that the water treatment system can be carried out centrally so that time and costs in construction and maintenance are more efficient (Fanianto, 2018).

3.2 Domestic Wastewater Distribution System PT. Perkebunan Karet (Rubber Plantation Ltd.)

The domestic wastewater distribution system used at PT. Perkebunan Karet (Rubber Plantation Ltd.) is a local waste water distribution system (On Site) which is carried out by treating domestic wastewater at the source location, then the processed sludge is transported by means of transport to the sub-system of sewage treatment. The technology used in domestic wastewater treatment at PT. Perkebunan Karet (Rubber Plantation Ltd.) is a septic tank with a separate communal scale system. The septic tank in PT. There are 5 rubber plantations consisting of the first septic tank receiving domestic wastewater from public toilet facilities, the second and third septic tanks receiving wastewater from office facilities, the fourth septic tank receiving wastewater from employee mess facilities, the fifth septic tank receiving wastewater which comes from the central document control room, dining room, canteen, and laboratory room. The domestic wastewater discharge can increase the burden of domestic wastewater pollution and reduce water quality in rivers. Pollution of domestic wastewater can cause the composition of organic matter in rivers and increase COD and BOD which causes reduced oxygen in river water (Anwariani, 2019).

3.3 Domestic Wastewater Treatment Plant PT. Perkebunan Karet (Rubber Plantation Ltd.)

PT. Perkebunan Karet (Rubber Plantation Ltd.) still use conventional methods in the form of physical, chemical and biological wastewater treatment. PT. Perkebunan Karet (Rubber Plantation Ltd.) include inlet channels, oil and

grease traps, sedimentation tanks, filtration tanks, disinfection tanks, and outlet doors.

The inlet channel is a channel that carries wastewater from each septic tank to the wastewater treatment plant. The inlet channel is equipped with a filter consisting of small holes that function to filter out solids and waste carried from the source so that they do not enter the domestic WWTP. Oil and fat catcher tank is one of the physical wastewater treatment units that aims to separate oil and fat at a slow speed. This slow speed allows time for the oil and grease to separate from the wastewater by gravity. The separated oil and fat will then be collected in a disposal container.

Sedimentation basin is a physical wastewater treatment unit which aims to precipitate and separate suspended solid particles in wastewater with the help of gravity. In this sedimentation tank unit, the particles that have a higher density will settle to the bottom and the smaller ones will float. In this sedimentation tank there is also a water spinach plant which also functions as wastewater treatment using the phytoremediation method. Phytoremediation of wastewater treatment using water spinach plants can also reduce the content of heavy metals, ammonia, TSS and other organic substances.

Filtration tub is a waste treatment system that aims to separate and remove suspended solids using a porous medium. Filtration tub unit at PT. Perkebunan Karet (Rubber Plantation Ltd.) use dual media in the form of zeolite and activated carbon. This disinfection tub serves to kill pathogenic microorganisms. Wastewater in the disinfection basin is contacted with a liquid chlorine solution so that all pathogenic microorganisms can be killed. The results of previous studies showed that there was a decrease in ammonia pollutant levels along with the rate of addition of zeolite. One of the uses of zeolite is for water management from groundwater, distilled water, industrial waste, household waste and also agricultural waste. This dirty water contains insoluble waste, dissolved materials and colloids. So it must be handled mechanically, chemically and biologically depending on the dirt and contaminants and the standard of clean water required (Nurlela and Husnah, 2019).

Outlet is a place for waste water discharge or the last door for waste water disposal at the wastewater treatment plant. Outlets at WWTP PT. Perkebunan Karet (Rubber Plantation Ltd.) is equipped with a v-notch as a means of measuring the discharge of domestic wastewater. Wastewater that comes out of the outlet door will be tested on the quality of domestic wastewater first so that the waste water is safely discharged into the environment and does not disturb the community around the river.

Wastewater that comes out of the outlet door is accommodated first and then will be flowed using a pump to the Batang Kandis river, this is because the location of the domestic WWTP is not near the river, so it requires a pump to drain the domestic wastewater.

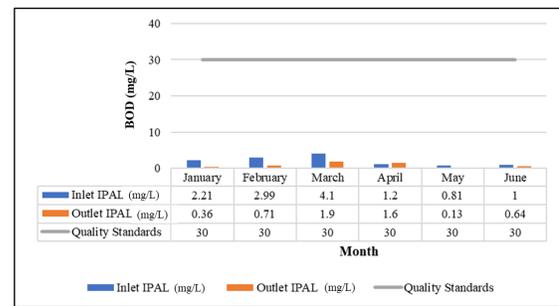


Figure 1. Graph of Inlet and Outlet Quality of Domestic Wastewater BOD Parameters for January-June 2021

3.4 Domestic Wastewater Quality Measurement PT. Perkebunan Karet (Rubber Plantation Ltd.)

3.4.1 BOD Measurement

Biological Oxygen Demand (BOD) is the amount of dissolved oxygen needed by microorganisms to decompose organic matter contained in wastewater. The high content of BOD in wastewater indicates the amount of organic content contained in wastewater, this is because the higher the BOD value, the more oxygen is needed by microorganisms in decomposing the existing organic matter. Factors that affect the high levels of BOD in wastewater, namely the high content of organic substances in the waste so that more oxygen is needed to degrade these organic substances (Wasita, 2019).

The results of the BOD parameter test at the inlet and outlet of the domestic wastewater treatment plant can be seen in the following Figure 1.

In April 2021 there was an increase in the BOD value at the outlet, the increase in the BOD value was influenced by the high content of organic materials that entered the domestic WWTP system, but was not matched by an adequate wastewater treatment process (Rosita et al., 2013). In addition, wastewater discharge also affects the ability of WWTP to reduce BOD, where the greater the wastewater discharge, the lower the efficiency of BOD reduction (Sulihingtyas et al., 2010). The quality of domestic wastewater outlets, the BOD parameter after processing, has decreased and meets the quality standard requirements set by the Minister of Environment Regulation No. 68 of 2016 which for the BOD parameter is 30 mg/L (Menteri Lingkungan Hidup dan Kehutanan, 2016).

3.4.2 COD Measurement

Chemical Oxygen Demand (COD) is the amount of oxygen needed to chemically oxidize organic and inorganic materials. COD measurements in wastewater can detect the amount of organic matter in water up to 90%, it will be seen that the COD measurement results will be greater than BOD. COD

Table 1. Percentage of Domestic Wastewater Treatment Efficiency BOD Parameters in January-June 2021

Month	Results		Efficiency (%)	Efficiency Level
	Inlet IPAL (mg/L)	Outlet IPAL (mg/L)		
January	2.21	0.36	83.71	Very Efficient
February	2.99	0.71	76.25	Efficient
March	4.10	1.90	53.66	Quite Efficient
April	1.20	1.60	-33.33	Not Efficient
May	0.81	0.13	83.95	Verry Efficient
June	1	0.64	36	Less Efficient

Table 2. Percentage of Domestic Wastewater Treatment Efficiency COD Parameters in January-June 2021

Month	Results		Efficiency (%)	Efficiency Level
	Inlet IPAL (mg/L)	Outlet IPAL (mg/L)		
January	14	3	78.57	Efficient
February	28	15	46.43	Quite Efficient
March	17	16	5.88	Not Efficient
April	9	10	-11.11	Not Efficient
May	4	5	-25	Not Efficient
June	3	3	0	Not Efficient

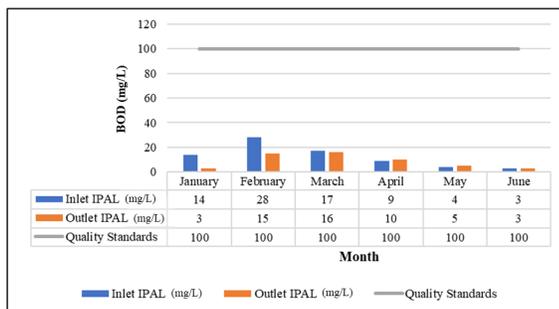


Figure 2. Graph of Domestic Wastewater Inlet and Outlet Quality COD Parameters January-June 2021

measurement will take much faster time, which can be done for three hours, while the maximum BOD measurement takes five days (Siregar, 2005). The results of the COD parameter test at the inlet and outlet of domestic wastewater can be seen in the following Figure 2.

In April and May 2021 there was an increase in the COD value at the outlets, while in June there was no decrease in the COD levels at the WWTP outlets. The increase in COD value can indicate the performance of decomposing microorganisms in the system that has not been effective. In addition, the factor of increasing COD occurs when a high content of organic matter enters the WWTP and causes microorganisms to experience saturation and death so that organic matter does not decompose as indicated by the

increase in COD value (Yazid et al., 2012). In addition, another factor that causes the COD value to increase is residence time, because the longer the hydraulic residence time, the greater the removal of COD and vice versa if the residence time is short, the removal is not optimal (Ainun and Hartati, 2012).

Based on the picture above, it can be seen that the quality of the domestic wastewater outlet COD parameters after processing has decreased and meets the quality standard requirements set by the Minister of Environment Regulation No. 68 of 2016 which for the COD parameter is 30 mg/L.

3.5 PT Wastewater Treatment Efficiency PT. Perkebunan Karet (Rubber Plantation Ltd.)

3.5.1 Domestic Wastewater Treatment Efficiency BOD Parameters in January-June 2021

Based on the table of percent efficiency of domestic wastewater treatment in January 2021, the percent efficiency value of the BOD parameter is 83.71% with an efficiency level that is very efficient. In February 2021, the percent efficiency value for the BOD parameter was 76.25% with the efficiency level being efficient. In March 2021, the percent efficiency value for the BOD parameter was 53.66% with an efficiency level that was quite efficient. In April 2021, the percent efficiency value of the BOD parameter was obtained, which was -33.33% with an efficiency level of inefficient. In May 2021, the percent efficiency value of the BOD parameter is 83.95% with an efficiency level that is very efficient. In June 2021, the percent efficiency value of the BOD parameter was obtained, which was 36% with an efficiency level that was less efficient.

3.5.2 Domestic Wastewater Treatment Efficiency COD Parameters in January-June 2021

Based on the table of percent efficiency of domestic wastewater treatment in January 2021, the percent value of COD parameter efficiency is 78.57% with an efficiency level of efficient. In February 2021, the percent efficiency value of the COD parameter was obtained, which was 46.43% with an efficiency level that was quite efficient. In March 2021, the percent efficiency value for the COD parameter was 5.88% with the efficiency level being inefficient. In April 2021, the percent efficiency value of the COD parameter was obtained, which was -11.11% with an efficiency level that was not efficient. In May 2021, the percent efficiency value of the COD parameter is -25% with an efficiency level that is inefficient. In June 2021, the percent efficiency value of the COD parameter was obtained, which was 0% with the efficiency level being inefficient.

One alternative in waste treatment is MBBR Technology which is a biological treatment unit that utilizes biofilms or microorganisms that grow on the media. These media have a large surface area to optimize contact between wastewater, air and microorganisms. Biological wastewater treatment is an important and inseparable part of any wastewater treatment plant, both domestic and industrial. Biological treatment is a secondary or advanced processing of physical processing to reduce substances suspended by microorganisms, such as algae or bacteria under aerobic or anaerobic conditions (Lestari, 2020). Biofilm is a term used to describe a special living environment of a group of microorganisms, which adhere to a solid surface in an aquatic environment (Busyairi et al., 2020). The advantages of wastewater treatment with an artificial land system, namely using aquatic plants in an artificial wetland system, are a technology that is simple, inexpensive, easy, efficient, economical and does not require special personnel to operate and maintain (Wanita, 2019).

4. CONCLUSIONS

Based on the results of observations regarding domestic wastewater treatment PT. Perkebunan Karet (Rubber Plantation Ltd.) concluded that the source of domestic wastewater PT. Perkebunan Karet (Rubber Plantation Ltd.) come from public toilet facilities, company offices, employee mess, document control center office, laboratory, canteen, and dining room, wastewater treatment process at domestic wastewater treatment plant PT. Perkebunan Karet (Rubber Plantation Ltd.) include oil and weak catching tanks, sedimentation, filtration and disinfection processes, the quality of wastewater before processing at the domestic WWTP inlet still does not meet the quality standards, while after processing at the domestic WWTP outlets it meets the quality standard requirements set by the Minister of Environment and Forestry Regulation Number 68 of 2016 concerning domestic wastewater quality standards. The efficiency of reducing the quality of domestic wastewater

from January to June for the average BOD parameter is 50.54%, the COD parameter is 15.79% on average.

Suggestions that can be given by the author to PT. Perkebunan Karet (Rubber Plantation Ltd.), namely the discharge of wastewater entering the domestic WWTP must be adjusted to the capacity of the domestic WWTP of each unit, so that the residence time is not too long and the wastewater treatment process can run efficiently. Domestic WWTP maintenance is required and regular cleaning once a month on clogged filters and pipes in each treatment unit so that domestic wastewater treatment can run efficiently.

5. ACKNOWLEDGEMENT

We thank to PT. Perkebunan Karet (Rubber Plantation Ltd.) for the opportunity to collect data research.

REFERENCES

- Ainun, R. M. K. H. S. and E. Hartati (2012). Characteristics of Substrate in Anaerobic Process Using Biodigester. *Journal of Environmental Engineering*, **2**; 63–75
- Anwariani, D. (2019). *Pengaruh Air Limbah Domestik Terhadap Kualitas Sungai*. INA-Rxiv (in Indonesia)
- Badan Pusat Statistik (2020). *Badan Pusat Statistik Provinsi Sumatera Barat Dalam Angka 2020*. Sumatera Barat (in Indonesia)
- Belladonna, M. (2017). *Analysis of The Level of River Pollution due to Rubber Industry Waste in Central Bengkulu District*. Semnastek Proceedings
- Busyairi, M., N. Adriyanti, A. Kahar, D. Nurcahya, and S. Sariyadi (2020). The Effectiveness of Gray Water Domestic Wastewater Treatment With Anaerobic Biofilter and Aerobic Biofilter Process (Case Study: INBIS IPAL Permata Bunda, Bontang). *Journal of Serambi Engineering*, **5**(4); 1
- Fanianto, D. (2018). *Infiltration Planning With Communal System in The Housing Development Project of Villa Indah Tegal Besar Jember*. Universitas Jember (in Indonesia)
- Husein, S. (2019). Domestic Wastewater Treatment Using Biofilm Technology with Bamboo Cut Media to Reduce Detergent, COD, BOD, and Ammonia Levels. *TechLINK Journal*, **3**(1); 1
- Lestari, D. S. (2020). Performance Evaluation of Domestic Wastewater Treatment Plant (Case Study: Domestic WTP for Reservoir "X", Jakarta). *Journal of Water Resources*, **16**(2); 91–102
- Menteri Lingkungan Hidup dan Kehutanan (2016). *Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Nomor: P.68/MENLHK/Setjen/Kum.1/8/2016 tentang Standar Kualitas Air Limbah Dalam Negeri*. Menteri Lingkungan Hidup dan Kehutanan (in Indonesia)
- Nurlela, N. and H. Husnah (2019). Effect of Zeolite Addition

- on Ammonia Reduction in Rubber Industry Liquid Waste. *Redox Journal*, **4**(2); 32–36
- Qasim, S. R. (2017). *Wastewater Treatment Plants: Planning, Design, and Operation*. Routledge
- Rarasari, D. M. G., I. W. Restu, and N. M. Ernawati (2019). Efektivitas Pengolahan Limbah Domestik di Instalasi Pengolahan Air Limbah (IPAL) Suwung-Denpasar, Bali. *Journal of Marine and Aquatic Sciences*, **5**(2); 153–163 (in Indonesia)
- Rosita, E., W. R. Melani, and A. Zulfikar (2013). Effectiveness Of Phytoremediation Of Water Spinach (*Ipomoea Aquatica* Forsk) On Orthophosphate Absorption In Detergents In Terms Of Detention Time And Concentration Of Orthophosphates. *Journal of Chemical Engineering*, **4**(1); 1–7
- Siregar, S. A. (2005). *Wastewater Treatment Plants*. Kaniisius
- Sulihingtyas, W. D., I. W. B. Suyasa, and N. M. I. Wahyuni (2010). Effectiveness of Denpasar Suwung Wastewater Treatment Plant Treatment System Against BOD, COD, and Ammonia Levels. *Journal of Chemistry*, **1**; 141–148
- United Nations (2016). *The Sustainable Development Goals Report*. New York, USA: United Nations
- Vachlepi, A. and R. A. Ardika (2019). Pemanfaatan Asap Cair Dari Pirolisis Limbah Perkebunan Karet Sebagai Koagulan Lateks. *Jurnal Industri Hasil Perkebunan*, **14**(1); 50–61 (in Indonesia)
- Wasita, D. H. (2019). *Pengolahan Air Limbah Domestik Dengan Tanaman Air Pada Parameter COD, BOD Dan DO*. INA-Rxiv (in Indonesia)
- Yazid, F. R., Syafrudin, and G. Samudro (2012). The Effect of Variations in Concentration and Discharge on Artificial Water Treatment (Mixed Gray Water and Black Water) Using the UASB Reactor. *Journal of Precipitation*, **9**; 31–40