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The Study of Using Recycled Chemical Floc for Reducing Chemical Doses in Treating Water of Ciliwung River at Bojong Gede

Aura Ryumandhina A.R.P.[1*], Temmy Wikaningrum[2]

Environmental Engineering Department, President University, Bekasi
***Koresponden email**: aura.putri@student.president.ac.id

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Abstract
Good water quality following to the criteria for clean water, a series of treatments is needed. One of the processes that aim to reduce turbidity value is coagulation-flocculation. To achieve the maximum result, optimum doses of coagulant are needed. This study aimed to explore the potential for the reuse of chemical flocs to reduce the optimum dose and effect on pH and water turbidity values. The method used is laboratory experiment using a jar test with rapid and slow stirring of 180 rpm for 90 seconds and 40 rpm for 10 minutes, respectively with 30 minutes of sedimentation. The characteristics of the flocs used are 76% from PAC with variants volume from 0.5 ml to 3 ml, which impact decreasing the optimum dose by 50% with achievement of turbidity value 0.16 NTU or equivalent to 99.65% reduction efficiency. Using the T-Test Two-Sample Equal Variances between the optimum dose turbidity value and decreasing the dose combined with the recycled floc, the p-value less than 0.05, means that chemically recycled has a significant different on the turbidity value. Meanwhile, the p-value obtained between the pH value before and after the addition of recycled flocs is less than 0.05, hence the water after treatment has less acidic than the conventional method. Water pH is significant different showed as less reduction of pH by having recycled PAC flocs.
Keywords: *coagulation, flocs, pH value, turbidity, water quality*

Abstrak
Kualitas air yang baik sesuai dengan kriteria air bersih, diperlukan serangkaian pengolahan. Salah satu proses untuk menurunkan nilai kekeruhan adalah koagulasi-flokulasi. Untuk mendapatkan hasil maksimal diperlukan dosis koagulan yang optimum. Penelitian ini bertujuan untuk mengeksplorasi potensi penggunaan kembali flok untuk mengurangi dosis koagulan optimum dan pengaruhnya terhadap nilai pH dan kekeruhan air. Metode yang digunakan adalah eksperimen di laboratorium menggunakan jar test dengan pengadukan cepat dan lambat 180 rpm selama 90 detik dan 40 rpm selama 10 menit, dengan waktu sedimentasi 30 menit. Karakteristik flok yang digunakan adalah 76% dari PAC dengan variasi volume 0,5 ml sampai 3 ml yang berdampak pada penurunan dosis optimum sebesar 50% dengan pencapaian nilai kekeruhan terbaik sebesar 0,16 NTU dengan efisiensi reduksi 99,65%. Menggunakan *T-Test Two-Sample Equal Variances* nilai kekeruhan dosis optimum dan penurunan dosis dikombinasikan dengan volume flok daur ulang, nilai p kurang dari 0,05, artinya penambahan flok memiliki perbedaan yang signifikan terhadap nilai kekeruhan. Sedangkan nilai p yang diperoleh antara nilai pH sebelum dan setelah penambahan flok memberikan hasil yang sama yaitu kurang dari 0,05, sehingga air memiliki kadar asam yang lebih rendah dibandingkan dengan metode konvensional. Adanya perbedaan yang signiikan terhadap dengan penurunan pH yang lebih kecil dengan penambahan flok PAC.
Kata Kunci: *flok, kekeruhan, koagulasi, kualitas air, nilai pH*

1. Introduction
Almost all activities related to living things need water, as plants need water in the photosynthesis process, the need for minerals for humans and others. Water quality is a requirement for the quality of human health because water quality can be used as an indicator of public health [1] and it needs a different processes for different water characteristics [2]. In Indonesia, there are still many water sources whose quality is still below the government's standards. It is proven by a report from (BPS, 2018) that only 72.55% of the total regions in Indonesia have good quality clean water intake. Proper clean water that can be used daily must meet physical, chemical and biological requirements [3]. The physical requirements include colorless, odorless, tasteless, normal temperature water, clear and no suspended solids. Water chemistry requirements include neutral pH, and do not contain toxic chemicals. And water does not contain bacteria, which is the biology of clean water. In general, groundwater and surface water must have some of these contents, but the levels vary depending on the water source's environmental conditions. Suitable clean water

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that can be used is odorless and tasteless water, water that is not cloudy does not contain bacteria, and has low chemical levels. Water sources can come from river water, lakes, or groundwater, then be processed into clean water.

There are about 25 rivers that stretch throughout West Java and have different characteristics. Due to the large number of industries in West Java that impact river water pollution, the government has created a particular program to prevent this. Also, around 15 watersheds have become the center of attention from the year (2015) until now. One of them is the Ciliwung River which has a length of 120 kilometers with a watershed area of 387 km2. Ciliwung River is one of the rivers used as raw material for clean water for several regions. Some areas that this river passes are Bogor Regency and Bogor City, Depok City and DKI Jakarta Province. Traversed by several areas with a fairly large population density and is an industrial area, causing the Ciliwung river water to contain various types of organic and inorganic materials that are harmful used by humans, then has a big impact to the pH and turbidity of water. Turbidity has significant effects on the water quality [4] including water in Ciliwung River. On the other hand, pH will be increased since the organic solvent terraces.

Recently there are several water treatments plants that do co-seeding which adds floc to the water to help the formation of more floc cores so that the optimum dose of coagulant can be reduced which will have an impact on the required cost. Coagulant has a main affection in reducing turbidity of water [5] Another study has tried to use the chemical sludge or activated sludge to increase the efficiency of coagulation and flocculation in water treatment [6]. Perumda Air Minum Tirta Kahuripan Kabupaten Bogor is one of the water treatment plants located in the Bogor District area that uses alum as a coagulant as their water treatment. Therefore, this research will also help to review the treatment of their flocculation coagulation using alum which will be compared with other types of coagulants. The purpose of this study is to find the optimum dose of coagulant for the treatment of Ciliwung water river and to consider the potential use of recycled sludge from coagulant to reduce the optimum dose. By this case, alum will be compared with PAC to gain the better performances in reducing turbidity of water sample.

2. Material and Methods

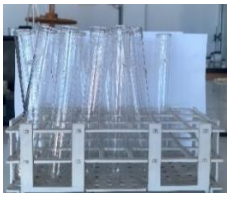
This research was conducted experimentally by conducting laboratory tests on several samples. There are three types of experiments, namely, determining the type of PAC in terms of decreasing turbidity. Second, to determine the optimum dose of PAC coagulant to decrease the turbidity value. And the last, determine the volume of floc/sludge required by lowering the optimum dose but giving the same/smaller turbidity value.

Equipment and Materials


Three types of PAC and Alum


EUTECH PD450 Portable PH DO and Temperature Meter


Digital turbidimeter (Portable TN100IR)


Test-tubes


Water Sample (15 Litres)

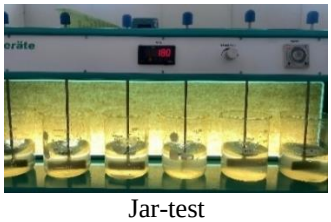

Jar-test

Figure 1. Equipment and materials
Source: Personal activity (2022)

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Experimental Treatment Method

1. Preparing the Solution of Coagulants

In this experiment, two types of powdered PAC from different stores were used would be mentioned as PAC 1 and PAC 2, while the liquid PAC type that came from PAC Jababeka would be coded as PAC 3. Meanwhile alum that will be tested also formed as powder. Each powder coagulants will be made into a solution with a concentration of 1% by preparing one gram of PAC 1, PAC 2, and alum in a 100 ml beaker glass, then solute with distilled water and mix it. Same with the 10% concentration of liquid PAC to make it equal 1% with additional 8.3 ml of PAC solution into a volumetric flask and then mixed with distilled water until 100 ml then well-stirring.

2. Jar-Test Method

In this experiment, all samples will perform a jar test by following the procedures state on SNI 19-6449-2000. This jar test consists of two stirring and sedimentation, rapid stirring for 90 seconds at 180 rpm. Each sample have 500 ml of water and slow stirring was carried out for 10 minutes at 40 rpm followed by sedimentation for 30 minutes. However, for the experiment using chemical recycled sludge, sample used is 250 ml of water with the same rapid and slow mixing time and rate as in the previous treatment of jar-test. The various dosage of coagulant will be used are 0 mg/l, 5 mg/l, 10 mg/l, 15 mg/l and 20 mg/l, 25 mg/l, 30 mg/l, 35 mg/l, and 40 mg/l to gain the optimum doses. And the rest of experiments will have an additional solution of recycled flocs about 0.5 ml, 1 ml, 1.5 ml, 2 ml and 2.5 ml, respectively.

3. Chemical Recycled Flocs

For optimization, the addition of floc will be carried out with the aim of helping the creating process of the floc core. Solemnly, the thing that must be done first is to characterize the flocs that has been collected from previous coagulation and flocculation activities by following these steps:

1. Collect the type of coagulation and flocculated floc into a 100 ml volumetric flask until full.
2. Let the floc settling for a while and separate the water by throwing it slowly to achieve the viscous flocs.
3. To characterize the floc, use a 10 ml of graduated cylinder and fill it with thickened flocs. Wait for 30 minutes and see if there is separated floc with the water surface. And write down the line in cylinder has been passed with the flocs. In this case, the flocs reach about 7.6 ml of height then means 76% of flocs will be used to help the optimization.

Figure 2. Floc characterization
Source: Personal activity (2022)

In this case, water sample used is 250 ml to have jar-test with same dosage of PAC 1 by adding various volume of prepared chemical recycled flocs. The coagulant with 1% concentration will be diluted to 0.1% to make the dosage measurement process easier.

Parameter Analysis Method

Parameters used for this experiment is turbidity. By comparing three types of PAC, the lowest number of turbidities gained will be chosen to be determine its optimum doses. And, the optimum doses will be examined the potential of additional chemical recycled sludge of PAC.

1. Turbidity Measurement

In measuring the value of turbidity, a method based on SNI 06-6989.25-2005 is used regarding the use of nephelometer as a tool for turbidity measurement. Before calculating the turbidity of water sample, the tool should have calibration first by following these steps:

1. Turn the turbidimeter on.
2. Calibrate the instrument using a turbidity standard solution (800 NTU, 100 NTU, 20 NTU, and 0.02 NTU).
3. Rinse cuvettes with standard solution before filling with standard (rinse with solution of the same type before use). Measure the turbidity value of the standard solution, if the value is not equal to the standard solution, adjust the calibration knob until the value is equal.
4. When the screen shows "READY" hence, water sample ready to be analyzed.

Measurement:

1. Prepare the solution and place it in a small, inserted tube.
2. Shake the sample properly, remove air or entrained gases from the sample prior to measurement.
3. Measure the turbidity with the instrument and read and record the value on the display.

2. pH Measurement

To gain the pH value, a method based on SNI 06-6989 11-2004 applied regarding the use of a pH meter as a pH measuring instrument. The instrument should be calibrated first before calculating the pH of water sample. The buffer method can be used to calibrate the instrument by following these steps:

1. Turn on the pH Meter. Make sure the electrode already clean.
2. Immerse the electrode in pH 4 of buffer solution, permit stand for some moments. Then observe whether the digital indicator shows a number that corresponds to the pH of the buffer or not.
3. Clean the electrodes, dry with a tissue. Then immerse the electrode into a buffer with a pH of 7, wait for a couple minutes. Ensure that the indicator shows the appropriate value.

Data Analysis Method

1. Hypothesis

The aim of this study at the end is to find out the potential of reducing optimum doses by adding at the certain volume of recycled sludge of PAC which presented as the lowering turbidity level. Also, to ensure is there a significant effect in pH due to the additional recycled sludge of PAC or not. Hypothesis models are tested as follows:

Hypothesis the reducing turbidity by adding PAC recycled sludge:

H0: $(\mu 1\text{-}\mu 2) = 0$, means there is no significant difference by adding PAC recycled sludge in reducing water turbidity in Ciliwung River.

Ha: $(\mu 1\text{-}\mu 2) \neq 0$, means there is a significant difference by adding PAC recycled sludge in reducing water turbidity in Ciliwung River.

Hypothesis pH affected by the additional recycled PAC:

H0: $(\mu 1\text{-}\mu 2) = 0$, means there is no significant difference due to the additional PAC recycled sludge to pH water in Ciliwung River.

Ha: $(\mu 1\text{-}\mu 2) \neq 0$, means there is a significant difference due to the additional PAC recycled sludge to pH water in Ciliwung River.

Both hypotheses will be examined and proven by statistical testing.

2. Calculation of Removal Efficiency

Water turbidity removal efficiency is calculated after adding PAC coagulant and PAC chemical recycled sludge. The removal efficiency formula is as follows:

$$R = \left(\frac{Initial\ turbidity - Final\ turbidity}{Initial\ turbidity}\right) \times 100\%$$

3. Statistical Testing Using T-Test: Two Sample Equal Variances

To achieve the significant testing for data, this final project will check by t-Test of two sample to find out whether the population means of two groups are equal or not. Both methods will use as deciding p-value as alpha is 0.05 of the population. Since this project has two hypotheses where null and alternative hypothesis are gained. It will be stated significant if the p-value is less than alpha (0.05) then, alternative hypothesis accepted and there is a difference between the means of treatments. Otherwise, if the p-value calculated more than alpha (0.05), measure the null hypothesis accepted and there is no difference between the means of treatments.

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3. Results and Discussion

In order collecting data for this final project, several experiments were performed on a laboratory scale.

Comparing Alum and PAC Performances

In order to find out the better result in turbidity by using alum or PAC as coagulant, this first experiment was carried out. The experiment which conducted on 14th October 2021 have tested 20 mg/l alum and PAC with the water sample using jar-test method and gives the results shown below.

Table 1. Comparison performances between Alum and PAC in decreasing pH and Turbidity

No.	Coagulant	Initial		Result	
		pH	Turbidity (NTU)	pH	Turbidity (NTU)
1.	Alum	8.26	6.70	8.09	3.06
2.	PAC			8.24	0.69

Source: Personal experiments (2022)

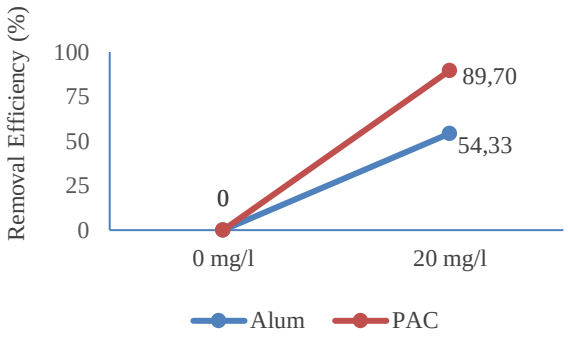

Figure 3. Alum and PAC removal efficiency (%)
Source: Data experiments (2022)

Table 1 presenting the results of comparing alum and PAC as coagulants in reducing the turbidity of water sample. Final turbidity achieved from 6.7 NTU with the addition of alum and PAC about 20 mg/l decreased to 3.06 NTU and 0.69 NTU, respectively. Means the use of PAC brings the better results with reducing turbidity efficiency up to 89.7% compared to alum about 54.33%. This result reveals the study from [7] that gain the effectiveness of turbidity reduction using 10 ppm PAC which about 96%. Since PAC has a larger pH range than Alum causes the bigger possibility of the floc formation faster. For this Ciliwung water sample, it is recommended by using PAC to achieve the better result compared to Alum.

Determining the Best Performances of PAC

On 17th October 2021, this experiment conducted to examine the reducing turbidity by using three types of PAC in total. This scientific observation applied at the same concentration and dose for each PAC to accomplish whether types of PAC giving the most significant turbidity reduction. The results are performed below:

Table 2. PAC performances in pH and turbidity

No.	Coagulant	Initial		Result	
		pH	Turbidity (NTU)	pH	Turbidity (NTU)
1.	PAC 1			7.17	1.19
2.	PAC 2	7.28	38.5	6.94	1.67
3.	PAC 3			6.76	9.46

Source: Data experiments (2022)

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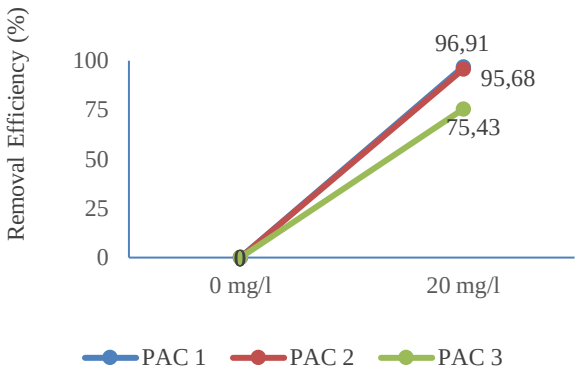

Figure 4. PAC performances in turbidity removal efficiency (%)
Source: Data experiments (2022)

The result above is the value of water turbidity that has been given each type of coagulant PAC 1, PAC 2 and PAC 3. From **Figure 4**, it shown that PAC 1, PAC 2, and PAC 3 offer the reducing turbidity up to 97%, 95,6%, and 75% respectively at the same dosage of coagulant for 20 mg/l or 1 ml each solution. PAC 1 provides the best results among other PAC types. The efficiency achieved by PAC 1 has the same value as the experiment of [8], which can alleviate up to 96% with an initial turbidity value around 13 NTU. Although slightly different from PAC 2, in this project PAC 1 is considered the best coagulant to reduce turbidity values. In determining the best coagulant, this project final considered the same outcome or result when using the same types of water samples with different turbidity values. Meanwhile, the selection PAC 1 also seen from the pH achieved about 7.17 which still categorized as a fairly good water quality.

Determining the Optimum Doses for Selected PAC

The results of the second experiment were completed on 30th December 2021, including determining the best type of coagulant, will remining to determine the optimal dosage. With the same volume of sample water as in the previous experiment, jar-test was repeated with the addition of the dose variation of PAC 1. The variation doses added during jar-test gives the following results.

Table 3. The result of the optimum doses for PAC 1

No.	Dosage (mg/l)	Initial		Result		Turbidity Avg	Removal Eff (%)
		pH	Turbidity (NTU)	pH	Turbidity (NTU)		
1.	0	6.6	43.9	6.60 6.60	25.30 25.20	25.25	42.48
2.	5			5.98 5.99	2.05 2.37	2.21	94.97
3.	10			5.77 5.81	0.25 0.40	0.33	99.26
4.	15			6.13 5.62	0.90 0.41	0.66	98.51
5.	20			5.71 5.73	1.22 2.09	1.66	96.23
6.	25			5.78 5.74	3.40 5.79	4.60	89.53
7.	30			5.69 5.81	24.7 24.8	24.75	43.62
8.	35			5.59 5.59	25.5 25.6	25.55	41.80
9.	40			5.52 5.45	25.8 25.9	25.85	41.12

Source: Data experiments (2022)

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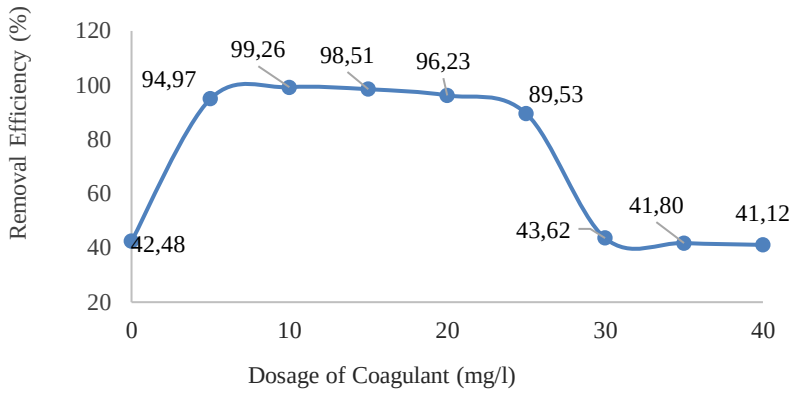

Figure 5. Removal efficiency (%) in turbidity of PAC 1
Source: Data experiments (2022)

The addition of 10 mg/l and 15 mg/l of PAC 1 doses to the water sample having the highest turbidity removal up to 99.26% and 98.51%, respectively. At first 5 mg/l of PAC 1 gained about 94.97% of removal percentage then it reached the highest point with the addition of 10 mg/l, after which the removal percentage decreased to 40 mg/l only by 41.12%. According to the graph above, 10 mg/l of PAC selected as the optimum doses for this study by having the uppermost of turbidity removal percentage. This outcome is resemblance with [9] studies, turbidity removal about 97% generated by adding 4 to10 mg/l of PAC. Study from [10], have been examined the different initial level of turbidity and the value of PAC turbidity removal efficiency is lower about 74% at the same dose of 10 mg/l. From the results, the doses of coagulant affecting the reduction of turbidity [11]. If the dosage is too deficient, it will not produce any accelerate flocs due to the undeveloped reaction between colloid and the ions contained in PAC [12]. Whereas, the addition of excessively dosage will result as an unfavorable deposition process by reason of the formed flocs are breaks and back to be dissolved in the water sample.

Experimental Using Recycled PAC Floc

In the coagulation flocculation process, the addition of recirculating floc as to rise the turbidity in the sample water is intended to obtain higher efficiency and support the formation of stronger flocs. Previous experiments have shown that the optimal dose of PAC 1 is 10 mg/l. This study having the experiment to develop the optimal dose by decreasing about 50% to get the same or lower turbidity value having 5 mg/l of dosage with 1.25 ml of solution combining with the chemical recycled floc of PAC 1. Hence, the results performed by **Table 4**.

Table 4. The result of additional recirculating floc by reducing 50% optimum doses of PAC

Dosage (mg/l)	Recirculating Floc (%)	pH	Turbidity (NTU)	Turbidity Avg
5	0	5.98	2.05	2.21
		5.99	2.37	
	0.2	6.2	0.29	0.30
		6.27	0.31	
	0.4	6.48	0.73	0.83
		6.42	0.92	
	0.6	6.45	0.44	0.37
		6.42	0.29	
	0.8	6.23	0.34	0.27
		6.05	0.20	
	1	6.11	0.23	0.20
		6.23	0.16	
	1.2	6.41	0.14	0.16
		6.43	0.17	

Source: Data experiments (2022)

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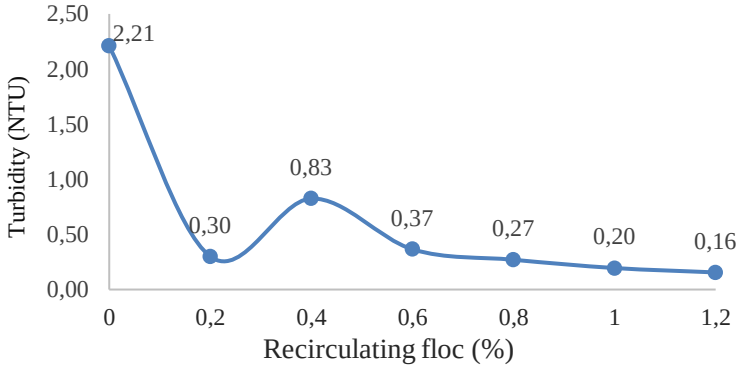

Figure 6. Potential recycled sludge by reducing 50% optimum doses
Source: Data experiments (2022)

From the 50% optimum dose reduction experiments, four out of six experiments succeeded in achieving the target turbidity value below 0.33 NTU (based on the turbidity value achieved by the optimum dosage, 10 mg/l). The addition of 0.2%, 0.8%, 1%, and 1.2% gave a good value of turbidity with 0.30 NTU, 0.27 NTU, 0.20 NTU, and 0.16 NTU, respectively. Based on the experiments [13], PAC recycled sludge has a 67% potential to reduce water turbidity values at a lower optimum dosage. Turbidity value achieved without the addition of chemical recycled sludge by optimum doses which 10 mg/l of coagulant is 0.33 NTU. Reducing the optimum dose of coagulant to 5 mg/l by adding numerous experiments in the volume of the recirculating flocs has a significant effect. The optimum volume achieved to obtain the lowest turbidity value about 0.16 NTU by adding 1.2% or 3 ml of recirculated sludge during the jar-test.

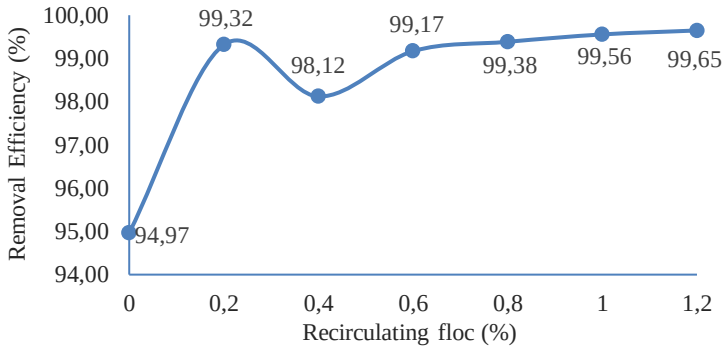

Figure 7. Removal efficiency (%) of turbidity in optimum volume of RF
Source: Data experiments (2022)

Treated water by using 5 mg/l doses of PAC achieved the 5.99 of pH water, meanwhile the additional of recycled PAC flocs give a better result in reducing pH water. As a result, the final pH water is between the range of 6.14 to 6.45 from initial pH was 6.60. This proven that the reduction was not as large as the conventional treatment by only using PAC as coagulant. At the Aluminum hydrolysis reaction, four types of Aluminum are generated, including Al^{3+}, $Al(OH)^{2+}$, $Al(OH)_2^{+}$, and $Al(OH)_4^{-}$ [14]**.** The flocs formed as aluminum hydroxide [$Al(OH)_3$]. Aluminum Hydroxide is amphoteric [15] which refers to Bronsted-Lowry law will act as a base in an acid solution by attracting hydrogen ions to neutralize the charge.

Data Analysis

Results based on the test using a two-sided t-test are shown in **Table 5** above. The p-value obtained in each experiment using recycled PAC flocs is less than 0.05 (p value < 0.05). This indicates that each of these experiments was significantly different from the control sample. In this case, H_0 will be rejected and accepting the Ha relate to the observation. It has been shown that the addition of recirculated sludge also has a significant impact in reducing turbidity aside to diminish PAC optimum doses

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Table 5. T-Test result for each experiment in turbidity value

Dosage (mg/l)	Recirculating Floc (%)	Turbidity (NTU)	Turbidity Avg	P (t-test, two tail to 5 mg/l with 0% of RF)
5	0	2.05 2.37	2.21	*Control*
	0.2	0.29 0.31	0.30	0.007
	0.4	0.73 0.92	0.83	0.018
	0.6	0.44 0.29	0.37	0.009
	0.8	0.34 0.20	0.27	0.008
	1	0.23 0.16	0.20	0.007
	1.2	0.14 0.17	0.16	0.006

Source: Data experiments (2022)

Table 6. T-Test result for each experiment in pH value

Dosage (mg/l)	Recirculating Floc (%)	pH	pH Avg	P (t-test, two tail to 5 mg/l with 0% of RF)
5	0	5.98 5.99	5.99	*Control*
	0.2	6.2 6.27	6.24	0.019
	0.4	6.48 6.42	6.45	0.004
	0.6	6.45 6.42	6.44	0.001
	0.8	6.23 6.05	6.14	0.228
	1	6.11 6.23	6.17	0.092
	1.2	6.41 6.43	6.42	0.001

Source: Data experiments (2022)

Experiments in which various volumes of recirculated flakes were added to water samples resulted in a lower pH drop than no recirculated flakes. This is expressed as a final average pH with added recycled flocs, still above 6, meanwhile the experiments with the same dose of PAC without recycled flocs give an average pH of less than 6. This shows that the use of recycled flocs can lowering the pH of the water more consistently than with conventional treatment. Two out of the six experiments with various percentage of Recirculating Floc (RF) showed there is no significant difference in pH reduction. For then, the experiments mostly had the p value is less than alpha ($p < 0.05$) which means there was a significant difference between the control with the addition of recycled floc treatment.

According to the predetermined hypothesis, notice that the null hypothesis was rejected due to the p-value is less than alpha. This assessment indicates that the presence or absence of PAC recycled flocs take control for adjustment in pH value. Studies from [16], states by adding 30 mg/l of PAC have an issue of lowering pH from 8.7 to 8.2. This is kind of evidence that PAC involved in pH adjustment.

4. Conclusion

Since PAC 1 has been chosen as the best coagulant in this study. Gaining the optimum doses of PAC by having 10 mg/l solution of coagulant with the same water and pH condition. The addition of PAC doses showed a reduction in the turbidity up to 99.26%. Using a dose of 10 mg/l gave the lowest turbidity value of 0.33 NTU from 43.9 NTU. The value of turbidity will increase in line with the addition of the coagulant dose. At the same time, the pH value will decrease if the dose is increased. The amount of sludge

characterization obtained from the previous coagulation activity was 76%. An experiment was carried out, adding 0.2%, 0.4%, 0.6%, 0.8%, 1%, and 1.2% of Recirculating Floc (RF) variants into the sample. The experiment used the optimum dose of PAC, which was reduced by 50% to the sample. With the same water sample and decreasing the usage of PAC doses only by 5 mg/l brings the results were quite promising. From the variation of several recycled sludge was obtained, namely 0.2%, 0.8, 1%, 1.2% and with turbidity values of 0.30 NTU, 0.27 NTU, 0.20 NTU, and 0.16 NTU, respectively. This experiment shows that with lower doses and combined with recycled sludge, the turbidity results can be better comparing with 10 mg/l of PAC as the previous optimum doses.

By applying statistical tests on the relationship between turbidity and pH values before and after the addition of recycled sludge, the results obtained are rejecting H_0 (p value < 0.05) which indicates there is a significant difference between the two treatments. Otherwise, from this study it has a slightly potential that chemical recycled flocs affecting the pH of water to become less acid at the end of flocculation process. This can lead the opportunity to reduce the chemical for neutralization.

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