Available online at: http://proceeding.rsfpress.com/index.php/ebs/index
LPPM UPN "Veteran" Yogyakarta Conference Series
Proceeding on Economic and Business Series (EBS)
Volume 1 Number 1 (2020): 205-213

Analysis of Water Plant Utilization using Organic Substrate Combinations to Manage COD BOD Turbidity in Pit Lake

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Abstract

Because of changing the physicochemical conditions of the water, the pit lake of the quarry feldspar has the potential to pollute the environment. The parameter values of COD, BOD, and turbidity in contaminated mine water are not according to quality standards. This research is water management with plant media in pit lake using a passive remediation method. The purpose of this study was to determine the ability to use Eichornia sp and Thypa Angustifolia plants using a combination of organic substrates in managing turbidity, COD, and BOD in post-mining feldspar water. This research is an experimental method by making a research reactor. There were six tubs with different treatments in each tub, treatment one as control, namely water, and MaterialMaterial in the pit lake; treatment 2 added organic substrate, treatment three added Thypa Angustifolia plants, treatment 4 added Thypa Angustifolia plants and organic substrate, treatment five added plants Eichornia sp, treatment six was added with Eichornia sp plants and organic substrate. The amount of water in each treatment is 350 liters, the pit lake material is 20 kg, and the organic substrate is 4 kg and the residence time is 15 days. Sampling was carried out every three consecutive days. The results showed that Thypa Angustifolia plants with a combination of organic substrates were able to reduce the turbidity value, while Eichornia sp plants using a combination of organic substrates could efficiently reduce COD and BOD values.

Keywords: Pit lake, Plants, Organic Substrate, Turbidity, COD, BOD

I. INTRODUCTION

At the end of the mining activity, it resulted in ex-mine pits and contaminated water. My water has the potential to pollute the environment and cannot be utilized (Low *et al.*, 2016). The ex-mining hole gradually filled with water resulting in the formation of a pit lake. Pit lake is a post-mining feature where open holes are filled with groundwater and runoff (Bargawa *et al.,* 2018; Bargawa, 2017). Like natural lakes, pit lakes also have the potential for multiple uses. Pit lakes are usually used during post-mining by considering various related aspects such as post-mining plans, the effect of lowering the mine surface, and water quality. At the completion of the mining operation phase, a detailed technical study of various aspects of the pit lake is required by considering

morphometry, geology, hydrology, water quality, filling rate, and biology (Soni *et al*., 2014). In an effort to utilize wastewater from the pit lake, efforts are needed to manage water quality. The pit lake water is categorized as good if the water can be used according to its utilization. Water conditions are maintained according to quality standards so that they are not contaminated by materials or particles or other substances so that water quality does not support the life of aquatic biota (Bargawa, 2017).

Some of the water quality parameters from the pit lake are turbidity, BOD (biological oxygen dissolved), and COD (chemical oxygen demand) parameters. Based on the BOD and COD values, the biological activity in the pit lake water was evaluated on the quality status of the pit lake. This condition becomes a reference for pit lake management in determining the pit lake handling method. Good management makes the pit lake function more useful (Pal *et al.,* 2013). One of the treatments for pit lake water is the passive remediation method or phytoremediation (Migaszewski *et al*., 2018).

Phytoremediation is the use of plants to remove pollutants from contaminated soil or waters (Muthusaravanan *et al.,* 2018). This method is easy to apply, efficient, inexpensive, and environmentally friendly. Nowadays, many plants have the ability to remediate polluted environments. Examples of plants as phytoremediators are Eichornia sp and Thypa Angustifolia (Sricoth *et al.,* 2018). Meanwhile, the organic substrate increases the pH value, which is contributed by the alkalinity content of the compost (Newcombe & Brennan, 2010). This is the background of the aim of the study, namely, to analyze the use of Eichornia sp and Thypa Angustifolia plants with a combination of organic substrates to manage turbidity, COD, and BOD.

II. LITERATURE REVIEW

The purpose of this study was to analyze the ability of Eichornia sp and Thypa Angustifolia plants combined with organic substrates to manage turbidity, COD, and BOD in pit lake feldspar. Pit lake is a basin that is deliberately constructed to accommodate wastewater from mining production activities and other waste activities (McCullough & Vandenberg, 2020). The water condition in this pit lake is acidic, a result of the formation of acid mine drainage from the mine production process. Acid mining water is formed due to the oxidation of several iron and metal sulfides minerals such as FeS2 (pyrite), CuS (chalco-cite), CuS (covellite), CuFeS2 (chalcopyrite), and FeAsS2 (arsenopyrite). Based on this acidic water content, the pH value of pit lake water is low (Ashraf *et al.,* 2010). The low pH will indirectly affect the BOD and COD values of pit lake water significantly.

Turbidity is basically caused by the presence of colloids, organic substances, microorganisms, mud, clay, and floating objects which do not settle immediately. Turbid water is difficult to disinfect because the microbes are protected by these suspended substances. This is dangerous for health if the microbe is pathogenic (Mohammed, 2015). The level of water turbidity can be determined through laboratory tests using the turbidimeter method. COD or Chemical Oxygen Demand is the amount of oxygen needed to break down all organic MaterialMaterial contained in the water (Boyle, 1997). All organic matter will be broken down. This COD measurement uses a strong oxidizer of potassium bichromate, under acidic and hot conditions, with silver sulfate as a catalyst. All kinds of organic materials, which are easy to decompose and which are complex and difficult to decompose, will be oxidized (Geerdink, 2017).

Thus, the difference in value between COD and BOD provides an overview of the amount of organic matter that is difficult to decompose in the waters. COD value describes the total amount of organic matter. BOD or Biochemical Oxygen Demand is the amount of dissolved oxygen needed by microorganisms (usually bacteria) to break down or decompose organic matter under aerobic conditions (Penn *et al.,* 2006). BOD as a measure of the amount of oxygen is used for the microbial population contained in the waters in response to the entry of biodegradable organic matter. The definition of BOD not only states the amount of oxygen but also states the amount of biodegradable organic matter in the waters (Jouanneau *et al.,* 2014).

The analysis of pit lake water in this study is based on the results of artificial experiments in a system, namely phytoremediation. Phytoremediation is a system in which certain plants collaborate with microorganisms in the media (soil, coral, and water), which can change contaminants (pollutants or pollutants) to be less or less dangerous and even become economically useful materials (Favas *et al*., 2014). Typha angustifolia and Eichornia sp. It can be found around natural wetlands in Indonesia. Type Angustifolia and Eichornia sp have strong resistance and survive. This plant has very thick root fibers so that the absorption of pollutants for the nutrients needed is relatively large (Chatterjee *et al.,* 2013). The mechanism of organic substrates in reducing dissolved metals and increasing pH is by stimulating the growth of sulfate-reducing bacteria (BPS). BPS will release electrons to bind metals and convert metals in the form of disulfide deposits and become a source of energy for sulfate-reducing bacteria (Zagury *et al.*, 2006). The organic substrate causes the growth of sulfate-reducing bacteria, which work to neutralize the pH of the water.

III. RESEARCH METHODOLOGY

The research method is an experimental method with a laboratory scale. The experimental method is a research method to determine the effect of treatment on research subjects. The experimental method was to make a reactor in the form of 6 research tanks using Eichornia sp., Thypa Angustifolia plants, and organic substrates. The reactor is filled with ex-mine feldspar pit water and given different treatments to find the management of ex-mine pit water.

In this research, it is necessary to prepare acclimatized Eichornia sp and Thypa Angustifolia plants. Plant acclimatization aims to adjust to new environmental conditions to start the wastewater treatment process (Zawani, 2013). Then prepared 20 kg of water and pit lake material and 4 kg of the organic substrate.

After all the materials are available, the reactor is made. The reactor in this experiment is in the form of an artificial tub that has a size of 100 x 100 x 50 cm and a volume of 350 L of water. Each reactor bath receives different treatments consisting of treatment 1 to treatment 6 (see Table 1).

Table 1. Treatment Series

Treatment Series	Treatment
Treatment 1	Water from pit lake + Pit lake material
Treatment 2	Water from pit lake + Pit lake material + 4kg of organic substrate
Treatment 3	Water from pit lake + Pit lake material + 25 Clumps of Thypa Angustifolia Plants
Treatment 4	Water from pit lake + MaterialMaterial from pit lake + 25 Clumps of

	Thypa Angustifolia Plants + 4kg of Organic Substrate.
Treatment 5	Water from pit lake + Pit lake material + 25 Clumps of Eichornia sp
Treatment 6	Water from pit lake + Pit lake material + 25 Clumps of Eichornia sp + 4kg organic substrate.

To evaluate the degree of reduction in the test parameters, the researcher used the length of residence variable to test the effectiveness of the management of turbidity, COD, and BOD in the reactor. Sampling activities were carried out in stages every three days of treatment to 15 days of treatment. This is based on several previous studies which stated that plant residence time affects water quality (Wilson *et al*., 2007). The water parameters from the reactor test analyzed in this study were turbidity, COD, and BOD. The data taken in this study is qualitative data derived from the results of the water sample test based on the results of the reactor of each treatment.

IV. FINDING AND DISCUSSION

The water in the pit lake feldspar is polluted water, which has not been subjected to special handling. The pit lake water is polluted as a result of mining activities that produce harmful elements for the environment. Before applying treatment to pit lake water, the activity is to first test the ex-mining lake water. Table 2 shows the results of the pit lake water quality test, which consists of three test parameters, namely turbidity, COD, and BOD.

Table.2 Initial Pit Lake Water Test Results

No	Parameter Value		
	Turbidity (NTU)	COD (mg/l)	BOD (mg/l)
1	2800	247	52.4

The results of the pit lake water test showed that the turbidity, COD, and BOD values were very high, so they needed special handling. The test results are sampling day 0 before entering the treatment. On the second day, it rained on the reactor, causing a correction to the reactor. On the 3rd day, there was a change in the turbidity content, COD, and BOD.

Pit lake water treatment ranged from 3 days to 15 days of treatment. Testing of water turbidity parameters for each treatment used the Standard of SNI 69-6989.25-2005. The number of test samples was 30 samples consisting of 6 treatments for 15 days. Table 3 shows the value of the treatment results of turbidity parameters.

Table.3 Value of Treatment Results of Turbidity Parameters (NTU)

Treatment Series	Turbidity value on treatment day (NTU)				
	3TD	6TD	9TD	12TD	15TD
Treatment 1	1,072	1,240	1,465	1,465	1,262
Treatment 2	705	589	562	383	392

Treatment 3	635	809	809	807	824
Treatment 4	404	99	63.5	35	19.5
Treatment 5	404	722	818	807.5	835
Treatment 6	697	665	538	404	219.5

Explanation: NTU = Nephelometric Turbidity Unit , TD = Treatment Day

In all treatments showed different results, Thypa Angustifolia plants using a combination of organic substrates efficiently reduced the turbidity value to 19.5 NTU. The decrease in the turbidity value was also caused by the Thypa Angustifolia plant having fiber roots. The floating colloids in the water stick to the roots. The number of colloids attached to these roots was caused by the higher plant biomass and the increasing number of root fibers. Meanwhile, Eichornia sp plants without using organic substrates actually increased the turbidity level to 835 NTU. This shows that the Thypa Angustifolia plant using a combination of organic substrates is able to manage the turbidity in pit lake feldspar water (see Table 4).

Table.4 Effectiveness of Increase / Decrease in Turbidity Value

Treatment Series	Percentage Effectiveness Increase / Decrease (+/-) Turbidity Value (NTU)
Treatment 1	+15%
Treatment 2	-44%
Treatment 3	+23%
Treatment 4	-95%
Treatment 5	+52%
Treatment 6	-69%

Based on the results of the treatment sample test showed that the percentage of effectiveness of the largest reduction in turbidity value was treatment four, which was a combination of Thypa Angustifolia plants and organic substrates. At the same time, the effectiveness of increasing turbidity was in treatment 5, namely Eichornia sp plants without using organic substrates. Table 4 above also shows that organic substrates play an important role in reducing turbidity in pit lake water.

The testing of COD parameters uses the SNI 6989.2-2019 standard. Table 5 shows the test results of 30 samples consisting of 6 treatments for 15 days.

Table.5 Treatment Results of COD Parameter (mg/l)

Treatment Series	COD value on treatment day (mg/l)				
	3TD	6TD	9TD	12TD	15TD
Treatment 1	30.7	30.7	46.1	47.6	56.5
Treatment 2	94.1	94.1	86.1	82.6	85.3
Treatment 3	29.1	86.8	37.2	39.1	53.4
Treatment 4	86.5	94.5	88.3	93	91.8

Treatment 5	19.5	32.2	43.8	60.3	41.1
Treatment 6	106	88.8	89.9	89.9	93.8

Explanation: TD = Treatment Day

The highest COD value was treatment six, starting from 106 mg / l, treatment 2 was 94.1 mg/l, and treatment 4 was 86.5 mg/l. Treating organic substrates causes high COD values. The occurrence of high COD value fluctuations indicates that microorganisms die due to the high organic content in the substrate. The organic matter does not decompose, whereas when the COD value decreases, it indicates that the microorganism is alive and begins to degrade the organic matter in the substrate.

Table.6 Effectiveness of Increase/Decrease of COD Value

Treatment Series	Percentage of Increase / Decrease (+/-) COD Value
Treatment 1	+46%
Treatment 2	-9%
Treatment 3	+46%
Treatment 4	+6%
Treatment 5	+53%
Treatment 6	-12%

The results of the treatment sample test show that the percentage of the effectiveness of impairment The highest COD value was treatment six, which was a combination of Eichornia sp and organic substrate. At the same time, the effectiveness of increasing COD value was in treatment 5, namely Eichornia sp plants without using organic substrates. Table 6 above also shows that three days after the organic substrate treatment has increased the COD value. Organic substrate plays a role in increasing COD value directly.

Testing parameters BOD water treatment using the standard SNI 6989.72-2009. The sample tested consisted of 30 samples consisting of 6 treatments for 15 days. Table 7 shows the value of BOD parameter treatment results.

Table.7 Value of BOD Parameter Treatment Results

Treatment Series	BOD value on treatment day (mg/l)				
	3TD	6TD	9TD	12TD	15TD
Treatment 1	4	3.3	4.5	4.6	5.7
Treatment 2	9.8	9.4	10.3	9.7	9.2
Treatment 3	3.1	9	3.8	3.9	5.7
Treatment 4	9.6	10.8	8.9	9.7	10
Treatment 5	2	3.8	4.9	6	4.9
Treatment 6	12.9	11.9	9.2	9.5	10.5

Explanation: TD = Treatment Day

In line with the COD value, the highest BOD value in treatment 6 was 12.9 mg/l, treatment 2 was 9.8 mg/l, and treatment 4 was 9.6 mg/l. The high BOD value was caused by the bacteria content in the organic substrate, Eichornia sp, and Thypa Angustifolia. These aquatic plants function to provide oxygen in the root zone of plants and increase the surface area for the growth of microorganisms in the root zone.

Table.8 Effectiveness of Increase/Decrease of BOD Value

Treatment Series	Percentage Increase / Decrease (+/-) BOD Value (mg / l)
Treatment 1	+30%
Treatment 2	-6%
Treatment 3	+46%
Treatment 4	+4%
Treatment 5	+59%
Treatment 6	-19%

The results of the treatment sample test showed that the largest percentage of the effectiveness of the reduction in BOD value was in treatment 6 of 19%. Treatment 6 was a combination of Eichornia sp and organic substrate. In the reactor, a filtration process occurs by the media and the roots of the Eichornia sp. This process occurs due to the ability of the media particles and the root system to form a filter that holds the solid particles in the wastewater. Meanwhile, the effectiveness of increasing the BOD value (59%) occurred in treatment 5. This treatment consisted of Eichornia sp plants without using organic substrates. Table 8 shows the increase in BOD value on the third day of treatment using plants with organic substrates.

V. CONCLUSION AND FURTHER RESEARCH

Based on the above discussion, it can be concluded:

1. Thypa Angustifolia using a combination of organic substrates can reduce the turbidity value so that Thypa Angustifolia plants plus organic substrates are able to manage the turbidity of feldspar pit lake water.
2. Eichornia sp plants plus organic substrate have a better ability to reduce COD and BOD values so that Eichornia sp plants are able to manage water clarity and reduce the content of microorganisms in feldspar pit lakes water.

The findings of this study are quite useful, but this study only discusses the parameters of COD, BOD, and Turbidity so that it does not cover the overall aspects of water quality. Suggestions for further research are to analyze TSS, pH, and dissolved metal parameters in pit lake water management.

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