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Conference Paper

Utilization of Can Waste as PAC Coagulant and Alum to Remove Turbidity

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ABSTRACT

Aluminum is an inorganic material that cannot be decomposed naturally in nature, while its presence in our lives is very abundant and quite crucial. One of its uses is as a raw material for food or drink cans. In the United States alone in 2012 around 38.2 billion cans of food or drink were produced. Therefore, efforts are needed to reduce aluminum waste. One use that can be made is by extracting the aluminum content in it to be used as raw material for alum coagulants and PAC. The aluminum that has been successfully extracted is then added with solutions that can cause polymerization and form alum and PAC coagulants. Next, the resulting synthetic coagulant was tested for its ability to reduce turbidity in laundry waste. Laundry waste itself was chosen because the waste processing is still simple, and generally, this type of waste contains suspended solids which can come from dirt attached to clothes or chemicals used in detergents. In this study, coagulation and flocculation were carried out with 500 mL of laundry waste sample taken and a synthetic coagulant dose of 100 PPM. After the coagulation-flocculation process was carried out, the sample was deposited with varying settling times of 30 minutes, 60 minutes, and 90 minutes. From the results of this research, it was found that synthetic PAC coagulant was more effective than alum in reducing turbidity in laundry waste. At the most effective deposition time, namely a deposition time variation of 30 minutes, the removal percentage was 57%.

Keywords: Coagulants, turbidity, settling times

Introduction

Aluminum is an inorganic material that cannot be decomposed naturally and its waste can pollute the environment. Aluminum production in Australia, for example, contributes 6.5% of "greenhouse gas" emissions and produces toxic substances (Butler, 2020). Aluminum is widely used in our everyday items, such as food or drink cans. In the United States in 2012, approximately 38.2 billion aluminum beverage cans ended up in landfills (EPA, 2014). Therefore, efforts are needed to reduce waste and aluminum production, one of which is by recycling aluminum content to be used as a coagulant in liquid waste processing (Febrina & Zilda, 2019; Kirana et al., 2022; Rosyidah & Purwanti, 2018). However, further research is still needed regarding the effectiveness of this coagulant in treating liquid waste.

One common type of liquid waste is waste from laundry businesses. Processing this waste is still simple and usually only uses absorption wells (Yuliana et al., 2020). Several studies show that the use of coagulants can help process laundry waste (Hak et al., 2018; Hermida et al., 2023). Therefore, this research will focus on the effectiveness of synthetic coagulants from used cans in reducing turbidity in laundry wastewater.

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Material and Methods

Preparation for making coagulant from used cans

Characteristics of laundry waste

Laundry waste itself has the character of being cloudy white, smelly, and foamy (Yuliana et al., 2020). This is because this waste generally contains fats, oils, and greases (FOG) as well as total suspended solids (TSS) which can come from dirt attached to clothes or chemicals used in detergents (Sheth & Patel, 2017). Turbidity itself is the level of transparency of a water body which can be measured with a turbidimeter and is generally expressed in NTU (Nephelometric Turbidity Unit) units (Tamim & Tumpu, 2022).

Synthesis of coagulants from used cans

In this research, the coagulants that will be made are alum and PAC (polyaluminum chloride). Alum has the chemical formula $Al_2(SO_4)_3.14H_2$ which is generally sold commercially in the crystal form $K_2SO_4.Al_2(SO_4)_3.24H_2O$ (Shreve & Austin, 2012). Meanwhile, PAC has the general formula $Al_m(OH)_nCl_{(3m-n)}$ (Rahimah et al., 2016).

To make synthetic coagulants, the main ingredient needed is the aluminum content in used cans, therefore this study used Pocari Sweat cans which contain quite a lot of aluminum (Manurung & Ayuningtyas). Used cans that have had their paint cleaned are cut into small pieces and then take approximately 1 gram. In making alum, the can pieces are reacted with 50 mL of 30% KOH, then the resulting solution is filtered and added with 30 mL of 8M H_2SO_4. The results of this reaction will be cooled in the refrigerator to form alum crystals (Purnawan & Ramadhani, 2014). Meanwhile, to make PAC, the can pieces are reacted with 35 mL of commercial HCl and then left for 24 hours. Next, around 200 mL of 25% Na_2CO_3 is added and left to sit until polymerization occurs for approximately the next 48 hours (Agusta et al., 2022).

Coagulation and flocculation

To proceed to the coagulation-flocculation process, first, a solution of synthetic alum and synthetic PAC is made by dissolving 50 mg of alum from used cans and 50 mL of PAC from used cans into 500 mL of distilled water each to produce 100 PPM of alum and PAC. Next, a wastewater sample of 500 mL was prepared and each alum and PAC were added to the wastewater sample. Coagulation (fast stirring) was carried out for 1 minute at a speed of 150 RPM and then flocculation (slow stirring) for 20 minutes at a speed of 30 RPM. Next, deposition was carried out at varying times, namely 30 minutes, 60 minutes, and 90 minutes.

Results and Discussion

Effectiveness of coagulants in reducing turbidity

It can be seen from the graph in figure 1 that the efficiency of PAC coagulants and alum has a peak point, where after passing a certain point of time there will be a decrease in the percent removal value or in other words a deficiency in the ability to degrade turbidity in wastewater. The peak time itself can also be influenced by the concentration of coagulant used and the size of the flocs formed. If the coagulant concentration is too high, over-dosing will occur which causes the flocs to become brittle and break easily when they settle (Rusdi et al., 2014). According to Said (2017), the difference in peak time is possible due to differences in the size of the colloid particles in the waste, so the time required for the flocs formed to settle can be different. Meanwhile, the highest effectiveness occurs in the 100 PPM PAC coagulant variation at a settling time of 30 minutes, based on research by Sisnayati et al. (2021), Nur et al. (2016) the ability of PAC to reduce turbidity is better than alum, this is because PAC has compounds that bind more when compared to alum. Al_2O_3 in PAC will bind with water during coagulation-flocculation, this process will form a fast reaction and produce salt and acid which causes a very fast decrease in turbidity.

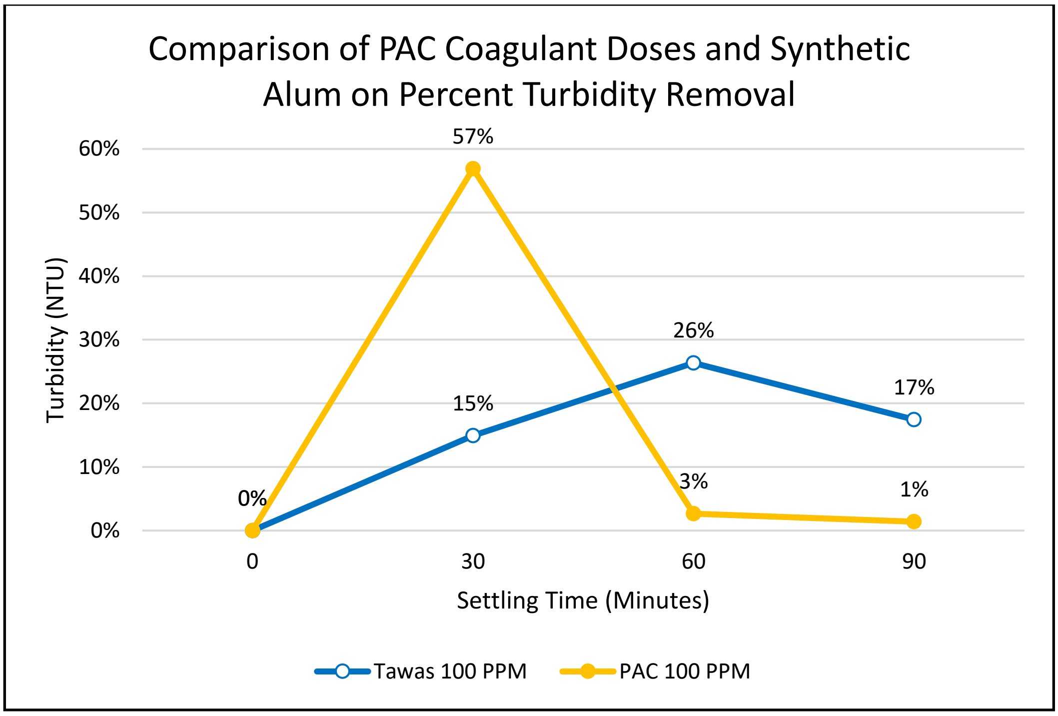

Figure 1. Comparison of the effectiveness of the percent turbidity removal of each coagulant

One-way ANOVA Test

The effect of settling time in reducing turbidity

From the data obtained, statistical testing was carried out with the general hypothesis used as follows:

H0: There is no significant difference in the percentage reduction in levels of TSS based on variations in the settling time used.

H1: There is a significant difference in the percentage reduction in levels of TSS is based on variations in the settling time used.

Rejection area:

P-value < 0.05 = H0 is rejected

P-value > 0.05 = H1 is rejected

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Waktu Pengendapan	2	0,1163	0,05817	2,19	0,147
Error	15	0,3992	0,02662		
Total	17	0,5156			

Means

Waktu Pengendapan	N	Mean	StDev	95% CI
30	6	0,3075	0,1988	(0,1655; 0,4494)
60	6	0,2456	0,1788	(0,1036; 0,3875)
90	6	0,1146	0,0914	(-0,0273; 0,2566)

Pooled StDev = 0,163144

Figure 2. One-way ANOVA test results

From figure 2 above we had the One Way ANOVA test on the percentage of turbidity reduction with variations in settling time, a p-value of 0.147 was obtained, so the p-value <0.05, which means

H0 was rejected. This indicates that there are significant differences based on the deposition time used. From statistical tests, it was found that the highest mean value was at a deposition time of 30 minutes, with an average value of 0.3075.

The effect of the coagulant type in reducing turbidity

From the data obtained, statistical testing was carried out with the general hypothesis used as follows:

H0: There is no significant difference in the percentage of turbidity reduction based on the type of synthetic coagulant used.

H1: There is a significant difference in the percentage of turbidity reduction based on the type of synthetic coagulant used.

Rejection area:

P-value < 0.05 = H0 is rejected

P-value > 0.05 = H1 is rejected

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Jenis Koagulan	1	0,000081	0,000081	0,00	0,970
Error	4	0,208057	0,052014		
Total	5	0,208138			

Means

Jenis Koagulan	N	Mean	StDev	95% CI
PAC sintetis	3	0,203	0,317	(-0,162; 0,569)
Tawas sintetis	3	0,1958	0,0600	(-0,1698; 0,5613)

Pooled StDev = 0,228066

Figure 3. One-way ANOVA test results

From figure 3 above we had the One Way ANOVA test on the percentage of turbidity reduction with variations in coagulant type, a p-value of 0.970 was obtained, so the p-value was > 0.05, which means H1 was rejected. This indicates that there is no significant difference in the effect of the percentage of turbidity reduction based on the type of coagulant used. From statistical tests, it was found that the highest mean value was for the synthetic PAC coagulant type, with an average value of 0.203.

Conclusion

Based on research conducted, it has been shown that alum coagulants and synthetic PAC made from used cans can reduce turbidity in laundry wastewater. Where in this study a dose of 100 PPM was used for each coagulant with varying settling times of 30 minutes, 60 minutes and 90 minutes. The most effective variation is synthetic PAC with a settling time of 30 minutes which is capable of producing a turbidity removal percentage of 57%. Further experiments need to be carried out by paying attention to the pH value of wastewater and varying dosages.

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