Effect of Aeration Injection Technology Application on Dissolved Oxygen in Floating Net Cages in Cengklik Reservoir Waters, Boyolali Regency

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Abstract. Eutrophication in the Cengklik Reservoir has become a problem that occurs every year which results in the faster growth of water hyacinth (Eichhornia crassipes) around the reservoir waters. This occurs due to increased utilization of the reservoir causing a large amount of waste input into the waters, one of which is from floating net cages aquaculture. Based on the analysis of satellite imagery in 2022, there are approximately 1.355 floating net cage units. The application of intensive aquaculture is considered not optimal because only 70% of the feed is eaten by fish and the rest settles to the bottom of the water. Therefore, there is also an increase in oxygen consumption by fish and microbes for the decomposition process of organic matter.

This study aims to increase dissolved oxygen in the waters using injection aeration technology in floating net cages by pumping microbubbles with a diameter of 1 m–1 mm into the water. Aeration was carried out in one floating net cage with a size of 6 m × 6 m for 8 h with 3 stages of dissolved oxygen testing, namely 06.00 (before aeration), 10.00 (after 4 h aeration) and 14.00 (final aeration). The results showed that aeration injection in floating net cages could increase dissolved oxygen 42–58% higher than non-aerated cages. In addition, aeration also increases the appetite of fish in consuming feed. Aeration injection technology can be recommended to improve water quality in Cengklik Reservoir, especially when oxygen is low in the morning.

Keywords: Aeration Injection · Cengklik Reservoir · Eutrophication · Floating Net Cage

1 Introduction

Eutrophication in the Cengklik Reservoir has become a problem that occurs every year. This is indicated by the growth of water hyacinth (Eichhornia crassipes) in the water body as shown in Fig. 1. This excess water hyacinth on the water surface occurs due

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to increased utilization of the reservoir causing a large amount of waste input into the waters. One example is the increase in aquaculture activities using floating net cages in the Cengklik Reservoir. Based on analysis from satellite imagery in 2022, there are approximately 1,355 cages in the Cengklik Reservoir. The fish cultured is dominated by red tilapia.

In general, floating net cages apply an intensive aquaculture systems, but this is considered not optimal. [1] explained that only 70% of the total feed eaten by fish and the rest is released in water bodies, then settles to the bottom of the waters. In addition, the results of fish metabolism produce waste which is a source of pollution. In general, fish feed contains carbohydrates, protein, and fat with a composition of 24–26% nitrogen and 0.96% phosphate which has the potential to increase trophic level of water [2]. In addition, aquaculture activities using floating net cages in reservoir also causes an increase in oxygen consumption by fish and microbes for the decomposition process of organic matter. Increased oxygen consumption that is not balanced with oxygen production in the waters can cause a decrease in water quality [3].

Currently, cage farmers in the Cengklik Reservoir use the propellers on the boats for aeration of the cages, but this is only done in emergencies, for example when the dissolved oxygen in the water is low and there are changes in the weather. Currently cage cultivators in the Cengklik Reservoir use propellers on boats for cage aeration, but this is only done in emergencies, for example when dissolved oxygen levels in the water are low and weather changes occur. Aeration with this method produces larger bubbles that break easily, so the rate of water oxidation is less effective.

Based on these problems, this study aims to increase dissolved oxygen in the water using injection aeration technology in floating net cage This technology is a method of aeration by pumping air into the waters, so the addition of dissolved oxygen increases the decomposition of organic waste. The aeration injection technology uses an aerator that produces micro-sized air bubbles called microbubbles. Microbubbles refer to bubbles that have a diameter between 1 m and 1 mm. Microbubbles can increase the oxidation rate more than conventional aeration units because their very small bubble size facilitates

Fig. 1. Water hyacinth growth due to eutrophication of Cengklik Reservoir.

greater mass transfer than normal air bubbles [4]. This research is expected to support sustainable reservoir management based on the Sustainable Development Goals (SDGs) program in goals 6 (Clean and Water Sanitation) and 14 (Life Below Water).

2 Methods

This research was carried out on 5, 7, and 9 September 2022 in the floating net cage area in the Cengklik Reservoir with location coordinates 7°30′47.5"S 110°43′51.6"E and is shown in Fig. 2. Aeration injection technology is installed in red tilapia floating net cage with a size of 6x6 meters for 8 h, from 06.00 - 14.00 WIB. The water quality parameter is the focused on dissolved oxygen. Dissolved oxygen measurement was carried out using the Winkler method at three stages of aeration, namely 06.00 (before aeration), 10.00 (after 4 h aeration), and 14.00 (final aeration). Dissolved oxygen measurement was carried out by taking water samples on 4 sides of floating net cage waters (TA-B, T2, T3, T4) and 12 m from cage area as control (Tcontrol). In addition, this study also observed changes in dissolved oxygen at the point of aeration injection technology (TA-B) based on depth, namely surface (TA) and bottom (TB). Water sampling points based on distance and depth are described in Fig. 3. Microbubble aerator use a pump with output discharge of 4000 L/hour and electrical energy source of 110 W from the Prost 4700 E mobile generator.

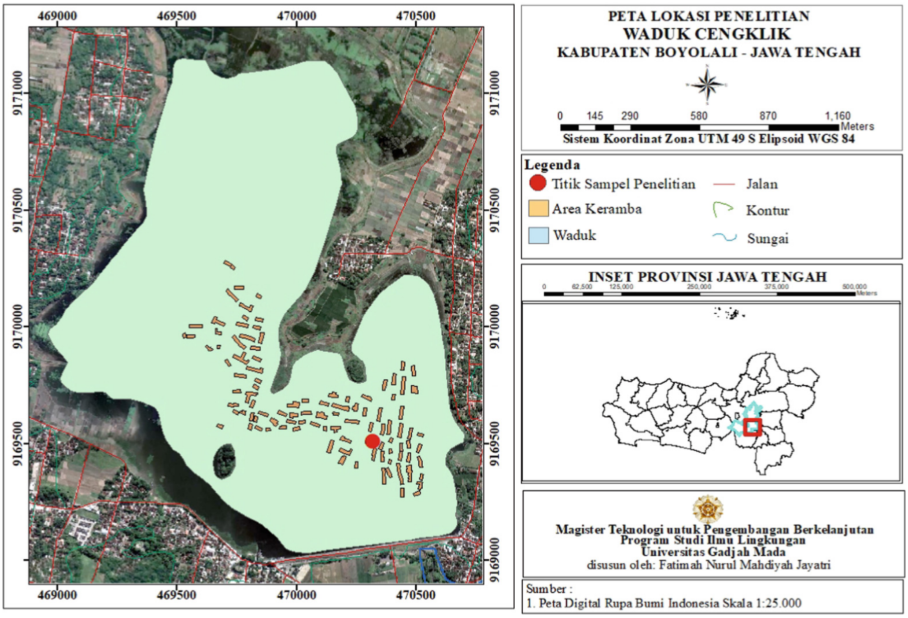

Fig. 2. Location of Floating Net Cage Observation Point.

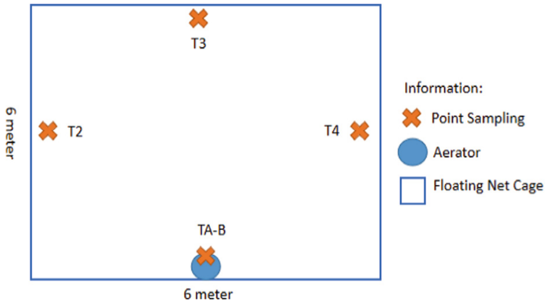

Fig. 3. Water Sampling Point.

3 Result and Discussions

The dissolved oxygen in aerated floating net cages and control cages (unaerated) is presented in Fig. 4.

The dissolved oxygen in floating net cages before aeration (06.00 WIB) ranged from 3.2–3.6 mg/L. This value is very low and below the water quality standard according

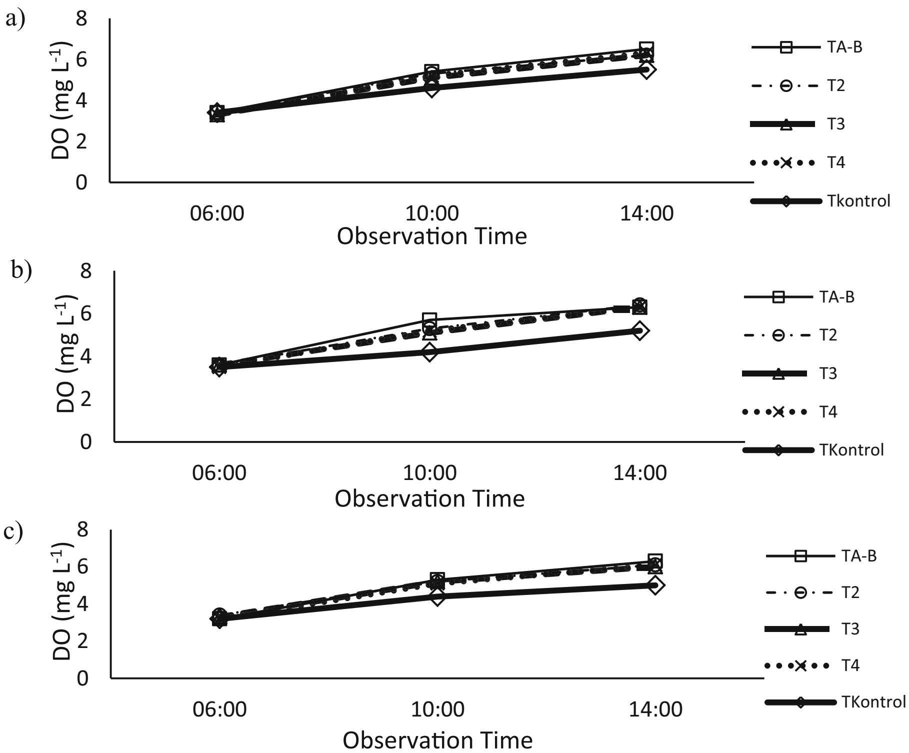

Fig. 4. Dissolved Oxygen in Aerated and Unaerated Cage (a) observation 1, (b) observation 2, and (c) observation 3.

to Government Regulation No. 22 of 2021, which state a good dissolved oxygen for reservoir waters must be more than 4 mg/L. Waters with dissolved oxygen below 4 mg/L are not suitable for aquaculture. This is following the explanation [5] that the optimum dissolved oxygen value for fish culture ranges from 5–9 mg/L. Therefore, the aeration to the floating net cage can help increase oxygen. After injection of aeration for 8 h, the aerated cages had dissolved oxygen of 5.9–6.5 mg/L, while the unaerated cages only experienced an increase in oxygen up to 5–5.5 mg/L. It means that the aerated cages had a higher increase in oxygen levels ranging from 42–58% than the unaerated cages.

Aeration injection can increase dissolved oxygen and create aerobic conditions. This condition triggers the decomposition of organic matter through ammonification and nitrification processes, namely the oxidation of ammonia to nitrite and nitrite to nitrate. This nitrogen reform can reduce the toxicity level of the waters due to the reduced ammonia content in the waters [6]. However, the decomposition process requires a very long aeration time so further research is needed.

Dissolved oxygen also have a direct effect on the pH parameters. This statement is explained by [7] that biological activity of respiration requires dissolved oxygen and produces CO_2 which causes the decrease of pH. In aerated cages pH tended to increase after 8 h with a range of 7.78–8.12, which became more alkaline. However, in unaerated

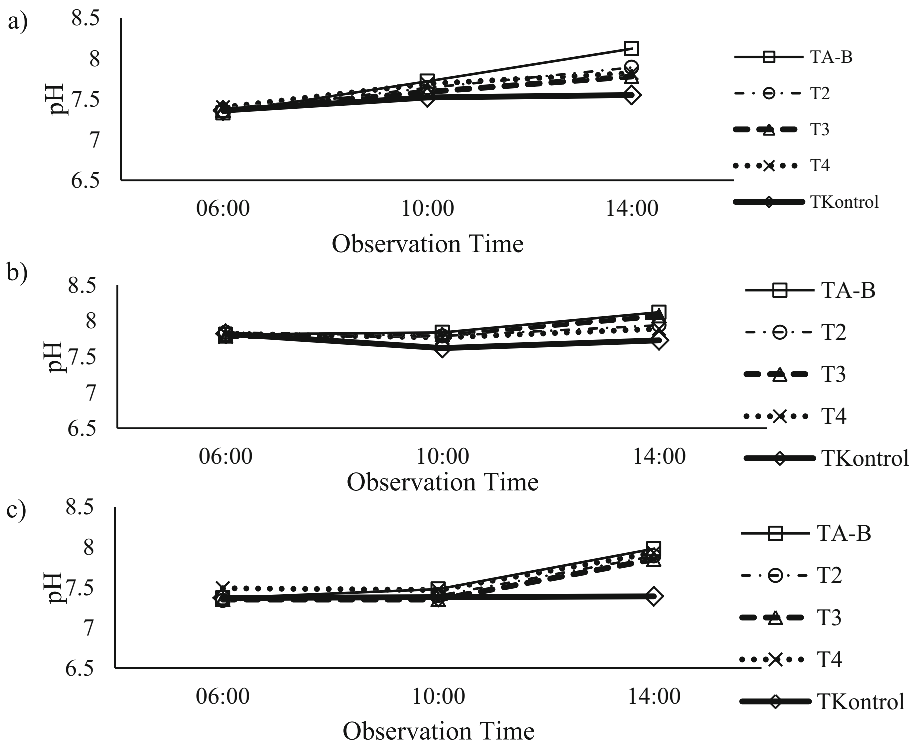

Fig. 5. pH in Aerated and Unaerated Cage (a) observation 1, (b) observation 2, and (c) observation 3.

cages, the increase of pH was not significant compared to aerated cages with a range of 7.39–7.55. The ideal pH for aquaculture is 6.7–8.6 [5], so the pH in the Cengklik Reservoir waters is still categorized as suitable for aquaculture.

Figure 5 shows a slight decrease in the pH at 10.00 and 14,00, this is because farmers fed at 09.30, while on the first day farmers fed at 11.00. The difference in feeding time by farmers is based on the suitability of their work free time. The decrease in pH that occurs is explained by [8] that fish feed flour tends to reduce the pH become acidic, due to the decomposition process of organic substances. [9] explained that in waters that have a low pH, the dissolved oxygen content decreases, resulting in increased respiratory activity and reduced appetite. This is in line with the results which showing the differences between fish behavior in aerated and unaerated cages. In aerated cages, more fish are below the surface water and schooling near the aerator. While in unaerated cages, fish tend to school near the surface waters to take air. In addition, fish in aerated cages had a higher appetite to consume feed compared to fish in unaerated cages.

4 Conclusion

Injection aeration in floating net cage is able to increase dissolved oxygen of 42–58% higher than the cages that were not aerated. In addition, aeration also increases the fish's appetite to consume feed. The waters of the Cengklik Reservoir have a fairly low dissolved oxygen level in the morning, so that the application of aeration injection technology can be recommended to improve water quality. The development of this injection aeration technology also needs to be further adapted to the conditions in the Cengklik Reservoir.

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