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Research article

The Effectiveness of Reducing COD, TSS, and Detergent using Banana Stem Filter Media in the Wastewater Treatment of Motor Vehicles Waste Treatment

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Abstract

The development of the area around the river continues to increase in line with the pace of development to improve community welfare. Likewise, with small-scale motorized vehicle washing businesses that are widely located on the riverbank, if there is no processing, there is a concern that it will also pollute the river. One of the requirements for an effective wastewater treatment plant is minimal maintenance and costs and safe and easy operation. The cellulose content and hygroscopic ability of banana stems make banana stems usable as a porous medium. Based on previous research, banana stem filter media can reduce TSS concentration and detergent for motorized vehicle washing wastewater. This research uses descriptive quantitative research methods. The test variables were the concentrations of COD, TSS, and detergent. This study aims to design WWTP using banana stem filters and to determine the effectiveness of WWTP in reducing the test parameters. The analysis results show that the WWTP of banana stem filter media can be used to treat motorized vehicle washing wastewater with an average value of the effectiveness of reducing the overall test parameters by 51%. The percentage of the best reduction effectiveness was 77% in the TSS parameter on day 4. The average reduction effectiveness of each COD parameter was 48%, TSS 55%, and detergent was 51%.

Keywords: *wastewater treatment plant; filtration; filter media; banana stem*

1. Introduction

River water has an important function in meeting various community needs, including as a source of raw water, a means of water transportation, and business activities. The development of the area around the river continues to increase in line with the pace of development and community welfare improvement. Likewise, small-scale motorized vehicle washing businesses are widely available on the riverbank. Liquid waste from washing motor vehicles disposed of directly into the river has increased river water pollutant content (Kusumawardani et al., 2019). Increasing the level of pollution in water bodies, especially river water, will undoubtedly worsen the environment's quality.

There are three ways or processes in wastewater treatment, including biological, physical, and chemical treatment processes. According to (Ikhwan, 2017), physical processing and biological processing are the simplest processing and do not require much money. Several things that need to be considered in choosing wastewater treatment technology are the quality of treated water, the amount of

treated wastewater, easy technology management, the presence of energy sources and land availability, and affordable operating and maintenance costs. In selecting a process or method of treating wastewater, it is necessary to pay attention to technical aspects, economic aspects, environmental aspects, and human resources who will manage it because each type of technology has its own advantages and disadvantages.

Filtration is a process of filtering or purifying wastewater through filter media or porous materials to remove suspended fine solids and colloids (Rahayu et al., 2015). Wastewater Treatment Plant, commonly referred to as IPAL is a form of technology designed to treat wastewater instead of polluting the environment and reusing it. One of the requirements for an effective WWTP includes minimal maintenance and costs and safe and easy operation (Iskandar et al., 2016). The use of filter media or filter is a filter tool that separates the solid-liquid mixture from porous media or porous material to divide the finest amount of suspended solids (Syahrir & Gani, 2020).

Based on previous research, the use of banana stem midribs and water hyacinth can neutralize waste chemicals, such as heavy metals, and control the COD (Chemical Oxygen Demand) value so that water quality is better, especially pH becomes stable and DO (Dissolved Oxygen or oxygen) dissolved) remains (Prabawati & Wijaya, 2008). This study aims to design a wastewater treatment plant using banana stem filters and to analyze the effectiveness of the IPAL in reducing TSS, COD, and detergent concentrations. While the target obtained is the existence of motorized vehicle washing wastewater treatment technology that can overcome environmental pollution. This research can provide an alternative to using organic filter media that is easy and inexpensive for plants that are widely available around the community to treat motorized vehicle washing wastewater.

2. Metodhology

This experimental research uses quantitative descriptive methods to analyze the effectiveness of using the equipment design as WWTP in treating liquid waste from washing motor vehicles. The research dependent variable used in the Portable Wastewater Treatment Plant (WWTP) design test is the concentration of TSS, COD, and detergent. The filtration media uses dried banana stem material with a thickness of 50 cm and a down upflow system. The banana stem used in this research is the Kepok banana stem that has been fruitful and is taken from the middle of the banana tree.

WWTP Design Specifications:

Banana filter media thickness = 50 cm
WWTP tube height = 60 cm
WWTP tube diameter = 10 cm
Distance between Tubes = 10 cm
Complete WWTP accessories : Inlet, Outlet, Washout, Cover

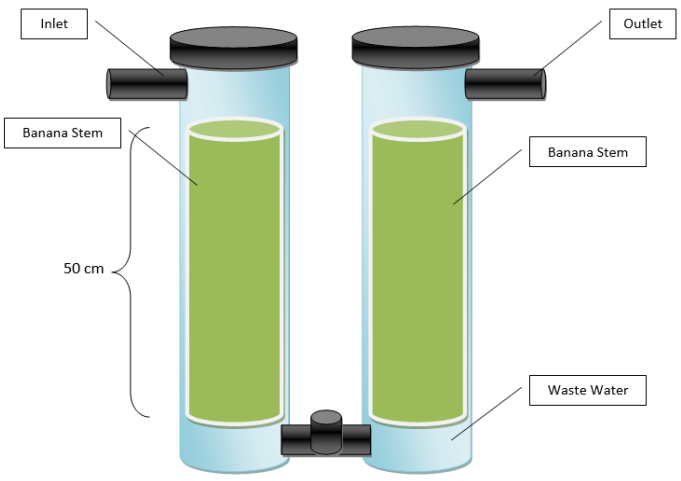

Figure 2. Sketch and Design of Portable WWTP

For six consecutive days, water sampling was carried out to determine the banana stem filter media's durability in treating wastewater. This research's wastewater parameters were analyzed in the laboratory based on the analysis of the Indonesian National Standard (SNI) test for each of the test parameters as follows; TSS SNI 06-6989-2004, COD SNI 6989.73: 2009, detergent SNI 06-6989.51-2005. The calculation of the effectiveness of decreasing parameters is as follows: = E = (Co-C) / Co x 100% Where: Co = initial concentration and C = final concentration.

In the filtration process, chemical and biological activities occur. This biological activity contains the interaction of bacteria that live in the filter layer, where one of the factors supporting these microorganisms' activity is the temperature parameter. However, this research focuses more on the physical process of wastewater filtration. From the results of previous study, the temperature conditions tend to be uniform and not too influential in the physical filtering process (Kusumawardani et al., 2019).

3. Results and Discussion

Water used from washing motor vehicles in general will contain several pollutants such as detergents and other hazardous materials (Mustafa, 2012). The characteristics of the wastewater used as a test material for the design and construction of motorized vehicle washing WWTP are as follows:

Table 1. Concentration of Household Scale Motor Vehicle Washing Wastewater based on Central Java Regional Regulation Number 5 of 2012

No	Parameter	Concentration (mg/L)	Threshold value (mg/L)
1.	COD	2.272	100
2.	TSS	358	100
3.	Detergen	276	5

Based on the Central Java Regional Regulation Number 5 of 2012 concerning Wastewater Quality Standards, the data on the concentration of wastewater in Table 1 above are still above the threshold value. The high content of pollutants in wastewater can certainly cause the amount of dissolved oxygen in the water to decrease. According to (Chrisafitri & Karnaningroem, 2012) waste water from washing motor vehicles is generally in the form of dirt such as dust or dirt, as well as detergent foam (surfactants). The concentration value of organic and inorganic content in wastewater can be determined by measuring TSS and COD concentrations (Setyobudiarso & Yuwono, 2014). So that the decrease in TSS, COD and detergent can represent the parameters of waste water from motor vehicle washing.

The part of the banana tree that is rarely used or utilized is the banana trunk. Banana stems, which function as filter media in small scale WWTPs, contain cellulose and high hygroscopic capabilities. The high cellulose content allows it to be used as an absorbent medium (Prabawati & Wijaya, 2008). Hygroscopic properties are useful for absorbing harmful inorganic chemicals in water media (Edahwati, 2010). Based on previous research, banana stems have the potential as a direct filter media for wastewater treatment and the results are quite effective in reducing TSS parameters and motor vehicle washing wastewater detergents (Kusumawardani et al., 2019).

The wastewater treatment plant (IPAL) is a design of equipment and equipment and its equipment designed to process wastewater. According to (Adella, 2017) portable IPAL is an individual treatment before waste water is discharged into the water body through an open channel so that the resulting effluent does not damage the surrounding environment. Among the functions of WWTP are to treat wastewater, which contains pollutants and chemicals. So that the waste water that will be disposed of in the future does not pollute the environment. In this study, the test parameters of the performance

of portable WWTP were the decrease in TSS, COD, and detergent parameters. The following are the results of the outlet wastewater test.

Table 2. Wastewater Test Results after passing WWTP

No.	Parameter	Day-						Mean
		1	2	3	4	5	6	
1.	COD	989	842	1178	1347	1010	774	1023,3
2.	TSS	228	184	94	82	136	212	156,0
3	Detergen	86	129	115	106	83	108	104,03

a. COD

COD (Chemical Oxygen Demand) is an indicator of water pollution caused by organic content. The existence of COD concentration values in the environment is determined by organic waste originating from motor vehicle washing waste. The following is a graph of the effectiveness and value of COD in the study.

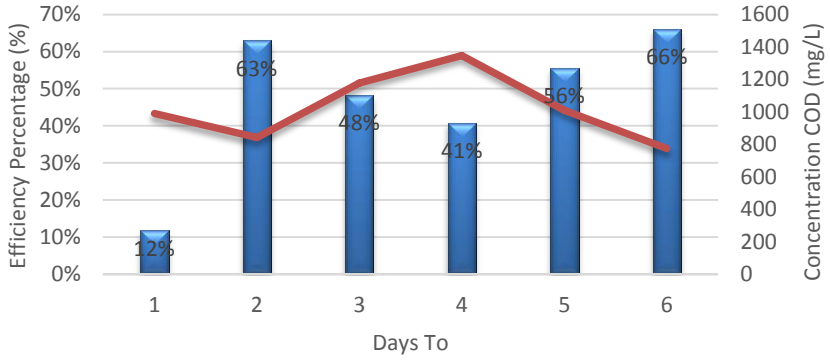

Figure 2. Diagram of the percentage of COD reduction effectiveness

COD measurements were measured for 6 consecutive days. The lowest COD concentration was on the sixth day with a COD concentration of 774 mg/l. The highest COD concentration on the fourth day was 1347 mg/l. The lowest COD reduction effectiveness percentage of 12% occurred on day 1 and the highest was 66% on day 6. This shows that the presence of banana stems as the IPAL filter media has an effect on the COD removal process from motor vehicle washing waste. However, the reduction is less effective and is still above the threshold value of the quality standard. This is made possible by the influence of biological processes from banana stems and the high percentage of organic matter in banana stems (Kusumawardani et al., 2019). On the second day, the COD concentration decreased to 63% but decreased again the percentage of its effectiveness on the 3rd and 4th days by 48% and 41%. The percentage of COD reduction effectiveness looks quite dynamic and does not show a relationship between the length of time of the filter media and its COD concentration. According to previous research, the amount of COD concentration in the input tends to be dynamic and continues to change along with variations in the conditions of the raw water, so that the COD parameter removal value also changes (Kusumawardani & Astuti, 2019).

b. TSS

One of the important parameters in domestic wastewater quality standards is the total suspended solids (TSS). The total suspended solid is a solid in solution but is not dissolved, causing a cloudy water condition. Following are diagrams and graphs of TSS concentration in the study.

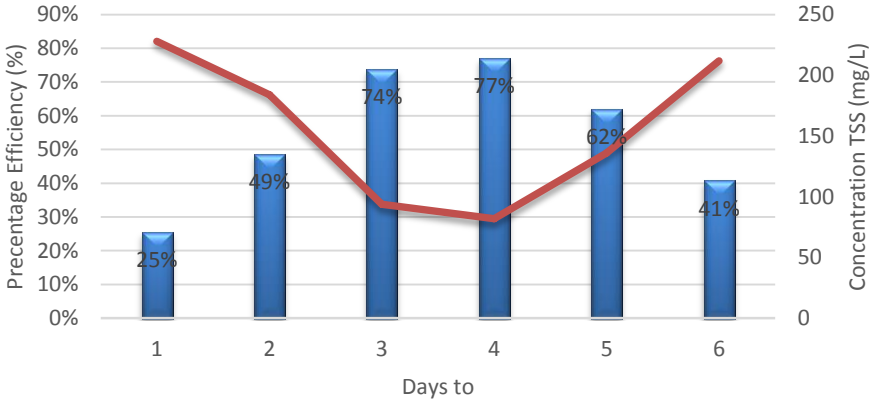

Figure 3. Diagram of the percentage of effectiveness of TSS reduction

The results showed that TSS concentration decreased on days 3 and 4 with a concentration value of 94 mg/L and 82 mg/L and the percentage effectiveness of the decrease was 74% and 77%. From the diagram image, the percentage of effectiveness of the decrease in TSS parameters above shows a convex curve where there is an increase in the initial phase, then decreases. The percentage at the beginning of day 1 was 25%, then increased to 77% on day 4, then decreased in percentage until day 6 with a percentage of 41% and TSS construction of 212 mg / L. The concentration of TSS in wastewater after passing through WWTP with banana stem filter media on the 3rd and 4th day is in accordance with the quality standards of the Central Java Provincial Regulation Number 5 of 2012. However, on the 5th day, it has decreased performance, so that the best decline occurred on day 5, 4.

The process of filtration of wastewater through WWTP of banana stem filter media occurs by gravity downflow upflow on the entire surface of the media. The filtering process is a combination of physical processes (filtration, sedimentation, and adsorption), biochemical processes, and biological processes (Josephinne et al., 2009). Several mechanical methods play a role in water treatment, namely: mechanical straining, sedimentation, adsorption, biochemistry, and bacterial activity or the biological process (Nisaul & Notodarmojo, 2010). It does not seem to work optimally at the beginning of the filtration process because the filtration processing processes such as mechanical straining, sedimentation, and biological activities have not been formed and running optimally.

c. Detergent

Detergent is generally applied as a cleaning agent to remove dirt or dust from clothes or other objects. Detergent base ingredients are organic materials that have surface-active properties in liquids so they are called surface agents or commonly known as surfactants (Nuringtyas, 2007). The following is a diagram of the effectiveness of the percentage reduction in test parameters.

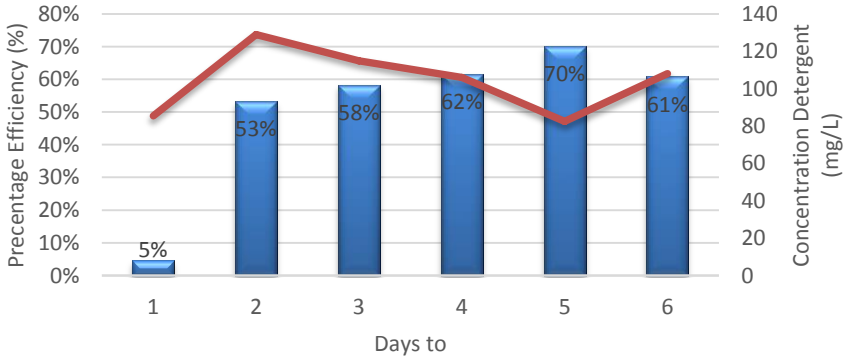

Figure 4. Percentage diagram of detergent reduction effectiveness

The results showed that the detergent parameter had a small decrease on the first day, then increased on the 2nd to 5th day with the highest percentage of effectiveness of 70%. The detergent concentration value in the wastewater test results is 83 mg / L to 129 mg / L where this value still exceeds the predetermined quality standard threshold. The chemicals in detergents can negatively impact both health and the environment (Setyobudiarso & Yuwono, 2014). The original wastewater's existing initial detergent concentration is relatively high, with a 276 mg/L attention.

In the processing process through IPAL, banana stem filter media, the percentage of efficiency reduction is quite good because it is more than 50% and the highest reaches 70%. Still, the allowance has not reached the quality standard according to existing regulations. The percentage value of up to 70% is due to the increasingly better filtration process. There is a combination of several processes such as mechanical screening, sedimentation, and adsorption. The high concentration of detergents in motor vehicle washing wastewater is because detergents are the primary pollutants in motor vehicle washing waste. The function of detergents that contain surfactants is to clean, float, dissolve, and prevent stains and antibacterial. According to (Rizki & Agung R, 2020), the detergent content consists of surfactants such as LAS (Linear Alkyl Benzene Sulfonate), which reduces surface tension the water, so that it can release dirt that sticks to the surface of the material.

d. Decreasing Effectiveness of COD, TSS and Detergent Parameter

This study aims to analyze the effectiveness of using WWTP with filter media from banana stems to reduce the concentration of TSS, COD, and detergent. The following table is a summary of the percentage of the effectiveness of WWTP performance in reducing the test parameters which include COD, TSS and detergents.

Table 3. Percentage of WWTP Performance Effectiveness

No.	Prosentase	1	2	3	4	5	6	Rata-rata
1.	COD	12%	63%	48%	41%	56%	66%	48%
2.	TSS	25%	49%	74%	77%	62%	41%	55%
3.	Deterjen	5%	53%	58%	62%	70%	61%	51%
	Rata-rata	14%	55%	60%	60%	63%	56%	51%

From the table above, the best percentage of WWTP performance effectiveness is the decrease in TSS parameters by 77% on day 4, then for COD parameters by 66% on day 6 and detergent / MBAS parameters by 70% on day 5.Percentage graph the effectiveness of the IPAL performance mentioned above appears to be quite a dynamic change. Where at the beginning of the screening process on the first day, the performance of WWTP has shown a decline but not so good, the average has only reached 14% with details of the percentage of effectiveness in reducing COD parameters 12%, TSS 25%, and 5% detergent. The parameter of total suspended solids (TSS) is a fine material in water containing silt, organic matter, microorganisms, industrial waste and household waste whose weight can be determined after filtering with filter paper measuring 0.042 mm (Hariyanto & Budianto, 2018). The results of previous research also stated that the process of treating wastewater using banana stem filter media for 1 day provided a fairly good percentage of TSS parameter reduction (Kusumawardani et al., 2019).

On the second day, the effectiveness of WWTP performance in all variables increased. Based on the data analysis, it shows that the longer the detergent concentration remains, the decreasing will be. Likewise, the COD and TSS parameters also showed a decrease. The average percentage of effectiveness in reducing TSS, COD and detergent parameters in the banana stem filter media showed the best results on day 5. This is because in the process of filtration and water treatment, the process of removing pollutants in wastewater has been running optimally both mechanically. , precipitation (sedimentation) and biological activity (biological action). According to previous research, the COD value of raw water, in this case wastewater, tends to be dynamic and continues to change along with variations in the

conditions of the motorized vehicle washing waste water, resulting in changing COD parameter removal values (Kusumawardani & Astuti, 2019).

4. Conclusion

The wastewater treatment plant (IPAL) with banana stem filter media can be used to treat motor vehicle washing wastewater with an average value of the effectiveness of reducing the overall test parameters by 51%. The test parameter with the best percentage reduction effectiveness value was 77% on the TSS parameter on day 4. The average reduction effectiveness of each parameter was as follows; COD is 48, TSS 55%, and Detergent is 51%. The analysis of the wastewater sample's test results shows that most of the phases of the effectiveness of the reduction increase from the first day then the best on the 4th and 5th day then decrease on the 6th day.The existence of the technology of motorized vehicle washing wastewater treatment plants (IPAL) can provide an alternative to applied technology. to small-scale motorized vehicle washing service entrepreneurs to use IPAL with organic filter media from banana stems which is cheap, easy and lightweight for motor vehicle washing wastewater treatment that can overcome environmental pollution.

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