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Effluent Quality Monitoring in Industrial Waste Water Treatment at PT. X

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Abstract: PT. X is an industry that produces waste from the main product manufacturing process and production residues. The waste produced is waste water. The purpose of carrying out this activity is to identify the sources and characteristics of waste water, know the waste water treatment system, know the results of waste water quality tests, and analyze the results of monitoring the quality of waste water. This activity is carried out by literature study, field observation, and primary data collection as well as secondary data. The results of this activity found that the source of waste water came from process waste water and cooling water. Data on the quality of waste water outlets used in 2022. The quality standards used are based on Minister of Environment and Forestry No. 19 of 2010, Governor Regulation No. 08 of 2012, and Palembang Mayor License No. 658.31 / IPLC / 0015 / DPMPTSP-PPL / 2020. Effluent monitoring at PT. X is tested monthly. The monitoring results of the effleunt liquid waste treatment at PT. X is observed to be still below the quality standards that have been set by safe funds to be discharged into water bodies.
Keywords: effluent, monitoring, effluent, oil and gas

1. Introduction

The increasing number of population growth will have an impact on increasing the number of living needs. To meet these needs, many industries have been established to date. Industrial development in Indonesia is very rapid accompanied by advances in industrial technology. Strategizing with technological advances can increase the competitiveness of national industries while creating wider employment. One industry whose development has greatly increased is an industry whose main activity is utilizing the wealth of natural resources. Natural resources used are oil and gas. Oil and gas are well known as one of the natural wealth that has high potential for state revenue [1].

Oil and gas are energy sources that are the main choice in various activities in the industrial, transportation, and household sectors. Thus, we are always faced with a dilemma between increasing fossil fuel production with industrial waste control and preserving natural resources. It is undeniable that the development of the oil and gas industry is one of the sources of environmental pollution [2].

PT. X is one of the oil and gas industries, where the processing process produces the main product and the rest of the production to produce waste. The waste produced includes solid waste, liquid waste, toxic and hazardous waste, and non-toxic and hazardous waste.

Then for waste water, treatment will be carried out at the treatment unit so that it is safe to be discharged into the environment. Location of PT. X is adjacent to two rivers, resulting in the process of processing waste water from the industry being a major concern so as not to cause pollution to both rivers. Therefore, it is necessary to review, monitor, and supervise the waste water produced from the treatment unit both in terms of physical and content so that the waste is suitable for disposal into water bodies.

The purpose of this study is to find out the results of waste water quality tests and analyze the results of effluent quality monitoring in waste water treatment at PT. X.

2. Materials and Method

2.1. Location

The research was conducted at PT. X which has two refineries of 258 hektare and 153 hektare. PT X is located in the province of South Sumatra, Indonesia. This area includes operating units, refinery control center rooms, feed and product tank areas, and office buildings [3].

2.2. Flow Chart

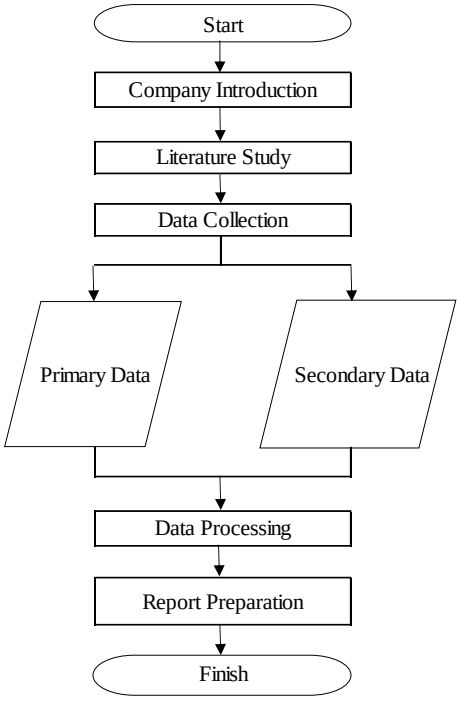

Figure 1. Research Flow Chart

2.3. Data Collection

Data collection was carried out in several ways, namely by conducting direct observation studies, interviews, and literature studies both previous reports, journals, and company activity reports. Interviews were conducted on 5 people who were employees of PT.X. The number of respondents was determined by purposive sampling.

2.4. Data Processing and Analysis

Data that has been obtained during practical work activities is carried out data processing with the help of MicrosoftExcel software. Then, for data analysis using descriptive analysis methods that have the aim of providing solutions related to problems that exist at the location of practical work activities based on facts. The data carried out by processing is in the form of parameter data and the test result certificate in waste water. In conducting data analysis, literature studies are also used in the form of articles, journals, books, regulations, and various other sources relevant to the topic of practical work taken.

3. Results and Discussion

3.1. Waste Water Sources

Waste water generated from PT. X is derived from primary, secondary, and tertiary production units. Waste water generated from each production unit will be flowed with a gravity system with open and closed channels and end up at the treatment unit.

3.1.1 Process Residual Water

Process wastewater is waste water that comes from each production unit, be it primary, secondary, or tertiary, and water that is in direct contact with crude oil or crude oil in the processing process. The residual water of this process becomes effluent which cannot be used directly, this is due to the high content of pollutants and is dangerous if used without treatment first. Effluent waste water PT. X comes from oily drains in the refinery equipment area such as desalter, boiler, and blow down and other effluent from the laboratory, fire water, and tank drain.

3.1.2 Cooling Water

PT. X utilizes cooling water technology that functions for heat transplantation so that the temperature in the processing unit is maintained. Cooling water source at PT. X comes from the Komering River, a tributary of the Musi River. There are two types of cooling water systems used, namely, once trough systems, cooling water systems that are carried out directly using raw water and then rebuilt into the river body without repeated use, and Circulation Systems This system uses cooling media that tastes from RWC 1 (Raw Water Clarification) processing through the processing process until it holds a clear well. Then, the water from the clear well flows to the storage area, namely the cooling tower with a pump. This cooling tower functions to provide cooling water circulation that will be flowed to units in PT X.

3.2. Waste Water Treatment Process

The waste water treatment process at PT. X makes use of PET-SET.

3.2.1 Primary Effluent Treatment (PET)

PET is a primary processing unit that aims to remove solid components that have been mixed with precipitation by gravity or flotation. In addition to precipitation, chemicals are added that serve to reduce small particles that are mixed. The deposition process can reduce oxygen demand at the next stage of treatment, namely in Secondary Effluent Treatment (SET).

3.2.2 Secondary Effluent Treatment (SET)

SET it is a processing unit that functions to regulate pH and reduce the oil content in the previous system, namely PET. In this process, utilizing the aeration process with activated sludge with the help of microorganisms or bacteria.

Figure 2. Waste Water Treatment Process with PET-SET

3.3. Characteristics of Waste Water PT. X

3.3.1 Influent characteristics

Table 1. Influent Quality of PET-SET

Parameters	Unit	Averege of 2022	Quality Standards	
			1	2
COD	mg/L	208.2	160	159
BOD	mg/L	36.2	80	79
Oil & Fats	mg/L	10.8	20	19
Ammonia	mg/L	0.8	8	8
Total Phenol	mg/L	0.1	0.8	0.8
Sulfides	mg/L	0.1	0.5	0.5
pH	mg/L	7.7	6.0-9.0	6.0-9.0
TOC	mg/L	200.8	110	-
Temperature	^{0}C	30.7	45	45
MPN Coliform	particle /100ml	4300.0	-	3000

Note: MPN is the Most Probable Number

3.3.2 Effluent Characteristics

Table 2 Effluent Quality of PET-SET

Parameters	Unit	Average of 2022	Quality Standards	
			1	2
COD	mg/L	84.2	160	159
BOD	mg/L	28.3	80	79
Oil & Fats	mg/L	3.6	20	19
Ammonia	mg/L	0.3	8	8
Total Phenol	mg/L	0.038	0.8	0.8
Sulfides	mg/L	0.029	0.5	0.5
pH	mg/L	7.5	6.0-9.0	6.0-9.0
TOC	mg/L	36.7	110	-
Temperature	^{0}C	31.1	45	45
MPN Coliform	particle /100ml	2591.7	-	3000

Note: MPN is the Most Probable Number

The quality of waste water at PT. X is tested every month. Testing is out for approximately 5-7 days. Sampling was carried out by the Environmental Laboratory team of the Environment and Land Service (DLHP) and the Environment HSSE section team of PT. X. Sample testing and laboratory analysis are also carried out by the DLHP Environmental Laboratory of South Sumatera Province. The laboratory that conducts this test has been accredited by KAN (National Accreditation Committee) and supervised directly by KAN so that the results of the analysis obtained can be accounted for. The parameters analyzed in waste water samples are COD, BOD, oil & fat, ammonia, total phenol, sulfide, pH, TOC, temperature, and MPN Coliform.

Based on the parameter analysis, there are two quality standard references used. PT. X uses two quality standards that are used as a reference in determining the quality of effluent waste water. Quality standard 1 based on the Regulation of the Minister of Environment No. 19 of 2010 concerning Wastewater Quality Standards for Oil and Gas and Geothermal Businesses and/or Activities and Governor Regulation No. 08 of 2012 concerning Quality Standards for Waste water for Industrial, Hotel, Hospital, Domestic and Coal Mining Activities.

Quality standard 2 is based on Palembang Mayor License No.658.31/IPLC/0015/DPMPTSP-PPL/2020 concerning Waste water Disposal Permit. PT. X chooses the quality standards used based on the strictest quality standards so that the expected output or final result of treatment does not pollute the environment, especially water bodies.

3.3.3. COD (Chemical Oxygen Demand)

COD is the oxygen needed to oxidize organic matter in water chemically. The COD value indicates the level of organic matter pollution in water and can be oxidized by biological processes, causing the dissolved oxygen

value [4]. Based on the average value of influent COD in 2022, PT. X in Table 1 shows a value of 208.2 mg/L, that the COD value still exceeds the quality standards used, which are below 160 mg/L and 159 mg/L.

The analytical method in determining COD value based on SNI 6989.2.2019 concerning How to Test Chemical Oxygen Demand (COD) with Spectrophotometric Closed Reflux). After processing, effluent on PET-SET shows the average value of COD in 2022 PT. X is 84.2 mg/L. This value shows that the COD effluent level has decreased from influent so the COD value is below the established quality standard.

Compared to [5], COD levels in refinery waste water with the same test treatment get a value of 93.248 mg/L. The value obtained is not much different from the effluent of PT. X. It can be concluded that the processing unit used can work properly.

3.3.4 BOD (Biochemical Oxygen Demand)

BOD (Biological Oxygen Demand) is the value of the amount of dissolved oxygen needed by microorganisms to decompose or oxidize organic matter in the waste water. The BOD value does not indicate the quantity of organic matter but only measures the oxygen needed to perform oxidation [4]. The average influent value in 2022 is 36.2 mg/L. This data shows that the BOD value is still below the quality standard.

However, processing is still carried out so that the value of the effluent BOD content decreases and does not exceed quality standards. Analytical method for determining BOD value based on SNI 6989.72.2009 concerning How to Test Biochemical Oxygen Demand (BOD). So that in effluent, in Table 1 the average value of BOD in 2022 is 28.3 mg/L which is far below the quality standards of 80 mg/L and 79 mg/L.

Based on [6], the BOD content in effluent is 0.0337 mg / L. This value is very different from the effluent content in PT.X. This can be caused by the different processing units applied by both. However, these two effluent values are still below the applied quality standard.

3.3.5. Oil and Fat

Oil and fat become one of the characteristics of waste water that is difficult to decompose by microorganisms [7]. Oil and fat are organic parameters in waste water that will have a large impact if they pollute in large quantities and are not handled specifically [8].

The average influent value in 2022, oils and fats amounted to 10.8 mg/L. This value shows that the value of oil and fat in influent is still below the quality standards of 20 mg/L and 19 mg/L. In the analysis of oils and fats based on SNI-06-6989.10.2011 concerning How to Test Vegetable Oil and Mineral Oil Gravimetrically. After going through the processing process in the PET-SET unit, the average value of oil and fat in 2022 is 3.6 mg/L, which is very far below the quality standard.

3.3.6. Ammonia

Ammonia is one of the pollutants of waste water that in certain contents can endanger human health. High ammonia levels, it can indicate organic matter pollution in waste water [9]. Based on the average value of ammonia influent in 2022, PT. X in Table 1 shows a value of 0.8 mg/L, and the ammonia value is still far below the quality standard of 8 mg/L.

The analytical method in determining ammonia value based on SNI-06-6989.30-2005 concerning How to Test Ammonia Content with a Phenate Spectrophotometer. After processing, effluent on PET-SET shows the average value of ammonia in 2022 PT. X by 0.3 mg/L. This value shows ammonia has decreased from influent and below quality standards. In [5], the ammonia content in refinery wastewater with the same test was 0.67 mg/L. When compared to the effluent PT. X, ammonia content has a value that is not much different and is still far below the established quality standards.

3.3.7. Total Phenol

Phenol is one of the toxic pollutants in waste water of an industry that can inhibit the process of biological degradation by microorganisms. Phenol is classified as a hazardous material that is toxic and corrosive when polluting water causes an unpleasant taste and odor and causes disruption to the health of living things [10].

Based on the average value of total influent phenol in 2022, PT. X in Table 1 shows a value of 0.1 mg / L, that the total phenol value is still below the quality standard of 0.8 mg/L. Analytical method in determining phenol value based on Environmental Laboratory Competence 15.31/ IK / LL/2015 with a Spectrophotometer. After processing, effluent on PET-SET shows that the average value of phenol in 2022 PT. X is 0.038 mg/L. This value shows that phenol has decreased from influent and below quality standards.

In [3], phenol levels in refinery wastewater after testing amounted to 0.0018 mg/L. When compared to effluent PT. X, phenol content has a fairly different value and is still far below the established quality standards.

3.3.8. Sulfides

Sulfide is an inorganic substance in the form of ions found in industrial waste water that has high-affinity level so that it can form H_2S compounds. H_2S at certain levels is toxic which causes death in living things and causes corrosion [9].

Based on the average value of influent sulfide in 2022, PT. X in Table 1 shows a value of 0.1 mg/L, that the sulfide value is still below the quality standard of 0.5 mg/L. Analytical method in determining sulfide values based on Environmental Laboratory Competence 15.28/IK/LL/2015 with a Spectrophotometer. After processing, effluent on PET-SET shows that the average

value of sulfide in 2022 PT. X is 0.029 mg/L. This value indicates that sulfide has decreased from influent and below quality.

3.3.9. pH

The pH value (potential hydrogen) is an indicator of the level of acidity or alkalinity of the waste water produced which has a function as an important parameter in chemical or biological reactions that occur in the waste water [11].

The average influent value in 2022, pH hovered around 7.7. This value shows that the pH in the influent is still in the quality standard range of 6.0-9.0. In pH analysis based on SNI 6989.11.2019 concerning How to Test the Degree of Acidity (pH) Using a pH meter. After going through the processing in the PET-SET unit, the average pH value in 2022 is around 7.5. This shows that the pH value of the effluent is still in the range of the quality standards set by PT. X. In [6], the pH value of the effluent is 7.06. The pH values of both are still within the quality standard range and indicate that the acidity condition of wastewater is close to neutral.

3.3.10. TOC

TOC is an overall picture of organic matter contained in waste water. TOC is closely related to COD and BOD parameters in the treatment of waste water [12]. Based on the average influent TOC score in 2022, PT. X in Table 1 shows a value of 200.8 mg/L, and the TOC value still exceeds the quality standard used, which is below 110 mg/L.

The analytical method in determining TOC value based on Environmental Laboratory Competence 15.35/IK/LL/2015. After processing, the effluent on the PET-SET shows the average TOC value in 2022 PT. X of 36.7 mg/L which has decreased drastically from influent and is below the quality standard.

3.3.11. Temperature

Temperature or temperature has a major influence on the oxygen solubility in the waste water. When the temperature increases, the oxygen content contained in waste water will decrease [13]. The average influent value in 2022, wastewater temperature is around 30.7°C. This value indicates that the temperature in the influent is still below the quality standard of 45°C. In temperature analysis based on SNI-06-6989.23.2005 concerning How to Test Temperature with a Thermometer. After going through the processing process in the PET-SET unit, the average temperature value in 2022 is around 31.1°C. So that the average effluent temperature is still below the quality standard.

The temperature of waste water in [6] in the effluent section ranges from 32.5°C. This condition when compared to PT. X is still categorized as not significantly different and is still classified as safe for waste water.

3.3.12. MPN Coliform

Microorganisms contained in the waste water usually contain an important role in biological processing of waste water, but some micro-organisms endanger human life. These micro-organisms include bacteria, fungi, protozoa, and algae. One example of bacteria that needs to be considered in industrial waste water is Coliform bacteria [14].

The average influent value in 2022, MPN Coliform is 4300 amounts/100 mL This value shows that MPN Coliform in influent is above the quality standard, which is 3000 quantities/100 mL. This value shows that MPN Coliform in influent is above the quality standard, which is 3000 amount/100 mL. In the MPN Coliform analysis based on Environmental Laboratory Competence 15.3/IK-MB/LL/2019. After going through the processing process in the PET-SET unit, the average value of MPN Coliform in 2022 is 2591.7 amounts/100 mL. This value has decreased from influent and is below the established quality standards.

3.4 Effluent Monitoring

In monitoring the quality of treated waste water, monitoring efforts are made at the outlet and the area around the unit. Efforts are made by providing daily monitoring flag markers at each disposal point. Marking at PT. X has procedures with guideline No. A-012/EI3500/2010-SO on monitoring and marking of wastewater conditions and oil spills and other chemicals.

The monitor flag used as a marker consists of 3 colors. The green flag indicates the visual condition of the wastewater is only visible thin oil layer and there are no oil spills or chemicals in the area around the ground. The blue flag indicates the visual condition of oily wastewater and there is an oil spill in the ground area with a thickness of less than 1 cm. Finally, a black flag indicates that the condition of oil in wastewater is very much and there is an oil spill in the ground with a thickness of more than 1 cm [15].

In addition to direct monitoring with laboratory observation and analysis, PT. X has been equipped with real-time monitoring using tools that have been integrated with the Ministry of Environment and Forestry. This monitoring is known as the Continuous and In-Network Wastewater Quality Monitoring System called Sparing. This system is used to measure, monitor, record, and report the measurement of the level of a parameter and/or wastewater discharge automatically, continuously, and connected in a network [16].

The results of monitoring with this SPARING tool were obtained from the processing of liquid waste at PT. X is still below the established quality standards. In monitoring with this SPARING tool, actual data related to effluent quality is obtained every minute of every day. So that it can be ensured, the quality of effluent can be

controlled properly and can prevent quality loss.

4. Conclusion

Based on the test results, it was found that all existing pollutant parameters were below the established quality standards. Efforts to monitor the causality of waste water at PT. X by monitoring every month, providing daily monitoring flag markers at each disposal point, and real-time monitoring using the SPARING tool integrated with the Ministry of Environment and Forestry in a network.

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