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Original Research Article

Reducing Lake Water Pollution Level With Media Filter Variations

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ABSTRACT

Most of the surface water such as rivers, lakes, or freshwater swamps were mostly polluted by human activities. This research analyzed the quality of surface lake water located in Gunugkidul Yogyakarta and the treatment of polluted water with three different filtration media variations based on the value obtained from the calculation of Water Quality Index (WQI) methodology. Based on the value obtained from water quality calculations using the Water Quality Index (WQI) system, the value of Winong Lake water ranges between 25.41-44.24 or is at a fair water quality level. Filter A reduces turbidity with an average of 26.98 NTU, but a significant reduction can be seen from the filtration results of filter B with an average value of 15.3 NTU. Furthermore, filter C with different media thicknesses has the potential to reduce turbidity although the results are not as significant as filter B with an average of 22.08 NTU. For color parameters, Filter A can reduce color with an average of 59 Pt-Co. filter B reduces the color by a further value with an average of 30 Pt-Co. Filter C produces quite good results, namely with an average value of 53 Pt-Co. In filter A, the detergent reduction reached an average of 0.06 mg/L, while in filter B, a very significant value was obtained, namely an average of 0.03 mg/L. For filter C, a slightly different value was obtained from filter A, namely with an average of 0.055 mg/L. The use of more active carbon media in filter B has a very big effect not only on reducing detergent but also on turbidity and color. Furthermore, the dose of chlorine chosen to remove pollutants and organic materials is 0.3 ml/100ml. From the research results, it was found that using more active carbon media in filter B was up to 77% effective in reducing all pollutant parameters in Winong Lake water.

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1. INTRODUCTION

Water is an important resource for all life on earth. Water is a substance that naturally occurs on the surface of the Earth in three forms, namely solid (ice), liquid (water) and gas (water vapor). Apart from consumption, water can also be used for daily needs such as washing, bathing, etc. Water is also used for industrial activities, agriculture, firefighting, recreation areas, transportation, and others (Effendi, 2003). Excessive water use can cause a water crisis. In addition, dumping waste into water bodies can result in a decrease in water quality and a reduction in water resources (Damayanti, 2012).

There are various methods that can be used to assess the quality of a water body. The method that has been used by the National Sanitation Foundation USA, since 1970, is through calculating the Water Quality Index (WQI). This method is an attempt to integrate many water quality parameter data into a single unit so that water data becomes more informative. The parameters measured include: temperature, pH, turbidity, total solids, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), total phosphate, nitrate and fecal coliform, which are considered the main parameters of water quality (Edzwald, 2011). Based on the Water Quality Index (WQI) value, water sources will be classified into quality rankings according to the Water Quality Index (WQI) standard (EPA, 2002). The clean water requirements that have been determined in Indonesia are in accordance with Appendix VI of the Republic of Indonesia Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management.

Gunung Kidul Regency area has a tropical climate, with the topography of the area being dominated by karst hills. The southern region is dominated by the Gunung Sewu karst area, which has many natural caves and flowing underground rivers, as well as lakes formed due to karst processes. One of the villages in the Gunung Sewu karst area is Kepek Village, Saptosari District. People in Kepek Village use the lake to fulfill their daily needs, such as bathing, washing, irrigation, fishing and animal husbandry. The cause of the decline in the quality of the lake is that people use the lake as a place to dispose of liquid household waste such as toilet waste and washing. Apart from that, the environment around the lake, such as agricultural land and livestock, also causes a decline in the quality of the lake, for example the use of chemical fertilizers and livestock manure which is carried by rainwater into the lake. Seasonal changes are also the cause of the decline in lake quality (Kusnaedi, 2010).

Lake in general is where sunlight can even reach the bottom. A lake or lake is a depression on land that is filled with water. In general, the depth of the lake varies between 5 - 20 meters, but many also have a depth lower than 50 meters. Winong Lake water is used for daily needs such as bathing, washing, watering plants, bathing livestock and so on. The conditions around Winong Lake include residential areas, livestock pens such as cows and goats and rubbish bins (Damayanti, 2012).

Winong Lake water pollution can occur from the activities of local residents who use the lake water for bathing, washing and bathing livestock, as well as rubbish bins that are very close to the lake making the Winong Lake water dirty and polluted (Arifiani et al, 2007). Residential waste contains domestic waste in the form of organic and inorganic waste and detergents. Organic waste is waste that can be broken down or decomposed by bacteria. For example, leftover vegetables, fruit and leaves. Meanwhile, inorganic waste such as paper, plastic, glass, cloth, wood, metal, rubber and leather (Effendi, 2003).

Activated carbon is one of the adsorbants commonly used in drinking water (also wastewater) treatment, namely activated carbon or activated charcoal (Holt et al,2004). In the filtration process, this charcoal is used to remove the odor, color and taste of water, including heavy metal ions. Quartz sand is a mineral commonly found in the Earth's continental crust (Huisman, 2004). This mineral has a hexagonal crystal structure made from crystallized trigonal silica (silicon dioxide, SiO_2) (Husaeni, 2016). Quartz sand is a type of sand that has many benefits for human life. For example, silica sand can be used as raw material for glass, ceramics and even for water filters. In the filtration process, quartz sand functions to absorb substances suspended in the water (Harmiyati, 2018).

2. METHODS

This research was carried out using a filtration unit and using a down flow system (Kawamura, 2000). This unit consists of 4.6 inch pipes, water storage bucket, PVC pipe, water tank storage support, valve and sample bottle. The filter materials or media used are quartz sand, activated carbon and gravel (Masduqi et al, 2012). Meanwhile, the water samples used came from Winong Lake in Kepek village, Saptosari sub-district, Gunung Kidul district, Yogyakarta. The water discharge used for each filtration device is 1.32 L/minute (Ridwan. 2021). This research was carried out with 3 repetitions of filtration (Badan Standar Nasional, 2008). There are three types of media thickness used in the filtration process, including: 1) filter A with media thickness: 30 cm gravel, 30 cm activated carbon and 30 cm quartz sand, 2) filter B with media thickness: 10 cm gravel, 50 cm activated carbon and 30 cm of quartz sand and 3) filter C with media thickness: 10 cm of gravel, 30 cm of activated carbon and 50 cm of quartz sand. Data on the main water quality parameters will be analyzed according to the Water Quality Index (WQI) values (Week, 2012). Next, this value is used as a determinant of water quality ranking based on the ranking on the Water Quality Index (WQI). After all the data is obtained, the next step is determining the right filtration and filtration media that can filter Winong Lake water into clean water (Edzwald, 2011).

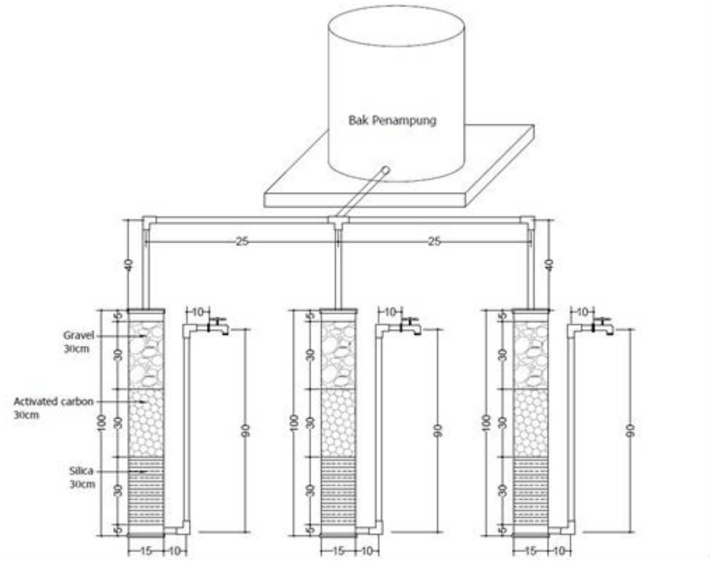

Figure 1. Filtration media

3. RESULTS AND DISCUSSIONS

Telaga Winong is close to the residential area of Kepek village, so Telaga Winong is a place for bathing and washing activities. The soap and detergent used by residents is the pollutant factor in Winong Lake water (Harmiyati, 2018). Local residents also use Winong Lake water to bathe livestock and water plants. The water of Winong Lake is greenish in color and has a slight smell caused by algae and moss. In the water of Lake Winong there are also aquatic biota such as fish, tadpoles and frogs, this is proven by the presence of residents of Kepek village who fish on the shores of Lake Winong (Damayanti, 2012).

The Kepek village government has actually provided a simple filtration tool so that Winong Lake water can be used better. The filtration model they provide is very simple, namely palm fiber and gravel (Novitasari er al,2013)(Husaeni et al, 2016). This filtration has been around for a long time in Kepek village but is not used by local residents. The filtered water is clearer than lake water, although it still has a slight odor. For initial sampling data from Winong Lake water in Kepek village, it was taken at four different location.

The water sampling location in Winong Lake was taken at four different points. At each water sampling point there are activities of local residents who use Winong Lake (Sutrisno, 2010). Residents use almost the entire perimeter of Winong Lake for bathing, washing and other activities, so the lake water tends to be cloudy and contains high levels of detergent. Turbidity and high detergent content are almost evenly distributed at every water sampling point. Data from the initial sampling results for Winong Lake can be seen below.

Table 1. Winong Lake water quality test results

No	Parameter	Test result				Unit	Quality standards
		Location 1	Location 2	Location 3	Location 4		
1	Temperature	30	30	30	30	^oC	Suhu udara ± 3ºC
2	pH	7,2	6,6	6,4	6,6	-	6,5-9,0
3	Turbidity	55,78	48,64	47,45	48,64	NTU	25
4	TDS	61	44	41	41	mg/L	1500
5	DO	4,3	6,1	7,9	5,9	mg/L	-
6	BOD	46,96	47,55	43,38	45,10	mg/L	-
7	Total Phosphate (PO_4)	2,444	2,300	2,3007	1,8707	mg/L	-
8	Nitrate (NO_3)	0,1006	0,0823	0,1052	0,0659	mg/L	10
9	*Fecal Coliform*	2400	120	2400	2400	N/100 mL	50
10	Hardness	67,805	59,329	42,378	59,329	mg/L $CaCO_3$	500
11	Fe	0,2	0,15	0,3	0,1	mg/L	1,0
12	Mn	0,1	0,06	0,05	0,04	mg/L	0,5
13	Detergent	0,2477	0,1543	0,1613	0,0935	mg/L	0,5
14	Plankton	17	202	10	1092	mg/L	-

(Source: Primary Data, 2015)

The table above shows that the parameters for turbidity and fecal coliform exceed the standard limits for clean water quality in accordance with Appendix VI of the Government Regulation of the Republic of Indonesia Number 22 of 2021 concerning the Implementation of Environmental Protection and Management, this is caused by the activities of residents around Winong Lake who use the lake water for bathing, washing and urinating. At certain times the Winong talga water becomes more turbid than usual, such as during the dry season when the water flow becomes low and all residents use the existing lake water for daily needs. For fecal coliform problems that exceed quality standards caused by the activities of residents who use Winong Lake water for bathing, washing and so on, this has the same effect as the results of sample water from the lake as mentioned in table 4.1. the lab test for Winong Lake water samples was carried out with the aim of determining pollutant parameters and water quality index (WQI) values as well as determining filter efficiency in reducing turbidity, color and detergent. The sampling results were carried out in two stages, namely initial sampling and sampling from the filtration equipment. Based on data obtained from two different lab tests at the ITY "STTL" and BBTKL laboratories, it can be seen that the turbidity and total coliform parameters exceed the standard limits for clean water quality in accordance with Minister of Health Regulation No. 492. (2010). Minister of Health Regulation Number 492 of 2010 concerning Drinking Water Quality Requirements.

Winong Lake water quality data is analyzed using the Water Quality Index to obtain a scale value for this index using numbers 1 to 100 with an indication of the worst water quality at 1 and the best at 100. This assessment system is determined based on the main parameters of water quality, namely ;

temperature, pH, turbidity, total solids, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), total phosphate, nitrate, and fecal coliform. The index rankings are as follows:

Table 2. Water Quality Indeks Values and Rankings for Telaga Winong

No	Parameter	Test result					Unit	Q Value	Weighting Factors	Sub Total
		T1	T2	T3	T4	Avrg				
1	Temp	30	30	30	30	30	°C	9	0,11	1,54
2	pH	7,2	6,6	6,4	6,6	6,7	-	77	0,11	8,47
3	Turbidity	55,8	48,6	47,45	48,64	50,12	NTU	38	0,08	3,04
4	TDS	61	44	41	41	46,75	mg/L	85	0,07	5,95
5	DO	4,3	6,1	7,9	5,9	6,05	mg/L	5	0,17	0,85
6	BOD	46,9	47,6	43,38	45,10	45,74	mg/L	2	0,11	0.22
7	Total Phosphate (PO_4)	2,4	2,3	2,30	1,87	2,23	mg/L	27	0,1	2,7
8	NitratE	0,10	0,08	0,1	0,07	0,09	mg/L	99	0,1	9,9
9	Fecal coliform	2400	120	2400	2400	1830	MPN/ 100ml	17	0,16	2,72
10	***Water Quality Index***									35,39
11	***Water Quality Indeks Scale***									Fair

(Source: Primary Data, 2015)

Information:

Water Quality Index Scale

91-100	Excellent water quality
71-90	Good water quality
51-70	Medium or average water quality
26-50	Fair water quality
0-25	Poor water quality

Based on the value obtained from water quality calculations using the Water Quality Index (WQI) system, it was found that the water value of Winong Lake ranges between 25.41-44.24 or is in the fair water quality ranking (Al-Najar, 2010). The water quality of Winong Lake is still quite good as clean water if used for daily needs, however, when used for consumption such as drinking and cooking, the water quality of Winong Lake is still very far from drinking water quality standards (Pracoyo et al, 2006). Therefore, further processing is needed to reduce the three dominant pollutant parameters, namely turbidity, color, detergent and fecal coliform so that Winong Lake water is safe for consumption (Abdullah, 2018).

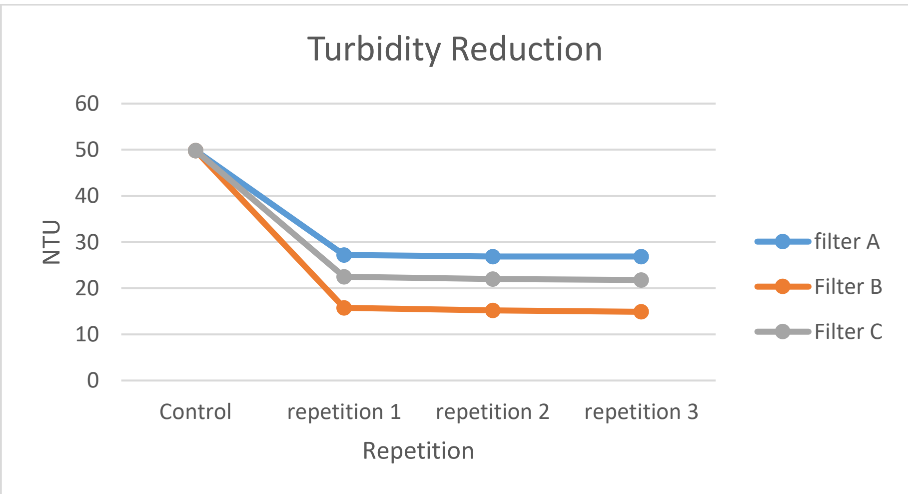

Figure 2. Results of turbidity reduction using various media

From the figure it can be seen that the decrease in turbidity after the filtration process is different for each filter. This is caused by differences in the thickness of the media used (Crittenden et al, 2012). Filter A with the same media thickness, namely 30 cm of gravel, 30 cm of activated carbon and 30 cm of quartz sand can reduce turbidity by an average of 26.98 NTU. However, a significant reduction can be seen from the filtration results of filter B with a media thickness of 10 cm of gravel, 50 cm of activated carbon and 30 cm of quartz sand with an average value of 15.3 NTU. This is caused by the use of more active carbon filter media than other media. Activated carbon is more effective in absorbing particles suspended in water because it has high porosity. Furthermore, filter C with different media thicknesses of 10 cm of gravel, 30 cm of activated carbon and 50 cm of quartz sand, has the potential to reduce turbidity although the results are not as significant as filter B with an average of 22.08.

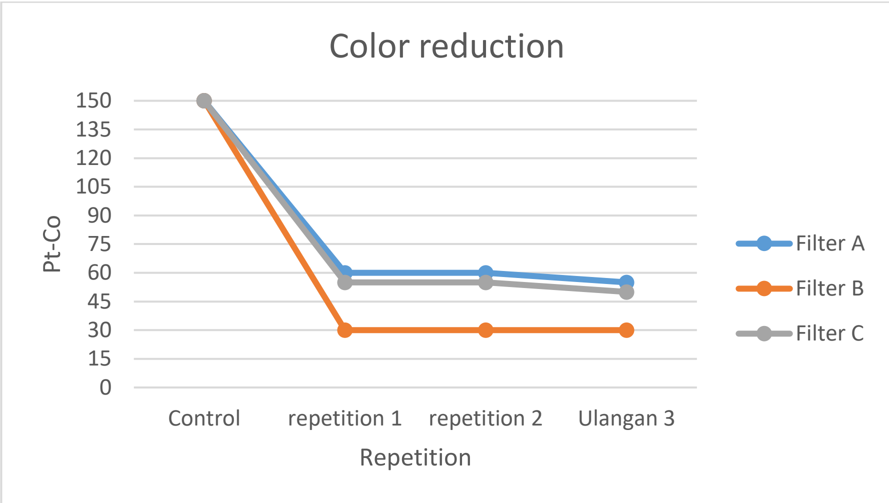

Figure 3. Results of color reduction using various media

From the figure above you can see the results after the filtration process for each filter. Filter A with the same media thickness, namely 30 cm of gravel, 30 cm of activated carbon and 30 cm of quartz sand can reduce color with an average of 59 Pt-Co. Almost the same as the results in reducing turbidity, filter B reduces color by a further value compared to filter A and filter C, namely by an average of 30 Pt-Co. This very significant result was caused by the use of more active carbon media than quartz sand and gravel media. On filter C, quite good results were obtained, namely with an average value of 53 Pt-Co.

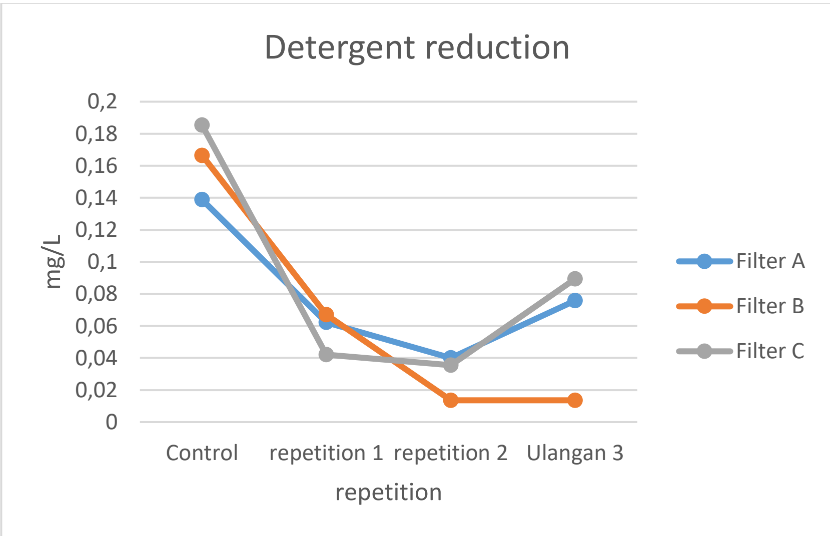

Figure 4. Results of color reduction using various media

From Figure above it can be seen that there is a different decrease in each filter. In filter A, the detergent reduction reached an average of 0.06 mg/L, while in filter B, a very significant value was obtained, namely with an average of 0.03 mg/L. For filter C, a slightly different value was obtained from filter A, namely with an average of 0.055 mg/L. The use of more active carbon media on filter B has a very big effect not only on reducing detergent but also on turbidity and color (Qasim et al, 2000) (Pizzy, 2010).

4. CONCLUSION

From the experiments that have been carried out, it can be concluded that the existing condition of Winong Lake water quality is below quality standards based on Appendix VI of the Government Regulation of the Republic of Indonesia Number 22 of 2021 concerning the Implementation of Environmental Protection and Management with the Water Quality Index (WQI) scale value for Winong Lake water. is ranked quite well. Furthermore, the results of filtration tests on all filters have not been able to reduce turbidity and color parameters to drinking water quality standards, but can reduce detergent parameters to drinking water quality standards. From the research results, it was found that using more active carbon media in filter B was up to 81% effective in reducing the three pollutant parameters in Winong Lake water.

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