Engineering and Technology Journal e-ISSN: 2456-3358

Volume 09 Issue 06 June-2024, Page No.-4202-4210

DOI: 10.47191/etj/v9i06.05, I.F. – 8.227

Readiness of Industrial Fisheries Wastewater Treatment at the Nusantara Fishing Port in Sibolga

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ABSTRACT: The Nusantara Sibolga fishing port has a fish processing industry, which generates waste, including liquid waste, from its activities. The handling of wastewater from the industry involves treating the wastewater to meet quality standards before it is discharged into the open environment. In this study, the wastewater is channeled to the sea through an integrated wastewater treatment plant, as it originates from three different fishery industries. This is stipulated in the Minister of Environment Regulation Number 05 of 2014. The purpose of this study is to identify the facilities of the wastewater treatment installation and the final quality of its process. Data were obtained through direct surveys and interviews with stakeholders, and then samples for water quality were tested in a laboratory. The wastewater treatment installation equipment has the highest value from the readiness analysis results of the Sibolga fishing port wastewater treatment installation. The analysis showed that the highest score, 13 out of a total of 16, came from the collection tank of PT.ASL. The highest scores for treatment units were the sedimentation pond and the main collection tank, both scoring 11. This evaluation is also related to the quality results of the wastewater at the outlet. The evaluation of the readiness analysis results involves improving each device of the wastewater treatment installation for optimal results.

KEYWORDS: Sibolga Nusantara Fishing Port, pollution, strategy, waste, Wastewater Treatment Plant

I. INTRODUCTION

The Nusantara Sibolga Fisheries Port consists of several main activities, including fish landing, unloading activities, auctioning, sorting and packing activities, and marketing, along with the availability of the fishing industry. Additionally, in accordance with the Ministry of Marine Affairs and Fisheries Regulation Number 20 of 2014, the fisheries port has the duty of implementing environmental control at the fisheries port. Muninggar et al. (2016) describe fisheries ports as a very complex system, hence they are not far from various environmental problems. Based on the interview results, NFP Sibolga has been striving towards becoming an environmentally-based fisheries port. Waste management is one form of environmental control carried out by NFP Sibolga.

There are three fish processing industries that generate wastewater in the Sibolga Fishing Port area. An integrated wastewater treatment facility is available for wastewater treatment. The wastewater treatment facility consists of a collection unit at PT. DTU, which is engaged in the frozen fish processing industry, and at PT. ASL and PT. TSI, which are involved in both frozen fish and fish meal industries. The largest contributor of wastewater to the integrated wastewater treatment plant (WWTP) is PT. ASL, with an average frozen fish processing capacity of 100 tons per month. As a frozen fish processing industry, the wastewater generated is approximately 3,384 m³ out of the total 4,487 m³ channeled to the WWTP from January to June 2022, with an average of 18.8 m³ per day, followed by PT. TSI with 786 m³ and an average of 4.36 m³ per day. This indicates that the readiness of the integrated WWTP is crucial for treating wastewater, especially from the fish processing industry.

Preliminary research shows that some facilities at PT. ASL have experienced damage, specifically the wastewater meter, which affects the accuracy of the data on wastewater entering the integrated WWTP. Additionally, the contactor on the processing blender is damaged, causing it to not function optimally, which frequently results in blockages. The sludge drying tank, or the final treatment before wastewater is discharged into the sea, has never been drained or inspected for the bottom part, according to interviews.

Regarding the quality of wastewater, Sibolga Port has conducted laboratory tests based on the recommendation of Government Regulation No. 22 of 2021 for the maintenance and management of wastewater. Among the three wastewater channels, the first channel shows high levels of BOD (Biochemical Oxygen Demand), with a measurement of 202 mg/l and COD (Chemical Oxygen Demand) at 428 mg/l. These results exceed the quality standards set by the Minister of Environment Regulation No. 05 of 2014. Therefore, an evaluation is necessary to address the causes of the high levels of contaminants still above the standard limits. If this is not managed promptly, it could affect the wastewater treatment process in subsequent tanks. Research by Sutrini et al. (2018) describes that the WWTP at Sibolga NFPhas been utilized but has not yet been evaluated for its utilization level. Similarly, Ariani et al. (2020) indicated that the utilization level of the wastewater treatment facility at Sibolga Fishing Port has not been optimally assessed, suggesting unpreparedness in handling liquid waste. To achieve optimal wastewater treatment, good management, adequate facilities, and proper maintenance of available facilities are necessary (Rhomadhoni 2019).

The above descriptions highlight the need for research on appropriate strategies to assist the Sibolga Fishing Port management in environmental management, particularly in maintaining the quality of port wastewater to reduce environmental pollution. The objectives of this research are to analyze the quality of wastewater from the fishing industry activities of the Integrated WWTP at Sibolga NFPand to evaluate the readiness of the WWTP in managing wastewater according to physical requirements and standard treatment criteria. This research is expected to benefit relevant stakeholders by providing comparative information based on quality standards and liquid waste levels at Sibolga PPN, and informing stakeholders about wastewater management in line with superior conditions.

II. METHOD

The research was conducted from February to May 2023 at the Nusantara Fisheries Port (NFP) Sibolga in Aek Habil Bay, Pondok Batu Village, Sarudik Subdistrict, Central Tapanuli Regency, North Sumatra. The geographical location of NFP Sibolga is between 1º71ˈ87ˈˈ N and 98º79ˈ83ˈˈ E, with an area of 15.2 hectares. The data collection methods included sampling, direct observation, and interviews based on the research objectives. The technique for selecting respondents for interviews was based on the capacity of each respondent. The criteria determined for respondents were those with authority and understanding of the NFP Sibolga situation, including the head of the NFP Sibolga technical implementation unit, fishery product industry managers, fishermen, and academics. The data collection and processing are described in Table 1.

Table 1. The data collection

Objective	Required Data	Data Source	Data Collection Method	Data Processing	Data Analysis
Analyzing the quality of wastewater from fishing activities at the port Wastewater Treatment Plant (WWTP) NFP Sibolga	Wastewater quality standards	Wastewater in the final tank of the Integrated Wastewater Treatment Plant (WWTP) NFP Sibolga	Sampling of wastewater in the final tank of the Integrated Wastewater Treatment Plant (WWTP)	Laboratory Testing	Descriptive analysis of laboratory test results compared with Regulation of the Minister of Environment and Forestry No. 05 of 2014
Evaluating the readiness of the WWTP in managing wastewater according to physical requirements and standard wastewater treatment	Physical completeness of WWTP devices, WWTP capacity, multi-purpose WWTP devices, device activity	WWTP tank	Direct observation	Compilation of observation results	Analysis of readiness level

Data processing for analyzing wastewater quality is done through laboratory tests in accordance with Ministerial Regulation No. 05 of 2014 with several parameters, namely pH, chemical oxygen demand, biological oxygen demand, total suspended solids, sulfide, ammonia, free chlorine, and fat oil. Subsequently, the laboratory test results are tabulated for easier analysis. The following are the assessment parameters of the laboratory test elaborated in Table 2.

Table 2. Wastewater quality parameters

Parameter	Unit	Level
Ph	-	6-9
TSS	mg/L	100
Sulfide	mg/L	1
Ammonia	mg/L	5
Free Chlorine	mg/L	1
BOD	mg/L	100
COD	mg/L	200
Oil and grase	mg/L	15

Source : LH Ministerial Regulation No. 5 of 2014

The results of the sample test will be analyzed for the effectiveness of wastewater reduction after undergoing treatment at the wastewater treatment plant (WWTP) (Tchobanoglous et al. 2014) using the following formula.

Formula: Removal efficiency = (a - b) / a x 100%

Explanation:

a = wastewater level at the inlet

b = wastewater level at the outlet

The calculation of effectiveness reduction will result in a percentage and be entered into a table to observe the wastewater removal after the treatment process.

The evaluation of WWTP readiness from observations needs to be processed first before further analysis is conducted. Data processing involves entering the observation results of the physical completeness criteria of the WWTP equipment, WWTP capacity, multifunctionality of WWTP equipment, activeness of WWTP equipment, with the value for each criterion found in Table 3.

Table 3. Data processing involves entering the observation results

Criteria	Physical Completeness	Capacity	Multi-functionality	Activity
1	Main and supporting equipment are incomplete (< 25%)	25% of installed capacity met	Processes 1 type of waste	Operates discontinuously and all outputs do not meet standards/manuals for processing stag
2	Main and supporting equipment are less complete (> 25 – 50%)	25 – 50% of installed capacity met	Processes several specific liquid wastes	Operates discontinuously, and some outputs do not meet standards/manuals for processing stage
3	Main and supporting equipment are fairly complete (> 50 – 75%)	50 – 75% of installed capacity met	Processes many types of liquid waste but with certain separations in processing	Operates continuously and some outputs do not meet standards/manuals for processing stage
4	Main and supporting equipment are complete (> 75 – 100%)	75 – 100% of installed capacity met	Processes all types of liquid waste with various supply methods to WWTP	Operates continuously and outputs meet standards/manuals for processing stage

The results of data processing will be analyzed by assigning each criterion a value on the WWTP device. The scale used in the evaluation analysis assesses the completeness, capacity, versatility, and activity of each WWTP device (modified from Mustaruddin et al., 2020, and Saputri et al., 2021). Each device in the data processing that meets criterion 1 has a value of 1, criterion 2 has a value of 2, criterion 3 has a value of 3, and criterion 4 has a value of 4. The steps taken to analyze the readiness of the WWTP devices in treating wastewater are as follows:

Evaluate the readiness of each WWTP device. This calculation uses the readiness level/RL formula (Mustaruddin et al., 2020) in equation 1:

RL (Readiness level) = $(\Sigma vi)/n$ (1)

Where:

RL = readiness level of a specific device

vi = value of criterion i for a specific device

i =1,2, ...,

n = (criteria for physical condition, capacity, multy-functionility, and activity)

Evaluate the overall readiness of the WWTP devices using the formula in equation 2:

$$RLgab = (\sum RL)/j \qquad (2)$$

Where:

RL overall = overall readiness level of the WWTP devices,

RL = readiness level of a specific device

j = 10unit storage tank and 4unit device WWTP

The analysis of the wastewater quality from the fishing industry activities in Sibolga NFPis based on laboratory tests compared with the quality standards parameters according to PERMEN LH Number 05 of 2014. The analysis of the WWTP devices using the WWTP readiness level method functions to measure the performance and support of a device in the technical operations to meet the established standards and requirements (Mustaruddin et al., 2020).

III. RESULT

A. Fishery Industry Activities

The Nusantara Sibolga Fishery Port hosts several industries engaged in fish processing, including PT. DTU, which specializes in frozen fish processing; PT. ASL, which focuses on loin fish processing; and PT. TSI, which produces both loin fish and fish meal. These three industries generate waste from their processing activities, such as liquid waste. According to interviews with stakeholders and direct field observations, the liquid waste mainly originates from various freezing and loin processing activities, which predominantly channel wastewater to the wastewater treatment plant (WWTP) as indicated in Table 4.

Activity	Process	Wastewater Generated
Receiving raw materials and dismantling	Receiving raw materials, all equipment is cleaned in the frozen warehouse area, then sorted. Raw materials are kept free from contamination by foreign objects such as wood, plastic, hair, etc.	Wastewater from equipment cleaning and fish blood
First washing	Washing with ultraviolet water while maintaining a maximum temperature of 50°C	Wastewater from fish rinsing
Cold storage	Storage is required to maintain a maximum temperature of 50°C to prevent cross-contamination. Ice is added to prevent bacterial growth, employee hygiene control, sanitation, and hygiene are conducted to prevent contamination of raw materials from decreasing quality.	Wastewater from ice melting and sanitation
Cutting and gutting	This stage is done manually by employees to remove the head, skin, bones, fins, and fish belly which can increase the risk of damage and decrease in fish quality.	Fish blood and leftover fish belly contents
Second washing	Raw materials that have undergone gutting must be cleaned again to avoid post-gutting bacterial contamination. Cold water is used and replaced several times to ensure the cleanliness of gutted raw materials.	Wastewater from raw material washing
Sizing	Sorting is done manually to obtain product size uniformity while maintaining hygiene.	Drippings from raw material washing
Arranging fish types	Products are arranged in long pans before freezing, then arranged on freezing racks with temperature maintained at 50°C to prevent bacterial growth.	Drippings from product arrangement
Freezing	In the initial freezing stage, the fish is cleaned and sanitized first, then arranged on freezing racks with a temperature of 4.40°C.	Wastewater from cleaning process
Weighing	Weighing is done in preparation for product	Leftover frozen water

	packaging.	
. Packaging and labeling	Employees first sterilize and maintain hygiene. Frozen products are stored in cardboard boxes and labeled, this process is done quickly to avoid contamination.	Wastewater from cleaning process
. Frozen storage	At this stage, it is done in a cold room with a temperature of 20°C and should not be contaminated, and temperature changes are not recommended to prevent product damage until the distribution stage.	Leftover water drips from transporting packaged products to frozen storage room

B. Wastewater Quality

The process of testing wastewater quality is conducted by taking water samples from both the inlet and outlet channels. The outlet sample is obtained from the final channel before it discharges into the sea. The parameters tested are in accordance with the Ministry of Environment Regulation No. 05 of 2014. Based on the test results of the wastewater samples, three parameters do not meet the quality standards: free chlorine, BOD (Biochemical Oxygen Demand), and COD (Chemical Oxygen Demand). The laboratory test results can be seen in Table 5.

Table 5: Laboratory Test Results of Inlet and Outlet Wastewater Samples

Parameter	*Inlet Value*	*Outlet Value*	Unit	Quality Standard
TSS	0,006	0,01	mg/L	100
Sulfida	0,206	0,22	mg/L	1
Ammonia	0,31	0,13	mg/L	5
Free Chlorine	697,788	387,66	mg/L	1
Oil and grase	0,002	0,004	mg/L	15
BOD	57,3	127	mg/L	100
COD	142	274	mg/L	200
pH	7,6	8,2	-	6-9

Primary Data: Inlet and Outlet Quality 2023

The activities of the fishing industry that generate wastewater have environmental impacts, especially the wastewater discharged into the sea. There are several parameters that do not yet meet the wastewater quality standards from the sample tests conducted, which will be reviewed as follows.

Total Suspended Solids (TSS)

This parameter measures the total amount of suspended solid particles in the water, including silt, soil, microorganisms, and other materials. The test results for total suspended solids (TSS) showed that the values fluctuate but do not exceed the wastewater quality standard, which is below 100 mg/L. Turbid wastewater reduces water clarity, impairing the photosynthesis process in microorganisms (Putri 2022). Observational results of the solid particles visually decreased at the WWTP outlet in line with laboratory test results.

Sulfide

Sulfide from fish processing activities can take the form of hydrogen sulfide (H2S), with sample test results showing values below the quality standard. However, direct observation detected an odor that can be inhaled. Dissolved sulfide in wastewater is produced after sedimentation processes in the WWTP. The presence of sulfide in wastewater is due to acid and base mixing, resulting in a foul odor affecting both air and water quality (Ummah and Herumurti 2018). The test results showed values of less than 1 mg/L, which comply with the quality standards.

Ammonia

The ammonia levels from the inlet and outlet are around 0.13 mg/L, which is within the quality standard of <5 mg/L. Ammonia can reduce dissolved oxygen levels, negatively impacting aquatic life. If ammonia levels exceed the quality standard, it can contaminate seawater, the final discharge point of wastewater, by reducing dissolved oxygen and harming the ecosystem (Febrianty 2022).

Free Chlorine (Cl2)

The sample test results for free chlorine exceed the quality standard at 387.66 mg/L. High levels of free chlorine can become a source of environmental pollution when discharged into the sea. Free chlorine originates from sterilization and sanitation activities of equipment used in the industry to prevent microbial growth. One reason for free chlorine not meeting standards at the outlet is the suboptimal processing.

Oil and Grease

Oil and grease come from the fish cutting process and from unused fish parts such as fish entrails. Oil and grease waste can form a layer on the water surface, blocking sunlight and affecting the photosynthesis process. Oil and grease on the wastewater surface can influence microbial activity and hinder oxidation processes (Ummah and Herumurti 2018). The sample test results show oil and grease levels of <15 mg/L, meeting the wastewater quality standards.

Biological Oxygen Demand5 (BOD)

BOD samples are tested to determine the pollution load of the wastewater. The BOD test results at the outlet were 127 mg/L, exceeding the quality standard, compared to the inlet which was below the standard at 57.3 mg/L. The increase in BOD is due to the high content of organic compounds, indicating a rise in suspended solids. Field observations showed that the increase in BOD levels was due to the unstable volume of wastewater entering the final sludge drying tank at the WWTP, leading to ineffective processing. Another cause was high rainfall during the study period at NFP Sibolga.

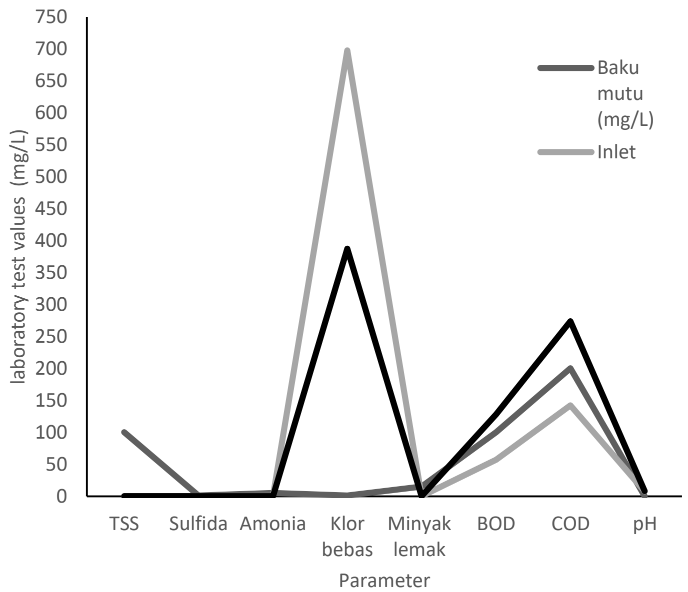
Chemical Oxygen Demand (COD)

Chemical oxygen demand (COD) represents the amount of oxygen needed to oxidize organic compounds. The sample test results exceeded the quality standard at the outlet, around 274 mg/L, and were also higher than the BOD values. High COD levels are harmful to the environment as they can reduce dissolved oxygen content (Sasiang et al. 2019). The wastewater condition from the outlet can cause marine pollution. The sample test results showed a significant increase in COD from 142 mg/L at the inlet to 274 mg/L at the outlet, indicating active bacteria could not break down the organic matter during processing at the WWTP.

pH

The pH parameter from the sample test results showed stable values of 7.2 at the inlet and 8.2 at the outlet, within the quality standards. pH measurement is a key parameter in determining the reaction rates of several other parameters (Sulistia and Septisya 2020). The acidity level of the wastewater significantly affects microorganism life. The sample test results can be displayed in a graph to compare the inlet, outlet, and wastewater quality standards. This graph also provides information on parameters significantly exceeding the quality standards. Below is Figure 2, a graph of wastewater quality.

The effectiveness of wastewater treatment at WWTP can be seen from the removal data results. Removal refers to the reduction volume of wastewater after treatment at the WWTP (Arif 2020). Sample test results showed that only two samples had positive removal values or a reduction in levels, namely ammonia with a removal of 58.1% and free chlorine with a removal of 44.4%. The other parameters did not show a reduction or had negative values. Complete removal data is presented in the graph below.



The removal in wastewater quality testing has a negative value because it does not decrease after undergoing treatment or processes at the WWTP (Wastewater Treatment Plant), and it has a positive value because it experiences a reduction (Apriliyani et al. 2023). One of the factors affecting the inefficient removal at the WWTP is during the sampling of the inlet wastewater, which has already mixed and settled in the collection tank before entering the WWTP process. Then, it is observed by the staff until the maximum limit in the collection tank because the automatic machine leading to the initial treatment in the WWTP is not functioning or is damaged, so the water is not treated immediately. Wastewater samples from the outlet are taken from the final channel when the treatment process is ongoing. This affects the samples, mixing with the wastewater that has previously settled in the sludge drying bed. Therefore, the removal rate of several parameters does not show a decrease. Table 6 total wastewater in WWTP per month in 2022.

Month	PT. TSI (m^3)	PT. ASL (m^3)	PT. DTU (m^3)	Total (m^3)
January	251	587	63	901
February	-	147	58	205
March	35	-	58	93
April	165	900	60	1125
May	131	850	55	1036
June	164	900	63	1127
July	122	920	65	1107
August	67	450	65	582
September	43	950	65	1058
October	43	950	65	1058
November	-	1250	65	1315
December	15	1000	65	1080

Wastewater Treatment Plant Equipment and Retention Time
The integrated wastewater treatment plant (WWTP) at NFP Sibolga consists of various devices at different stages of the waste treatment process, each serving different functions. This WWTP employs a method of collecting wastewater from three source points. The volume and size of each WWTP device vary, and field observations have identified the functions of each device as follows.

1. Industrial Collection Tank

Wastewater from fish processing industries is first collected in a holding tank. Wastewater from PT. ASL, PT. TSI, and PT. DTU each has a holding tank with a volume of 5.5 m³. These tanks serve not only to hold wastewater from each industry but also to filter and separate solid waste, such as fish entrails discarded during cleaning. These holding tanks support the wastewater treatment process by separating solid and liquid waste.

2. Main Wastewater Collection Tank

Wastewater from industrial activities is collected in an inlet tank before entering the WWTP. The wastewater undergoes initial filtering using small hole sieves to trap leaves and other debris. The main collection tank measures 3.1 m x 2.5 m x 5 m with a volume of 38.75 m³. This tank has two pumps that transport the wastewater to the aeration tank, ensuring it can be directly pumped once it reaches a certain level. The pump system activates automatically when the wastewater reaches a set volume, but during the study, one of the pumps was malfunctioning, so only one pump was operational.

3. Aeration Tank

The aeration tank functions to introduce air to increase oxygen levels, reducing organic substances and BOD (Biochemical Oxygen Demand). This tank has two scrappers that act as mixers. The tank is divided into left and right sides: one side collects wastewater from the main collection tank, and the other side collects overflow water during mixing. Each side is equipped with a mixer placed above the bottom to ensure optimal mixing. These mixers, known as Scrapper 1 and Scrapper 2, help maintain the aeration process. The tank has a capacity of 250 liters.

4. Sedimentation Tank

The sedimentation tank separates suspended particles through gravity. It increases the size and weight of solid particles to facilitate their settling. This tank has pipes reaching its bottom and walls that filter particles before the water moves to the next tank. Sedimentation occurs here, where solid masses formed during coagulation settle over time due to increased weight, eventually settling at the bottom. A sludge tap pipe is located at the bottom of this 100-liter sedimentation tank, which also has walls for filtering incoming particles.

5. Sludge Drying Tank

Wastewater from the sedimentation tank undergoes further settling in the sludge drying tank. This tank is layered with materials: gravel at the bottom, followed by coarse gravel, broken bamboo, coarse sand, ijuk (a type of fiber), and fine sand on top. The wastewater is then transferred to the sludge drying channels, where it settles again. This drying process, which reduces water content, involves pumping sludge onto a drying bed about 1 or 2 meters deep.

The WWTP equipment review includes calculating the retention time, which is essential for separating particles effectively before discharging treated wastewater into the sea (Apriliyani et al., 2023). The required retention time can be calculated as follows.

To separate particles optimally during wastewater discharge to the sea surface (Apriliyani et al. 2023), the retention time can be calculated as follows:

1. Retention Time in the Main Wastewater Collection Tank at the WWTP

The water from the industry is temporarily stored in the main collection tank before further treatment. This tank has a volume of 38.75 m³. Based on direct observations, the main collection tank has bubbles on the water surface and emits a strong odor. Below are the specifications of the main collection tank at WWTP NFP Sibolga:

- Tank length: 3.1 m
- Tank width: 2.5 m
- Tank height: 5 m
- Tank volume: 38.75 m³
- Wastewater flow rate (Q): 4.73 m³/hour
- Required retention time = Tank volume / Q
  - 38.75 m³ / 4.73 m³/hour = 8.19 hours ~ 8 hours

2. Retention Time in the Aeration Tank

The aeration tank supplies oxygen from the air, allowing microorganisms to decompose organic matter in the wastewater. The aeration tank has 2 fan-shaped scrapers for mixing. Below are the dimensions of the aeration tank at WWTP NFP Sibolga:

- Tank length: 9.5 m
- Tank width: 8 m
- Tank height: 3.3 m
- Tank volume: 250 m³
- Required retention time = Tank volume / Q
  - 250 m³ / 4.73 m³/hour = 52.85 ~ 53 hours

3. Retention Time in the Sedimentation Tank

The sedimentation tank is used to settle the sludge. This tank has a pipe at the bottom of the tank. Observations show that the sedimentation tank has filters on the tank walls, and the filtered water is channeled to the sludge drying pond. Below are the dimensions of the sedimentation tank at WWTP NFP Sibolga:

- Height: 2.36 m
- Diameter: 6 m
- Volume: 100 m³
- Required retention time = Tank volume / Q
  - 100 m³ / 4.73 m³/hour = 21.14 ~ 21 hours

4. Retention Time in the Sludge Drying Bed

The sludge drying bed functions to filter the sludge and consists of 2 beds. The filter components include gravel, broken bamboo, coarse sand, and fibers. Below are the dimensions of the sludge drying bed:

- Length: 20 m
- Width: 8 m
- Height: 1 m
- Volume: 320 m³
- Required retention time = Tank volume / Q
  - 320 m³ / 4.73 m³/hour = 67.65 ~ 68 hours

The retention time varies based on the wastewater volume divided by the flow rate (Parasmita et al. 2013). However, the calculated retention times are not strictly followed, as the WWTP management typically channels the wastewater based on tank volume.

a. Main Wastewater Collection Tank, Design Criteria by Metcalf and Eddy (Tchobanoglous et al. 2014):
- Number of units: 1, Existing: 1 unit
- Length: 4.50 m, Existing: 3.1 m
- Width: 2.00 m, Existing: 2.5 m
- Depth: 1.55 m, Existing: 5 m
- Td: 1-2 days, Existing: 8 hours

b. Aeration Tank, Criteria from Qasim (1985):
- Length: 3.70 m, Existing: 9.5 m
- Width: 3.00 m, Existing: 2.5 m
- Depth: 1.0 m, Existing: 3.3 m
- Td: 3-5 hours, Existing: 53 hours

c. Sedimentation Tank, Design Criteria by Permen PUPR (2017):
- Length: 3.26 m, Existing: -
- Width: 1.76 m, Existing: -
- Depth: 2.7 m, Existing: 2.36 m
- Td: 2 hours, Existing: 21 hours

d. Sludge Drying Bed, Design Criteria by Permen PUPR no. 4 of 2017 and Metcalf & Eddy (2003):
- Length: 1.87 m, Existing: 20 m
- Width: 0.71 m, Existing: 8 m
- Depth: 2.7 m, Existing: 1 m
- Td: 1-3 hours, Existing: 68 hours

The results of the evaluation of WWTP equipment readiness are presented in the form of tables and radar charts to display the readiness of each equipment. The evaluation scores for the equipment are shown in Table 7.

Equipment	Physical Completeness	Capacity	Multi-function	Activeness	Total
1. PT. ASL tank	3	4	2	4	13
2. PT. TSI tank	3	1	2	2	8
3. PT. DTU tank	1	1	2	2	6
4. Main Wastewater Collection Tank	2	4	2	3	11
5. Aeration Pond	3	2	2	3	10

6. Sedimentation Pond	3	3	2	3	11
7. Sludge Drying Pond	3	2	2	2	9

The source: primary data processing 2023

Evaluation of the readiness of the Sibolga NFPWWTP shows that the highest number of units comes from the industry's tanks, with a maximum score of 13 from PT. ASL's collection tank. The highest processing unit is the sedimentation pond with a score of 11, along with the main collection tank also scoring 11. This WWTP evaluation is also related to the quality of wastewater at the outlet. One of the reasons for the non-compliance of wastewater with quality standards is the inadequate WWTP equipment for treating wastewater.

CONCLUSIONS

The wastewater quality from the Sibolga NFPWWTP at the outlet still has several parameters that do not meet the quality standards according to PERMEN LH No. 05 of 2014, namely free chlorine, BOD, and COD. The readiness of the WWTP in treating wastewater from the fisheries industry in NFP Sibolga is not optimal, with the highest score from PT. ASL and 11 for the main collection tanks and sedimentation with an optimum score of 16.

RECOMMENDATIONS

Further research is needed to assess the wastewater quality of each unit of the WWTP equipment periodically, so that the value of each parameter can be analyzed. The results of this analysis can then be evaluated in more detail for each WWTP unit.

ACKNOWLEDGMENT

The author would like to thank the Sibolga Nusantara fishing port for providing research data.

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