American Journal of Engineering Research (AJER) 2025

American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN: 2320-0936
Volume-14, Issue-6, pp-60-64
www.ajer.org
Research Paper Open Access

Algae Control Study in Clean Water Treatment Plant Case Study at Water Treatment Plant (WTP)

[1)]Eko Purba Sarri, [2)]Purnawan, [3)]Yuli Pratiwi*
[1, 2, 3)]*Department of Environmental Engineering, AKPRIND University Indonesia*
**Corresponding Author*

ABSTRACT: *The NadraKrenceng Reservoir, with an area of 112 ha and a volume of ±5.4 million m3, is one of the sources of raw water for PT. KTI in Cilegon, Banten, Indonesia. This reservoir water has the potential to undergo eutrophication due to nutrient-rich agricultural and domestic waste (nitrates and orthophosphates). Eutrophication can trigger the blooming of phytoplankton, which is characterised by changes in the diversity index and the individual abundance index. This study aims to examine the effectiveness of disinfectants in algae control in the clean water treatment plant of PT. KTI.The effectiveness test of Sodium hypochlorite (NaOCl) and Calcium hypochlorite (chlorine) disinfectants was carried out at a concentration of 0.5; 1.0; 1.5; 2.0; 2.5; 3.0 ppm.The test results on the addition of sodium hypochlorite disinfectant with a concentration of 3.0 ppm reduced the lowest diversity index with the results at the intake down by 16.67%, Spilway 19.44% and Bottom outlet 11.86% with the individual abundance index with the results at the intake down by 43.6%, Spilway 43.08% and Bottom outlet 48.96%.For the addition of chlorine disinfectant, a concentration of 3.0 ppm lowered the algae diversity index with the results at the intake decreased by 24.78%, Spilway 22.68% and Bottom outlet 17.53% and the individual abundance index with the results at the intake decreased by 51.34%, Spilway 55.8% and Bottom outlet 52.96%.So the results of the test with a concentration of 3.0 ppm* calcium hypochlorite *were more effective in changing the diversity index and lowering the individual abundance index.*By using statistical tests, an analysis of the relationship and effect of disinfectant concentration (ppm) on biodiversity index was obtained through correlation coefficient (r) and determination (R^2), as well as regression model.

KEYWORDS: *Phytoplankton blooming, eutrophication, disinfectant, algae diversity index, individual abundance index.*

Date of Submission: 05-06-2025 Date of acceptance: 16-06-2025

I. INTRODUCTION

Water is an essential resource that affects almost every aspect of human life and other living things.In its management, innovative and collaborative solutions are needed to ensure the availability of water with adequate quality for current and future generations both for humans and other living things and to meet the increasing needs of industry as the population increases.The NadraKrenceng Reservoir, with an area of 112 ha and a volume of ± 5.4 million m3, is one of the sources of raw water for PT. KTI.The water quality of the reservoir is greatly influenced by the condition of the surrounding river water. Agricultural and domestic wastes with high concentrations can trigger eutrophication.Eutrophication can cause phytoplankton blooming, which can interfere with the filtration process at PT. KTI.The problem currently faced at the clean water treatment installation of PT KTI is during certain periods, especially in the peak dry season from July to September, the raw water sources in the NadraKrenceng Reservoir experience algal blooming, which interferes with the filtration process by causing clogging in the filters, resulting in a relatively short backwash duration for the filter media.

The abundance of plankton is influenced by the seasons. In the rainy season, nutrient concentrations tend to be lower than in dry seasons. Consequently, the density of plankton is also reduced.Uncontrolled algae growth can cause clogging in the filter of a clean water treatment plant, as the algae forms a thick, sticky layer.This condition interferes with water treatment and reduces operational efficiency. This layer will gradually clog the filter pores and hinder the flow of water in and out of the system, resulting in an increase in water pressure within the system. This blockage can also cause a decrease in flow rate, an increase in retention time, and even physical damage to the filter.Therefore, algae control is key in maintaining the performance of the WTP (Water Treatment Plant) filter and ensuring the availability of adequate clean water[1].

This study was conducted to assess the effectiveness of disinfectants in controlling algae growth in raw water from reservoirs to prevent eutrophication that induces phytoplankton blooms.Through laboratory testing, this study aims to identify the most effective and efficient types of disinfectants, as well as to develop recommendations for algae growth control methods to improve the efficiency of the overall water treatment system.The process of processing raw water into clean water aims to eliminate harmful substances (physical, biological, and chemical) so that water quality meets environmental health quality standards for water supply systems in accordance with PERMENKES RI No. 2 of 2023[2]. Clean water treatment plants are specifically designed to reduce pollutant levels in raw water to meet clean water standards[3]. Raw water collection is carried out through the Intake building[4]. In the process of processing raw water into clean water, PT KTI goes through several stages starting from the process of preparing and procuring raw water, pumping raw water into the intake building process of coagulation, flocculation, sedimentation, filtration, disinfection and distribution.

II. MATERIAL AND METHOD

This research uses equipment and materials including: beaker glass 500 mL, plankton net, light microscope, object cover glass, dropper, measuring pipette 10 mL, sedgwick rafter, tissue, akuades, formalin alcohol. This research examines the effects of calcium hypochlorite and sodium hypochlorite disinfectants on diversity index and individual abundance index in a quantitative laboratory experiment. The diversity index is measured using the Shannon-Wiener formula, and the individual abundance index is calculated based on the number of individuals of each algae species, with the aim of understanding the impact of disinfectants on algae communities in clean water treatment facilities.The calculation of algae diversity index uses the Shannon-Wiener index equation as follows[5].

$$H = -\sum_{i=0}^{1} p_i \ln p_i$$

Description:
H = Diversity index
pi = ni/N
ni = Number of individuals of type i
N = Total number of individuals

The calculation of algae abundance using SRC is as follows [6]:

$$N = n\,x\,\frac{1}{V_d}\,x\,\frac{V_t}{V_s}$$

Description:
N = Abundance (cells/L or individuals/L)
n = Number of observed cells/individuals
Vd = Volume of filtered water (L)
Vt = Volume of displaced water (ml)
Vs = Volume of water observed in the Sedgwick rafter (ml)

The research variables consist of: independent variable: Concentration of disinfectants: Calcium hypochlorite and Sodium hypochlorite; dependent variable: diversity and abundance index of algae. To determine the relationship between the two variables using simple linear regression statistical analysis.Nadra Krenceng Reservoir as a raw water source for PT. K TI at the Intake, Bottom Outlet, and Spillway locations, in the morning, afternoon, and evening.

III. RESULT AND DISCUSSION

The results of the color parameter measurements as shown in Table 1 indicate values above the threshold set by the PERMENKES no 2 tahun 2023. Factors that can cause this include the growth of algae of the Mougeutia and Microspora types, both types of algae belong to the group of green algae

(Chlorophyta).Chlorophyta, or green algae, can influence the color of water because they have a high content of chlorophyll pigments, especially chlorophyll a and b.These pigments absorb most of the red and blue light, and reflect green light, which gives the typical green color to the water when the algae population increases.Chlorophyta reproduce rapidly due to the availability of adequate nutrients (phosphates and nitrates). This can reduce the quality of raw water.

Table 1, results of the analysis of physical & chemical parameters above the threshold.

Parameter	Unit	Maximum standard	Analysis Results		
			Intake	Spillway	Botom Outlet
Color	Pt Co	50	133	272	120
Suspended Solids	mg/L	50	58	56	57
Copper (Cu)	mg/L	0,02	0,51	0,44	0,34
Phosphate (PO4)	mg/L	0,2	1,06	0,32	0,62
Dissolved Oxygen (DO)	mg/L	0,2	1,06	0,32	0,62

The measurement results of the Suspended Solid parameters, as stated in Table 1, show values above the threshold. Factors that may cause this include algal bodies, which are solid particles that are also measured in the Suspended Solid measurement.When the growth of algae increases, they produce a significant amount of biomass, and when the algae die or undergo decomposition, this biomass will fragment into small particles that increase the value of Suspended Solids.Algae can act as a nucleus for the aggregation of other particles such as clay, silt, or organic material and cause the formation of larger particles, thereby increasing the value of Suspended Solids.

The increase in Copper (Cu) levels, as shown in Table 1, caused by domestic and agricultural waste when water is in a eutrophic condition, coupled with the increase of other nutrients (like nitrogen and phosphorus), can enhance algal growth. There are types of algae that can show different responses to high levels of Copper (Cu) in water. Some studies have shown that Mougeotia has relatively high tolerance to heavy metals, including copper. This allows Mougeotia to survive and even reproduce in environments with copper levels above quality standards.

The increase in phosphate levels in reservoir water sourced from domestic and agricultural waste is a major factor that triggers excessive algae growth.Likewise, the increase in dissolved oxygen (DO) in water, as shown in Table 1, can be caused by the photosynthesis process carried out by algae. Under sufficient light conditions, suitable water temperatures, and availability of nutrients (nitrogen and phosphorus), oxygen production by algae will be very high. This oxygen is then released into the water, increasing the DO value. Algae, particularly from the Chlorophyta group, have a significant impact on the levels of dissolved oxygen (DO) in water. Chlorophyta generally have photosynthetic capabilities. High DO values can indicate the presence of algal blooming as algae produce oxygen during photosynthesis.

Table 2. The effect of sodium hypochlorite concentration on the diversity index of algae.

Concentration of sodium hypochlorite (mg/L)	**Index of algal diversity**		
	Intake	**Spillway**	**BottomOutlet**
0,0	2,34	2,16	1,94
0,5	2,31	2,12	1,96
1,0	2,26	2,05	1,89
1,5	2,20	2,00	1,93
2,0	2,12	1,97	1,90
2,5	2,06	1,89	1,82
3,0	1,95	1,74	1,71

Based on Table 2, it shows that the addition of sodium hypochlorite disinfectant at a concentration of 3.0 ppm reduces the lowest diversity index with results showing a decrease of 16.67% at the Intake, 19.44% at the Spillway, and 11.86% at the Bottom outlet.

Table 3. The effect of sodium hypochlorite concentration on individual abundance index

Location	Concentration of sodium hypochlorite (ppm)						
	0,0	0,5	1,0	1,5	2,0	2,5	3,0
Intake	711	654	589	532	484	446	401
Spillway	629	588	530	496	441	400	358
BottomOutlet	727	662	613	518	470	414	371

Based on Table 3, it shows that the addition of sodium hypochlorite disinfectant at a concentration of 3.0 ppm reduced the individual abundance index with results showing a decrease of 43.6% at the Intake, 43.08% at the Spilway, and 48.96% at the Bottom outlet. This reduction is caused by hypochlorite ions (OCl-) and free chlorine (Cl2) acting as algicidal agents. Hypochlorite ions, being strong oxidizers, oxidise important components in algae cells, leading to the death of the algae.

Table 4. Analysis of the effect of sodium hypochlorite concentration (X) on algae diversity index (Y)

Location	Correlationcoefficient value (r)	Regression Equation	Coefficient of Determination Value (R^2)
Intake	- 0,987	Y = 2,37 – 0.129 X	97.4%
Spillway	- 0,972	Y = 2,18 – 0.128 X	94.5%
Bottom Outlet	- 0,851	Y = 1.98 – 0.069 X	72.4%

Statistical analysis of the effect of sodium hypochlorite concentration (X) on the diversity index (Y), using simple linear regression.Based on the results in Table 4, it can be concluded that the concentration of Sodium hypochlorite (ppm) significantly affects the diversity index of both Intake, Spillway, and Bottom outlet. With a negative correlation value (-), it can be said that if the concentration of Sodium hypochlorite (ppm) is high, it decreases the diversity index of both intake, spillway, and bottom outlet. Based on the coefficient of determination (R2) value, the concentration of Sodium hypochlorite has the greatest influence on the diversity index of Intake.The concentration of sodium hypochlorite significantly affects the diversity index Intake, which is 97.4%.If the concentration of sodium hypochlorite is high, the diversity index of Intake will be low.If the concentration of sodium hypochlorite is low, then the diversity index of Intake will be high.

Table 5. The effect of calcium hypochlorite concentration on algae diversity index

Concentration of calcium hypochlorite (ppm)	Index of algal diversity		
	Intake	Spillway	BottomOutlet
0,0	2,34	2,16	1,94
0,5	2,26	2,05	1,93
1,0	2,19	1,96	1,80
1,5	2,12	1,93	1,90
2,0	2,03	1,85	1,83
2,5	1,94	1,74	1,73
3,0	1,76	1,67	1,60

Based on Table 5it shows that the addition of 3.0 ppm calcium hypochlorite disinfectant reduces the diversity index of algae, resulting in a decrease at the Intake by 24.78%, Spilway by 22.68%, and Bottom outlet by 17.53%.

Table 6. The effect of calcium hypochlorite concentration on the individual abundance index

Location	Concentration of calcium hypochlorite (ppm)						
	0,0	**0,5**	**1,0**	**1,5**	**2,0**	**2,5**	**3,0**
Intake	711	575	528	470	430	390	346
Spillway	629	532	461	426	362	312	278
BottomOutlet	727	635	572	457	426	386	342

Based on Table 6, it shows that the addition of calcium hypochlorite disinfectant at a concentration of 3.0 ppm reduces the individual abundance index with results at the Intake decreasing by 51.34%, Spilway 55.8%, and Bottom Outlet 52.96%.This decrease is caused by hypochlorite ions (OCl-) and free chlorine (Cl2) which act as algicidal agents. Hypochlorite ions, as strong oxidizers, oxidize important components in algae cells, leading to algae death.

Table 7. Analysis of the effect of calcium hypochlorite concentration (X) on algae diversity index (Y)

Location	Correlation coefficient value (r)	Regression Equation	Coefficient of Determination Value (R^2)
Intake	- 0,985	Y=2,36–0.181 X	97.1%
Spillway	- 0,994	Y=2.144– 0.15X	98.7%
Bottom Outlet	- 0,876	Y=1.96–0.09 X	76.7%

Statistical analysis of the effect of calcium hypochlorite concentration (X) on the diversity index (Y), using simple linear regression.Based on the results in Table 7, it can be concluded that the concentration of calcium hypochlorite (ppm) significantly affects the algal diversity index in both Intake, Spillway, and Bottom Outlet. With a negative correlation value (-), it can be stated that a high concentration of calcium hypochlorite (ppm) decreases the algal diversity index in both Intake, Spillway, and Bottom Outlet. Based on the coefficient of determination (R2), the concentration of calcium hypochlorite has the most significant effect on the diversity index at the Spilway.

Table 8. Addition of disinfectant doses

	Concentration of sodium hypochlorite (mg/L)		Concentration of calcium hypochlorite (mg/L)	
	0,00	**3,00**	**0,00**	**3,00**
Diversity index				
Intake	2,34	1,95	2,34	1,76
Spillway	2,16	1,74	2,16	1,67
Bottomoutlet	1,94	1,71	1,94	1,6
Individual abundance index				
Intake	711	401	711	346
Spillway	629	358	629	278
BottomOutlet	727	371	727	342

The analysis results in Table 8, show that the use of sodium hypochlorite and calcium hypochlorite at a concentration of 3 ppm, according to the calculation of the Shannon-Wiener index, results in a diversity index indicating a mild level of pollution, as well as a low individual abundance index. These results will serve as a basis for determining the optimal disinfectant dose for controlling algae in the NadraKrenceng reservoir of PT. KTI.

IV. CONCLUSION

Based on the results of the analysis and discussion above, the method to prevent clogging in filters at the Water Treatment Plant (WTP) can be done by adding disinfectants. The addition of sodium hypochlorite and calcium hypochlorite has been proven effective in reducing the number of individual algae (individual abundance index) as well as altering the diversity index. The use of calcium hypochlorite at a concentration of 3.00 ppm is more effective compared to sodium hypochlorite in reducing the individual abundance index and the diversity index.

REFERENCES

[1] J.-K. S. and J. L. Joh Gyeongje, Yang Soon Choi, “Problematic alga in the sedimentation and filtration process of water treatment plants,” *J. Water Supply Res. Technol. AQUA*, pp. 219–229, 2011.

[2] Kementerian Kesehatan, “Permenkes No. 2 Tahun 2023,” *Kemenkes Republik Indones.*, no. 55, pp. 1–175, 2023.

[3] G. A. Nurbaiti, T. A. Rachmanto, and A. U. Farahdiba, “Life Cycle Assessment (Lca) Sebagai Metode Kajian Dampak Lingkungan Proses Pengolahan Air Bersih Di Instalasi Pengolahan Air (Ipa) Siwalanpanji,” *Envirous*, vol. 2, no. 2, pp. 21–27, 2023, doi: 10.33005/envirous.v2i2.102.

[4] M. A. Setyaninditha, T. Kadri, and W. Sejati, “Studi Perencanaan Bangunan Intake Saluran Pembawa Air Baku Karian Barat,” *Pros. Semin. Intelekt. Muda*, vol. 2, no. 2, pp. 52–57, 2021, doi: 10.25105/psia.v2i2.10312.

[5] S. Dewi, Indrayani, and Salwiyah, “Kelimpahan dan Distribusi Spasial Fitoplankton di Perairan Danau Tailaronto’oge Kapota Kecamatan Wangi-Wangi Selatan Kabupaten Wakatobi,” *J. Manaj. Sumber Daya Perair.*, vol. 5, no. 2, pp. 98–105, 2020.

[6] APHA (American Public Health Association)., *Standard Methods for the Examination of Water and Wastewater*, 17th Editi. New York.: American Public Health Asociation Inc, 2005.