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Optimization of coagulation and flocculation in concrete wastewater of precast industry

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Abstract. The The population increase until the end of 2019 reached 267 million. This is in line with developments that support activities. This is inseparable from the actions of one of the precast concrete companies PT.WB Precast Plant Karawang in supporting development that produces waste in the form of wastewater. The parameter measured as a reference in carrying out processing is the Minister of Health Regulation Number 32 of 2017. This study's method refers to turbidity as a physical parameter, namely 25NTU and hardness total as a chemical parameter, which is 500 mg / l. $CaCO_3$. **Objectives:** The purpose of this study was to determine the optimization of the use of PAC as a coagulant and flocculant to reduce the turbidity and total hardness and determine the optimum detention time of flocculation. **Method and results:** The sampling method in this study is observation with the data collection method is descriptive. The population in this study is concrete wastewater with parameter values that are not in accordance with the standard. **Conclusion:** By using PAC 10% the optimum doses is 140 ppm, and the optimum detention time of flocculation is 5 minute that can reduce the turbidity from 275 NTU to be 11.615 NTU or 95.7% and can reduce total hardness from 948.75 mg/l $CaCO_3$ to be 491.25 mg/l $CaCO_3$ or 48.2%.

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1 Introduction

The population in Indonesia until the end of 2019 reached 267 million people[1]. This made development inevitable. The construction industry is a significant sector for increasing economic growth. Economic activity in almost all countries is closely related to the construction industry[2]. Furthermore, all developments also generate residual content from the activity which is called waste and is a serious problems[3]. If the waste produced is not properly managed, it will interfere with activities in the construction project itself and the environment around the project [4].

Construction with various wasteful factors makes people think of creating innovations, one of which is precast concrete technology to make development more practical, convenient and save time. One of the precast concrete providers is PT. WB Precast. With a production capacity of up to 575,000 tons / year[5], companies need to participate in waste management and environmental protection. Adequate management system to minimize negative impacts on the environment from industrial activities[6]. Improving the quality of industrial wastewater will have a positive impact by improving the quality of wastewater in the area, which will increase customer, government and banking confidence in supporting economic conditions and industrial business[7].

Waste at PT. WB Precast produced is a type in the form of wastewater which is the result of the activities of the spinning spun pile process, washing the batching plant and truck mixer [5]. In the regulation of the Minister of Health, Number 32 of 2017 (3), regulates water quality from physical parameters, namely turbidity with a maximum value of 25 NTU and chemical parameters, namely hardness with a maximum value of 500 mg/l $CaCO_3$ [8]. Meanwhile, the waste here does not undergo a treatment process that is able to comply with the standards before the waste is disposed of into the water body. This is a problem for both the company and for the environment as the water body is in the process of Accelerating Control of Pollution and Damage to the Citarum Watershed (DAS) with its main program known as the 'Harum Citarum Program' as outlined in Presidential Regulation No. 15/2018 signed by the President Indonesia

The water purification process is carried out using Poly Aluminum Chloride (PAC) because it is good for reducing water turbidity and waste in binding impurities in the form of sludge[9] . The dosing of chemicals must be in accordance with the conditions of the water to suit the needs [10].

In addition to providing the appropriate doses, optimization of the slow mixing detention time is also carried out to save energy while still providing results according to needs. Therefore, the dosing of chemicals and the flocculation detention time must be efficient and produce clean water products that apply to the standard.

1.2 Objectives

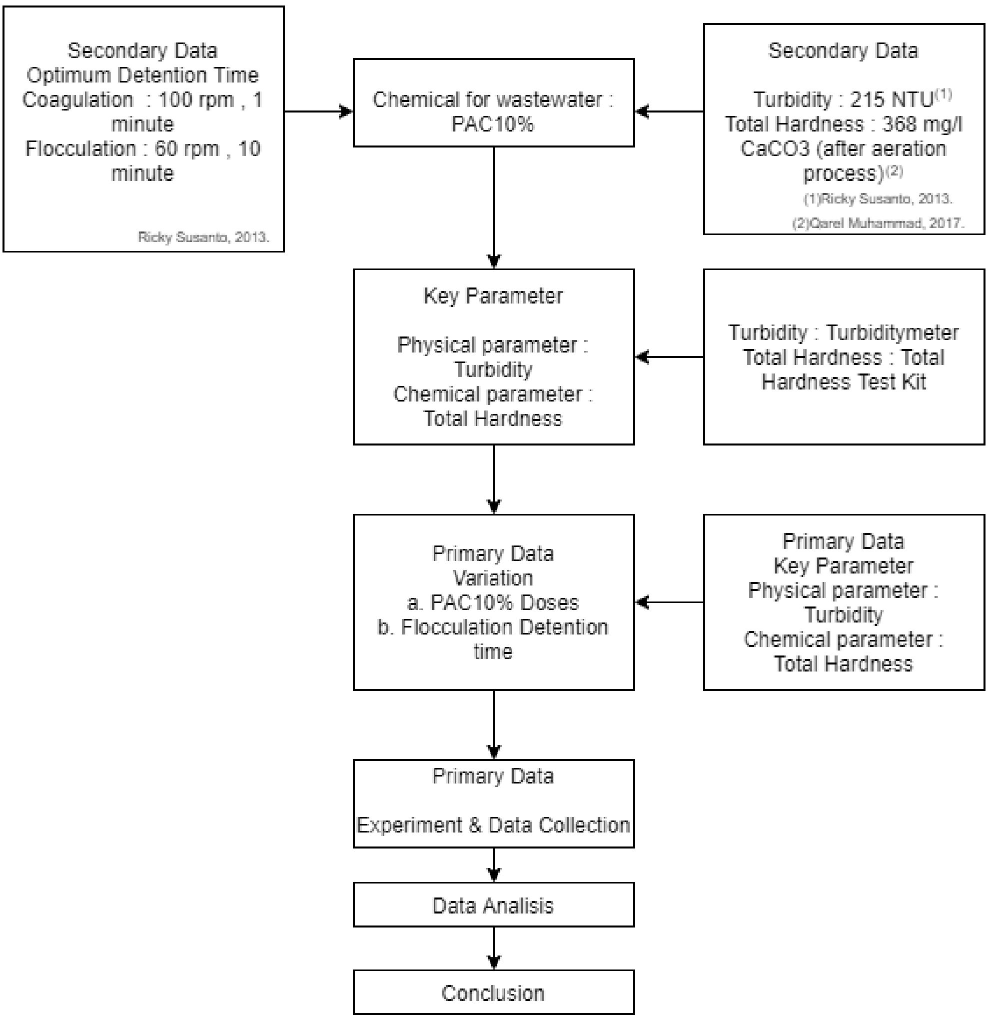
For this study, the objectives are carried out to determine the key parameter of concrete wastewater, determine the optimum doses of PAC 10% and detention time of flocculation slow mixing.

1.3 Problem Limitation

For this study to remain in focus, namely with the desired objective, the writer sets the following restrictions as scope and limitation. The scopes of this study are the sample were taken during May 2020 – June 2020 from PT. WB Precast Plant Karawang, and Coagulant and Flocculant using PAC10% from PT. Pantai Masand parameter that measured are turbidity and total hardness. The limitation of this study is the turbidity of the wastewater range for research is 270 NTU to 380 NTU, while the hardness ranges from 840 to 1080 mg/l $CaCO_3$ that was concrete wastewater from the spinning spun piles process, the washing of the batching plant, and the truck mixer process.

2 Method

2.1 Research Framework



2.2 Data Collection Method

The sampling method in this study is observation. The population in this study is concrete wastewater. The samples taken were conducted by May 2020 – June 2020 at PT. Precast Plant Karawang. The sample used in this study is wastewater from the spinning spun pile process, washing batching plants and truck mixers. Ensure the company has production, and the weather conditions are not raining so that the character of the wastewater samples taken is almost the same. Check the turbidity and hardness of the sample before starting the experiment to get initian values.

2.3 Tools and Materials

2.3.1 Tools

The tools used in this study include jar test, beaker glass 1000 ml, bulb, pipette 5 ml, volumetric pipette 10 ml, volumetric flask 50 ml, volumetric flask 100 ml, measuring glass 250 ml, beaker glass 1000 ml, wash bottle, Eutech TN-100 Handheld Infrared Turbidity meter and Hanna Instrument 3812 Test-kit total hardness.

2.3.2 Materials

The materials used in this study include wastewater samples, 10% PAC solution, and aquadest.

2.4 Procedure

2.4.1 Sampling Preparation

The sample used in this study is wastewater from the spinning spun pile process, washing batching plants and truck mixers, where the wastewater has passed the cement sludge deposition process in the settling tank. Ensure the company has production, and the weather conditions are not raining so that the character of the wastewater samples taken is almost the same. Check the turbidity and hardness of the sample before starting the experiment to get initial values.

2.4.2 Jar Test

Jar Test is a method used to determine the effectiveness of adding coagulants and flocculants to water purification processes. So it can determine the optimum amount in addition of PAC10% as a coagulant and flocculant and optimum of flocculation detention time.

2.4.3 Measurement of Turbidity

The working principle of turbidity is the measurement of water turbidity in the presence of the influence of the intensity of the transmitted light. When the light beam hits the scattering particle medium, most of the light will be transmitted and part of the light will be scattered in all directions randomly by these particles[11]. Measurements were made using the Eutech TN-100 Handheld Infrared Turbidity meter.

2.4.4 Measurement of Total Hardness

Measurements were made using the Hanna Instrument 3812 test-kit with hardness checking capabilities ranging from 0 to 300mg / L $CaCO_3$. Regarding clean water quality requirements, the maximum permissible hardness level is 500 mg / L. Therefore, samples that have been given the concentration need to be dissolved up to 10 times. After do the titration, read off the millilitre of titration solution from the syringe scale. Total hardness = a ml x 10 dellution x 300 (mg/L $CaCO_3$)

2.4.5 Measurement Optimum Doses PAC10%

In determining the optimum dosage of PAC10%, variations of 60 ppm, 70 ppm, 80 ppm, 90 ppm, 100 ppm, 110 ppm, 120 ppm, 130 ppm, 140 ppm and 150 ppm were carried out.

2.4.6 Measurement Flocculation Detention Time

In determining the optimum flocculation detention time, determine the optimum dose to be used and then vary the stirring time, namely 5 minutes, 6 minutes, 7 minutes, 8 minutes, 9 minutes and 10 minutes.

3 Results and Discussion

3.1 Result

Based on the results of research conducted using water samples at PT. WB Precast, data as many as 7 samples of wastewater taken at the same place, namely after passing through the sedimentation basin ensuring that there is production and the weather is not raining.

Overall, it can be seen that the addition of PAC to the wastewater samples obtained values of purification and hardness results which generally meet the quality of the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017. PAC's addition ranges from 100ppm to 150ppm in 5 different wastewater samples, then conducted experiments on 2 different wastewater samples to determine the flocculation mixing time.

3.1.1 Doses of PAC

PAC has a substantial impact on the remediation of the city's black and odorous river sediments and overlying water [12].Poly Aluminium Chloride (PAC) accumulates at high concentrations in the waste activated sludge[13]. Poly Aluminium Chloride (PAC) as a coagulant in the water purification process has been carried out on a laboratory scale to determine the performance of this PAC[14]. However, because in the process, PAC can form flocc well, it functions as a flocculant to save on chemical use.

3.1.1.1Turbidity

Turbidity is a physical parameter that is measured to determine the effectiveness of the coagulation-flocculation process. The turbidity can be seen in figure 1.

Table 1. Average turbidity of concrete wastewater after PAC10% doses variation

	0 ppm (NTU)	60 ppm (NTU)	70 ppm (NTU)	80 ppm (NTU)	90 ppm (NTU)	100 ppm (NTU)
Average	335.7	21.7	17.44	16. 34	15.61	15.54

	0 ppm (NTU)	110 ppm (NTU)	120 ppm (NTU)	130 ppm (NTU)	140 ppm (NTU)	150 ppm (NTU)
Average	335.7	13.98	10.82	9.22	7.02	5.69

In Table 1, a graph of the change in turbidity can be seen after adding PAC. This figure can be seen that the value of turbidity as a physical parameter can be below the water standard based on the Minister of Health Regulation Number 32 of 2017, namely 25 NTU. Therefore, the turbidity value reached the standard since the addition of PAC10% at a dose of 60ppm with a value 21.7 NTU.

3.1.1.2 Total Hardness

Total hardness is a chemical parameter that is measured to determine the effectiveness of the coagulation-flocculation process. The total hardness value can be seen in figure 2.

Table 2. Average hardness of concrete wastewater after PAC10% doses variation

	0 ppm (CaCO3 mg/L)	60 ppm (CaCO3 mg/L)	70 ppm (CaCO3 mg/L)	80 ppm (CaCO3 mg/L)	90 ppm (CaCO3 mg/L)	100 ppm (CaCO3 mg/L)
Average	945	840	815.63	795	783.75	736.88

	0 ppm (CaCO3 mg/L)	110 ppm (CaCO3 mg/L)	120 ppm (CaCO3 mg/L)	130 ppm (CaCO3 mg/L)	140 ppm (CaCO3 mg/L)	150 ppm (CaCO3 mg/L)
Average	945	673.5	602.1	538.5	471	381

In Table 2, to find out the hardness value as a chemical parameter it can be below the standard of clean water based on the Minister of Health Regulation Number 32 of 2017, namely 500 mg / l $CaCO_3$. According to result, total hardness value reached the standard since addition of PAC10% at a dose of 140 ppm with a value 471 CaCO3 mg/l.

3.1.2 Flocculation Detention Time

In the slow mixing of flocculation, the speed is 60 rpm for detention time is 10 minutes. The wastewater is then allowed to settle for 30 minutes to precipitate the formed floc [15]. The parameters are measured to determine the effectiveness of the coagulation and flocculation processes. This is done to get the optimum value for mixing. Slow mixing needs to be calculated to find the most efficient time. In this experiment, slow stirring was performed at 60 rpm starting from 5 minutes, 6 minutes, 7 minutes, 8 minutes, 9 minutes, and 10 minutes.

a. Turbidity

Table 3. Turbidity after variation of flocculation detention time using 140 ppm of PAC10%

Experiment	0 min (NTU)	5 min (NTU)	6 min (NTU)	7 min (NTU)	8 min (NTU)	9 min (NTU)	10 min (NTU
1a	277	12.3	6.8	5.7	5.56	5.26	4.69
1b	277	12.24	6.5	5.73	5.63	5.21	4.71
2a	273	11.40	6.37	5.69	5.38	5.16	4.98
2b	273	10.52	6.35	5.67	5.31	5.15	4.32

In table 3, it can be seen that the results of the variation of slow stirring were carried out using 2 samples on different days and each experiment was carried out 2 times. The first and second samples had relatively the same turbidity values, namely 277 NTU and 273 NTU. Since the first experiment, a variation of the stirring time was 5 minutes at a speed of 60 rpm to get an average value of 11,615, which results in accordance with the standard below 25 NTU.

b. Total Hardness

Table 3. Turbidity after variation of flocculation detention time using 140 ppm of PAC10%

Experiment	0 min (CaCO3 mg/L)	5 min (CaCO3 mg/L)	6 min (CaCO3 mg/L)	7 min (CaCO3 mg/L)	8 min (CaCO3 mg/L)	9 min (CaCO3 mg/L)	10 min (CaCO3 mg/L)
1a	945	487.5	480	466.5	459	457.5	450
1b	945	487.5	480	466.5	459	457.5	450
2a	952.5	495	487.5	472.5	469.5	465	465
2b	952.5	495	487.5	472.5	469.5	465	465

Based on the graph of **Table 4**, the optimum of flocculation detention time is 5 minute because can reduce the turbidity from 275 NTU to be 11.62 NTU and can reduce the total hardness from 948.75 mg/l CaCO3 to be 491.25 mg/l CaCO3 . In the process of flocculation or slow mixing, coagulated dissolved solid particles occur to form larger floc particles. Floc particles which already has a mass and size that is maximal enough then it will settle to the bottom and form like mud at the bottom. However, when the particle size is maximum and sufficient to settle, meaning that the optimum slow stirring as flocculation detention time has been reached, it is not necessary to give additional detention time for slow stirring because it can cause the floc to break and this pollute the water bodies.

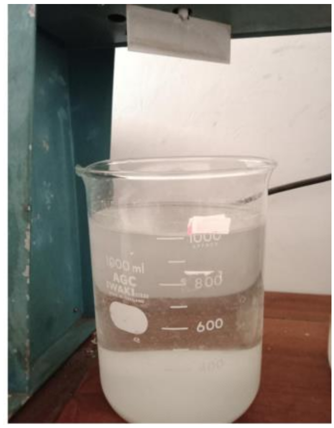
Before	After
	

Figure 1. Turbidity before and after variation flocculation detention time 5 minutes using 140 ppm

1.2 Discussion

Based on experiment, after varying the dose of 100 ppm to 150 ppm, turbidity can reach the standard since the dose of 100 ppm. However, at total hardness, turbidity can reach the standard from a dose of 140 ppm. Therefore, the optimum dose is 140 ppm so that both parameters can reach the value according to the standard.

The settling time velocity of each sand particle is 10,361 m / s and the mud is 0.0016 m / s[16]. This is the reason the flocculant detention time is 8 minutes or faster, because the liquid waste from the concrete industry has relatively high suspended solids because it comes from sand so that it is easier to settle and form floc, compared to colloids such as mud from river water.

4 Conclusions

The key parameters of concrete wastewater are turbidity and total hardness. The application of PAC 10% used to get the optimum dose is 140 ppm because it can reduce the turbidity from 275 NTU to be 11.615 NTU or 95.7% and can reduce total hardness from 948.75 mg/l $CaCO_3$ to be 491.25 mg/l $CaCO_3$ or 48.2%. The optimum flocculation detention time is 60 rpm for 5 minutes because in that time has been able to reduce the turbidity and total hardness to complete the standards of that meet Minister of Health, Number 32 of 2017 of sanitation hygiene requirements standard of 25 NTU and 500 ppm CaCO3.

5 Recommendation

The recommendation in this study is the planning of the dimensions of waste processing on a lab scale made on an industrial scale and there will be further research on the use of PAC10% in the coagulation and flocculation process in the concrete industrial wastewater.

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