Poltekita: Jurnal Ilmu Kesehatan
http://jurnal.poltekkespalu.ac.id/index.php/JIK

Vol.17 No.3 November 2023: Hal. 996-1007
p-ISSN: 1907-459X e-ISSN: 2527-7170

Original Article

The Influence of Electrode Plate Area in Reducing Turbidity and Color Levels in Peat Water

Zainal Akhmadi[1], **Fara Chitra**[2*], **Daeng Wulantika**[1]

[1] Bachelor of Applied Sanitation Study Program, Department of Environmental Health, Poltekkes Kemenkes Pontianak, Pontianak City, West Kalimantan, Indonesia
[2] Diploma III Sanitation Study Program, Department of Environmental Health, Poltekkes Kemenkes Pontianak, Pontianak City, West Kalimantan, Indonesia

(Correspondence author's email, chitrafara@gmail.com)

ABSTRACT

Peat water generally exhibits characteristics ranging from dark brown to black, with high organic content and a pH range between 3.7 and 5.3. These features pose challenges in meeting clean water quality standards, essential for maintaining human health. Consequently, the treatment of peat water becomes a pressing need to enhance its quality for suitable use. Electrocoagulation has emerged as a widely applied method in peat water treatment. This research aims to evaluate the influence of electrode plate area and contact time in reducing turbidity and color in peat water. The research methodology employed a quasi-experimental design known as the One-Group Pretest-Posttest. Thirty test samples were collected with variations in electrode plate areas of 4 x 30 cm, 5 x 30 cm, and 6 x 30 cm. Contact time was varied within the range of 30, 60, 90, 120, and 150 minutes, applying a voltage of 48 volts. The results indicated fluctuations in the increase of turbidity in peat water after the electrocoagulation treatment. A plate area of 6 x 30 cm led to a turbidity increase of 27.33 NTU or approximately 83% after a contact time of 150 minutes. Meanwhile, the color level in peat water decreased by 65 TCU with a 5 x 30 cm electrode plate area after 150 minutes of contact time, achieving an effectiveness of 90% in color reduction. In conclusion, the electrode plate area significantly influences the reduction of turbidity and color in peat water. Although there is no discernible effect of contact time on turbidity levels, prolonged contact time has a significant impact on reducing the color level in peat water.

Keywords: *Peat Water, Electrocoagulation, Plate Area, Turbidity, Color*

https://doi.org/10.33860/jik.v17i3.3387

INTRODUCTION

Water is a crucial natural resource for the survival of living beings on Earth and plays a vital role in various aspects of human life[1]. The use of water in daily activities such as eating, cooking, bathing, washing, and others indicates that water is not only a consumption necessity but also supports individual hygiene and sanitation[2]. However, rapid population growth and the passage of time have made the provision of clean water increasingly challenging.

According to Lestari et al. (2021), the minimum water requirement for hygiene and sanitation purposes in a household is around 50 liters per individual per day[3]. In Indonesia, particularly in West Kalimantan, the provision of clean water still faces disparities. Areas not covered by clean water services generally rely on water sources such as dug wells or river water, which may not always meet cleanliness standards. This is particularly true in peat swamp areas where peat water is commonly used for various purposes, including sanitation, even though its quality often fails to meet requirements[2].

According to Putra et al. (2022), Indonesia has extensive peatland potential, especially in Kalimantan, Sumatra, and Papua[4]. The peatland area in West Kalimantan, specifically in Kuburaya and Pontianak, reaches 354,474 hectares or 33% of the total peatland area in West Kalimantan[5]. The distribution of this extensive peatland area results in abundant peat water in West Kalimantan, especially in Pontianak.

Characteristics of peat water in West Kalimantan, including Pontianak, encompass low turbidity, dark brown to black color, high organic content, and a pH range of 3.7 to 5.3 [6]. In Pontianak and Kuburaya, physical parameters of peat water include acidity levels (pH) between 4 and 5.7, conductivity ranging from approximately 1.31 µS/cm to 82.2 µS/cm, and turbidity ranging from 1.31 µS/cm to 82.2 µS/cm, with all peat water being brown in color. Chemical parameters involve organic substance content ranging from approximately 11 mg/L to 16 mg/L, iron content from around 2 mg/L to 5 mg/L, and total hardness from about 590 mg/L to 1302 mg/L [7].

However, challenges in meeting clean water needs in West Kalimantan persist. Data from the Central Statistics Agency (2020) shows that the volume of clean water distributed by the Clean Water Company of West Kalimantan Province continues to increase but still falls short of requirements[8]. Additionally, the use of rainwater as an alternative source of clean water is hindered by climate change, leading to droughts during the dry season[9].

In this context, communities often rely on peat water to meet sanitation needs. However, peat water does not meet the standard quality as clean water, as regulated by the Ministry of Health of the Republic of Indonesia No. 32 of 2017 [10]. Previous research by Apriana (2022) indicates that peat water in Parit Nanas Siantan Hulu, North Pontianak, exceeds the standard limits for turbidity and color[11].

Water that does not meet quality standards can have negative impacts on public health, causing waterborne diseases such as diarrhea, cholera, dysentery, and typhoid [12]. In the context of peat water, dental erosion due to low pH effects is also one of the health impacts that may arise [13].

Lack of disinfection effectiveness is also a serious problem because peat water characteristics such as turbidity, color, and odor can protect microorganisms from disinfection efforts[14]. Data on diarrhea cases in Pontianak City shows that North Pontianak has the highest contribution to the number of diarrhea cases in 2018, 2019, and 2020 [15].

Therefore, efforts are needed to treat peat water to meet quality standards as clean water. Electrocoagulation methods are promising approaches. This process combines electrochemical and flocculation-coagulation aspects to produce easily separable clumps[16]. Several previous studies Putra et al., (2022); Apriana, (2022); Lavianiga et al., (2019), have shown that electrocoagulation, especially using aluminum electrodes, can effectively reduce turbidity, color, and iron content in peat water [4,11,17].

Although previous research has provided a good understanding of the potential of electrocoagulation, further research is needed to understand the influence of electrode plate area in the peat water treatment process. This research will use aluminum electrodes with variations in plate area (4 x 30 cm, 5 x 30 cm, and 6 x 30 cm) to evaluate the efficiency of peat water treatment in reducing turbidity and color without adding coagulant or supporting electrolyte. In addition, variations in contact time (30 minutes, 60 minutes, 90 minutes, 120 minutes, and 150 minutes) will also be tested to determine the optimal conditions in the electrocoagulation process. Thus, this research is expected to make a significant contribution to the development of more effective and efficient peat water treatment technology to meet clean water quality standards. This research aims to investigate the influence of electrode plate area and contact time in reducing turbidity and color in peat water.

METHOD

This study is a type of quantitative research using a quasi-experimental method with a One-Group Pretest-Posttest research design. This design involves administering treatment after conducting a pretest, followed by a posttest to compare the results with the conditions before treatment[18]. The research was conducted from November to June 2023 at the Integrated Laboratory of the Ministry of Health Polytechnic Pontianak. The research sample is peat water taken from Parit Nanas street, Siantan Hulu, North Pontianak.

The research population is peat water

on Jalan Parit Nanas Siantan Hulu, North Pontianak, and the number of samples used is 30 samples for turbidity and 30 samples for color. Sample collection was carried out using predetermined procedures.

In the analysis stage, tests for turbidity and color of peat water were conducted with variations in the electrode plate sizes, namely 4 x 30 cm, 5 x 30 cm, and 6 x 30 cm. The obtained data were then statistically tested using the Paired Sample T-Test to compare the results before and after treatment with the electrocoagulation method. Conclusions were drawn based on the p-value, where $p \leq 0.05$ indicates that the alternative hypothesis (Ha) is accepted, while if $p > 0.05$, Ha is rejected.

Furthermore, to evaluate the influence of plate area, direct current, and contact time, a Two-Way ANOVA test was conducted. Prior to this, tests for Normality and Homogeneity assumptions were performed to ensure that the data met the analysis requirements. Conclusions were made by comparing the p-values from the Two-Way ANOVA, where $p < 0.05$ indicates a difference in the influence of plate area on turbidity and color when treated with direct current, while if $p > 0.05$, there is no difference.

The results of the turbidity and color analysis were then compared with the standards set by the Ministry of Health of the Republic of Indonesia No. 32 of 2017 to assess the water quality resulting from the experiment.

RESULTS

The peat water used in this research is river water located in Jalan Parit Nanas, Siantan Hulu Village, North Pontianak District. Based on the results of preliminary tests conducted by previous researchers Apriana, (2022) obtained turbidity levels, namely turbidity levels of 972 NTU and color levels of 1746 TCU. The turbidity level allowed according to Permenkes Number 32 of 2017 is 25 NTU and for color levels which is 50 TCU. So it can be seen that the turbidity and color levels of peat water on Parit Nanas street, exceed the quality standard.

Table 1. Initial Data of Turbidity Levels Before and After Processing Electrocoagulation Method Electrode Area 4 x 30 cm, 5 x 30 cm and 6 x 30 cm

Repetition	**Turbidity Level (NTU)**									
	X					**Y**				
	30	60	90	120	150	30	60	90	120	150
Electrode Area 4 x 30 cm										
1	5,65	5,47	5,38	4,97	4,76	15,21	12,84	13,35	12,42	14,42
2	4,21	4,43	4,88	4,65	4,68	14.41	12,58	11,58	13,86	12,50
Average	4,93	4,95	5,13	4,81	4,72	14,81	12,71	12,46	13,14	13,46
Electrode Area 5 x 30 cm										
1	5,40	6,09	5,96	4,58	5,10	20,25	18,05	17,44	18,10	17,24
2	4,57	4,60	4,72	4,78	4,25	21,14	19,48	16,20	17,53	17,92
Average	4,98	5,34	5,34	4,68	4,67	20,69	18,76	16,82	17,81	17,58
Electrode Area 6 x 30 cm										
1	4,55	5,38	4,80	4,30	4,80	24,17	23,15	21,25	26,87	28,90
2	4,33	4,26	4,85	4,85	4,50	27,05	22,12	21,79	20,27	25,77
Average	4,44	4,82	4,83	4,57	4,65	25,61	22,63	21,52	23,57	27,33

Source: Primary Data 2023
Table description:
X = Before Processing
Y = After Processing

Based on the measurement results in table 1 with the 4x30 cm Electrode Area electrocoagulation method shows a fluctuating increase, the least increase occurs at a contact time of 90 minutes which is 12.46 NTU. For measurements on the 5x30 cm Electrode Area electrocoagulation method, Table 1 above shows a fluctuating increase, the least increase occurred at a contact time of 90 minutes, which amounted to 16.82 NTU. In Table 1 with the 6x30 cm Electrode Area electrocoagulation method also shows a fluctuating increase, the least increase occurs at a contact time of 90 minutes, which is 21.52 NTU.

Table 2. Initial Data of Color Levels Before and After Treatment Electrocoagulation Method Electrode Area 4 x 30 cm, 5 x 30 cm and 6 x 30 cm

Repetition	Color Levels (NTU)									
	X					Y				
	30	60	90	120	150	30	60	90	120	150
Electrode Area 6 x 30 cm										
1	610	660	650	690	670	550	650	490	320	220
2	670	680	650	670	640	690	540	400	280	150
Average	640	670	650	680	655	620	595	445	300	185
Electrode Area 5 x 30 cm										
1	670	640	650	680	690	480	300	180	100	80
2	700	670	670	660	620	560	180	200	150	50
Average	685	655	660	670	655	520	240	190	125	65
Electrode Area 6 x 30 cm										
1	610	620	650	720	670	570	490	350	250	150
2	660	670	650	640	630	500	600	320	390	110
Average	635	645	650	680	650	535	545	335	320	125

Source: Primary Data 2023
Table description:
X = Before Processing
Y = After Processing

Based on the measurement results on Electrocoagulation Method Processing Electrode Area 4 x 30 cm table 2 above shows a continuous decrease, the most decrease occurs at a contact time of 150 minutes which is 185 TCU. The measurement results on Electrocoagulation Method Processing Electrode Area 5 x 30 cm table 2 above shows a continuous decrease, the most decrease occurs at a contact time of 150 minutes which is 65 TCU. In Processing Electrocoagulation Method Electrode Area 6 x 30 cm table 2 above shows a continuous decrease, the most decrease occurs at a contact time of 150 minutes which is 125 TCU.

Table 3. Preliminary data on acidity (pH) before and after treatment Electrocoagulation Method Electrode Area 4 x 30 cm, 5 X 30 cm and 6 x 30 cm

Repetition	Degree of acidity (pH) (NTU)									
	X					Y				
	30	**60**	**90**	**120**	**150**	**30**	**60**	**90**	**120**	**150**
Electrode Area 4 x 30 cm										
1	5	5	5	5	5	6	6	6	6	6
2	5	5	5	5	5	6	6	6	6	6
Average	5	5	5	5	5	6	6	6	6	6
Electrode Area 5 x 30 cm										
1	5	5	5	5	5	6	6	6	6	6
2	5	5	5	5	5	6	6	6	6	6
Average	5	5	5	5	5	6	6	6	6	6
Electrode Area 6 x 30 cm										
1	5	5	5	5	5	6	6	6	6	6
2	5	5	5	5	5	6	6	6	6	6
Average	5	5	5	5	5	6	6	6	6	6

Source: Primary Data 2023
Table description:
X = Before Processing
Y = After Processing

Based on the measurement results in Table 3 above, the pH of peat water after processing increased by 6 for each contact time at a plate area of 4 x 30 cm. The measurement results on the pH of peat water after processing increased by 6 for each contact time at a plate area of 5 x 30 cm. The 6 x 30 cm plate area also showed that the pH of the peat water increased by 6 for each contact time after treatment.

Table 4. Initial Temperature Data Before and After Processing Electrocoagulation Method Electrode Area 4 x 30 cm, 5x30 cm, and 6x30 cm

Repetition	Temperature (NTU)									
	X					Y				
	30	60	90	120	150	30	60	90	120	150
Electrode Area 4 x 30 cm										
1	27	27	27	27	27	28	28	28	28	28
2	27	27	27	27	27	28	28	28	28	28
Average	27	27	27	27	27	28	28	28	28	28
Electrode Area 5 x 30 cm										
1	27	27	27	27	27	28	28	28	28	28
2	27	27	27	27	27	28	28	28	28	28
Average	27	27	27	27	27	28	28	28	28	28
Electrode Area 6 x 30 cm										
1	27	27	27	27	27	28	28	28	28	28
2	27	27	27	27	27	28	28	28	28	28
Average	27	27	27	27	27	28	28	28	28	28

Source: Primary Data 2023
Table description:
X = Before Processing
Y = After Processing

Based on the measurement results in Table 4 above, the temperature of peat water after processing increased by 28 degrees for each contact time at a plate area of 4 x 30 cm. The 5 x 30 cm plate area also experienced an increase of 28 degrees for each contact time. The table above also shows that the temperature of peat water after treatment increased by 28 degrees for each contact time at a plate area of 6 x 30 cm.

Table 5. Results of Normality Test for variation of plate area and contact time on turbidity levels in peat water.

Treatment group	Shapiro-Wilk		
	Statistic	df	Sig.
Before treatment 4x30 cm	0,904	10	0,240
Before treatment 5x30 cm	0,880	10	0,130
Before treatment 6x30 cm	0,904	10	0,244
After treatment 4x30 cm	0,892	10	0,179
After treatment 5x30 cm	0,924	10	0,389
After treatment 6x30 cm	0,947	10	0,636

Based on the table above, it shows that each of them has a p value> 0.05, so it is concluded that the data is normally distributed.

Table 6. Results of Analysis of Turbidity Difference with Electrode Plate Area 4 x 30 cm, 5x30 cm and 6x30 cm

Variable	N	Mean	SD	Deviation (d)		Sig. (2-tailed)
				Mean	SD	
Electrode Plate Area 4x30 cm						
Color Content						
Before Treatment	10	5,07	0,32	-8,41	0,84	0,000
After Treatment	10	13,48	0,99			
Electrode Plate Area 5x30 cm						
Color Content						
Before Treatment	10	5,00	0,320	-13,33	1,673	0,000
After Treatment	10	18,33	0,996			
Electrode Plate Area 6x30 cm						
Color Content						
Before Treatment	10	4,66	0,320	-19,47	3,023	0,000
After Treatment	10	24,13	0,996			

Based on the table 6, the average turbidity level before treatment is and the average turbidity level after treatment is 5 NTU.

While the average difference in turbidity levels before and after treatment is 8.41 NTU. Statistically there is a significant difference in the average turbidity levels before and after treatment with an electrode plate area of 4 x 30 cm, the results of the analysis obtained p value = 0.000.

Based on the table 6, the average turbidity before treatment is 5 and the average turbidity level after treatment is 18.33 NTU. While the average difference in turbidity levels before and after treatment is 13.33 NTU. Statistically there is a significant difference in the average turbidity levels before and after treatment with an electrode plate area of 5 x 30 cm, the results of the analysis obtained p value = 0.000.

The average turbidity level before treatment is 4.66 and the average turbidity level after treatment is 24.13 NTU. While the average difference in turbidity levels before and after treatment is 19.47 NTU. Statistically there is a significant difference in the average turbidity levels before and after treatment with an electrode plate area of 6 x 30 cm, the analysis results obtained p value = 0.000.

Table 7. Two Way Anova Test Results Turbidity Levels

Indicators	Sig.
Plate Area	0,000
Contact Time	0,303

Based on table 7 regarding the parametric test using two way anova, it is found that on the plate area the p value = 0.000 means that there is an influence between the plate area and the turbidity level in peat water. In contact time, the value of p=0.303 means that there is no influence between contact time and turbidity levels in peat water.

Table 8. Normality Test of Color Level

Treatment group	Shapiro-Wilk		
	Statistic	df	Sig.
Before treatment 4x30 cm	0,934	10	0,493
Before treatment 5x30 cm	0,970	10	0,895
Before treatment 6x30 x cm	0,937	10	0,518
After treatment 4x30 cm	0,958	10	0,764
After treatment 5x30 cm	0,860	10	0,076
After treatment 6x30 cm	0,928	10	0,689

Based on the table 8, it shows that each obtained a p value> 0.05, so it is concluded that the data is normally distributed. Hypothesis analysis testing with parametric tests, namely the Paired Sample test.

Table 9. Results of Color Difference Paired Sample T-Test Analysis with Electrode Plate Area 4 x 30 cm, 5X30 cm and 6x30 cm

Variable	N	Mean	SD	Deviation (d)		Sig. (2-tailed)
				Mean	SD	
Electrode Plate Area 4x30 cm						
Color Content						
Before Treatment	10	659	22,828	230	186.90	0,004
After Treatment	10	429	183,81			
Electrode Plate Area 5x30 cm						
Color Content						
Before Treatment	10	665	23,68	437	162,27	0,000
After Treatment	10	228	170,08			
Electrode Plate Area 6x30 cm						
Color Content						
Before Treatment	10	652	31,1	279	180.64	0,001
After Treatment	10	373	169,2			

Based on the table 9, the average color level before treatment is 659 TCU and the average color level after treatment is 429 TCU. While the average difference in color levels before and after treatment is 230 TCU. Statistically there is a significant difference in the average color content before and after treatment with an electrode plate area of 4 x 30 cm, the analysis results obtained p value = 0.004.

The average color level before treatment is 665 TCU and the average color level after treatment is 228 TCU. While the average difference in color levels before and after treatment is 437 TCU. Statistically there is a significant difference in the average color content before and after treatment with an electrode plate area of 5 x 30 cm, the results of the analysis obtained p value = 0.000.

The average color level before

treatment is 652 TCU and the average color level after treatment is 373 TCU. While the average difference in color levels before and after treatment is 279 TCU. Statistically there is a significant difference in the average color content before and after treatment with an electrode plate area of 6 x 30 cm, the results of the analysis obtained p value = 0.001.

Table 10. Two Way Anova Test results to see the color effect of plate area and contact time on peat water color content using the electrocoagulation method.

Indicators	Sig.
Plate Area	0,000
Contact Time	0,000

Based on the results of the parametric test using two-way anova, it was found that on the plate area, the p value is 0.000, meaning that there is an influence between the plate area and the decrease in color levels in peat water, then on the contact time, the p value is 0.000, meaning that there is an influence between the contact time and the decrease in color levels in peat water.

DISCUSSION

Measurement of peat water turbidity levels before and after treatment of the electrode plate area.

Based on the measurement of the peat water turbidity level, in the treatment of the electrode plate area of 4 x 30 cm, the average value before processing at 30 minutes was 4.93 NTU, 60 minutes was 4.95 NTU, 90 minutes was 5.13 NTU, 120 minutes was 4.81 NTU and 150 minutes was 4.72 NTU. Then after processing, it was found that there was a fluctuating increase in the turbidity level of peat water where after being given a contact time of 30 minutes the turbidity level became 14.81 NTU, 60 minutes was 12.71 NTU, 90 minutes was 12.46 NTU, 120 minutes was 13.14 NTU and 150 minutes was 13.46 NTU.

In the measurement results for the treatment with an electrode plate area of 5 x 30 cm. The average result before processing at 30 minutes is 4.98 NTU, 60 minutes is 5.34 NTU, 90 minutes is 5.34 NTU, 120 minutes is 4.68 NTU and 150 minutes is 4.67 NTU. After processing, there was a fluctuating increase in turbidity levels where the contact time of 30 minutes was 20.69 NTU, 60 minutes was 18.76 NTU, 90 minutes was 16.82 NTU, 120 was 17.81 NTU and 150 minutes was 17.58 NTU.

With the treatment of the electrode plate area of 6 x 30 cm in measurements before processing, the average result at 30 minutes was 4.44 NTU, 60 minutes was 4.82 NTU, 90 minutes was 4.83 NTU, 120 minutes was 4.57 NTU and 150 minutes was 4.65 NTU. Then there was a fluctuating increase in the turbidity level of peat water. After processing, the average increase was obtained at a contact time of 30 minutes to 25.61 NTU, 60 minutes to 22.63 NTU, 90 minutes to 21.52 NTU, 120 minutes to 23.57 NTU and at a contact time of 150 minutes to 27.33 NTU.

The increase in turbidity with the treatment of the electrode plate area of 4 x 30 cm was greatest at a contact time of 30 minutes, which was 67% or 14.81 NTU and at a contact time of 90 minutes showed a decrease of 59% or 12.46 NTU and again showed an increase in turbidity value at a contact time of 120 minutes, which was 13.14 NTU. Furthermore, in the treatment of a plate area of 5 x 30 cm, there was an increase in turbidity of 75.5% or 14.81 NTU at a contact time of 30 minutes and at a contact time of 90 minutes a decrease of 68.5% or 16.82 NTU and then an increase again at a contact time of 120 minutes, namely 74% or 17.81 NTU. For the treatment with the electrode plate area, the largest increase was shown at a contact time of 30 minutes, which amounted to 82.5% or 25.61 NTU and at a contact time of 90 minutes showed a decrease to 77.5% or 22.63 NTU and again increased at a contact time of 120 minutes by 80% or 23.57 NTU.

The pH of the peat water before treatment was 5 degrees of acidity, while after treatment the pH of the peat water increased to 6 or 17% for each plate area and contact time. And the temperature of the peat water before treatment was 27oC while after treatment it became 28oC or 4% on each plate area and contact time. The increase in pH and temperature was caused by the electrocoagulation process.

According to Novianti & Tuhu, (2018) said that in the electrocoagulation process there are factors that can affect it, such as temperature, contact time, current strength, voltage and acidity (pH)[19]. In this study, the increase in turbidity levels can be influenced by the factor of current strength and voltage where the volt used is 48 volts. Based on the information in the input tool produced is 110-220 v and 240 watts. Where in this strong current in the electrocoagulation process the current used is direct current, the magnitude of the current can cause the formation of hydroxide gas (H2) which occurs at the cathode which is too large and fast then can break the floc that has been formed. At a strong voltage, the current that produces chemical changes flows through the medium (metal or electrolyte) due to a potential difference, because the electrical resistance in the medium is greater than the metal. The increase in the larger plate area tends to have a higher turbidity number, this is likely due to the ability to produce hydroxide (H2) which is greater where the increase in turbidity levels is 82.5% or 25.61 NTU at a contact time of 30 minutes while at a smaller plate area at a contact time of 30 minutes the increase in turbidity is only 67% or 14.81 NTU. According to Rezagama & Notodarmojo (2012), the decomposition of metal compounds related to humic acid or humic acid contained in peat water, which was originally dissolved, into non-dissolved, is likely to cause an increase in turbidity[20]. Hanafi et al (2016) stated that the characteristics of peat water in West Kalimantan have high organic content, namely 138 - 1560 mg/l $KMNO_4$ [6]. So that with the high organic content which then causes the breakdown of metal compounds due to direct electric current.

In this electrocoagulation process, oxidation and reduction processes occur where the anode will produce gas in the form of air bubbles and foam. Hasrianti & Nuraisa (2015) state that one of the substances that can cause turbidity in water is the presence of iron (Fe) in the water, then if this is related to the increase in peat water turbidity levels in this study, it is because the large voltage results in a strong current so that it produces more bubble formation reactions and reacts with iron (Fe) related to humus acid or organic substances in peat water to break down metal compounds so that this also causes the wider electrode plate to experience more turbidity than the other two electrode sizes[21]. Furthermore, the formation of particles resulting from the electrocoagulation process that will be fluttered to the surface has not settled completely so that it is carried away during the reading of the turbidity test sample.

Based on the results obtained regarding the contact time of the electrode plates, it can be seen that each variation of the plate area increased at a contact time of 30 minutes, then decreased at a contact time of 90 minutes and increased again at a contact time of 120 minutes. The possibility of a large increase at the beginning of the contact time is due to the ability of the plates to produce reactions that can break the flocs due to the large amount of hydroxide (H2) produced, which is what causes the high turbidity levels in peat water. For a contact time of 120 - 150 minutes, it can be seen that the increase in this contact time can be due to the length of contact time causing saturation of the electrode plate so that it causes the ability to reduce turbidity levels in peat water. Syamsur et al (2018) that the longer contact time can cause the electrode to become saturated and the magnetic field that occurs is already small so that the electrocoagulation process is at a minimum, it is suspected that most of the turbidity is due to flocs that settle in the vessel or container[22].

For this contact time, it can be seen that the 90-minute contact time is better because it shows a decrease in turbidity levels where the 4 x 30 cm plate area turbidity drops to 59%, the 5 x 30 cm plate area is 68.5% and the 6 x 30 cm plate area is 77.5%.

Based on this, it can be concluded that the wider the electrode plate can cause an increase in the turbidity level of peat water after treatment with the electrocoagulation method. The better contact time in reducing turbidity levels occurs at a contact time of 90 minutes.

Measurement of the color content of peat water before and after treatment of the electrode plate area.

Furthermore, the results of the examination of the color content of peat water with the treatment of the electrode plate area measuring 4 x 30 cm, obtained the average value of the color content before treatment at 30 minutes, namely 640 TCU, 60 minutes 670 TCU, 90 minutes 650 TCU, 120 minutes 680 TCU and 150 minutes 655 TCU. While the average value of color levels that have been processed using the electrocoagulation method in the treatment of the electrode plate area of 4 x 30 cm, namely at a contact time of 30 minutes of 620 TCU, 60 minutes 595 TCU, 90 minutes 445 TCU, 120 minutes 300 TCU and at 150 minutes 185 TCU, it can be seen that there is a difference between the color levels before and after processing and there is a decrease in the color levels carried out processing from time to time. In this 4 x 30 cm electrode plate area, it can be seen that the most optimum time in reducing the color level is 150 minutes with a color level of 185 TCU, meaning that there is a decrease of 72% from the average color level before processing.

In the examination of color levels on the electrode plate area of 5 x 30 cm, the average value at 30 minutes is 685 TCU, 60 minutes 655 TCU, 90 minutes 660 TCU, 120 minutes 670 TCU and 150 minutes 655 TCU. The average value of color content after processing was 520 TCU at 30 minutes of contact time, 240 TCU at 60 minutes, 190 TCU at 90 minutes, 125 TCU at 120 minutes and 65 TCU at 150 minutes. It can be seen that in the treatment of peat water with the electrocoagulation method in the treatment of the electrode plate area of 5 x 30 cm, there is a decrease from time to time and there is a decrease between the color level before treatment and the color level after treatment. From this decrease, it can be seen that the optimum time in reducing the color level is 150 minutes with a color level of 65 TCU, meaning that there is a decrease of 90% from the average color level before processing.

Furthermore, at an electrode plate area of 6 x 30 cm, the average value obtained before processing at a time of 30 minutes was 635 TCU, 60 minutes was 645 TCU, 90 minutes was 650 TCU, 120 minutes was 680 TCU and time 150 minutes was 650 TCU. While the results after processing with the electrocoagulation method in the treatment of the electrode plate area of 6 x 30 cm were produced at a contact time of 30 minutes of 535 TCU, 60 minutes of 545 TCU, 90 minutes of 335 TCU, 120 minutes of 320 TCU and 150 minutes of 125 TCU. It can be seen that there is a decrease in the color level between before processing and after processing. However, in the color content that has been processed there is a fluctuating decrease and increase, where there is an increase in the 60-minute contact time of 545 TCU on a 6 x 30 cm plate and decreases in the next minute. In the treatment with this electrode plate area, the optimum time in reducing color levels is 150 minutes, namely the resulting level of 125 TCU. There was a percentage decrease of 79%.

The pH of the peat water before treatment was 5 degrees of acidity, while after treatment the pH of the peat water increased to 6 or by 17% for each plate area and contact time. And the temperature of the peat water before treatment was 27^{o}C while after treatment it became 28^{o}C or 4% on each plate area and contact time. The increase in pH and temperature was caused by the electrocoagulation process.

According to Suwanto et al (2017) the occurrence of a decrease in color levels in water occurs when $Al(OH)_3$ flocs are formed when the anode is electrified. Then the floc that has been formed will bind to organic molecules contained in water, this will cause a decrease in color levels[13]. As for previous research, it is said that the more aluminum hydroxide that is formed, the more compounds will react with organic compounds in water that contain a lot of humic acid so that this is what causes the color to decrease.

Thus, it can be concluded that there is a reduction in the average value of the color content of peat water before and after the treatment of variations in the electrode plate area of 4 x 30 cm, 5 x 30 cm and 6 x 30 cm. However, based on the results of the average value obtained, the largest decrease in color content occurred at a plate area of 5 x 30 cm and a contact time of 150 minutes with an average decrease of 65 TCU and a percentage effectiveness of 90%. This research is in line with research conducted by Suwanto et al (2017) which states that the longer the contact time in electrocoagulation processing, the greater the color reduction efficiency obtained[13].

Analysis of the effect of electrode plate area on peat water turbidity levels.

Based on the Paired Sample T-Test statistical test, the calculated p value for the electrode plate area of 4 x 30 cm is 0.000, for the electrode plate of 5 x 30 cm the p value is 0.000 and for the electrode plate of 6 x 30 cm the p value is 0.000, meaning that there is a significant difference between the turbidity levels before treatment and after treatment with a variation of the electrode plate area of 4 x 30 cm, 5 x 30 cm and 6 x 30 cm. This difference is the fluctuating increase in turbidity levels in peat water after treatment in each plate area treatment.

Furthermore, the Two Way ANOVA test conducted obtained a value of p = 0.000, meaning that Ha is accepted, so it can be concluded that there is an effect of electrode plate area on peat water content. Where the effect of the plate area is the increase in peat water turbidity levels.

From the three variations of electrode plates, it appears that there is a different magnitude of increase where for the larger electrode plate area, namely 6 x 30 cm, there is a greater increase in turbidity levels, namely 83% or 27.33, on the other hand, the size of the electrode plate which tends to be smaller, namely 4 x 30 cm, the increase in turbidity levels is also less, namely 67%.

According to Rezagama & Notodarmojo (2012), the decomposition of metal compounds associated with humic acid or humus contained in peat water, which was originally dissolved, into non-dissolved water, is likely to cause an increase in turbidity[20].

Thus, it can be concluded that there is an influence of the plate area but in this case in increasing the turbidity value of peat water. Then based on the percentage results obtained, the largest increase in the level of increase occurred at a plate area of 6 x 30 cm.

Analysis of the effect of electrode plate area on peat water color content. Based on the Paired Sample T-Test statistical test, the calculated p value for the electrode plate area of 4 x 30 cm is 0.004, for the electrode plate area of 5 x 30 cm the p value is 0.000 and for the electrode plate area of 6 x 30 cm the p value is 0.001, meaning that there is a significant difference between the color levels before treatment and after treatment with variations in electrode plate area of 4 x 30 cm, 5 x 30 cm and 6 x 30 cm. This difference is a decrease in the color level of peat water after processing in each plate area treatment.

Furthermore, the Two Way ANOVA test carried out obtained a value of p = 0.000, meaning that Ha was accepted that there was an effect of electrode plate area on the color content of peat water. This shows that there is an effect of the plate area on reducing the color content of peat water.

According to the results of the processing carried out using the electrocoagulation method from the third variation of the electrode plate area, it can be seen that there is a different decrease. The most optimum decrease in color content in the variation of 5 x 30 cm electrode plates is 90% with a value at the color level of 65 TCU. Then when compared to the electrode plate size of 6 x 30 cm and the electrode plate size of 4 x 30 cm where the 6 x 30 cm plate area reduces the color level by 79% or 125 TCU while the electrode plate size of 4 x 30 cm decreases efficiency is 72% or 185 TCU. This shows that the wider the plate, the better the efficiency of reducing color levels.

This is in line with the research of Suwanto et al (2017) which states that the occurrence of a decrease in color levels in water occurs when Al (OH) 3 flocs are formed when the anode is electrified. Then the floc that has been formed will bind to organic molecules contained in water, this will cause a decrease in color levels. As for previous research, it is said that the more aluminum hydroxide that is formed, the more compounds will react with organic compounds in water that contain a lot of humic acid so that this is what causes the color to decrease.

Analysis of contact time on peat water turbidity levels.

Based on the Two Way ANOVA test conducted, the value of p=0.303 means that Ha is rejected, so there is no effect of contact time on peat water turbidity levels. Contact time has no effect on reducing turbidity levels, possibly because the turbidity rate fluctuates in the 30-minute contact time at an electrode plate area of 4 x 30 an increase of 67% (14.81 NTU), a plate area of 5 x 30 the increase in turbidity that occurs is 75, 5% (20.25 NTU), plate area 6 x 30 the increase in turbidity that occurred was 82.2% (25.61 NTU) while at a contact time of 90 minutes the turbidity rate decreased by 59% (12.46 NTU) plate area 4 x 30 cm, 68.5% (16.82 NTU) plate area 5 x 30 cm, and 77.5% (21.52 NTU) plate area 6 x 30 cm. And the turbidity levels increased again at a contact time of 120 minutes the area of the electrode plate 4 x 30 increased 63% (13.14 NTU), the area of the plate 5 x 30 the increase in turbidity that occurred was 74% (17.81 NTU), the area of the plate 6 x 30 the increase in turbidity that occurred 80% (23.57 NTU). Syamsur et al (2018) the longer contact time can cause the electrode to become saturated and the magnetic field that occurs is already small so that the electrocoagulation process is at a minimum, it is suspected that most of the turbidity is due to flocs that settle in the vessel or container.

Analysis of contact time on peat water color content.

Based on the Two Way ANOVA test conducted, the value of p=0.000 means that Ha is accepted that there is an effect of contact time on peat water treatment with the electrocoagulation method. Where the effect of this time shows a decrease in the color level. It can be seen from time to time that there is a reduction in the color content of peat water after treatment with the electrocoagulation method. At an electrode plate area of 4 x 30 cm there was a decrease of 4% (620 TCU) with a contact time of 30 minutes, 11% (595 TCU) with a contact time of 60 minutes, 32% (445 TCU) with a contact time of 90 minutes, 56% (300 TCU) with a contact time of 120 minutes and 72% (185 TCU) with a contact time of 150 minutes. For a plate area of 5 x 30 minutes the color reduction that occurs is 24% (520 TCU) 30 minutes contact time, 63% (240 TCU) 60 minutes contact time, 71% (190 TCU) 90 minutes contact time, 81% (125 TCU) 120 minutes contact time and 90% (65 TCU) 150 minutes contact time. Then the plate area of 6 x 30 minutes the decrease in color levels that occurred was 16% (535 TCU) 30 minutes contact time, 16% (545 TCU) 60 minutes contact time, 49% (335 TCU) 90 minutes contact time, 52% (320 TCU) 120 minutes contact time and 79% (125 TCU) 150 minutes contact time.

The longest contact time showed the most decrease for each area variation and the most optimum was at an electrode plate area of 5 x 30 cm by 90% or 65 TCU. This research is in line with research conducted by Suwanto et al (2017) which states that the longer the contact in electrocoagulation processing, the greater the color reduction efficiency obtained[13].

The limitation of this study is that the researcher did not replace the electrode plates with new ones during the repetitions and did not immerse the electrode plates in a 5% H_2SO_4 solution, which serves to clean impurities or substances adhering to the electrode plates.

CONCLUSION

The conclusion is that there is an influence of the electrode plate size on the turbidity and color levels of peat water. There is no influence of the prolonged contact time on the turbidity levels, whereas there is an influence of the prolonged contact time on the color levels of peat water using the electrocoagulation method.

As a suggestion for further research, researchers may conduct experiments by combining the electrode plate size with different types of plates, such as iron or copper, to evaluate their effectiveness. Additionally, using smaller electrode plate sizes or lower voltages could be an alternative for treating the turbidity of peat water. When repeating the treatment, it is advisable to replace the electrode plates with new ones to prevent saturation, thus expecting to make a positive contribution to the development of the electrocoagulation method for peat water treatment.

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