

USE OF PACI AND ALUM TO REDUCE TSS LEVELS IN PEOPLE'S RUBBER SOAKING LIQUID WASTE

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Article Info

Article history:

Received July 31, 2023

Revised July 31, 2023

Accepted January 01, 2024

Keywords:

Effect of PACI and Alum

TSS Levels

Rubber waste

ABSTRACT

Use of Paci and Alum to Reduce Tss Levels in People's Rubber Soaking Liquid Waste. The coagulants used are PACI and alum coagulants, because, in addition to their low price, PACI and alum are also proven to be able to reduce turbidity and TSS levels in wastewater. The purpose of this study was to determine the effect of PACI and alum on reducing TSS levels in people's rubber bath waste. This type of research is classified as a true experiment, utilizing a pretest and posttest design with a control group. Integrated sampling was the sampling technique used in this study. Statistical analysis is performed using the normality test, and if the data is normally distributed, it is continued with the one-way Anova test. The normality test results showed normal distributed TSS level data and continued the Anova test ($p = 0.005 < \alpha = 0.05$), which found a difference between PACI coagulant and alum coagulant in reducing TSS levels in people's rubber immersion liquid waste. A PACI dose of 1200 mg/L lowered TSS levels by 46%. While the alum dose of 3000 mg/LL has not been able to reduce TSS levels, The variation in the dose of PACI and alum coagulants should be reduced again so that it can be optimal for reducing TSS levels in liquid waste. To meet the quality standards of rubber immersion waste by reducing TSS levels, liquid waste with acidic or alkaline properties needs a neutralization process by adding lime.

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INTRODUCTION

Rubber is one of the mainstay national plantation commodities. Rubber is known for its elastic qualities and is widely used in a variety of products and equipment. The total area of dry rubber plantations in Indonesia will reach 3.78 million hectares (ha) in 2021. This area has increased by 1.34% compared to the previous year, which was only 3.73 million hectares. South Kalimantan is in fifth place, with an area of 201.6 thousand ha ⁽¹⁾. Many large rubber plantations are operated by the government and the private sector. Meanwhile, people generally own small-scale rubber plantations ⁽²⁾. In detail, the dry rubber area of large state plantations is 129,254 ha, and that of large private rubber plantations is 213,957 ha. Meanwhile, community rubber plantations cover 3.43 million hectares. Tanah Laut Regency has a rubber plantation area of 21,256 ha ⁽³⁾.

The majority of rubber still undergoes conventional processing, commonly referred to as community rubber, where the latex is soaked in water to maintain its quality before being sold to rubber companies. This rubber-soaking water must be changed periodically because

it is very cloudy and smells very bad ⁽⁴⁾. In line with these developments, the problem of environmental pollution caused by waste produced in the form of liquid, solid, or gas waste has raised concerns for the surrounding community, necessitating further processing of this waste to prevent any negative impact on the community ⁽⁵⁾. Direct disposal of rubber industry liquid waste can disrupt the surrounding environment and lead to pollution ⁽⁶⁾. Rubber-soaking waste that is not processed optimally can be one of the causes of environmental damage ⁽⁷⁾. The high costs involved in processing rubber waste sometimes make rubber collectors not process the existing waste, so that the water discharged into the environment does not meet the quality standards for rubber industry liquid waste according to Regulation of the Minister of Environment of the Republic of Indonesia No. 5 of 2014. Rubber-soaking waste processing needs to be done to reduce the amount of pollutants contained in it. Among these techniques, coagulation/flocculation is one of the most widely used techniques to remove suspended and dissolved solids, colloids, and organic materials from wastewater ⁽⁸⁾. The types of coagulants that are often used include alum (alum), lime, ferrous sulfate (FeSO_4), poly aluminum chloride (PACl), moringa seed flour, rice husk powder, and others. Some individuals and collectors remain unaware of this, as the use and research of coagulants in Indonesia are still in their early stages. People often perceive the use of these materials as time-consuming and costly, which contributes to their relatively low usage ⁽⁹⁾.

They were tested to see which coagulant worked best at lowering the turbidity of peat water for 16 minutes. The coagulant concentrations used were 0, 80, 120, 160, and 200 ppm. The results showed that alum worked better than PACl, with an effective concentration of 160 ppm and a reduction efficiency of 96.17% compared to 95% for PACl ⁽¹⁰⁾. Other research indicates that the X3 group on PACl and Tawas had the highest reduction rate for PH, with reductions reaching 9.72% and 12.5%, respectively. Group X2 PACl was able to reduce the highest TSS, reaching 51.34%, while group 3 in Tawas was able to reduce the highest TSS, reaching 91.59% ⁽¹¹⁾.

Coagulants have been used in wastewater treatment for a long time. This is due to its ease of use in waste processing. Additional coagulants are generally positively charged, multivalent molecules ⁽¹²⁾. In this study, PACl and Tawas coagulants were used because, apart from being cheap, PACl and Tawas have also been proven to be able to reduce the level of turbidity and TSS in wastewater. The use of these two coagulants, with certain dose variations, aims to see which one is more effective in reducing TSS levels in people's rubber-soaking waste. Based on the description above, mSo researchers are interested in conducting research related to the effect of PACl and Tawas on reducing TSS levels in people's rubber-soaking waste.

MATERIALS AND RESEARCH METHODS

This research is experimental because, in this design, the researcher can control all external variables that can influence the course of the experiment ⁽¹³⁾. Rubber-soaking liquid waste processing using PACl and alum with varying doses is carried out by taking samples at two points and then combining them. Next, the pH of the sample is measured, and PACl and alum coagulants are prepared at the specified dosage. The sample is mixed with the coagulant, and then a jar test is conducted by adjusting the mixer's time and strength. In the coagulation stage, after adding the coagulant, rapid stirring was carried out at 200 rpm for 1 minute to homogenize the solution. Then the stirring speed was reduced to 30 rpm for 15 minutes (slow stirring) to ensure that the floc particles formed were not destroyed.

After slow stirring, the time and settling of the floc particles were observed. After 60 minutes, the pH and TSS levels were measured. The jar-test experiment was carried out at the Environmental Health Department Laboratory of the Banjarmasin Ministry of Health Polytechnic, while the TSS examination was carried out at the UPT Laboratory of the Banjarbaru City Environmental Service using the gravimetric method. Samples of community rubber-soaking liquid waste were examined before and after treatment to determine any differences between the control group and the experimental group as a result of the

intervention. The inspection results are then compared to Regulation No. 5 of 2014 of the Republic of Indonesia's Minister of Environment.

RESEARCH RESULTS AND DISCUSSION

Total Suspended Solid (TSS) levels in community rubber soaking liquid waste with the addition of PACl coagulant

In Table 1, you can see the results of measuring TSS levels in rubber-soaked liquid waste from the community with PACl coagulant added.

Table 1: Results of measuring TSS levels with PACl coagulant added

Coagulant	Dosage (mg/L)	TSS Levels on Repeat (mg/L)			Average	Quality standards
		P1	P2	P3		
PACl	0	660	215	274	383	100 mg/L
	400	365	206	284	285	
	600	184	194	277	218	
	800	191	255	303	250	
	1000	180	243	278	234	
	1200	153	242	216	204	

Source: Research Data, 2023

The total suspended solids (TSS) level, either at a dose of 0 mg/L or at a control of 660 mg/L, did not meet the standards set by the Minister of Environment of the Republic of Indonesia in Regulation number 5 of 2014. High suspended solids will block or reduce light penetration into the water column, thereby inhibiting the photosynthesis process by phytoplankton or other aquatic plants. This condition will reduce the supply of dissolved oxygen, potentially disrupting the biota ⁽¹⁴⁾. The jar test is an experiment that functions to determine the optimum dose of coagulant used in the water treatment process. Coagulants are ingredients or chemical substances that are added to water to produce coagulation ⁽¹⁵⁾. The average TSS level in the control group was 383 mg/L. After adding PACl at a dose of 400 mg/L, there was a decrease to 285 mg/L (25.6%). An additional dose of 600 mg/L caused a decrease to 218 mg/L (43%). Adding an 800 mg/L dose resulted in a decrease to 250 mg/L (34.8%). An additional dose of 1000 mg/L caused a decrease to 234 mg/L (39%). Adding a dose of 1200 mg/L resulted in a decrease to 204 mg/L (46.8%), which was the highest. PACl causes faster floc formation than ordinary coagulants because it has a high positive electrical charge. PACl can easily get rid of the electric charge on the colloid's surface and overcome and weaken the electrostatic repulsive force between particles to the lowest level possible. This lets the colloidal particles move closer together due to the covalent attractive force and form a bigger mass. PACl has the advantage of having a larger usage range, namely between 6 and 9. PACl's coagulation power is also better because the floc produced is relatively larger. PACl consumption is less, so the cost of water purification per time is smaller ⁽¹⁶⁾. At a dose of 1200 mg/L, PACl was not able to reduce TSS levels to reach the quality standard of 100 mg/L. Other studies have shown that PACl coagulant at a dose of 250 mg/L can reduce water TSS levels by up to 55.528% ⁽¹⁷⁾.

The study examined the Total Suspended Solids (TSS) content in community rubber-soaking liquid waste, with the addition of Tawas coagulant.

Table 2 shows the results of testing TSS levels in urine that had been soaked in rubber and mixed with Tawas coagulant.

Table 2: Results of measuring TSS levels with an alum coagulant added

Coagulant	Dosage (mg/L)	TSS Levels on Repeat (mg/L)			Average	Quality standards
		P1	P2	P3		
Alum	0	359	449	346	385	100 mg/L
	2000	695	473	240	469	
	2500	1098	559	584	747	
	3000	559	365	248	391	
	3500	489	430	320	413	
	4000	618	569	484	557	

Source: Research Data, 2023

Alum is a white crystal in the form of gelatin that has properties that can attract other particles so that its weight, size, and shape become larger, and it settles easily ⁽¹⁸⁾. Average TSS levels in the control group were 385 mg/L. After adding alum at a dose of 2000 mg/L, there was an increase to 469 mg/L. An additional dose of 2500 mg/L caused an increase to 747 mg/L. An additional dose of 3000 mg/L caused an increase to 391 mg/L. Adding a dose of 3500 mg/L resulted in an increase to 413 mg/L. An additional dose of 4000 mg/L caused an increase to 557 mg/L. As a result, the addition of alum does not allow suspended particles in the waste to precipitate. It is important to note that the pH in this experiment was not neutral. It is known that coagulant behavior may differ under certain conditions according to the number of interfering factors, including pH and wastewater constituents ⁽¹⁹⁾. pH and temperature values are important supporting parameters to analyze because they are determinants of coagulant performance, as well as indicators for the continuity of the decomposition process by microorganisms in a waste processing system ⁽²⁰⁾. The pH value of liquid waste was measured after soaking people's rubber with the addition of PACl coagulant.

Table 3 displays the pH measurements of liquid waste from soaking people's rubber with PACl coagulant.

Table 3: Results of pH Measurements in Waste with the Addition of PACl Coagulant

Coagulant	Dose (mg/L)	pH results with repetition			Average	Rawquality
		P ₁	P ₂	P ₃		
PACl	0	4.4	4.4	4.4	4.4	6.9 – 9.0
	400	4.2	4.2	4.2	4.2	
	600	4.2	4.2	4.1	4.1	
	800	4	4.1	4	4.0	
	1000	4	4.1	4	4.0	
	1200	4	4	4	4	

Source: Research Data, 2023

pH is a key parameter in the coagulation process. The optimum pH value depends on the properties of the water being treated, the type of coagulant used, and its concentration. A good pH level is one that still allows biological life in the water to run well. A good pH for wastewater is 7 ⁽²¹⁾. The control's pH measurement resulted in 4.4. After adding the PACl coagulant, the pH decreased at each dose. When PACl was added at a dose of 1200 mg/L, the pH decreased the most, from an average of 4.4 to 4. This occurred because the more the PACl coagulant dose was added, the higher the pH decreased ⁽²²⁾.

The pH value of liquid waste from soaking people's rubber with the addition of Tawas coagulant was measured.

Table 4 shows the pH levels of rubber-soaked liquid waste from the community that was mixed with Tawas coagulant.

Table 4: pH measurement results with an alum coagulant added

Coagulant	Dosage (mg/L)	pH on Repetition			Average	Quality standards
		P1	P2	P3		
Alum	0	4.4	4.4	4.4	4.4	6.9 – 9.0
	2000	3.8	3.7	3.8	3.8	
	2500	3.8	3.7	3.7	3.7	
	3000	3.6	3.6	3.6	3.6	
	3500	3.7	3.5	3.6	3.6	
	4000	3.6	3.5	3.6	3.6	

Source: Research Data, 2023

When alum is dissolved in water, it will produce H_2SO_4 , which will lower the pH of the water. The greater the dose of alum, the lower the pH of the waste water produced ⁽²³⁾. The control had a pH of 4.4. After adding alum, the pH decreased with each dose. Adding doses of 3000 mg/L, 3500 mg/L, and 4000 mg/L caused an average decrease in pH from 4.4 to 3.6. At low temperatures, alum's working process is less effective. The experiment results demonstrate that the addition of PACl and aluminum coagulants lowers the pH, preventing it from meeting the quality standards outlined in Minister of the Environment Regulation No.05 of 2014, which are 6.9–9.0.

The temperature value of liquid waste from soaking people's rubber was measured with the addition of PACl coagulant.

Table 5 shows the results of temperature measurements on liquid waste from soaking people's rubber with PACl coagulant.

Table 5: Results of temperature measurements with the addition of PACl coagulant

Koagulan	Dosis (mg/L)	Waste Temperature on Repetition (°C)			Rata-rata
		P1	P2	P3	
PACl	0	28,5	28,5	28,5	28,5
	400	27	26,8	25,8	26,5
	600	27	26,8	26	26,6
	800	27,1	26,9	26	26,7
	1000	27	26,9	25,9	26,6
	1200	28,5	28,5	28,5	28,5

The waste temperature before treatment is 28.5 °C. The temperature of people's liquid rubber-soaked wastewater after adding PACl at doses of 400 mg/L, 600 mg/L, 800 mg/L, 1000 mg/L, and 1200 mg/L is 26.5°C and 26.6°C, respectively. 26.7°C, 26.6°C, 26.7°C. The temperature of people's rubber-soaked wastewater is in the range of 26.5°C to 26.7°C.

The temperature value of liquid waste from soaking people's rubber with the addition of Tawas coagulant was measured.

The results of temperature measurements on community rubber-soaking liquid waste with the addition of Tawas coagulant can be seen in Table 6.

Table 7. of temperature measurements on community rubber-soaking liquid waste with the addition of Tawas coagulant

Coagulant	Dosage (mg/L)	Waste Temperature on Repetition (°C)			Average
		P1	P2	P3	
Alum	0	28.5	28.5	28.5	28.5
	2000	26.3	26.7	27	26.7
	2500	26.8	26.9	27	26.9
	3000	26.7	26.6	27.2	26.8
	3500	26.5	27	27.2	26.9
	4000	28.5	28.5	28.5	28.5

Source: Research Data, 2023

The wastewater temperature after adding Tawas coagulant with varying doses of 2000 mg/L, 2500 mg/L, 3000 mg/L, 3500 mg/L, and 4000 mg/L did not show a significant change as did the addition of PACl coagulant. The temperature of waste water with the addition of alum coagulant is in the range of 26.7°C–26.9°C. There was no significant change in temperature after adding PACl or aluminum coagulants, there was no significant temperature change.

The removal efficiency of PACl coagulant and Tawas coagulant in reducing TSS levels in rubber-soaking liquid waste is impressive.

Table 7 shows that the amount of TSS in community rubber-soaking liquid waste went down after PACl and Tawas coagulants were added.

Table 7 shows the differences in TSS levels of people's rubber-soaking liquid waste after adding PACl and Tawas coagulants.

Coagulant	Dosage (mg/L)	Results of Reducing TSS Levels with repetition			Average	Decrease (%)
		P ₁	P ₂	P ₃		
PACl	0	660	215	274	383	0
	400	365	206	284	285	25.6
	600	184	194	277	218	43.0
	800	191	255	303	250	34.8
	1000	180	243	278	234	39.0
	1200	153	242	216	204	46.8
Alum	0	359	449	346	385	0
	2000	695	473	240	469	-22.0
	2500	1098	559	584	747	-94.2
	3000	559	365	248	391	-1.6
	3500	489	430	320	413	-7.4
	4000	618	569	484	557	-44.8

The addition of PACl coagulant at a dose of 1200 mg/L resulted in the highest reduction in TSS levels, with a reduction of 204 mg/L (46.8%). However, when compared with the Minister of Environment Regulation No. 05 of 2014 concerning Waste Water Quality Standards, this value still does not meet the requirements of 100 mg/L. It creates floc more quickly than other coagulants because it has an

active aluminate group that binds colloids well. The bond is strengthened by polymer chains from polyelectrolyte groups, which makes the floc clumps denser ⁽²⁴⁾. The highest dose of alum was not able to reduce TSS levels, so it was necessary to use a higher dose than PACl. The addition of alum affects the pH range and the final TSS levels. Due to the acidic nature of rubber-soaking wastewater, the research showed that TSS levels went up when Tawas coagulant was added. The wastewater pH of 4.4 is less than the optimum pH working range for alum, which is between 6 and 9. The acidic condition of the wastewater means that the Tawas coagulant process, like PACl, cannot function optimally. The restabilization of colloid particles due to excessive doses is the cause of the increase in TSS levels ⁽²⁵⁾. Several factors, including problems with temperature differences, can influence TSS levels in testing. Temperature is one of the parameters that influences the deposition process. When testing in the field, samples are directly exposed to sunlight, which results in an increase in temperature. This is different from when testing in a laboratory, where the temperature is in accordance with laboratory room conditions. The water temperature in the field was 28.5°C, while in the laboratory it was 26°C. Increasing temperatures will increase the speed of particle movement, allowing for more collisions between particles and ultimately accelerating the formation of flocs. 2) Short stirring time during laboratory tests and weighing filter paper. 3) Lack of accuracy when adding coagulant doses to test samples and weighing filter paper ⁽²⁶⁾.

The study examines the differences in influence between PACl and Tawas on reducing TSS levels in people's rubber-soaking liquid waste.

Based on the results of the normality test using the Kolmogorov-Smirnov test, the p value $> \alpha$ (0.05) was obtained so that all TSS level data was normally distributed. However, because the data was not homogeneous with a value of $p > \alpha$ (0.05), the test was continued with the Kruskal-Wallis test and obtained a value of $p = 0.026 < \alpha$ (0.05), which means there is a difference in dose variations between PACl and alum in reducing TSS levels. Furthermore, according to the Mann-Whitney test results, there were 22 differences in the effects of dose variations between PACl and alum. The same thing also happened with the pH value, where the results of the Mann-Whitney test showed a difference in the effect of 38 pairs of PACl and alum dose variations. The Kruskal-Wallis test for temperature showed no differences as a result of varying treatment doses of PACl and Tawas coagulants.

CONCLUSIONS AND RECOMMENDATIONS

Statistical test results prove that there is a difference between PACl coagulant and Tawas coagulant in reducing TSS levels in people's rubber-soaked liquid waste. A PACl dose of 1200 mg/L reduced TSS levels by 46%. Meanwhile, the alum dose of 3000 mg/L was unable to reduce TSS levels. Variations in the dosage of PACl and Tawas coagulants should be reduced further so that they can optimally reduce TSS levels in liquid waste. To meet TSS quality standards for rubber-soaking waste, the acidic liquid waste needs to be neutralized by adding lime.

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