Vertical Profile of Oxygen in the Lacustrine and Transition Zones, Koto Panjang Reservoir, Riau Province

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ABSTRACT

Oxygen concentration in the water is significantly affected by environmental condition. In this research, oxygen concentration in the lacustrine and transition zones of the Koto Panjang reservoir is studied from June to September 2013, it was coincidence with the minimum water level. A post facto survey method was applied and there were 4 sampling sites, in the Lacustrine 1 (L1), Lakustrine 2 (L2), Transition 1 (T1) and Transition 2 (T2). The vertical sampling points were decided based on the brightness of the water (in the surface, 3m, 6 m, 12 m depth and above the sediment in the bottom). The number of vertical sampling sites was depend on the depth of the water. Results shown that the DO concentration in the surface of the lacustrine zone was 6.14 to 8.26 mg/l and in the transition zone was 7.38-8.6 mg/l. In the bottom of the lacustrine zone was 0 to 0.41 mg/l and that of the transition zone was 0.41-3.29 mg/l. The vertical profile of the Dissolved Oxygen in both stations shown that the highest decrement rate of the oxygen occur from 2 secchi depth (3 m) to 4 secchi depth (6 m). In the lacustrine zone, oxygen concentration drop into critical level (< 2 mg/l) in 12 m depth and in this research, the oxic depth was 7.0 m in L1 and 8.0 m in L2. Whereas in T1: 6.2 m and 8.0 m in T2. During the minimum water level, the oxic depth decrease due to decrement of water volume that lead into increment of organic matter loaded.

Keywords: Koto Panjang dam, lacustrine, transition, oxygen.

INTRODUCTION

There is 2.1 million hectares of aquatic area, especially dam area in Indonesia that can be used for developing the floating fish caged aquaculture (Kartamihardja, 1998). The Koto Panjang dam is one of dam in Riau that was constructed from 1992 to 1997. The area of the Koto Panjang was 12,400 hectares, with 73-85 m depth, and 96 m height of water gate. The water of the dam is flown from the Kampar and Batang Mahat Rivers (PLN, 2002).

In the Koto Panjang dam, there are numbers of fish floating cages aquaculture. The average size of the cage is 4 m x 4 m and 6 m x 6 m. Total area covered by the cage was 17.688 m^2 and most of the cage was placedin the area close to the water gate (355 cages). In the Koto Panjang dam, the fish culture is intensively conducted as the fish is kept in high density and they fed with nutritious commersial fish pellet. So far, the aquaculture in the Koto Panjang dam was succed, however organic meterial waste produced by the aquaculture activities seem to affect the ecological condition of the dam. Mc. Donald *et al.* (1996) stated that around 30% of feed provided might not be consumed and 25-30% of the consumed feed might be discharged in the form of fecal pellets. Food remains and fecal pellets flown to the water may serve as organic material resources that enriched the water and increase the fertility of the water in general.Philips *et al*., (1993) and Boyd (1999) stated that the aquaculture activities increase the nutrient content in the water.

The presence of organic materials in the water may affects the oxygen concentration. As the oxygen content is very important for supporting the biochemical process in the water, any changing in the oxygen concentration may affects the biological and biochemical reactions in the water in general and thus the oxygen concentration is a boundary factor that affect the ability of water in receiving organic materials loaded (Umaly and Cuvin, 1988).

In the water, the oxygen concentration is fluctuated. The oxygen may enter the water as there is diffusion process between water and atmosphere, photosynthesis of phytoplankton living in the water, wind and the entrance of dissolved oxygen. The dissolved oxygen was then used by microorganisms as well as the aquatic organism to conduct their life support activities such asaerobic decomposition process and respiration.

In the dam, carrying capacity of the dam is depended on the Dissolved Oxygen concentration in the epylimnion and hypolimnionlayers. The oxygen concentration is fluctuated asit is affected by aeration and photosynthetic proccess, the oxygen content in the hypolimnion layer. In the hypolimnion layer, however, the oxygen present was preserved, and only be used when there is stagnation period. It predicted that decrement of oxygen concentration in the hypolimnion areas may be able to cause mass death of fish. As there is no information on the oxygen content in the distribution pattern of Dissolved Oxygen in g dam.

MATERIALS AND METHODS

In this research, sampling was conducted in 2 stations, in the lacustrine and in the transition areas of the Koto Panjang dam, from June to September 2013. There were 2 sampling sites in each stations , namely L1, L2 and T1, T2 (Figure 1). The L1 was located around the water gate (00.16.51,1 Nand 100.51.16,9 E); L2 was in Tanjung Alai Village (00.16.50,3Nand 100.46.37,8 E), T1 was in the river mouth of the Kampar River (00.16.28,3 N and 100.48.22,8 E) andT2 was in the rivermouth of the Batang Mahat River (00.20.55,7 Nand 100.43.31,8 E).

In each sampling site, water sampleswere taken from 3 different depth, there are 3m, 6m, 12 m depth and in thebottom of the dam. The depth of each sampling point was decided based on the transparency of the water and the number of sampling point/ sampling site was depended on the depth of the water. Sampling was conducted once / three weeks period.

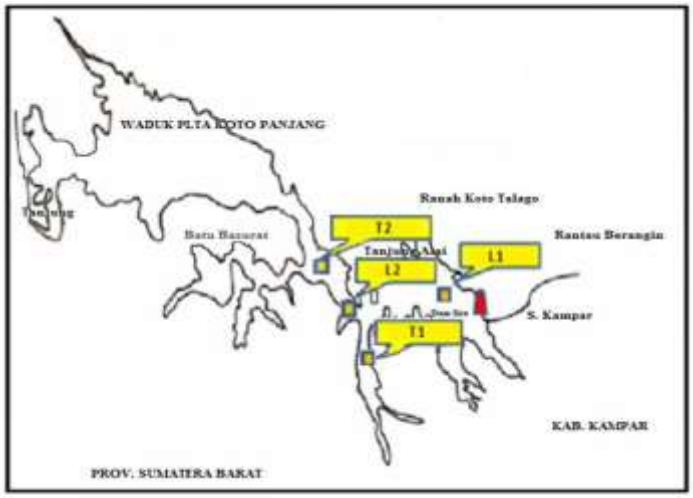

Figure 1. Research stations in the Koto Panjang dam

Water quality parameters measured are temperature, transparency, depth, pH, Dissolved Oxygen and BOD_5. The water was taken using a Van Dorn Water Sampler 2 l and then were analyzed in the Aquatic Productivity Laboratory based on APHA (1998).

RESULTS AND DISCUSSION

The oxygen consentration in in the transition zone was relatively higher than that of the lacustrine. In the surface of the lacustrine zone, the oxygen concentration was 6.14-8.26 mg/l andin the bottom was 0-0.41 mg/l, whilein the transition zone, it was 7.38 -10.74 mg/lin the surface and 0.41-3.29 mg/l in the bottom. The difference of oxygen concentration in both stations might be due to the difference of nutrient content and sunlight available in these area. Thornton, Kimmel, and Payne (1990) stated that in the transition zone, there is nutrient and sunlight available for supporting the photosynthesis process and this area is considered as the most fertile area. The process of oxygen diffusion also increase the oxygen concentration in this area and as a consequence it is become higher than that of the lacustrine zone.

Data obtained in this research shown that the oxygen concentration tend to decrease in the deeper area (Figure2.). In each research station, the oxygen concentration in the surface is higher than that of the deeper area. It is predicted that photosynthesis process and oxygen diffusion increase the oxygen content in the surface area. Welch and Lindell (1980) stated that in the low intensity sunlight, photosynthesis rate is corresponding to light intensity. In certain intensity, however, the photosynthesis rate become constant (Pmaximum) and it is not depended on the light intensity anymore.

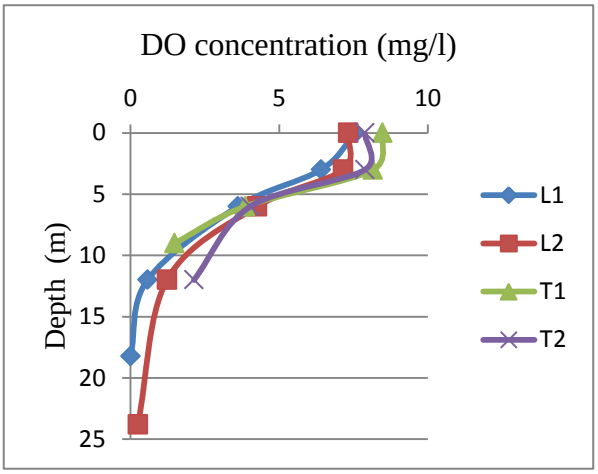

Figure 2. Vertical profile of the Dissolved Oxygen in the lacustrine and transition zones of the Koto Panjang dam.

Photosynthesis is a function of light intensity and nutrient available, thus the availability of nutrient and the light will affect the photosynthesis process and as a consequence it will also affects the oxygen production.The low oxygen concentration in the lacustrine area (0-.41 mg/l) might be due to the scarcity of oxygen resource and the presence of high amount of organic materials in that area. It is predicted that this organic materials might be originated from fish cage aquacultur. Mc Donald *et al*., (1996) stated that 30% of the fish feed provided might be uneaten and 25-30% of the eaten feed might be excreted as fecal pellets.

In the hypolimnion of the lacustrin area, the oxygen concentration is very low, it is in the critical limit (Figure 1). In the bottom of the transition zone the oxygen concentration is relatively low (0.41-3.92 mg/l),but it is slightly higher than that of the lacustrine area.

As the oxygen concentration needed for the aquaculture activity is 4 mg/l, the oxic areas depth in each sampling stations in the Koto Panjang dam can be expected.It was 7.0 m (L1) and 9.0 m (L2)in the lacustrine zone; and 6.2 m (T2)and 8.0 m (T1) in the transition zone.It is predicted that the shallow oxic zone in the T2is resulted from the highness of the cage number present in this area.In the L2, the oxic layer was the highest (9m), this condition due to the limited number of fish cage in this area.

The oxygen concentration in the hypolimnion of the lacustrine area is very low or there is an oxygen deficiency in this area. Pacini (1994) *in* Mwaura (2006) stated that in several dam in Kenya and South Afrika, the oxygen deficiency in the hypolimnion area indicates that the water is productive. Mwaura (2006) also stated that the oxygen concentration in the dam and lake is very important for supporting the life of aquatic organism, including fish. The oxygen concentration may affects fish movement, as fish prefer to stay in the water with suitable oxygen concentration (Boyd dan Lichtkopper, 1979, Taub, 1996 *in* Mwaura, 2006).In the Koto Panjang dam, the average size of fish cage was 4x4m^{2}or 6x6 m^2 and 3.5 m depth. Based on the vertical oxygen profile obtained in this research, it is suggested that the cages in the Koto Panjang dam should be manage, especially during the minimum water level, in order to minimize negative effects that are related to oxygen availability. As water surface become lower, the oxic layer might be change and it will affect the oxygen concentration that is crucial for supporting the life of cultured fish.

Other water quality parameters values indicate that there was slight changing in the Koto Panjang water quality in general.There was increase in BOD_5 concentration. In this recent study, the BOD_5in the surface of the lacustrine zone was 7.86 mg/l in and that of the transition zone was2.39mg/l. These values were higher than the surface BOD_5 values obtained by Siagian (2010), which was 2.28 mg/l in the lacustrine and 1.50 mg/l in the transition zones respectively. As well as the surface, the bottom BOD_5 concentration obtained in this recent study is higher than those that were obtained by Siagian (2010). It was 11.656 mg/l in the lacustrine zone and 7.66 mg/l in the transition zone, while those of Siagian (2010) was 2.80 mg/l and 2.185 mg/lin the lacustrine and transition zones respectively. In the case of Koto Panjang, changing of in water might be due to the input of organic materials originated from caged fish culture activities.

CONCLUSION

Based on data obtained, it can be concluded that in the lacustrine zone, there was oxygen nion. To prevent the the negative impact of

oxygen related problems, it is suggested to improve the manajemen of the lake, especially during the minimum water level period.

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