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The Effect of Chlorine on The Reduction of Coliform and Total Suspended Solids in Domestic Wastewater at Port X Batam City in 2024

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Abstract
Introduction: *Daily activities at Port X generate domestic wastewater containing total coliform and Total Suspended Solids (TSS) levels exceeding the environmental quality standards. Elevated concentrations of these parameters pose a risk of waterbody pollution and can lead to gastrointestinal diseases in nearby communities.* ***Objective:*** *This study aims to evaluate the effect of calcium hypochlorite (kaporit) treatment on the reduction of total coliform and TSS in domestic wastewater at Port X, Batam City, in 2024.* ***Method:*** *A true experimental research method was employed, using a pretest-posttest control group design. Samples were treated with varying doses of calcium hypochlorite, followed by laboratory analysis to measure changes in coliform and TSS concentrations. Primary data were analyzed using paired t-tests with a significance level of $p < 0.05$.* ***Result and Discussion:*** *The results indicate that calcium hypochlorite treatment significantly reduces both total coliform counts and TSS levels. The most effective treatment was achieved with a dosage of 2 g/L of calcium hypochlorite combined with 4 hours of aeration, resulting in reduction efficiencies of 82.71% for total coliform and 85.16% for TSS.* ***Conclusion:*** *It can be concluded that calcium hypochlorite is effective in reducing pollutant loads in domestic wastewater, demonstrating its potential as an efficient and affordable solution for wastewater treatment in port areas.*

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Introduction

Batam is one of the cities in the Riau Islands Province which has several ports as entrances and connections between regions both domestic and international. The economic, social, and cultural development of the community is enhanced by the existence of the port. Ports also contribute indirectly to the advancement of education, international relations, and politics, and are often used as a measure of the development of a region (Stephen, Riani, & Anwar, 2018)

The terminal building, which serves as a transit point for people, goods, and means of transport, is an important facility at the port. In the terminal building, liquid waste comes from bathrooms, toilets, sinks, kitchens where food is processed, and other cleaning activities (Rifan & Suhardi, 2021). Secondary data obtained from the Batam Health Quarantine Center is known that there are total coliform and Total Suspended Solid (TSS) parameters that exceed the quality standard values in the examination of domestic waste samples at Port X with the following results, total coliform parameters ≥ 16000 MPN/100 mL and TSS parameters 71 mg/L (Batam KKP, 2023). In an initial survey on March 1, 2024, physical observations were made at the Port X domestic waste final disposal outlet, the results showed that the wastewater was cloudy in color and smelled bad.

TSS causes turbidity that limits light penetration for photosynthesis and visibility in waters. TSS typically consists of sludge, clay, metal oxides, sulfides, algae, bacteria, and fungi (Pramita & Puspita, 2019); (Roberth AN, 2023). A higher total coliform concentration than the wastewater quality standard indicates the presence of infectious pathogen contamination that spreads the disease through the medium of water media (Sebayang, Aritonang, Silaban, & Arwita, 2025); (Syaripuddin, Arifin, Haris, & Hamzani, 2025); (Wibowo & Yogisutanti, 2023). The presence of high TSS can be a triggering factor for an increase in coliform bacteria, as these bacteria can live on TSS-forming elements. Therefore, effective waste treatment is needed to prevent the impact on humans such as diarrhea and other diseases of the gastrointestinal tract.

Domestic waste treatment must be carried out by port managers, considering that there are provisions on the implementation of healthy ports contained in the Minister of Health Regulation Number 44 of 2014 concerning the Implementation of Healthy Ports and Airports (Angraini et al., 2024). Domestic waste is considered a risk factor that must be eliminated by carrying out proper treatment. Some of the treatment principles commonly used to reduce coliform and TSS contamination include filtration, aeration, adsorbsion, coagulation-flocculation, biofilm, phytoremediation and disinfection (Ahmad, Bibi, Chandrasekaran, Ahmad, & Kyriakopoulos, 2024). The implementation of all stages of processing will give the best results, but there are obstacles such as the amount of cost and availability of land to build the installation, so it is very necessary to have a concise but specific processing plan based on the characteristics of the problems encountered.

Disinfection is one of the stages of treatment in domestic waste that aims to remove pathogenic bacteria and oxidation of suspended substances. The principle of disinfection can use ozonization, heating and chlorination. Chlorination is usually done by adding chlorine because bahai is an economical material, easy to store and easy to apply. In addition, chlorine in chlorine, especially HOCl, is generally effective in eliminating pathogens and indicator bacteria, as well as hypochlorite ions OCl- which are able to reduce organic and inorganic substances in waste (Ali, 2022)

Khamimatus Salamatur Rohmah conducted a previous study that showed that chlorine dose reduced total coliform in wastewater at PKU Muhammadiyah Hospital Surakarta. With a reduction percentage of 99.834%, a dose of 1.5 gr/L is the most effective to reduce all coliforms (Salamatur, 2015). In addition, previous research by Tamzil Aziz et al. showed a decrease in TSS in the water of the Lambidaro River with the addition of chlorine as an oxidizer. Initially, the TSS concentration was 37.8 mg/L, but with the addition of 40 ppm of chlorine, the concentration dropped by 24.33% to 28.6 mg/L (Aziz, Pratiwi and Rethiana, 2013). Based on the above background, it is necessary to conduct research on the effect of chlorine dosage, stirring and aeration on the reduction of coliform and TSS numbers in port domestic waste.

The purpose of this study is to determine the effect of chlorine on the reduction of the amount of coliform and Total Suspended Solid (TSS) in domestic wastewater at Port X in Batam

Methods

This research is an actual experimental research. *Pretest-posttest control* group design is part of research design. where objects are divided into two groups, one is given a treatment and the other is not. The untreated group is called the control group. This research was conducted at the Batam Health Quarantine Center Laboratory, and will last for six months, from February to July 2024. Domestic liquid waste of 47 liters is the population and sample of this study. Samples were taken at the final outlet at Port X Batam City. The total reduction of coliform and total suspended solid (TSS) in domestic waste at Port X Batam City in 2024 is a bound variable in this study.

This study used the following independent variables: Different doses of chlorine were used, 1 gram per liter, 1.5 grams per liter, and 2 grams per liter, respectively, with three repetitions at each dose. Stir is carried out at each dose of chlorine and repeated treatment for 10 minutes and 20 minutes, respectively. Aeration is carried out at each dose of chlorine and repetition of treatment for 2 hours and 4 hours, respectively. Primary data was obtained from samples examined at the Batam Public Health Laboratory (BLKM). This quantitative data is processed and analyzed later. Secondary data comes from the Batam Health Quarantine Center, which functions as a health authority at the Port of Batam City.

Materials and Tools: The materials and equipment used in this study come from the BBKK Laboratory. Tools, Beaker glass 1000 mL, Plastic container with volume 1.5 L, Plastic container size 6 Liter, Automatic stirrer, Automatic aerator, Stopwatch, Jerry can size 35 Liter, Form and ATK

Sample Taking: The initial sample was taken at the final outlet of Port X Batam City as much as 47 liters, a 35-liter jerry can was used for collection, the sample was taken to the BBKK Batam laboratory on Jl. Kuda Laut Number 1 Batu Ampar

Control Sampling

1. One liter of waste is put in a 1000 mL bottle of Erlenmeyer
2. A total of 200 mL of waste from the first Erlenmeyer tube was taken and put into a microbiology bottle with a micro-control label
3. A total of 400 mL of waste from the first Erlenmeyer tube is taken and put into a 500 mL plastic bottle with a TSS control label
4. The final stage was to take a control sample that was not given the treatment, as much as 200 mL.
5. Take a sample from the same 500 mL container and label the TSS 2 control

Chlorine Addition

1. Pour 1 liter of waste into a 1000 mL Erlenmeyer and repeat until 5 liters of waste have been measured
2. Using a digital scale, weigh 5 powdered chlorine preparations at a dose of 1 gram per liter, so that 5 grams of powdered chlorine are obtained in total
3. Insert the controls into the ice box containing the ice pack
4. Pour 5 liters of waste samples from Erlenmeyer into a 6-liter plastic container
5. Add 5 grams of chlorine powder to a 6 L container that has filled the waste Separate the waste into five parts of equal volume, each amounting to 1 liter
6. Label the sample container with numbers 1, 2, 3, 4, and 5
7. Take a sample in container 1 of 200 mL and label 1 for coliform sample examination after the addition of 1 gr/L of chlorine
8. Take a sample in container 1 of 400 mL and label 2 for TSS sample examination after the addition of 1 gr/L of chlorine
9. Take note of each sample number and treatment, Before starting the treatment or dose change, wash the container with soap and dry it with a tissue
10. Repeat the dose of 1 gr/L 3 times, replace the treatment with a dose of 1.5 gr/L and 2 gr/L, and repeat at each dose

Working Steps

Stirring Containers labeled 2 and 3 show treatment groups with stirring for ten minutes and twenty minutes using an automatic stirring. After stirring for 10 minutes, take a sample from container 2 of 200 mL each and place it on a microbiology bottle and label it, Next, take a sample of 400 mL and place it on a TSS bottle and label it 4. Record the label number and the type of treatment on the work form that has been prepared Place the sample in a coolbox that has been given a frozen ice pack After twenty minutes, a sample of 200 mL is taken from container 5 and placed in a microbiology bottle. A sample of 400 mL was taken again and placed on a TSS bottle and labeled.

The sample is then placed on a frozen ice box. Record the label number and the type of treatment given on the prepared work form, Record the label number and the type of treatment given on the prepared work form, Clean and wash the containers and tools used before entering the next treatment, Repeat three times at a dose of 1 gr/L, Perform the stirring treatment in the same way for doses of 1.5 gr/L and 2 gr/L, with three repetitions on each

Aeration

Containers labeled 4 and 5 were a group of treatments that were aerated for two hours and four hours using an automatic aerator After two hours, take a sample of 200 mL from container 4 and place it in a microbiology bottle. Next, take a sample of 400 mL from the same container and place it on a TSS bottle and label it, Record the sample number and treatment given. 4. Place the sample in the coolbox containing the frozen ice pack, After four hours, put the sample as much as 200 mL into the bottle number five and label, Next, put the sample as much as 400 mL into the TSS bottle and label it Record the sample number and procedure given Place the sample in the coolbox containing the frozen ice pack. Place the sample in the same container as the frozen ice pack. Before going to the next treatment, wash and dry all equipment Repeat three times at a dose of 1 gr/L, Perform the aeration treatment in the same way at a dose of 1.5 gr/L and 2 gr/L, with three repetitions at each dose

Data Processing: Laboratory examination data is the result data which is then processed using the SPSS system. Processing is carried out by entering code, cleaning, and dividing data so that it becomes valid data and can be tested with the SPSS system.

Data Analysis: The initial stage of data analysis is carried out with a normality test which aims to determine whether the data obtained has a normal distribution distribution. The normality test was carried out with SPSS. To start the data analysis, a normality test is performed to ensure that the data obtained has a normal distribution distribution. The normality test was carried out with SPSS. Furthermore, the probability value of sig. (p-value) is calculated by a paired t-test against the chlorine dose variable on the total coliform decrease and TSS decrease. This probability value is used to determine the accepted research hypothesis, if sig. (p-value) ≤ 0.05 then Ha is accepted. To calculate the percentage of decline, a basic formula of mathematical logic is used. The percentage decrease is calculated by multiplying ((initial amount-final amount)/initial amount) x 100% (Full Moon, 2019)

Results and Discussion

1. Results

Table 1

Initial Characteristics of Domestic Wastewater Port X Batam City Domestic waste taken at the final disposal point at Port X Batam City has the following initial characteristics

No.	Parameters	Unit	Result
1.	TTS	Mg/L	137
2.	MPN/100mL	>16000	62.08%

Source: Laboratory Results Data (2024)

Table 1. Results of Initial Characteristics Examination of Domestic Waste Port X Batam City No. Unit Parameter 1. TSS mg/L results 2. 137 Coliform MPN/100 mL Source: Laboratory Results Data (2024) >16000

Based on table 1, it is known that the parameters of TSS and coliform of domestic waste at Port X Batam City do not meet the quality standard value. The results of the TSS test were obtained at 137 mg/L with a quality standard value of 30 mg/L, while the results of the coliform test were obtained >16000 MPN/100 mL with a quality standard value of 3000 MPN/100 mL These initial characteristics will be used as data control without treatment and become a comparison on each treatment variable.

Total *Suspended Solid* (TSS) Levels in Chlorine Dose Variation Treatment

The results of TSS level testing were obtained after treatment of chlorine dose variations as shown in the table below

Table 2

TSS Level Test Results on Chlorine Dose Variations

No.	Dosage Variation TSS Level (mg/L)	TSS level (mg/L)		Difference in Decline	Percentage Decrease
		Control	Already		
1.	1	137	116.7	20.3	**14.84%**
2.	1.5	137	98.3	38.7	28.22%
3.	2	137	88.7	48.3	**35.28%**

Source: Laboratory Results Data (2024)

Based on table 2, it is known that the greatest decrease in TSS levels occurred in the variation in the dose of chlorine of 2 mg/L with a percentage decrease of 35.28%, and the least decrease occurred in the variation in the dose of chlorine of 1 gr/L, with a percentage decrease of 14.84%.

Total Suspended Solid (TSS) Levels in Chlorine Dose Variation and Stirring Treatment

Table 3
TSS test results on chlorine dose variation treatment and stirring with a duration of 10 minutes and 20 minutes

No.	Stirring Duration (Minutes)	Variations in Chlorine Dosage (gr/L)	TSS level (mg/L)		Difference in Decline	Percentage Decrease
			Control	After		
1	**10**	1	137	100.7	36.3	26.52%
		1.5	137	97.0	40.0	29.20%
		2	137	43.7	93.3	**68.13%**
2	**20**	1	137	84.3	52.7	38.44%
		1.5	137	81.3	55.7	40.63%
		2	137	30.7	106.3	**77.62%**

Source: Laboratory Results Data (2024)

Based on the data in table 3, it is known that there is a decrease in TSS levels after being given stirring treatment at each dose of chlorine. The least decrease occurred at a dose of 1 gr/L and the most decrease occurred at a dose of 2 gr/L. Variations of stirring for 10 minutes and 20 minutes with a dose of chlorine of 2 gr/L reduced TSS levels by 68.13% and 77.62%, respectively.

Total Suspended Solid (TSS) Levels in Treatment of Chlorine Dose Variation and Aeration

Table 4
The results of TSS level testing in the treatment of chlorine dose variation and aeration with a duration of 2 hours and 4 hours

No.	Aeration Duration (Hours)	Variations in Chlorine Dosage (gr/L)	TSS level (mg/L)		Difference in Decline	Percentage Decrease
			Control	After		
1	**2**	1	137	88.0	49.0	35.77%
		1.5	137	86.0	51.0	37.23%
		2	137	28.7	108.3	**79.08%**
2	**4**	1	137	85.0	52.0	37.96%
		1.5	137	84.3	52.7	38.44%
		2	137	20.3	116.7	**85.16%**

Source: Laboratory Results Data (2024)

Based on the data in table 4, it is known that there is a decrease in TSS levels after being given aeration treatment at each dose of chlorine. The smallest decrease occurred at a dose of 1 gr/L and the largest decrease occurred at a dose of 2 gr/L. Aeration treatment for 2 hours and 4 hours at a dose of 2 gr/L of chlorine reduced TSS levels by 79.08% and 85.16%, respectively.

Total Amount of Coliform in Treatment of Chlorine Dose Variation

Table 5

The results of the total coliform count test after treatment of chlorine dose variation in the sample

No.	Variations in Chlorine Dosage (gr/L)	Total Amount of Coliform (MPN/ 100 mL)		Difference in Decline	Percentage Decrease
		Control	After		
1	1	16000	8166.7	7833.3	48.96%
	1.5	16000	6066.7	9933.3	62.08%
	2	16000	3700.0	12300.0	**76.88%**

Source: Laboratory Results Data (2024)

Based on the data in table 5, it is known that the decrease in the total number of coliforms occurred most in the variation in the dose of chlorine of 2 mg/L with a percentage decrease of 76.88%, while the least decrease occurred in the dose of 1 gr/L with a percentage decrease of 48.96%.

Total Amount of Coliform in Treatment of Chlorine Dosage Variation and Stirring

Table 6

The results of the test of the total amount of coliform in the treatment of chlorine dose variation and stirring with a duration of 10 minutes and 20 minutes

No.	Stirring Duration (Minutes)	Variations in Chlorine Dosage (gr/L)	Total Amount of Coliform (MPN/ 100 mL)		Difference in Decline	Percentage Decrease
			Control	After		
1	**10**	1	16000	7933.3	8066.7	50.42%
		1.5	16000	5166.7	10833.3	67.71%
		2	16000	3666.7	12333.3	**77.08%**
2	**20**	1	16000	7633.3	8366.7	52.29%
		1.5	16000	4866.7	11133.3	69.58%
		2	16000	3466.7	12533.3	**78.33%**

Source: Laboratory Results Data (2024)

Based on the data in table 6, it is known that there is a decrease in the total amount of coliform after being given stirring treatment at each dose of chlorine. The smallest decrease occurred at a dose of 1 gr/L and the largest decrease occurred at 50 at a dose of 2 gr/L. Variations of stirring for 10 minutes and 20 minutes with a dose of chlorine of 2 gr/L reduced TSS levels by 77.08% and 78.33%, respectively.

Total Amount of Coliform in Treatment of Chlorine Dose Variation and Aeration

Table 7

The results of the test of the total number of coliforms in the treatment of chlorine dose variation and aeration with a duration of 2 hours and 4 hours

No.	Aeration Duration (Hours)	Variations in Chlorine Dosage (gr/L)	Total Coliform Count (MPN/ 100 mL)		Difference in Decline	Percentage Decrease
			Control	After		
1	**2**	1	16000	6100.0	9900.0	61.88%
		1.5	16000	4633.3	11366.7	71.04%
		2	16000	2966.7	13033.3	**81.46%**
2	**4**	1	16000	5933.3	10066.7	62.92%
		1.5	16000	4566.7	11433.3	71.46%
		2	16000	2766.7	13233.3	**82.71%**

Source: Laboratory Results Data (2024)

Based on the data in table 7, it is known that there is a decrease in the total amount of coliform after being given aeration treatment at each dose of chlorine. The smallest decrease occurred at a dose of 1 gr/L and the largest decrease occurred at a dose of 2 gr/L. Aeration treatment for 2 hours and 4 hours at a dose of 2 gr/L chlorine, lowered TSS levels by 81.46% and 82.71%, respectively.

Data Normality Test Results

Results of TSS Data Normality Test Calculation

Table 8

The normality test is carried out to see if the data obtained is normally or abnormally distributed.

Treatment Variables	Df	Sig.	Conclusion
Dose	3	.657	Normal distributed data
Stirring	6	.212	Normal distributed data
Aeration	6	.007	Normal undistributed data

Source: SPSS Test Result Data (2024)

Based on table 8, it is known that the significance value of the Shapiro Wilk test on the data on the results of dose treatment and stirring against the bound variable of TSS decrease is sig. > 0.05 so that it can be concluded that the results are distributed normally. There are data on the results of aeration treatment that do not meet the requirements for the sig normality test value. > 0.05 so it is concluded that the data is not distributed normally. Non-parametric tests were carried out on aeration treatment variables to find the effect of pretest and posttest on the reduction of TSS levels in samples.

Table 9

Results of Normality Test Calculation of Total Coliform Posttest Data

No.	Dosage Variations	Df	Sig.	Conclusion
1	3	3	.934	Normal distributed data
2	6	6	.232	Normal distributed data
3	6	6	.318	Normal distributed data

Based on table 9, it is known that the significance value of the Shapiro Wilk test on the total coliform bound variable is sig. > 0.05 so that it can be concluded that the results

are normally distributed

Hypothesis Test Results

Based on the results of the statistical analysis prerequisite test, it is known that the data of the posttest results is distributed normally. Therefore, the use of parametric analysis in the form of paired t-tests can be done for hypothesis testing.

Table 10

Two paired t-tests were performed on each bound variable, namely TSS and total coliform

Treatment Variables	Df	Sig.(2-tailed)	Conclusion
Dose	2	.049	There is an Influence
Stirring	5	.003	There is an Influence

Source: SPSS Test Result Data (2024)

Based on table 10, it is known that the p value with paired t-test on the data of the results of dose treatment and stirring against the reduction of TSS levels is a p value < 0.05. The paired t-test was carried out by 53 ways of comparing the initial data (pretest) with the result data (posttest) after treatment of dose variation and stirring.

A non-parametric test was carried out on the data of aeration treatment results on the reduction of TSS levels with the Wilcoxon Signed Test to see the effect of aeration on the reduction of TSS levels. This test was carried out because the result data on the aeration treatment was not distributed normally.

Table 11

Calculation Results of the Wilcoxon Signed Test on Aeration Treatment Results Data on TSS Level Reduction

Treatment Variables	Df	Asymp Sig.(2-tailed)	Conclusion
Aeration	6	.028	There is an influence

Source: SPSS Test Result Data (2024)

Based on table 11, it is known that the p value with the Wilcoxon test is a p value < 0.05. The Wilcoxon test was performed by comparing pretest and posttest data after aeration treatment. The results of the test showed that there was an effect of aeration on the reduction of TSS levels in the sample.

Table 12

Paired t-test of total coliform test results with results

Treatment Variables	Df	Sig.(2-tailed)	Conclusion
Dose	2	.016	There is an Influence
Stirring	5	.000	There is an Influence
Aeration	5	.000	There is an Influence

Source: SPSS Test Result Data (2024)

Based on table 12, it is known that the p value with paired t-tests is a p value < 0.05. The paired t-test was carried out by 54 comparing the initial data (pretest) with the result data (posttest) after treatment of dose variations, stirring and aeration. The results of the test showed that there was an influence of the free variable on the bound variable of the total coliform number

2. Discussion

Effect of Chlorine Dose on Sample TSS Levels

From this study, it can be seen that the addition of chlorine is able to reduce TSS levels with a percentage decrease of 14.84% at a dose of 1 gr/L, 28.22% at a dose of 1.5 gr/L and 35.28% at a dose of 2 gr/L. Variations in chlorine dosage have different abilities for the removal of TSS levels in samples. The decrease in TSS levels with the addition of chlorine is influenced by the ability of chlorine to reduce organic and inorganic substances contained in domestic wastewater. Chlorine reacts with water will become free active chlorine in the form of hypochloric acid (HOCl) and hypochlorite ions (OCl-). Free active chlorine then reacts with contaminants (organic and inorganic matter) contained in the sample (Setyaningsih, 2018). The higher the contaminant content, the higher the dose of chlorine needed, the stages of domestic waste treatment should consider the presence of organic and inorganic pollutants. Elimination of organic and inorganic pollutants in the early stages of treatment will help the effectiveness of chlorine to reduce the constituent elements of TSS. Therefore, the disinfection stage should be placed after the processing of organic and inorganic pollutants is carried out. There are several types of treatment techniques to reduce organic and inorganic contamination in domestic wastewater, one of which is commonly done is the use of bacterial reactors or often known as biofilm reactors.

Effect of Chlorine Dose and Stirring on TSS Levels of Domestic Waste

In this study, the stirring stage was carried out on samples that had been added chlorine before, the duration used was 10 minutes and 20 minutes. Stirring with a duration of 20 minutes at each dose of chlorine, gives better results than stirring with a duration of 10 minutes. Stirring affects the solubility of a substance (solubility), in this study the stirring treatment in the sample helps the chlorine dissolution process better so that it causes a difference in the decrease in TSS levels. Stirring for 20 minutes with a dose of 2 gr/L of chlorine was able to reduce TSS levels by 77.62%, while the same dose as stirring for 10 minutes reduced by 68.13%. This is in line with previous research conducted by Muhammad Aminulla in 2015, that stirring for 15 minutes with a dose of 10 gr/L of chlorine is most effective in reducing ammonia levels in liquid waste at PKU Muhammadiyah Hospital Surakarta (Aminullah, 2015). Ammonia itself is an organic contaminant that is very common in domestic waste, the presence of ammonia affects the dose of chlorine used. The higher the ammonia level in domestic waste, the more chlorine is needed to decompose it. This will affect the ability of ammonia to lower TSS in the sample.

Effect of Chlorine Dose and Aeration on TSS Levels of Domestic Waste

Aeration is a domestic waste treatment that aims to increase the oxygen level in the sample in order to help the process of degradation of contaminants with the help of oxygen. The aeration process creates air bubbles that will later rise to the surface, causing the sample to circulate, this circulation can also help the dissolution of chlorine because there is simultaneous movement in the sample. The air bubbles generated by the oxygen aerator make the surface of the sample in contact with the free oxygen in the air, so that the oxygen in the free air also enters the sample (Farahdiba, Rachmanto, Pamungkas, & Rizqa, 2022). The higher the amount of oxygen, the greater the oxidation activity of organic substances in the sample. Oxygen plays an important role in the process of

oxidation of organic substances into simpler constituent substances, in principle this process is called the aerobic process where organic compounds are oxidized into CO2, H2O and NH3 (Sholichin, 2012). The reduction of organic substances through the aeration process can improve the performance of chlorine to reduce TSS constituents in the sample. It is proven through this study that the aeration duration of 4 hours is able to reduce TSS levels better compared to the shorter aeration duration of 2 hours at the same dose of chlorine.

Effect of Chlorine Dose on Total Coliform Amount of Domestic Waste

The ability of chlorine to inactivate pathogenic bacteria in the sample is affected by the dose administered. Based on this study, it is known that the variation in the chlorine dose in the sample provides a percentage variation in the decrease in the total amount of coliform. The dose of 1 gr/L of chlorine reduced the total number of coliforms by 48.96%, the dose of 1.5 gr/L decreased by 62.08% and the dose of 2 gr/L was able to reduce by 76.88%. Previous research has shown that chlorine is a disinfectant that is often used to lower microbiological pollution indicators given the ability of chlorine to inactivate and destroy pathogenic bacteria in wastewater. Chlorine can destroy indicator bacteria by damaging cell permeability, nucleic acids and pathogenic bacterial enzymes, and can inhibit cell metabolic processes. Free chlorine is produced when chlorine reacts with wastewater causing leakage of proteins, RNA and DNA in bacteria, chlorine is also permeability damaging which means it causes damage to bacterial spores by chlorine. (Busyairi et al., 2016).

Effect of Chlorine Dosage and Stirring on the Total Amount of Coliform in Domestic Waste

In this study, it is known that the stirring variable after the addition of chlorine affects the amount of coliform contained in the sample. Stirring of a longer duration has a better effect on the decrease in the amount of coliform. The duration of stirring for 20 minutes at a dose of 2 gr/L reduced the number of coliforms by 78.33%, while the duration of stirring for 10 minutes at the same dose decreased by 77.08%. This can also be affected by the decrease in TSS levels in the sample after stirring, stirring treatment is able to lower TSS levels better. TSS is a life support element for coliform bacteria, so a decrease in TSS levels affects a decrease in the amount of coliform in the sample. The dosage affects the ability of chlorine as a disinfectant against indicator bacteria, this is influenced by the amount of hypochloric acid formed when chlorine reacts with water. Hypochloric acid acts as a destructive substance, cell membrane in bacteria and stops metabolism, resulting in bacteria dying or being destroyed (Sumbali in Komala, 2014).

Effect of Chlorine Dose and Aeration on Total Coliform Count

In this study, a 4-hour aeration duration provided a better percentage reduction in coliform compared to a 2-hour aeration duration at the same dose of chlorine. At a dose of 2 gr/L chlorine with an aeration duration of 2 hours, it reduced the amount of coliform by 81.46%, while the duration of 4 hours at the same dose was able to reduce coliform by 82.71%. Aeration of domestic waste helps aerobic conditions occur, so that organic chains can be broken down into other forms, namely CO2 and H2O through equations (Mena et al., 2008; Shelef, Gross and Rachmilevitch, 2013): C6H12O6 + 6 O2 ---> 6 CO2 + 6 H2O Longer aeration duration decomposes organic and inorganic contaminants better, so that chlorine can work optimally for coliform removal (Setyaningsih, 2018).

Conclusion

The results showed that the variation in chlorine dose had a significant effect on reducing coliform numbers, where a chlorine dose of 2 gr/L was able to reduce coliform by up to 76.88%. In addition, the variation in chlorine dose also affects the reduction of TSS levels with a percentage decrease of 35.28% at the same dose. The stirring time factor also affects the effectiveness of stirring, where stirring for 20 minutes with a dose of 2 gr/L chlorine can reduce coliform levels by 78.33% and reduce TSS levels by 77.62%. Furthermore, aeration treatment also had a significant impact, with an aeration duration of 4 hours at a chlorine dose of 2 gr/L which was able to reduce coliform by up to 82.71% and reduce TSS levels by 85.16%. Thus, the optimal treatment in reducing TSS levels and the amount of coliform in domestic waste samples at Port X Batam City was obtained in a combination of chlorine dose of 2 gr/L with aeration for 4 hours.

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