Removal Of Bod And Cod Concentration In Wastewater Using Constructed Wetland

Mutia Febry Haryani, Melati Ferianita Fachrul, Rositayanti Hadisoebroto

Abstract: Wastewater from household activities which is directly discharged into the sewers in settlements can be the cause of surface water pollution, which in turn has a harmful impact on the community This study aims to analyze the removal concentration of BOD and COD organic matter in household wastewater before being discharged into the river flow. Wastewater that directly enters the river can cause river water pollution, and thus it needs to be treated. The treated wastewater comes from residents' domestic activities in RW 08, Srengseng Sawah Village, South Jakarta. Treatment conducted using Constructed Wetland with a Sub-Surface Flow (CW-SSF) system with Echinodorus palaefolius and Vetiveria zizanioides plants. The method used to acclimatize the plants and then move the plants to the SCW-SSF unit, then analyze the quality of wastewater with a detention time of 2 days. The statistical calculation in this study used Analysis of variance. The result of this study shows that the removal efficiency of the BOD concentration is 50% while the COD concentration is 25%. This shows that treatment with constructed wetland can be used to remove the concentration of BOD and COD in grey water from domestic activities.

Index Terms : Domestic wastewater, BOD, COD, Echinodorus palaefolius, Constructed Wetland, Removal, Vetiveria zizanioides

1 INTRODUCTION

Waste water is a liquid or waste from households, industries and other public places that contain materials that can endanger the lives of humans and other living things and interfere with environmental sustainability [1]. Domestic wastewater is water that has been used by humans and contains all the ingredients added to the water during its use [2]. Wastewater from household activities which is directly discharged into the sewers in settlements can be the cause of surface water pollution, which in turn has a harmful impact on the community. In addition, other human activities such as industrial activities, agriculture and animal husbandry can also produce wastewater. According to UN WWAP, wastewater generated from human activities in the world can reach a volume of around 1,500 km3 per year [3]. The large amount of wastewater that enters the water body can be a serious problem in the surface water ecosystem, which is the river that will flow into the sea, as it is known that most people in Indonesia in general still use river water [2]. Domestic wastewater can be divided into 2 types, namely blackwater that comes from toilet waste, which amounts to 20% of total wastewater, while greywater is wastewater that comes from kitchens, bathrooms, and laundry waste totaling 80% of total wastewater [5]. Wastewater that generally enters the river is greywater wastewater which is discharged directly into the drain and finally into the river. Polluted rivers will result in loss of ecological balance in the river flow, and therefore can cause various losses for living creatures around it as well as humans. Therefore, before the water enters the river body, domestic wastewater should be treated to reduce the level of pollutants contained in the wastewater.

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Treatment can be initiated by knowing the condition of water quality by conducting water quality testing based on the physical chemistry of water, in which later would be able to clearly understand the effects caused by human activities [6]. One of the inexpensive and efficient processing that can be applied in cities in Indonesia is with constructed wetland technology. Constructed wetlands is a wastewater treatment system process which uses the performance of plants and planting media. The constructed wetlands have 2 types of flow systems namely surface flow and subsurface flow [7]. Constructed Wetland Surface flow type is the surface flow where water flows above the planting medium with plants floating above the surface of the water, while subsurface flow is where water flows under the surface through the pores of the growing media, such as gravel and soil [7]. Based on the flow pattern, constructed wetlands have 2 types, namely horizontal and vertical. Constructed wetlands is one of the waste treatment systems that is designed and built involving water plants and growing media. Wetlands are divided into 2 types namely surface flow which is the surface flow where water flows over the media with plants floating above the water surface. Sub surface flow is the flow under water where water flows below the surface through cavities in the planting medium [8]. Vertical flow in constructed wetlands is often used to treat domestic wastewater, especially for the allowance limit for ammonia-nitrogen [9]. Plants can be used for phytoremediation through various physiological processes that allow metal tolerance and absorption capacity [1]. Plants that can be used as phytoremedians are Echinodorus paleafoliu and Vetiveria zizanioides are aquatic plants that are known to reduce metal content in wastewater [10]. The process of plants in reducing pollutant levels is a symbiosis with microorganisms that convert complex compounds into simpler compounds and are used by plants as nutrients. Vetiveria zizanoides is well known as an eco-frendly plant that prevents soil erosion and rehabilittates metalliferous polluted land, vetiveria zizanoides is als the major source of vetiver oil for medicine and perfumery [4]. Echinodorus palaefolius is also well known or its capability in reducing nutrients of domestic wastewater [11] Famous aquatic plants can reduce concentration levels of pollutants in the environment. Some water plants that can absorb heavy metals include water hyacinth, kayambang, lotus and others. Aquatic plants can reduce levels of heavy metals including chromium (Cr) in the

waters. Besides water, plants also play a role as a provider of oxygen for the decomposition of pollutants [12]. Most of the carbon values that enter the constructed wetlands will be used by microorganisms, and the mineralization process carried out through aerobic microbial respiration requires more organic carbon available in wastewater than anaerobic microbial respiration [13]. The key parameter in domestic wastewater is BOD and COD levels which are measurements of the amount of oxygen needed to oxidize organic compounds both biologically and chemically [6]. This study aims to determine the effectiveness of constructed wetlands in reducing the concentration of BOD and COD in greywater wastewater.

2 RESEARCH METHOD

This research was carried out in an constructed wetland located on Jalan H. Shibi, Srengseng Sawah Village, Jagakarsa District, South Jakarta, Indonesia. The media contained in constructed wetlands are river stone, gravel, sand, and soil which have a thickness of 30 cm each. Figure 2.1 is a picture of sewage treatment of constructed wetland vertical flow type with subsurface flow system

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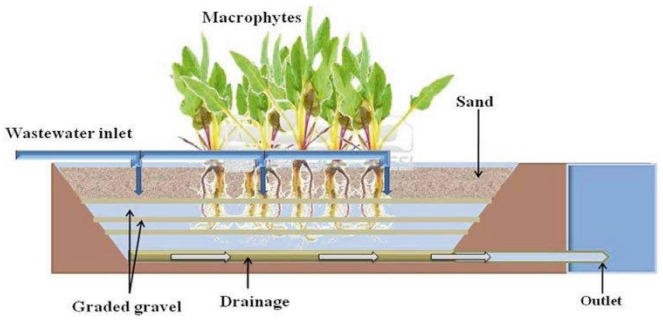

Fig. 2.1 *Constructed Wetland Subsurface Flow system with vertical flow type*

The study was conducted using aquatic plants Echinodorus palaefolius and Vetiveria zizanioides. The total number of aquatic plants used is as many as 40 plants with each type as many as 20 plants. Spacing between plants is 25 cm. The research was carried out with the initial stages of acclimatization of Echinodorus palaefolius and Vetiveria zizanioides, using wastewater and clean water at a ratio of 25%: 75%, 50%: 50%, 75%: 25%, 100%: 0%. This acclimatization is carried out for approximately 14 days. After acclimatization, the plants are moved to constructed wetlands. Then the plants were re-acclimatized in the constructed wetlands for approximately 14 days. In this study, 2 liters of water samples were taken in the morning at 08.00 - 10.00 WIB at the inlet and outlet points with a detention time of 2, 4 6 and 8 days, water samples were analyzed at the Trisakti University Environmental Laboratory, Jakarta on BOD parameters and COD, the analysis was conducted with 2 repetitions. The results of the analysis are compared with the Quality Standards stipulated by the Minister of Environment and Forestry Regulation No. P.68/Menlhk/Setjen/Kum.1/8. 2016 concerning the domestic wastewater quality standards.

3 RESULT AND DISCUSSION

3.1 Stages of Plant Growth in Constructed Wetlands Units

This research begins with the process of observing the growth of plants that have been placed on constructed wetlands. At this acclimatization stage, it is carried out for 14 days before the plants are planted in an constructed wetland, while the observation time has an interval of 3 days. Observation at this stage can be seen from two aspects, namely plant height and number of leaves. At this observation stage the plants obtained the results that the height range of the Vetiveria zizanoides plant was 31 cm - 45.5 cm while the Echinodorus palaefolius plant had a range namely between 19 cm - 31.5 cm. Based on the number of leaves, Vetiveria zizanioides has a range of leaves, namely an average of 8.5 - 13.5, whereas for Echinodorus palaefolius plants an average of 4 - 8.5. Based on these observations, it can be seen that plants have good resistance to growing in polluted water conditions. Figure 3.1 is the location of plants in an constructed wetland.

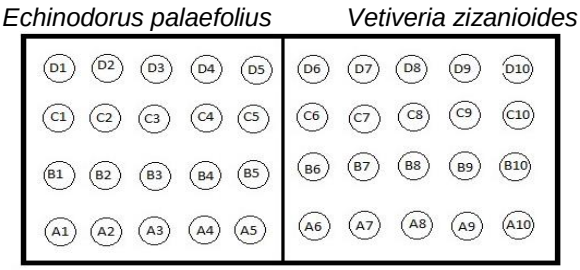

Fig. 3.1 *Plant Location on Constructed Wetlands*

3.2 BOD Concentration

Laboratory analysis results for BOD concentrations can be seen in Figure 1 and Table 1. In the above results show that the BOD parameters have decreased during the treatment. The greatest decrease occurred at a detention time of 4 days namely 229.77 mg/L, while the lowest decrease was at a detention time of 6 days amounting to 137.5 mg/L. The highest percentage of BOD removal was at a detention time of 6 days which reached 46.37%. The reduction in BOD levels still does not meet the quality standards set in the government. The regulation explained that the waste water quality standard for BOD parameters was 30 mg/L [14]. The decrease that occurs in domestic wastewater treatment is due to bacteria and microbes found in soil and plant roots working to set aside BOD parameters. Organic load that can be set aside that is equal to 532.8 kg/Ha/day to 1300 kg/Ha/day. Research conducted using Chrysopogon Zizanoides, Thypa Angustifolia, and Cyperus Papyrus plants with effluents derived from synthetic wastewater obtained the highest reduction results reaching 46.53 mg/L with the percentage reduction in BOD concentration levels of 61.54% [15].

3.3 COD Concentration

Regarding the results of the analysis of COD concentration can be seen in Table 2 and Figure 2. The results of the laboratory analysis showed a decrease in the highest COD concentration at the outlet namely at detention time 0 day at 128 mg/L. In Table 2, the highest decrease in COD parameters is seen at 4 days stay by 27.22%, while the lowest is at 2 days stay at 9.52%.However, this reduction still does not meet the quality standards stipulated by the Minister

of Environment and Forestry Regulation No. P.68/Menlhk/Setjen/Kum.1/8. 2016 concerning the domestic wastewater quality standards. The regulation explained that COD concentration allowed to enter water bodies were 100 mg/L [12]. Organic load that can be set aside is equal to 224 kg/Ha/day to 640 kg/Ha/day. In a study conducted the efficiency of reducing COD levels with Thypa Angustifolia plants was found. The highest percentage reduction in COD was 91.8% and the lowest was 18.4%. Efficiency of removal of wastewater content depends on concentration and length of time held in constructed wetlands [8].

3.4 Unit Control Analysis

In the control unit, constructed wetlands are not planted with plants. This analysis was conducted to compare the performance of constructed wetlands without plants against using plants. The results of laboratory analysis for the control unit obtained a COD concentration removal of 33% on the third day, while the BOD concentration removal results were 35% on the fifth day. These results indicate that wetlands planted with plants have a fairly good removal. In previous studies it was found that the results of laboratory tests with COD and BOD concentration have decreased as much, COD up to 26.22% and for BOD has a decrease in value of up to 38.60%. It can be seen that the efficiency of wastewater treatment systems with constructed wetland technology is one alternative that is quite effective to reduce levels of pollutants such as BOD and COD before entering the river.

TABLE 1
Laboratory Test Results BOD Concentration

Retention time (day)	Result (mg/L)		Removal (%)
	Inlet	outlet	
0	259.74	206.46	
2	250	185.0	28.77
4	256.41	229.77	8.09
6	187.5	137.5	46.37
8	232.5	177.5	5.33

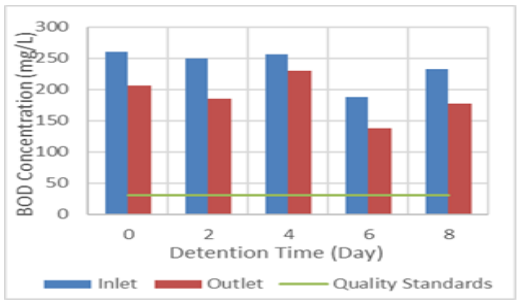

Fig. 3.2 *Removal of BOD Concentration (mg/L)*

TABLE 2
LABORATORY TEST RESULTS COD CONCENTRATION (MG/L)

Retention Time (day)	Result (mg/l)		Removal (%)
	inlet	outlet	
0	139.2	128.0	
2	156.8	124.8	10.34
4	134.4	113.6	27.55
6	139.2	120.0	10.71
8	134.4	115.2	17.24

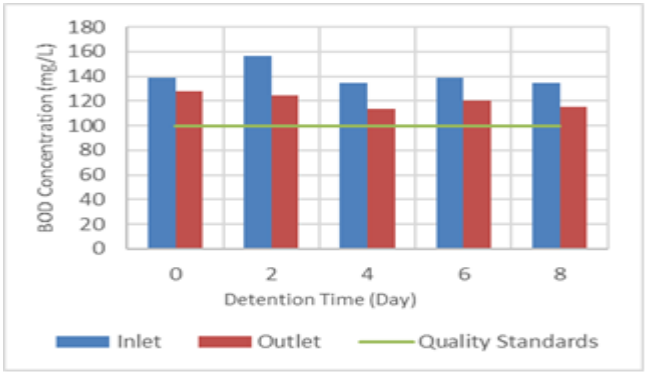

Fig. 3.3 *Removal of COD Concentration (mg/L)*

4 CONCLUSION

The results showed that the highest BOD removal reached 46.37% which occurred at 6 days detention time. The highest allowance for COD concentrations has a value of 27.22% which occurs at the detention time of 4 days. The BOD concentration removal does not meet the quality standards of the Minister of Environment and Forestry Regulation No. P.68/Menlhk/Setjen/Kum.1/8. 2016 concerning the domestic wastewater quality standards. However, this study shows that there is a decrease in the value of BOD and COD concentrations of greywater in domestic wastewater without primary treatment.

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