Deoxygenation Rate of Carbon in Upstream Brantas River in the City of Malang

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Deoxygenation Rate of Carbon in Upstream Brantas River in the City of Malang

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ABSTRACT

Oxygen depletion in water bodies from biochemical processes is determined from the rate of carbon deoxygenation. Rate of deoxygenation carbon become determinant variables in the calibration process of DO model. Several researchers have conducted deoxygenation carbon research for river outside Indonesia but is still limited to river in Indonesia. The study was conducted to determine the rate of deoxygenation of carbon in the Brantas river in Malang by using long-term BOD analysis and Thomas method. The results showed an increase in BOD value during the 30-day. The tendency is polynomial pattern orde 2 with the coefficient of determination, R_2 of 0.9085-0.9596. Rate of carbon deoxygenation fluctuates from upstream to downstream with a range of values from 0.019 to 0.046 /day. While the value of BOD_u ranges from 9.614 to 17.291 mg/L. The low rate of deoxygenation of the carbon indicates the low content of BOD of the river. Turbulent condition of river flow are also a factor to be considered of low value of k. The results of calculations by the method of Thomas has a coefficient of determination, R^2 is low (0.31 to 0.84). In this regard, the use of other methods such as the Least Square and Non Linear Regression should considAer in determining the value of the rate of carbon deoxygenation Brantas river in the city of Malang.
KEYWORD: carbon deoksigenation, river, BOD, Thomas method.

INTRODUCTION

DO parameter is one of the river water quality parameters that are important in preserving the river as a water resource. Dissolved oxygens needed by most aquatic biota. In addition, the oxygen also needed for other purposes besides fish such as algae respirations and biochemical oxidation processes [1]. The process of biochemical oxidation leads to reduced oxygen. Oxygen depletion in water bodies from biochemical processes is determined from the rate of carbon deoxygenation. Deoxygenation rate of carbon indicate speed of oxygen reduction per day from the decomposition of organic matter carbon dissolved in water. Its value depends on the level of organic matter of carbon that is in the river. So this is related to the characteristics of organic material that dumped in the river. Have higher value on the river with BOD and COD concentration is high. Several researchers have conducted research deoxygenation carbon at the river outside Indonesia [2,3,4] but is still confined to the river in Indonesia [5].

Value of Deoxygenation carbon is become determinant variables in the calibration process of simulation model DO river [4]. Generally use the rate of deoxygenation carbon from literature or previous studies [1]. Calibration process in this way takes in the process of trial and error because of the physical, chemical and biological river is not the same. The calibration process is expected to be faster when using carbon deoxygenation rate value of the results of research on the location of the same river. Therefore, in an attempt to make the river water quality simulation models and models of dynamics DO Brantas river in the city of Malang, this research is needed to determine the rate of carbon deoxygenation. Several methods of determining value of the rate of deoxygenation have been used like a method Moment, Least Square, Thomson, Iteration, Fujimoto [6]. Besides, also used of the methods O'Connor's [7] and Streeter Phelps formula [6]. From some of these methods, the non-linear regresion method, Least Square and Thomas should be the first choice in parameter estimation BOD [8]. So in this study is used Thomas method to determine value deoxygenation carbon.

MATERIALS AND METHODS

The activity of determination of carbon deoxygenation rate as in the image below.

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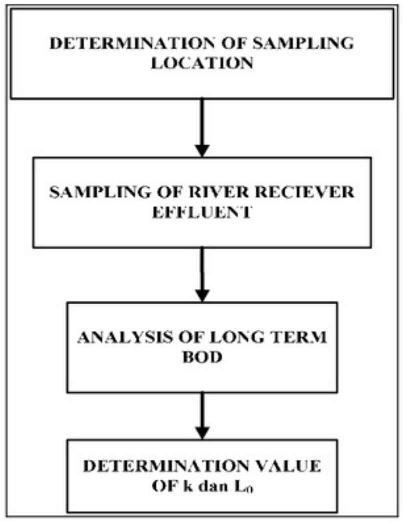

Figure 1.
Flow Diagram Of Determination Deoxygenation Rate Carbon

Description of each stage of activates are as the following:

1. Determination of sampling location

Locations sampling on the upstream of the river prior to the point of effluent discharge and downstream of the river after the point of effluent discharge. The determination of the length of river segments based on consideration of conditions affecting water quality such as the location of tributaries and the discharge point (point - source) and also security of access sampling.

Illustration of segmentation of the river as in Figure 2.

Figure 2
Segmentation of the River

2. Sampling river water based on SNI 6989.57 : 2008 Sampling Method of Surface Water [8].
3. Analysis of BOD with the time interval of observation every 5 days for each sample using standard methods APHA.5210 B -1998 [9].
4. Determination of value of deoxygenation rate of carbon or k using the method of Thomas.

RESULTS AND DISCUSSION

Analysis Result of Long Term BOD

BOD analysis done by taking a long-term BOD analysis with time interval 1 day , 2 days , 3 days , 4 days , 5 days , 10 days , 15 days , 25 days , and 30 days . Conducted sampling at any monitoring points at the river segments that have been determined as in Figure 2 above. The Result of BOD analysis of long-term can be seen in the following table.

Table 1.
Analysis Result of Long Term BOD

NO	LOCATION	BOD on day									
		1	2	3	4	5	10	15	20	25	30
1	Kasin Brantas	1,5	2,1	2,1	4,2	5,1	6,9	10,8	11,7	10,5	16,5
2	Jembatan Suhat	1,2	1,8	2,1	1,8	3,3	4,2	8,4	8,1	8,4	9,6
3	Telogo Mas	1,8	1,8	2,1	2,1	2,1	6,0	6,3	9,0	8,4	8,7
4	Jembatan Muharto	0,9	1,5	2,4	3,6	3,9	5,7	10,8	12,3	11,1	11,4
5	Brantas Bangau Amprong	0,6	3	3	2,4	3,0	4,8	5,4	12,3	12,6	14,1
6	Dinoyo	2,4	2,4	2,4	2,1	4,8	5,1	7,2	10,2	8,4	11,1
7	Jembatan Bumiayu	2,4	2,4	3	2,7	3,0	2,7	8,4	10,8	11,4	11,7
8	Bumiayu Mergosono	1,2	1,8	2,4	1,8	4,5	4,8	9,6	11,1	11,1	12,3

Source : Analysis Result, 2015

Illustration long term BOD value in the chart as follows.

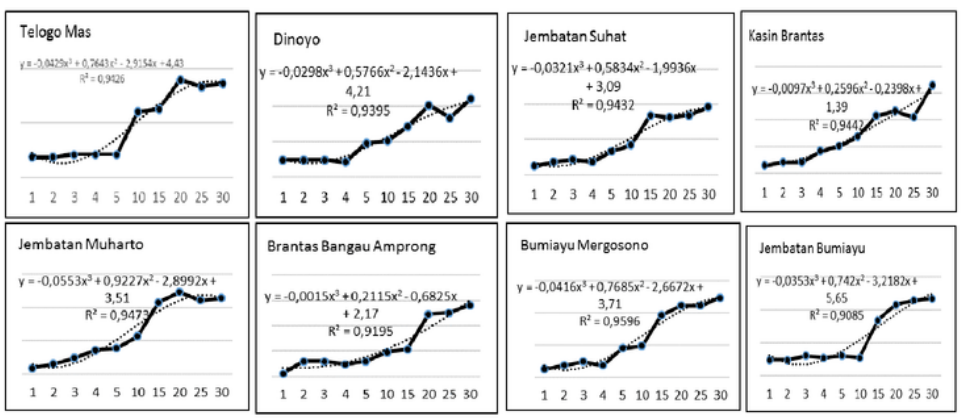

Figure 3. Trend of Long Term BOD Analysis

From the Figure 3, it can be seen BOD value increase during 30 day at all locations. Increasing the value of BOD for 30 days had a tendency polynomial pattern order 3 with the coefficient of determination R^2 0.9085 to 0.9596. BOD test shows the oxygen need for bio-oxidation of the biodegradable organic compounds. Through the measurement of initial and final DO can be estimated amount of oxygen required for the process bio-oxidation of the organic compounds. During the oxygen available, aerobic decomposition of organic compounds will take place until everything is consumed. The following figure shows the fate of biodegradable organic compounds during incubation in the BOD test.

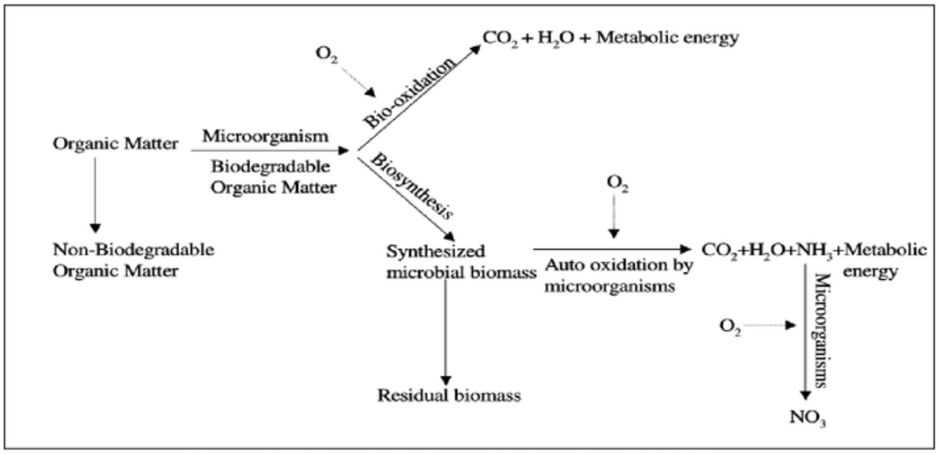

Figure 4. Biodegradable Organic Matter Fate in BOD Test

From Figure 4 above, biodegradable organic compounds undergo process bio-oxidation and biosynthetic that produce carbon dioxide, water and energy. Both these processes require oxygen and occurs in microorganisms.

From the Figure 3, the increase in value during the 30 -day BOD has a tendency polynomial pattern order 2 with the coefficient of determination R^2 0.9085 to 0.9596 . Furthermore, long-term BOD analysis results will be used to determine the value of carbon deoxygenation rate (K_d) and final BOD (BODu) by the method of Thomas.

Determination value of Deoxygenation Carbon (K_d) and BOD_u (L_0)

The determination of the value of deoxygenation Carbon and BOD_u with Thomas method using the following formula .

$(t/y)^{1/3} = 1/(2{,}3kL_0)^{1/3} + \left[(2{,}3k)^{2/3}/6L_0^{1/3}\right]t$ ....(formula 1)

Plot $(t/y)^{1/3}$ with t result slope as $(2{,}3k)^{2/3}/6L_0^{1/3}$ and intercept as $1/(2{,}3kL_0)^{1/3}$.

Deoxygenation value, k and BOD_u, L_0 calculated using this following formula.

k = 2,61(slope/intercept)..........(formula 2)

L_0 = 1/(2,3k.intercept^3)..........(formula 3)

For example, the used calculation in the location Jembatan Muharto that has a calculation results in the following table.

Table 2. The Calculation of $(t/y)^{1/3}$

T	BODt (y)	$(t/y)^{1/3}$
1	0,9	1,04
2	1,5	1,10
3	2,4	1,08
4	3,6	1,04
5	3,9	1,09
10	5,7	1,21
15	10,8	1,12
20	12,3	1,18
25	11,1	1,31
30	11,4	1,38

Plot $(t/y)^{1/3}$ with t result in following figure.

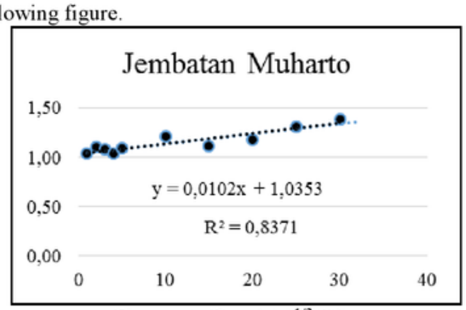

Figure 5. Plot $(t/y)^{1/3}$ VS t

From Figure 5, the value of slope = 0.0102 and intercept value = 1.0353. Furthermore, the value calculated from the formula 2, k = 0,026/day and the value L_0 of formula 3 = 15.237 mg/L. The determination of the value of carbon deoxygenation (k) and L_0 by the method of Thomas at each location of monitoring points Brantas river in the city of Malang can be seen in Table 3 below.

Table 3. Value of k and L_0

NO.	LOCATION	k_i/day	L_0, mg/L	R^2
1	Tlogomas	0,039	9,614	0,65
2	Dinoyo	0,046	10,502	0,67
3	Jembatan Suhat	0,034	10,353	0,71
4	Kasin Brantas	0,030	15,916	0,72
5	Jembatan Muharto	0,026	15,237	0,84
6	Brantas Bangau Amprong	0,019	17,291	0,31
7	Bumiayu Mergosono	0,024	15,055	0,53
8	Jembatan Bumiayu	0,036	11,823	0,41

Value of deoxygenation rate Carbon fluctuates from upstream to downstream with a range of values from 0.019 to 0.046. While the value of BOD_u are in the range of 9.614 to 17.291 mg/L. Figure of BOD_u and k value can be seen as follows.

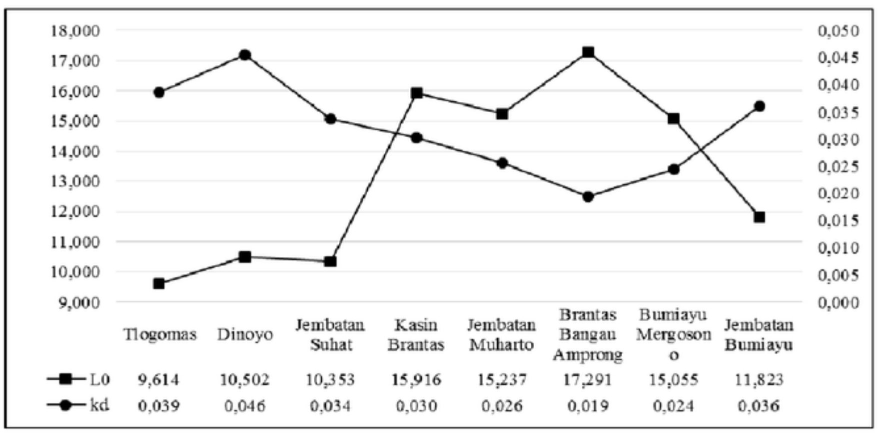

Figure 6. Fluctuation of k and L_0 Value

When compared to the results of other studies that determining the value of k, k value of Brantas river in the city of Malang lower. From [11] note the typical value of k for the stream of 0.1 to 0.23/day and L_0 of 1-30 mg/L. Value of deoxygenation carbon in the stream that receive effluent from secondary processing of 0.1/day [2], 0.11/day [3] and 0.19/day [4]. The river that receives effluent from primary processing 0.27/day [4]. In the rivers that receives from secondary treatment effluent with nitrification 0.057/day [4]. As for the rate of carbon deoxygenation Citarum upstream of 0.169861 to 0.482337/day [5]. The low value of BOD in Brantas river in the city of Malang and the characteristic of river flow that are turbulent becomes a factor causing the low value of carbon deoxygenation. The coefficient of determination R^2 in Table 3 is quite low, in the range 0.31 to 0.84. With the low value of the coefficient of determination by using the method of Thomas, it is necessary to make calculations using other methods in determining the value of the rate of carbon deoxygenation. Least Square method and Non Linear Regression could be compared with Thomas method that has been done.

CONCLUSION

1. Increment value of BOD for 30 days had a pattern tendency polynomial second orde with the coefficient of determination, R2 of 0.9085 to 0.9596.
2. The value of the carbon deoxygenation rate fluctuates from upstream to downstream with a range of values from 0.019 to 0.046. While the value of BOD_u are in the range 9.614 to 17.291 mg/L.
3. The low value of the coefficient of determination in the determination of the value of carbon deoxygenation using Thomas method, to be considered to use other determination methods such as Least Square and Non-Linear Regression.

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