Liquid Waste Management Techniques by Using Equipment Operation System and Ipal System in PT Pertamina Trans Continental Dumai, Riau

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Abstract

Managing liquid waste from the oil and gas industry is crucial to prevent water pollution. PT Pertamina Trans Kontinental Dumai is one of the companies active in oil and gas operations, which produces liquid waste from exploration and production processes. This study aims to determine the company's fluid waste management system and the readiness of oil spill response equipment. The methods include direct observation, interviews with relevant parties, and literature review. The observations indicate that wastewater treatment is carried out through three stages: physical separation, chemical treatment, and biological processes using aerated tanks and sedimentation. The quality test results show that parameters such as BOD, COD, oil and grease, ammonia, total phenol, pH, and temperature are within the established quality standards. Additionally, PT Pertamina Trans Kontinental Dumai has complete and well-maintained emergency response facilities for oil spills, including oil booms, oil skimmers, dispersants, and sorbents. In conclusion, the management of liquid waste and equipment readiness for oil spill response at PT Pertamina Trans Kontinental Dumai complies with standards, thereby minimizing the risk of marine environmental pollution.

1. Introduction

PT Pertamina is a company engaged in Indonesia's largest petroleum sector. It was founded in 1957 and has many branches throughout Indonesia, including Teluk Binjai, Dumai City, Riau. Pertamina is a place where oil processing and waste from the industry occur.

Waste is the residue from production processes, both industrial and domestic (household). One type of waste is liquid waste. Waste is the residual material from production processes that cannot be avoided and often contains hazardous substances that cannot be reused and hurt the environment (Umroningsih, 2022). Liquid waste is the residual material from business activities or processes in liquid form that is discharged into the atmosphere, which is considered to degrade environmental quality due to its composition. Oil and gas exploration and production activities generate one type of liquid waste. This waste originates from the separation of crude oil and water. The liquid waste produced from these industrial activities must be managed appropriately to ensure safe disposal into the marine environment and surrounding areas (Umroningsih, 2024).

Based on Indonesian Law No. 32 of 2009 concerning Environmental Protection and Management, every industry, agency, or business entity must be responsible for managing waste generated from its activities. On this occasion, the author intends to study the waste treatment system, especially liquid waste from the remaining production activities, and determine whether the liquid waste has met the quality standards that will be safe to discharge into the sea. Therefore, activities are carried out on liquid waste treatment at PT Pertamina Trans

Kontinental Teluk Binjai, Dumai City, Riau, which aims to determine the liquid waste treatment system originating from the remaining production activities and determine whether the liquid waste meets the quality standards.

2. Methodology

2.1. Time, Place, and Materials

This internship practice was carried out for 4 weeks, from January 01 to January 31, 2024, in the Marine Region 1 building JL. Sultan Syarif Kasim No. 262 PT Pertamina Trans Continental Teluk Binjai Dumai City Riau Province.

2.2. Method

The method used in this internship practice is active participation, namely, participation in direct observation in the field, where oil and primary data collection are done by direct data collection or interviews in the field. Secondary data is obtained from agencies or institutions, namely PT Pertamina Trans Continental Dumai. Primary data collection, secondary data, and their implementation include three approaches: 1) Directly following all activities and assisting in implementing all activities at PT Pertamina Trans Continental Dumai in waste management.

2) Interviews with the head of operations, field technicians, staff employees, and other competent parties in their fields. 3) Literature study and search for information or scientific information sourced from journals, research results, and other sources that cover the problems at hand.

2.3. Procedure

Literature Study

Literature study refers to journals, books, and other references, such as previous final assignments and internet articles, to understand and analyze the problems in this internship practice.

Data Collection

Data collection included general and attribute data in the form of secondary data from local government agencies and direct surveys, reviewing liquid waste processing sites and oil spill subscription equipment warehouses, documenting the study area, and interviewing Pertamina employees.

Analyzing General Data

General data obtained, such as equipment used in waste treatment, data on wastewater quality standards, and so on, will be processed and formed to be analyzed.

3. Result and Discussion

Implementation of Internship Practice Activities

Activities carried out during the internship at PT Pertamina Trans Continental Dumai, Riau, starting from introductions to all parts of PT Pertamina, given material about PT Pertamina, given material about field safety, going to the field to collect data, conducting simulation training for oil spill subscriptions, and others.

General Description of the Observation Site

Observations of field conditions at Pertamina Trans Continental Dumai (Figure 1) were conducted in the Oil Spill Response (OSR) section. Access to the observation location can be reached by using a company car. The trip takes approximately 5 minutes. Data collection was carried out during rainy weather. Data on equipment in the Oil Spill Response (OSR) is explained from the use of tools with various functions, the quality standards of the waste, the origin of the waste, as well as the procedures for processing liquid waste and the use of oil spill response tools.

Oil Spill Response works closely with several sections, such as Protection of the Aquatic Environment (LLP), Special Ports (PELSUS), Mooring Gang, and Oil Movement. Lindungan Lingkungan Perairan (LLP) is a section that ensures the implementation of fuel and non-fuel sea transportation activities in the Pertamina Trans Continental Dumai work area. This LLP also stores oil spill response tools and administers licensing for ships that dock.

Special Port (PELSUS) is a port whose use is specifically for the activities of the Industrial, mining, or agricultural sectors for their interests. The use and operation are carried out by the agency concerned for the loading and unloading raw materials and production products (Darsono, 2021). A Mooring Gang is a person who assists the ship's crew in docking the boat, installing mooring ropes and cargo hoses to facilitate the crew's carrying out the loading and unloading process ship to ship (Aljehani, 2019).

Oil Movement in the context of Pertamina's system refers to a series of processes involved in the movement and management of crude oil or petroleum products from one location to another. It requires oil's transportation, storage, distribution, and derivative products. In addition, the Oil Movement performs maintenance and cleaning of tanks, controls oil losses due to leakage, drainage, downgrading, and evaporation in tanks, and controls pollution (Salim, 2013). The results of observations in the field of existing equipment to deal with oil spills are almost all there and in good condition, although some tools need repair because their condition is already good

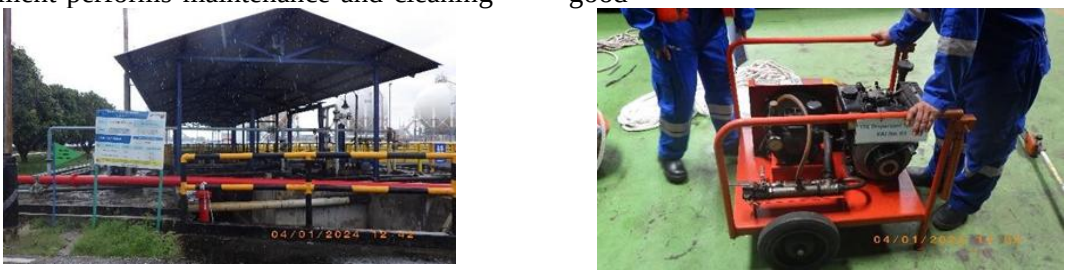

Figure 1. Liquid Waste Observation Site and Oil Spill Response Equipment Storage Warehouse

Liquid Waste Treatment Technique at Pertamina Trans Continental Dumai

Most wastewater comes from the water of various secondary process units. At the same time, Ammonia, Sulfide, COD, and Phenol are mainly derived from the leaching of participating compounds from the oil during the thermal cracking and hydrocracking processes. Pollution of waters by waste oil is commonly found in oil refinery areas, which can come from spills or pipe leaks during processing, transportation from tankers to processing units or stockpile tanks, and splashes during tank cleaning. Waste treatment techniques are carried out using three methods, namely physics, biology, and chemistry. Liquid wastes in Pertamina's environment will be collected into three separator tanks. Separator I collects liquid waste from oil tanks and leaking pipes. Separator I is not given any treatment because the liquid waste will be reprocessed. Waste that enters Separator II and Separator III undergoes chemical, biological, and physical therapy. Separator II will separate oil and water, accommodated in different tubs. Water that has been separated will be added to chemical treatment by providing chemicals such as aluminium sulfate, NaOH, and polymers. Adding these chemicals reduces the concentration of substances such as nitrates, phosphates, and ammonia in the water. Aluminium sulfate serves to purify water by precipitating these substances. NaOH also serves to reduce the concentration of substances. The content exists because water and waste oil are mixed, so harmful substances in the oil unite with water. In Separator II, an aerator supplies oxygen (Pertamina, 2013).

Furthermore, the wastewater has flowed into the biotreatment basin for biological treatment with aeration. There are three processes in the biotreatment section, namely: The equalization basin serves to equalize and prevent shock loading. This tub is equipped with three units of surface aerators. In addition, the equalization basin also functions for homogeneity, temperature reduction and evaporation of Sulfide, Ammonia and phenol compounds.

Aeration basin serves to degrade organic substances using aerobic bacteria. Surface aerator introduces oxygen into wastewater to maintain a minimum DO level of 2.5 mg / l. This oxygen is needed for the life of aerobic bacteria to decompose organic substances and for the nitrification process (converting ammonia compounds into nitrite compounds). The foam formed is one indication of active bacteria (not an indication of bacterial collapse). Aerobic biological processes are usually used for wastewater treatment with BOD loads that are not too large, while anaerobic biological methods are used for wastewater treatment with very high BOD loads (Nugraha, 2019).

The sedimentation basin serves to settle activated sludge containing bacteria that "hibernate" due to the absence of dissolved oxygen in the sedimentation basin and will be active again if returned to the biotreatment pond. At the time of returning the bottom sedimentation to biotreatment, to increase the efficiency of activated sludge biotreatment, some of it is also returned to the equalization

basin using the overlow flow from the thickener to the equalization basin with the aim that some bacteria that can live above a temperature of 30ºC, namely mesophile and thermophile bacteria can be active in the equalization basin. In this way, microorganisms can reduce waste organic levels, which are quite high in previous waste conditions (Sato et al., 2015).

Depending on the quality, quantity, and treatment techniques used, these effluent treatment technologies can be applied separately or combined to obtain maximum results. Oil industry wastewater treatment can be physical, chemical or biological. Physical-chemical or alternative treatment technologies include sedimentation, flocculation, and coagulation processes. While the biological process can be in the form of degradation using bacteria, both aerobically and anaerobically, with the growth of bound or suspended bacteria (Slamet, 2017).

Liquid Wastewater Quality Treatment Results

The results of wastewater quality treatment, January 2023, at PT Pertamina Trans Continental Dumai, can be seen in Table 1.

Table 1. Liquid Waste Treatment Result

Coordination Point	Coordinating Point	Parameters	Quality Standard	Measurement Result
4 Waste Water Outlet	01°40’59’’LU,101°28’42’’BT	BOD 5	80	5,89 mg/L
		COD	160	46,9 mg/L
		Oils and Fats	20	12,1 mg/L
		Dissolved Sulfide	0,5	< 0,001 mg/L
		Ammonia	8	1,55 mg/L
		Total Phenol	0,8	0,008 mg/L
		Temperature	45	31,3 °C
		pH	6-9	7,38
		Discharge	9600 m³/ Day	
5 Waste Water Outlet	01°40’58’’LU,101°28’41’’BT	Oil and Fat	15	3,75 mg/L
		Total Organic Carbon	110	3,22 mg/L
		Discharge	12000 m³/ Day	

Table 1 shows that PT Pertamina's measurement results meet the quality standard requirements for outlets 4 and 5 of process wastewater. From the table, it can be stated that: The outlet 4 BOD 5 quality limit is 80 mg/L, and the measurement results obtained in the wastewater test show that the BOD 5 parameter is 5.89 mg/L. The outlet 4 COD quality limit is 160 mg/L, and the measurement results obtained in the wastewater test show that the COD parameter is 46.9 mg/L.

The outlet 4 quality limit of oil and grease is 20 mg/L and the measurement results obtained in the wastewater test, the oil and grease parameter is 12.1 mg/L and for the outlet 5 quality limit of oil and grease is 15 mg/L and the measurement results obtained in the wastewater test, the oil and grease parameter is 3.75 mg/L.

The quality limit for outlet 4 Dissolved Sulfide is 0.5 mg/L, and the measurement results obtained in the wastewater test show that the Dissolved Sulfide parameter is <0.001 mg/L. Outlet 4 ammonia quality limit of 8 mg/L and measurement results obtained in wastewater testing, ammonia parameter of 1.55 mg/L.

Outlet 4 quality limit of total phenol of 0.8 mg/L and measurement results obtained in wastewater testing, total phenol parameter of 0.008 mg/L. The quality limit for outlet 4 temperature is 45°C, and the measurement results obtained in the wastewater test show that the temperature parameter is 31.3°C.

Outlet 4 quality limit pH of 6 - 9, and measurement results obtained in wastewater testing, pH parameter of 7.38. Outlet 5 quality limit dissolved organic carbon of 110 mg/L and measurement results obtained in wastewater testing, dissolved organic carbon parameter of 3.22 mg/L. The discharge limit for outlet 4 is 9600 m^3 / hour, and the discharge for outlet 5 is 12000 m^3 / hour.

The decrease in organic concentration is shown by removing COD and BOD_5 concentrations as parameters. The reduction in COD levels is caused by the decomposition of microorganisms on organic substances in waste when anaerobic conditions exist, where organic substances are converted into carbon dioxide (Suleman, 2022). The processing results prove that the longer the time required in the batch

reactor treatment process, the greater the organic substances degraded by microbes and can rincreasingly educe the concentration of BOD levels i BOD reduction is simple since most of the suspended solids are organic so that they can be decomposed biologically (Indrayani, 2018).

Operation Management of Oil Spill Handling Equipment at Pertamina Trans Continental Dumai

The management of oil spill equipment operations is commonly referred to as "Emergency Response Management" or "Oil Spill Response Management." In this context, it includes planning, training, and implementing emergency measures to respond to oil spills. The aim is to minimize environmental impacts, protect marine life, and minimize economic losses caused by oil spills. In responding to oil spills, marine and HSSE employees are closely related and are expected to be able to handle oil spills properly. Familiar sources of oil spills are bunker supply to ships, leaking pipes, and vessels. Oil spills due to operational activities are usually caused by errors in bunker distribution operations, waste disposal, ship repair and maintenance (docking). There are many tools used to overcome oil spills. At the marine post, some tools have been modified to modern tools; these tools are recorded in good condition. The following list of tools for dealing with oil spills is presented in the form of Table 2.

Table 2. Oil Spill Tool

No	Oil Spill Tool	Function	Brand/Type	State
1	Oil Boom	To localize the oil spill to prevent it from spreading	• Slick Bar / SL 24 • Troil Sea Boom • Modifikasi Oil Boom Bekas – Skirt Type RBR • Slick Bar Type RBR • KAJ	Good
2	Oil Skimmer	To remove oil floating on the water surface from oil spills	• GT.185 Pharos – Marine • Slick Bar – Type Slick Disc – MK 10 • Slick Bar – Type Weir Skimmer / Slick pack 700 + Disk/brush – MK 30	Good
3	Oil Containment Bag / Temporary Tank	For temporary storage, oil is taken with an Oil Skimmer to be disposed of at a predetermined location or further processed.	• Lancer Inflatable Barge 50 Ton • Oil Contaiment Bag 5 Ton	Good
4	Oil Dispersant Pump	Pump to spray/decompose oil.	• Water Spray – Robbin 3,5 (kap.200 L/S) • Spray modification (Kap 100 L/s) • KAJ –KDSU 40 • (Kap 70 ltr/mnt)	Good
5	Oil Dispersant chemical / Oil Spill Dispersant	As a surfactant-based product that can decompose oil spills in the environment	• Pertasurf 31 • OD 661 / Super Green Lite	Available
6	Oil Sorbent	To contain, repel and absorb oil spills on floors or water surfaces.	• Sorbent Pad • Sorbent Boom • Sorbent Pillow	Good

7	Floating Facility	As a fast transportation method to overcome oil spills and as an auxiliary tool when oil spills occur	• RBB Kerapu 723 (140 HP) • SB. Sinanbung (40 HP) • Pollution Fighting Craft (2x200 HP) • Patrol Boat ISFS Code (2x115 HP)	Good
8	Marine Environmental Protection Base	As a place for loading and unloading ships	LLP Building	Good

Table 3. How to Use the Oil Spill Tool

No	Tools	How it works
1	Oil Boom KAJ and SL 24 (Slick Bar)	Shaped like the letter U. two vessels are needed, each connected to the end of the Oil Boom. So, this configuration allows oil to be collected and led to the desired place.
2	Oil Skimmer	The Oil Skimmer is placed in the center of the spilled oil area, then two hoses with different functions are attached, then the oil is sucked and flowed into the oil storage tank. Which later oil and water will be separated by this tool
3	Oil Containment Bag	Oil Containment Bag is a container for spilt oil found in the waters.
4	Oil Spill Dispersant	Oil Dispersant is sprayed onto the spilt oil to disperse it. Once dispersed, the oil concentration will be harmless, or the oil particles will be broken into smaller particles. Furthermore, the biodegradation of oil by bacteria functions and blends with the water..
5	Oil Absorbent	Oil absorbent is made of polypropylene. Oil absorbent works

Based on the author's review in the field, the tools often used to handle oil spills around the jetty in the bunker supply process are Oil Skimmer, Oil Dispersant and Oil Boom. This is because the oil spills that occur are not too large, so the subscription is also simple and uses simple tools.

Operation Completion Stages

At this stage, the operation is completed, where all equipment used is collected from the working units and the equipment is also tidied up to be prepared to return to the Marine Environment Protection (LLP) base.

4. Conclusion

PT Pertamina Trans Kontinental Dumai has oil spill handling operation tools that meet the standards, so liquid waste in waters affected by oil spills is adequately handled before spreading to the surrounding environment. In addition, PT Pertamina Trans Kontinental Dumai also has a WWTP as a liquid waste flow installation from industrial activities that meets the standards, so that liquid waste can be discharged safely into the waters.

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