Laundry Waste Treatment for Decreasing BOD Levels Using the Household Filtration Model in Malang City

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Abstract. Indonesia is a developing country with a high population growth yearly. This has resulted in many students entering a productive age throughout Indonesia. Based on the Central Bureau of Statistics, in 2021, there were 3,115 public and private tertiary institutions with 7,665,516 active students: especially in Malang City. The high number of students in Malang City also affects the growth of the laundry business. Therefore, this study aims to create a filtration model to reduce the levels of BOD contained in laundry waste in Malang City. The method used is an experiment using ten samples of laundry waste in Malang City. Measurement of BOD levels will be carried out before and after filtration. In this study, the filtration model uses two filters with the letter L model. The statistical test used was the Wilcoxon test to see the difference before and after filtration using the filter model. Based on testing of 10 samples of laundry waste in Malang City, it showed that the BOD content of all samples exceeded the quality standard of 30 mg/l. To see the differences before and after filtration, the Wilcoxon statistical test resulted in a p-value of 0.022 with an alpha of 0.05, so there were differences in BOD levels before and after filtration. The average BOD in 10 laundry waste samples before filtration was 257,939 mg/l, and after filtration was 172,209 mg/l. Based on the results of the tests carried out, it was found that there were differences in BOD levels before and after filtration using the filter model that was made. In addition, from an average of 10 laundries, there was also a decrease of 83 mg/l. Even though the BOD level after filtration was still above the quality standard, the reduction was quite significant.

Keywords: BOD, Filtration Model, Laundry Waste

1 Introduction

Indonesia is a developing country that has a high population. Based on data from BPS in 2023, it shows that Indonesia's population is 277 million people and is ranked 4th in the world. Indonesia will face a "demographic bonus" in 2030 - 2040, that will be increase in economic growth characterized by high rates of productive age, financial independence, and a decline in the young population [1]. With the increase in population, of course the community's educational needs will also increase. Based on data from the Central Statistics Agency, in 2021 there are 3,115 state and private universities

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with 7,665,516 active students. Especially in Malang City, in 2021 there are 33 universities with 251,902 active students. This is one of the reasons for the large number of laundry industries in Malang City. Industrial laundry is not only close to the world of education, but also covers several sectors like hotels, hospitals, offices, and housing areas. Quoted from the Investor.id page, it is revealed that the laundry business in Indonesia increase from 2021 to 2022 by 50%. Industrial laundries are the one of industry that has rapid growth in Malang city every year.

Water has played the main role in industrial laundries. Based on research from [1] on average, industrial laundries use 15 Liter water to process 1 kg and produce 400 m3 wastewater that we call grey water. Whereas based on preliminary study in industrial laundries in Malang city, there are 63 kg of clothes per day in their production which end up with wastewater [2]. Industrial laundries are the one of the largest industries that produces wastewater. Water scarcity, water contamination, water pollution, and insufficient water still be the most challenging global issues especially in Indonesia as a developing country [3]. Generally, in Indonesia laundry waste is dumped directly into river or onto the ground, which impact on biological system, groundwater, water in the river that in some place still use it as clean and drinking water [4]. Laundry waste is bad for the environment and for people's health. High surfactant and COD concentrations decrease LD50 that indicates laundry wastewater becoming increasingly toxic and risk to the environment [5].

Laundry wastewater contains soap, soda, and detergent that are used to remove grease, dirt, and starch from clothes and garments. Laundry procedures include starching, bleaching, bluing, and white work washing in addition to various specific procedures for wool, silk, and other materials [6]. Laundry wastewater contains so many kinds of chemical hazards like surfactant, phosphate, COD, BOD, pH, high level turbidity, nitrate, nitrite, allergenic fragrance, and others [2]. Not only it, but other chemicals also contain in laundry waste like sodium, potassium, calcium, magnesium, fats, oil, greases, and suspended solid [6]. Wastewater management should be applied in this condition, one of them using filter.

COD, phosphate, and surfactant can be removal from laundry wastewater using coagulant [7]. Based on [8] wastewater treatment using cost effective and locally available materials like alumina, hydrated silica, natural adsorbent like waste wood, bagasse fly ash, coconut-hay carb, and peat can be effective removal percentages of suspended solid, pH, surfactant, BOD, COD, total nitrogen, and total phosphorus. BOD that can removal up to 79% till 83%. Based on Malang city condition, we want to create prototype of filtration using conservational and easy material so can decrease BOD in laundry wastewater before throwing it away in land or river. We focused on how to remove or decrease BOD levels from laundry wastewater before throwing it to the river or land. Laundry wastewater in Malang city will be treated using filter, so can produce an effluent that complies with water reuse and discharge standards.

2 Methods

This research method used an experimental study through making filtration prototypes. The filtration prototype uses simple materials that are cheap and easy to obtain, which are formed into two filters with an L-shaped design. In the first filter, the materials used include palm fiber, silica sand, black sand, zeolite stone, and natural adsorbent in the form of activated charcoal, and cotton. Meanwhile, the second filter uses the

same material as the first filter, but in a different order. The order of materials used are cotton, activated charcoal, zeolite stone, black sand, silica sand, and cotton. The laundry waste samples used were from ten business units in the area around the center of Malang City. Laundry waste collecting samples are taken using sterile containers and stored in a cool box when distributed to the laboratory for testing BOD levels. Testing for BOD levels is carried out before and after filtration using the filters. The laundry wastewater used for each test is 1 liter. The statistical test used was the Wilcoxon test to see the difference before and after filtration using the filter model.

3 Results

On laundry wastewater collecting from ten sample laundries industry in Malang city, we found that average textile that laundry per day is more than 20 kilograms.

Fig. 1. Textile laundry per day in kilograms

Based on Figure 1. Textile laundry per day in kilograms, show that so much textile laundry. Every laundry industry produces much water from this activity and will be wasted. This condition means the wastewater produced is so high. If there is no treatment for the water, it will contaminate all the river and the land. Because based on observation, all the industry throws away the waste directly in the river or land.

Table 1. Result Test for BOD Before and After Filtration

Laundry Sample	Before Filtration (mg/l)	After Filtration (mg/l)
1	221.7	180
2	40.94	124.1
3	204.7	107.5
4	55.18	31.8
5	1096	811.4
6	123.8	97.45

Laundry Sample	Before Filtration (mg/l)	After Filtration (mg/l)
7	289.9	101.2
8	243.2	116
9	54.27	34.24
10	249.7	118.4
Average	257.939	172.209
P-Value	0,022	

Based on Table 1. Result Test for BOD Before and After Filtration shows that laundry sample number 5 has the most significant gap. The Biological Oxygen Demand (BOD) was high before filtration but decreased after filtration. Laundry wastewater sample number 5 usually carries out laundry activities for 12 hours a day, with clothes weighing 70 kg per day. The decrease in BOD pre- and post-filtration is almost 25% because of this simple filter. Based on the research, shows that there is a decrease of average from ten laundry wastewater to 85,73 mg/l. We analyzed this result using Wilcoxon ranked test with error alpha 5%, the p-value is 0,022. Based on statistical analysis shows that there is a different means between pre- and post-filtration.

4 Discussion

Ten samples laundry industry in Malang city has average for textile that washed about 64 kg every day, this implied 448 kg of tents is washed every week. This condition is still less than with study from [3] that assume 7178 kg every week. So, there will be so much wastewater that is used every day or every week. If the wastewater is not treated well that can be removal all the contaminant, these could potentially be released into the environment.

BOD is one of the most essential contaminants in water pollution control because it indicates the actual level of microbiological that is needed to degrade the pollutants in the water [9]. High concentration of BOD from laundry wastewater before treatment shows that the water was contaminated. Based on Regulation from East Java Governor Number 72-year 2013 tolerable wastewater quality standards for BOD maximum 100 mg/l. Wastewater quality standards are limiting pollutants and the amount of pollutant elements that are tolerated its presence in wastewater.

Raw wastewater quality for laundry activities with wastewater volume. High level from BOD is from detergent that they used [10]. In this study, established quality standards were used as a control, and this research puts more emphasis on the efficiency of laundry wastewater management using filtration. Based on research both pre- and post-filtration even still over the tolerable standard for laundry wastewater but there was significantly removing BOD levels after using the filtration.

Based on [11] filtration using palm fiber is very effective to decrease BOD levels in wastewater. That filtration can decrease BOD levels from 644,06 mg/l being 355,92 mg/l which means almost 50%. Palm fiber has 22,2% pores that can be used as filtration for wastewater. Hydrolysis is one of the processes where organic material utilized by microorganisms degrades. This study supports earlier studies from [9] that percentage of BOD removal almost 22% since using stone, gravels, coarse sand, and activated

charcoal. Another study has related conclusions that a filtration using charcoal and sand can reducing BOD levels and enhance water quality. Reducing BOD levels from that study about 91 mg/l [12]. This could be explained by the fact that the activated charcoal, which is also organic, is thought to have contributed to the BOD removing (9).

Laundry wastewater should be treated before being thrown away in the environment because the effect of chemical contaminants can threaten human health from groundwater, agriculture, and aquatic life [13]. This filtration is one of the processes to remove or reducing BOD from laundry wastewater. Even laundry wastewater treatment using this filtration cannot make BOD less than standards, but this filtration makes it possible to manage resources sustainability by reducing BOD. Because this filtration is a prototype, so should be improve. One of the most environmentally friendly methods for increasing agriculture output, clean water, energy production, and water conservation is a wastewater treatment [14].

5 Conclusion

Based on the results of the tests carried out, it was found that there were differences in BOD levels before and after filtration using the filter model that was made. In addition, from an average of 10 laundries, there was also a decrease of 85,73 mg/l. Even though the BOD level after filtration was still above the quality standard, the reduction was quite significant. Not only it, based on analysis using Wilcoxon ranked test this simple filtration can make a difference of BOD between pre-filtration and post-filtration. The recommendation should be made by improvising the filter model that has been made and filtering the laundry waste more than twice. In addition, public health is a key factor in the usage of the cleaned laundry wastewater. Another contaminant, both chemicals and biological should be check before and after treatment should be the subject of the next study to determine the risk associated with potential disease transmission. Hopefully, every laundries industry in Malang city can apply this treatment first before throwing wastewater in river or land.

Author's Contribution

MVH participated in experimental study for wastewater treatment and carried out about writing the manuscript. NHU and SA carried out about writing manuscript and review the manuscript, SK participated to arrange design method and statistical analysis. MNNA and SI participated in collecting data that get the wastewater from ten laundry in Malang city. PMD conceived of the study and participated design. CS and MR participated in arrange the chemical parameter that should be removing from laundry wastewater, and then, AS contributed in made the filtration model for laundry waste water.

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