Jurnal Presipitasi
Media Komunikasi dan Pengembangan Teknik Lingkungan
e-ISSN : 2550-0023

Vol 18, No 3, 2021, 412-422
Article available at homepage presipitasi

Research Article

The Effect of Manganese Greensand Addition on Tray Aerator to Reduce COD Levels of Laundry's Wastewater

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Abstract

COD level of Pojok Laundry's wastewater did not meet the quality standard regulated in the Special Region of Yogyakarta Regulation No. 7 of 2016 (>150 mg/l) which was 442.5mg/l. This study was aimed to decrease COD levels using the tray aerator method. Manganese greensand with a diameter of 0.25 mm and a thickness of 2.4 cm/tray was also added. This type of research was a quasi-experimental with Nonequivalent Control Group Design. The sample in this study amounted to 50 samples with 5 treatments (30, 45, 60, 75, and 90 minutes), and 5 repetitions. Samples were taken from the washing machine outlet pipe. There were two groups, where the control group was only given aeration and the treatment group was given aeration with the addition of manganese greensand. Data analysis using the two-way ANOVA test showed that there was an effect of time variations on the decrease in COD levels ($p<0.05$), there was a difference in the average of decreased levels of COD between the control and treatment groups ($p<0.05$). The average decrease in COD levels after treatment with a time of 30, 45, 60, 75, and 90 minutes, respectively, was 195.7 mg/l (28.80%); 299.0 mg/l (43.63%); 372.1 mg/l (54.79%); 438.3 mg/l (64.61%); and 513.8 mg/l (75.45%). The decrease in COD levels increased with time. The conclusion of this research was that tray aerator with manganese greensand addition can reduce COD levels with the highest reduction up to 76.69% (90 minutes treatment, detergent usage: 30 g).

Keywords: chemical oxygen demand (cod); laundry wastewater; manganese greensand; tray aerator.

1. Introduction

Laundry business is one type of business that is currently growing rapidly throughout Indonesia, including in Yogyakarta. One of the laundry businesses located in Gondokusuman District, Yogyakarta City is Pojok Laundry. Currently, the average number of clothes washed per day ranges from 20 kg to 50 kg in one day. In a day, Pojok Laundry produces 200 liters to 500 liters of liquid waste. Detergent usage is very important in laundry activity. Detergents used in the laundry process generally have three main components, namely surfactants (detergent base ingredients), builders (phosphate compounds) and additives (bleach and fragrance). The largest components in detergents are builder ingredients between 70-80%, basic ingredients around 20-30%, and relatively few additives between 2-8%. The surfactant content in wastewater will affect the COD level of the waste. This happens because the organic compounds contained in the waste are also high (Dwi et al., 2015). Chemical Oxygen Demand is the amount of oxygen in mg/l which is used to chemically decompose organic matter in water. The higher the COD, the lower the dissolved oxygen content in the water (Boyd, 1998).

The use of detergents in laundry activities is closely related to high COD levels, because the surfactant content in detergents will affect the COD levels in the wastewater. The results of the initial measurement of COD levels in Pojok Laundry wastewater was 442.5 mg/l. This level was higher than the quality standard stipulated in the Regional Regulation of the Special Region of Yogyakarta number 7 of 2016, where the maximum COD level in laundry wastewater is 150 mg/l. The negative impact of laundry waste on the environment is that it can cause soil pollution, water pollution, unpleasant odors, and damage to environmental ecosystems (Salomo & Samosir, 2014). One of the rivers, namely the river in the research location, the Code River, is one of the rivers with moderate pollution category. Based on the results of the 2018 Code River Pollution Load Study, the water quality of the Code River in the downstream Yogyakarta City segment mostly exceeds the class II water quality standard. Code river has a pollution load of 1,709,638 kg/day. The burden of this pollution 98% comes from the domestic sector (Dinas Lingkungan Hidup, 2018). In this case, laundry waste is one source of domestic waste (Astuti & Sinaga, 2015).

In order to not pollute the environment, laundry wastewater should be processed before being discharged. Several methods can be used to eliminate high levels of COD in wastewater, and one is aeration. Aeration is a wastewater treatment by contacting oxygen into the wastewater. The addition of oxygen is a way of taking pollutants that depend on the water, so that the concentration of pollutants in the waste will be eliminated. The aeration method used in this study is tray aerator which is an aeration process that is carried out by dropping raw water from a certain height and passing it through a number of trays arranged vertically with a certain distance to ensure a contact between water and oxygen in the air (Joko, 2010). That way, there will be a transfer of oxygen gas into the water. An increase in dissolved oxygen levels in water will be followed by a decrease in COD levels (Anastiti, 2016).

The effectiveness of aeration in reducing COD levels can be increased by adding an adsorbent contact medium (Joko & Rachmawati, 2016). Based on previous research, many have used tray aerators to treat laundry's wastewater, but manganese using manganese has not been found in previous studies though manganese can reduce COD. In this research, we use manganese greensand which is a filter medium made of zeolite which has been enhanced by adding manganese to the zeolite, resulting in a fivefold increase in manganese oxide content. The content of manganese oxide has a function as a functional group that can bind phosphate ions, where phosphate levels are related to COD levels (Aprianti et al., 2015) (Lumaela et al., 2013). This study combines the tray aerator and manganese greensand filtration methods.

The importance of this research is due to the lack of laundry owners, awareness of awareness to treat their liquid waste before being discharged into the environment. For the readers, this research can be a new alternative in treating wastewater. Thus, it's necessary to find an effective and efficient treatment method to reduce COD levels in laundry wastewater. The purpose of this study was to determine the effect of manganese greensand addition on tray aerator with a diameter of 0.25 mm and a thickness of 2.4 cm/tray in Pojok Laundry wastewater.

2. Methodology

2.1 Study Design

The type of research used in this study is quasi-experimental, that is used to show a causal relationship in experimental research without controlling confounding variables completely and there is no randomization of the sample. The research design used in this study is the Nonequivalent Control Group Design. In this study there were two groups, namely the control group and the treatment group. Both the control and treatment groups were given aeration treatment with the same time variation, but the control group did not use manganese greensand filter media. The researcher will take a pre-test sample to the group that will be given treatment and then take a post-test sample after the treatment.

Water samples were taken at 07.00 am when the first washing process had started by grab sampling. The treatment was replicated five times to avoid errors.

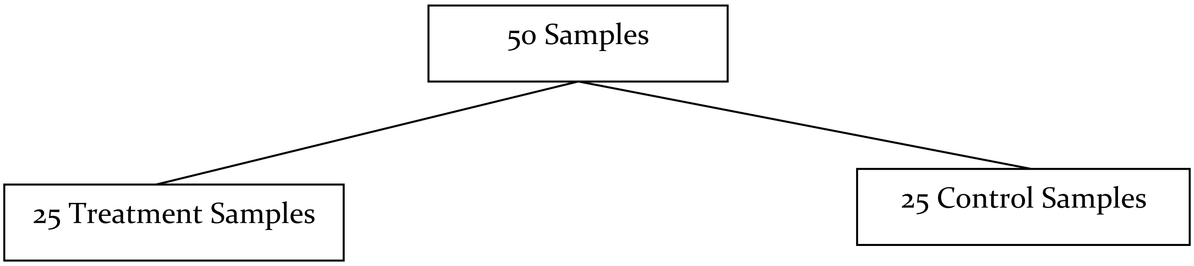


Figure 1. Flowchart of samples

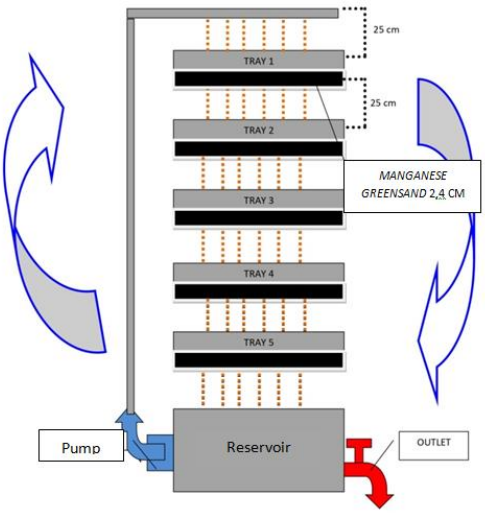
The independent variable of this study was the time variation of the treatment (30, 45, 60, 75, and 90 minutes). The dependent variable of this study was the Chemical Oxygen Demand (COD) levels. The confounding variables were water temperature (measured), thickness of filter media (controlled with a size of 2.4 cm per tray), the size of filter media (controlled with a size of 0.25 mm), number of trays (controlled, using 5 trays with 25 cm space), and the water flow rate (controlled, 129 ml/second).

2.2 Media Activation

Manganese greensand was grinded and sieved to obtain sizes with diameters of 0.25 mm. The media was soaked with aquades for 60 minutes, then dried at 105 °C for 2 hours.

2.3 Treatment

The tray aerator building was made from PVC pipe (1 inch diameter). The tray dimension is 33,7 cm x 24,5 cm x 10 cm. The tray placed vertically with 25 cm space (five levels). Dacron filter (2 cm) and 80 mesh wire were placed at the bottom of each tray. Manganese greensand added to the treatment group tool, with the thickness of 2.4 cm per tray. This tool uses a submersible water pump (inside the reservoir), connected with 5/8 inches hosepipe to the upper sprayer. There were four sprayers consist of two holes per sprayer. The sprayer was made from ½ inches plastic pipe. The tool works continuously, where the water from the reservoir will rotate as long as the tool is operated. Water samples were taken every 30, 45, 60, 75 and 90 minutes, with the amount of 200 ml.



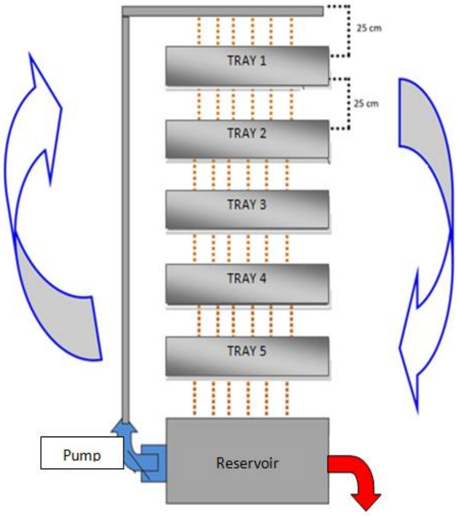


Figure 2. Treatment tool

Figure 3. Control tool

2.4 Calculation of COD Reduction Efficiency

The calculation of the percentage reduction in COD with variations in processing time can be done using the efficiency formula (1).

$$Ef = \frac{(Co - Ci)}{Co} \times 100\% \quad (1)$$

Description
Ef = COD reduction efficiency
Ci = COD levels after treatment
Co = COD levels before treatment

2.5 Data Analysis

Statistical analysis used was Two Way Anova test with 95% confidence value and 5% significance level (α). The further test used was the Post Hoc Test with the Bonferroni method.

3. Result and Discussion

COD levels in this study were measured in accordance with SNI 6989.2:2019 with closed reflux spectrophotometry at the BBTKLPP DIY Laboratory. In this study, there were two groups, namely the control and treatment groups. The samples tested consisted of 5 pre-test samples, 25 control group samples and 25 treatment samples. The samples were put into a 200 ml PET bottle, then brought as soon as possible to the laboratory so that they could be examined on the same day and get the most accurate results possible. The results of measuring COD levels are presented in the following table.

Table 1. The measurement result of COD levels

Group	Contact Time	Post-test (mg/l)					Average
		Repetition					
		1	2	3	4	5	
Pretest(mg/l)	-	422.5	707.5	852.5	400.5	1022.5	681.1
Control (mg/l)	30	339.5	561.5	671.5	323.5	814	542.0
	45	277.5	472	574.5	267.5	677.5	453.8
	60	252	413.5	495.5	229.5	596.5	397.4
	75	235.5	385.5	437.5	209.5	522.5	358.1
	90	179.5	296.5	366.5	170.5	432	289.0
Treatment (mg/l)	30	298.5	518.5	598.5	282.5	729	485.4
	45	244.5	401.5	478.5	225.5	560.5	382.1
	60	192	314.5	391	177.5	470	309.0
	75	142	244.5	318.5	142.5	366.5	242.8
	90	98.5	178.5	209.5	101.5	248.5	167.3

3.1 The COD Levels Before Treatment

Measurement of COD levels was carried out at the DIY BBTKLPP Laboratory according to SNI 6989.2:2019 with closed reflux spectrophotometry. Table 1 shows high and fluctuating levels of COD before treatment (pre-test). The results of the examination of COD levels for five consecutive days were 422.5 mg/L; 707.5 mg/L; 852.5mg/L; 400.5 mg/L and 1022.5 mg/L with a mean of 681.1mg/l. This is because wastewater samples were taken on different days and also the materials washed and the amount of detergent used were different, depending on the amount of washed material being processed. The highest COD level found was 1022.5 mg/l (5th day). This happened because on that day the amount of detergent used was the most, which was 70 grams. The surfactant content in wastewater will affect the

COD level of the waste. This happens because the organic compounds contained in the waste are also high(Dwi et al., 2015).

The high levels of COD in wastewater were caused by the use of detergents. The detergent used in this study was a powder detergent from the Rinso Matic brand. Basically, detergents consist of three main components, namely surfactants (detergent base ingredients), builders (phosphate compounds) and additives (bleach and fragrance). Rinso matic detergent has a surfactant active ingredient of 12% in a 1 kg package (listed on the package). Variations in COD levels in Pojok Laundry wastewater samples were caused by the amount of material washed, the source of the material being washed, and also the amount of detergent. This is explained as follows. The first day, washing materials in the form of clothes (boarding occupants) as much as 4 kg, the amount of detergent is 30 g; the second day, washing the material in the form of clothing (household) as much as 6 kg, the amount of detergent 40 g; the third day, washing materials in the form of clothing (household) as much as 8 kg, the amount of detergent 50 g; the fourth day, washing materials in the form of clothes (boarding occupants) as much as 3 kg, the amount of detergent as much as 30 g; and the fifth day, washing materials in the form of clothes and bed linen as much as 10 kg with 70 grams of detergent. The results of measuring COD levels before treatment was higher than the quality standard based on the Special Region of Yogyakarta Regulation No. 7 of 2016 (≤150 mg/l). Laundry wastewater treatment must be carried out because of the high levels of COD which can be harmful to the environment and human health.

3.2 The COD Levels After Treatment

The data in Table 1 shows a decrease in COD levels. After being given treatment, both in the control group and the treatment group there was a decrease in COD levels. The average COD level before treatment was 681.1 mg/l. The average COD levels in the control group with variations of 30, 45, 60, 75, and 90 minutes respectively were 542.0; 453.8; 397.4; 358.1; and 289.0 mg/L. Meanwhile, in the treatment group, the average COD levels with time variations were 30, 45, 60, 75, and 90 minutes, namely 485.4; 382.1; 309.0; 242.8; and 167.3 mg/l. The lowest COD level in the control group occurred in the 4th repetition, which was 170.5 mg/l and in the treatment group it occurred in the first repetition, which was 98.5 mg/l. This happened because the use of detergent in both repetitions was 30 grams, so that the initial COD level before treatment in the first repetition was 422.5 mg/l and the fourth was 400.5 mg/l. COD levels are influenced by the amount of detergent used. The surfactant content in the detergent will affect the COD level of the waste. This happens because the organic compounds contained in the waste are also high (Dwi et al., 2015).

These data indicate that there is a decrease in COD levels on average. However, all of them still exceed the quality standards regulated in DIY Regional Regulation Number 7 of 2016 concerning Industrial Liquid Waste Quality Standards, where the COD level of laundry wastewater is 150 mg/L. There are several factors that affect the process of aeration study. These factors include the size of the filter media thickness, water temperature, number of tray, treatment time, and water flow rate.

The thickness and size of the media in this study can affect the reduction of COD. The thickness of the media affects the length of time in contact with the filter media. The thicker the filter layer, the longer the contact time of water with the filter media layer. This will result in better filtered water quality. The size of the filter media can also affect the COD reduction. The smaller the grain diameter, the tighter the gap between the grains. In this way, the filtering speed becomes slower, and causes better filtering quality (Kusnaedi, 2010). In treatment group (aeration with manganese greensand addition) at a time variation of 90 minutes has an average COD level of 167.3 mg/L or 75, 45% of the original state. The quality standard in the Yogyakarta Special Region Regulation No. 7 of 2016 requires the COD quality standard in laundry wastewater to be 150 mg/L. This indicates that the thickness of the media used in this study needs to be increased. The addition of the thickness of the filter media can be done in multiples of 12, such as 24 cm, 36 cm, 48 cm, and so on. This is in line with Lavinia's research (2016) that an increase in the decrease in COD levels can be done by increasing the thickness of the media in multiples of 12 cm (Lavinia, 2016).

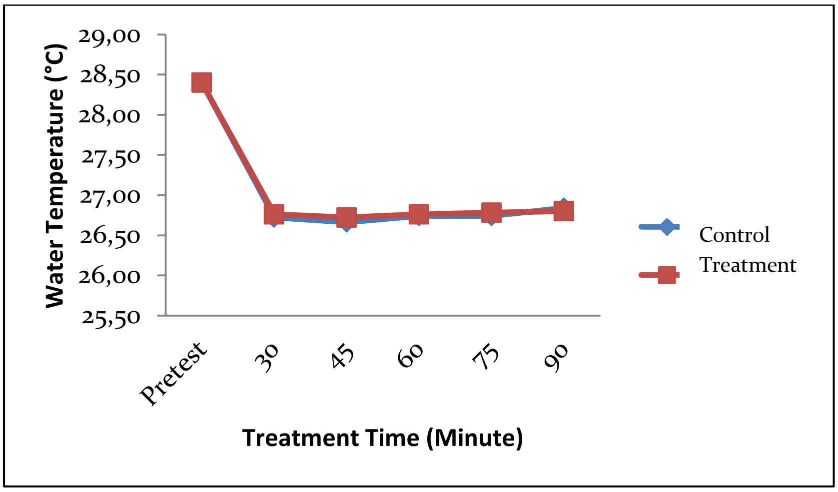


Figure 4. Graphic of the average reduction of water temperature

Measurement of water temperature in this study showed a decrease in water temperature after treatment in both groups. Water temperature that is too low can affect the aeration and adsorption process. The reduction of COD by the aeration method is strongly influenced by the occurrence of the oxygen transfer process. For every 1ºC increase in temperature, oxygen transfer will increase by 1.56% (Suparmin, 2002). Meanwhile, the absorption process with manganese greensand was also affected by temperature. This is in line with Lavinia's research (2016) that a water temperature of 30 °C will cause better absorption of manganese greensand. Therefore, it is necessary to control the temperature to remain in the range of 30°C so that the aeration and adsorption processes can run optimally and can reduce COD levels in order to meet quality standards (Lavinia, 2016).

The number of trays in the aeration treatment can affect the oxygen transfer process, where the oxygen transfer process greatly affects the decrease in COD levels. Based on research conducted by Putri (2016), every increase in dissolved oxygen in water is 0.1 mg/l; COD levels will decrease by 6.22 mg/L. (Anastiti, 2016) In this study, the number of trays used was 5 levels. This is in line with Lutfihani's research (2015), for the 3-level aerator tray produces dissolved oxygen of 6.84 mg/L, while the 5-level tray aerator is 7.24 mg/L (Lutfihani & Purnomo, 2015).

Treatment time is the length of time the equipment operates in rotating wastewater. The tools in this research work continuously. Processing for 90 minutes was able to reduce COD levels by an average of 75.45%. To determine the time required to reduce COD levels up to 100%, calculations were carried out using the extrapolation formula. Calculations show that to get a drop of up to 100% it will take at least 120 minutes. The decrease in COD levels will increase with the addition of aeration time. This is in line with Arsawan's research, where the decrease in COD levels increases with time (Arsawan et al., 2012).

The flow rate is the internal flow rate through a transverse container divided by time (m^3/s). If the velocity of flow and water flow increases, the effectiveness of aeration and adsorption will decrease because the speed of water flow and water discharge will affect saturation (Kusnaedi, 2010). The water discharge in this study was measured and controlled. After being measured, the instrument in this study had a sprayer discharge of 129 ml/second. The discharge is adjusted so that it is not too fast or too slow so that the pump can run stably and the aeration process can take place properly. This is in line with the research of Mubarokah (2010), where the flow of water that is too fast can reduce the effectiveness of aeration and absorption in reducing COD levels (Mubarokah, 2010).

3.3 Decrease in COD Levels After Treatment

The reduction of COD levels are shown on the table 2 below.

Table 2. The Percentage of COD reduction

Group	Time Contact	Average of COD Level		Reduction	Percentage of Reduction
		Pretest	Posttest		
Control	30	681.1	542.0	139.1	20.23%
	45	681.1	453.8	227.3	33.43%
	60	681.1	397.4	283.7	41.63%
	75	681.1	358.1	323.0	47.01%
	90	681.1	289.0	392.1	57.56%
Treatment	30	681.1	485.4	195.7	28.80%
	45	681.1	382.1	299.0	43.63%
	60	681.1	309.0	372.1	54.79%
	75	681.1	242.8	438.3	64.61%
	90	681.1	167.3	513.8	75.45%

Based on the data shown in table 2, we can conclude that the highest COD level reduction was 75.45% (90 minutes treatment group). In Lavinia's research (2016), manganese greensand filtration with the thickness of 12 cm could reduce the COD levels by 71% from the initial state (Lavinia, 2016). The aeration treatment in Marjono's study (2007) showed a decrease in COD levels starting from the first hour that was equal to 64.28% of the initial conditions (Marjono, 2007).

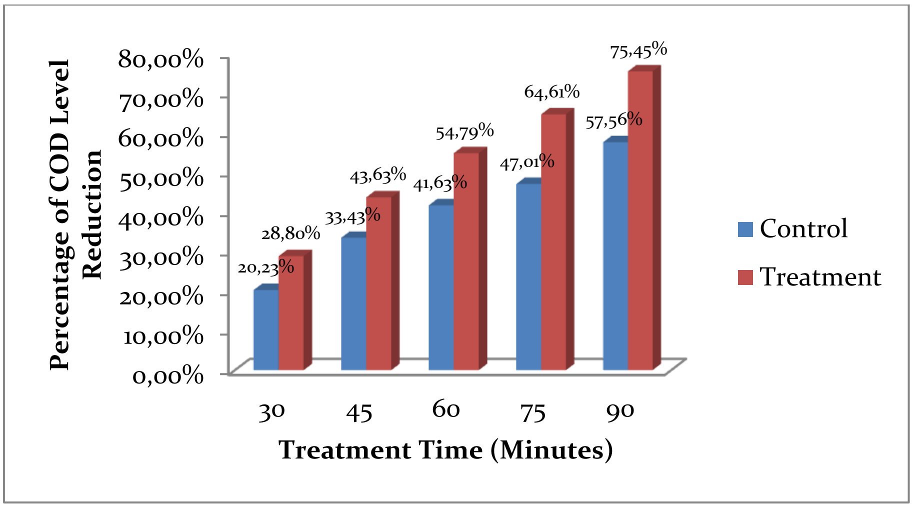


Figure 5. Graphic of COD level reduction (%)

Mathematically, it can be seen that there was an increase in the COD levels reduction in both the control group and the treatment group with contact time increase. To determine whether there was an effect of contact time on the decrease in COD levels, a two-way ANOVA test was carried out. The different test showed that there was an effect of time on the decrease in COD levels because the p-value ≤ 0.05. After knowing the difference through the different test, it was continued with the Bonferroni post hoc test. This test showed that those with p-value ≤ 0.05 were between 30 and 75 minutes; 30 and 90 minutes; and 45 minutes 90 minutes, so it can be concluded that the average difference in COD reduction occurred at variations of 30 and 75 minutes, 30 and 90 minutes, as well as 45 minutes and 90 minutes.

In addition, it is also seen that the treatment group has a higher level of effectiveness than the control group. To find out whether there was a statistical difference in the decrease in COD levels between the control and treatment groups, a different ANOVA test was performed. The different test showed that there was a difference in the average decrease in COD levels between the control and treatment groups (p-value 0.05). The two-way ANOVA test also showed that the method variables (control and treatment groups), time variations, and the interaction between methods and time variations simultaneously affected the decrease in COD because p-value $\leq$ 0.05 This is in line with Arsawan's research (2012), where the addition of aeration time can result in an increase in the decrease in COD levels (Arsawan et al., 2012).

The highest reduction in the control and treatment groups was not much different. The highest average decrease in COD levels in the control group occurred at a contact time of 90 minutes, which was 57.56%, while in the treatment group the largest decrease occurred at a contact time of 90 minutes, which was 75.45%. Both of them only have a difference of 17.89%. This can occur due to both the control and treatment equipment being given a 2 cm thick Dacron filter. The Dacron filter can provide a filtration effect even though it is not significant. In addition, in this study, the manganese greensand used to have a thickness of 2.4 cm on each tray. The effectiveness of reduction can be increased by moving the manganese greensand filter on one tray with a thickness of 12 cm or in multiples thereof. Another way that can be done is to increase the thickness of the manganese greensand on each tray by a multiple of 2.4 cm.

However, based on the results of statistical tests, there was a difference in the COD levels reduction between the control group and the treatment group. On average, the largest reduction in COD levels in the control group, which was 57.56%, was achieved with a treatment time of 90 minutes. A decrease of 54.79% can be achieved in the treatment group in just 60 minutes. This shows that the addition of manganese greensand media can increase processing efficiency, especially in the terms of processing time.

The decrease in COD levels in this study could occur with the treatment of the tray aerator method with manganese greensand addition. Aeration is a treatment that is carried out by contacting water with free air. That way, there will be a transfer of oxygen gas into the water. An increase in dissolved oxygen levels in water will be followed by a decrease in COD levels. This is in line with research of Anastiti, that every increase in dissolved oxygen in water by 0.1 mg/l; COD levels will decrease by 6.22 mg/L (Anastiti, 2016).

Apart from aeration, the decrease in COD levels in this study was also caused by adsorption with manganese greensand media. Manganese greensand is a zeolite that has been modified by adding manganese to the zeolite so that the manganese oxide content increases five times. Manganese greensand used in this study has a size of 0.25 mm. The following chemical equation (2) is a reaction for the absorption of COD by manganese greensand:

$$K_2ZMnOMn_2O_7 + SO_4^{2-} \rightarrow KZ + 3MnO_2 + K_3SO_4 \quad (2)$$

In the reaction, ion binding occurs in manganese greensand, where negatively charged ions (SO_4^{2-}) are bound by positively charged potassium ions (K^+) (Siska & Salam, 2012) High levels of COD are also influenced by the high levels of phosphate contained in wastewater. According to research by Lumaela (2013), phosphate has a positive relationship to COD, where an increase in phosphate is followed by an increase in COD. The following chemical equation (3) is phosphate absorption reaction by manganese greensand (Lumaela et al., 2013).

$$K_2ZMnOMn_2O_7 + PO_4^{3-} \rightarrow KZ + 3\ MnO_2 + K_3PO_4 \quad (3)$$

In the reaction, the binding of phosphate ions to the manganese greensand, where the negatively charged ions (PO_4^{3-}) by the positively charged potassium ions (K^+) (Siska & Salam, 2012).

3.4 Effectiveness and Efficiency of COD Levels Reduction After Treatment Using The Tray Aerator Method With The Addition Of Manganese Greensand

Overall, the highest decrease in COD levels occurred in the 90-minute time group in the first test, which was 76.69%; while the lowest decrease in COD levels occurred in the 30 minute time group on the second repetition, which was 26.71%. The lowest average decrease in COD levels occurred at a contact time of 30 minutes, which was 28.80% or 195.7 mg/l from the initial conditions, while the highest average decrease in COD levels occurred in the 90 minute group, which was 75.45%. or equal to 513.8 mg/l. The average COD level after treatment with a contact time of 90 minutes was 167.3 mg/l. It shows that tray aerator method with manganese greensand addition has not been able to reduce COD levels to meet the quality standards in the Special Region of Yogyakarta Regulation No. 7 of 2016. In Lavinia's research (2016), filtration of manganese greensand with a thickness of 12 cm can reduce COD levels by 71% from the initial state, which is also not effective in reducing COD levels to meet the quality standard levels (Lavinia, 2016). Aeration treatment in Marjono's research (2007) also showed a decrease in COD levels starting from the first 60 minutes, which was 64.28% from the initial condition (Marjono, 2007). A larger decrease can occur by adding the thickness of the filter media in multiples of 12 cm, or multiples of 2.4 cm on each tray. This can increase the contact time between the filter media and wastewater which will increase the effectiveness and efficiency of the filtering process (Kusnaedi, 2010).

The effectiveness of tray aerator method with manganese greensand addition with time variations were seen from its ability to reduce COD levels to meet the levels specified in the quality standard, while efficiency is judged by how much COD levels are derived from the initial conditions. Efficiency value was calculated by comparing the difference/decrease in COD levels with COD levels before treatment and presented in percentage form. The average efficiency value of reducing COD levels is shown in Figure 4. While the effectiveness of the tool was seen by comparing the COD levels with the quality standards contained in the Special Region of Yogyakarta Regulation Number 7 of 2016. The effectiveness of the tool can be seen in the following graph.

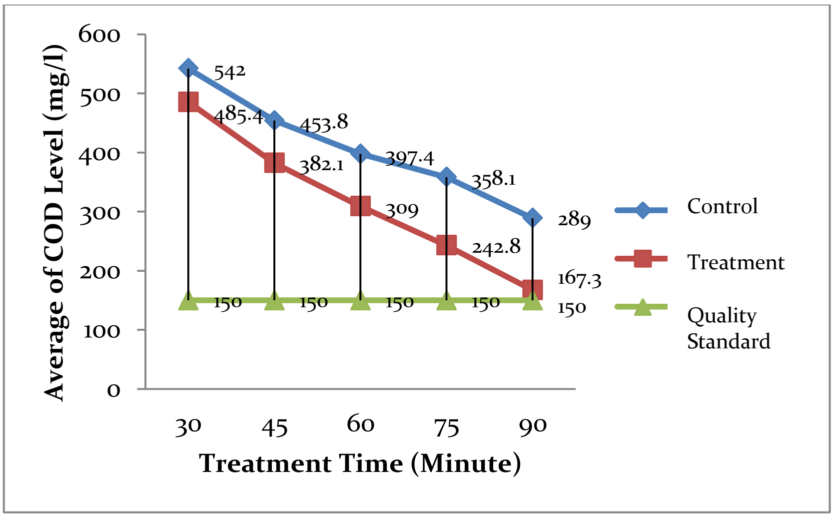


Figure 6. Comparison of COD levels with quality standards

The data in Figure 6 shows that there was a decrease in COD levels on average, but the final COD levels were still not below the quality standard, which is 150 mg/l. Although the average treatment has not been able to meet the COD levels in the quality standard, there were two groups that meet the quality standard levels. COD levels that met the quality standards were found in the treatment group which occurred at a contact time of 90 minutes, the first repetition was 98.5 mg/l and the fourth repetition was 101.5 mg/l. (Table 1)

Aeration treatment with the addition of manganese greensand has been shown to reduce COD levels, although in this study some improvements still need to be made. For this reason, it is recommended for laundry business owners to apply wastewater treatment through the tray aerator method with the addition of manganese greensand. Tray aerator tools are very easy to make and the costs involved are not too high. The design of this tool is not too big, so it does not require a large space. Even a laundry business that is not too big can use this tool. Calculations using the extrapolation formula show that to reduce the COD content to 100%, a processing operation time of at least 120 minutes is required. The laundry business owner can use a tool with the same design as this study, but they should increase the processing time at least 120 minutes. That way, the COD levels of wastewater can meet the quality standards and do not pollute the environment.

In this study, the decrease in COD levels was also influenced by the characteristics of the wastewater. The decrease in COD levels is influenced by the transfer of oxygen into the water. Based on the previous description, the use of detergent in the first and fourth repetition wastewater is at least 30 grams. Thus, the COD levels in the first and fourth repetitions had lower values than other repetitions. In practice there are differences in the value of the gas transfer coefficient (KLa) in clean water with KLa in wastewater containing suspended materials, surfactants (detergents) in solution and temperature differences. These factors can also affect the value of oxygen saturation (Cs). Oxygen saturation can affect the gas transfer process which can affect the decrease in COD levels (Benefield, 1985).

4. Conclusions

Laundry wastewater treatment with tray aerator method and manganese greensand addition was able to reduce COD levels up to 75.45% on average at a treatment time of 90 minutes. The average COD level after 90 minutes of treatment was 167.3 mg/l. This level still higher than the quality standard in the Special Region of Yogyakarta Regulation Number 7 of 2016 concerning the quality standard of industrial waste, which is 150 mg/l. Although it was still higher than the quality standard, the addition of manganese greensand could improve the effectiveness of COD reduction, compared with tray aerator only. The lowest COD level occurred in the first repetition, which was 98.5 mg/l. This happens because of the characteristics of wastewater which has a COD level that is not too high, namely 422.5 mg/l (using 30 grams of detergent).

There are some suggestions that can be noticed for the other researchers. First, further research is needed on the saturation of manganese greensand related to the optimal time of manganese greensand usage. Second, further research is needed regarding the thickness of manganese greensand filter media. And the last, further research is needed regarding wastewater temperature control during the treatment process.

Acknowledgement

I would like to express my gratitude for the kindness of Pojok Laundry's owner, who gave me the permission to carry out my study on their place.

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