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The Use of Rapid Sand Filtration (RSF) in treating Liquid Waste of Lambaro Fish Market Aceh Besar

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ABSTRACT. The fish market is one of the zones in the Lambaro fish market. Fishwashing waste in the Lambaro market is not treated but directly discharged into the drainage and then flows into the water body. Untreated fish market wastewater can cause environmental damage. One method that could be used to treat wastewater is using filtration. This study aims to determine the effectiveness of Lambaro fish market wastewater treatment using the *Rapid Sand Filtration* (RSF) method. This research uses the RSF method. Filter media in the form of activated charcoal, sand, palm fiber, and gravel are inserted into the filtration column with a residence time of 15, 30, and 45 minutes. Analysis of impurity removal, namely COD, TSS, and Turbidity. The results of this study for COD managed to remove 94.07%, TSS 89.86% and Turbidity 63.98%. In terms of environmental quality standards, this study succeeded in reducing COD and TSS pollutant parameters to below the quality standards of Permen LH 2014.

1. Introduction

Lambaro Market is one of the main markets in Aceh Besar District. Lambaro market consists of several market zones, including fish zone, meat zone, chicken zone, vegetable zone, and several other zones. Activities in the fish market zone produce waste water from washing and cleaning fish that is directly discharged into the sewer and then into the waters around the market. From initial observations, the waste from the Lambaro fish market is blackish-brown in color and has a foul odor. Liquid waste in the fish market is generated through cutting,

washing, and processing. The waste is in the form of small pieces of fish, entrails, skin, and fins that contain high protein, fat, organic substances, and nutrients that can pollute the environment (Widyawanti, 2021).

Fish washing wastewater can cause pollution of water bodies, which makes the water unusable for domestic use, industrial use, agricultural use, and fishing ponds. It is necessary to treat it first before discharging it into the environment to reduce the risk of environmental pollution from fish washing. The concentration of pollutants in fish wastewater must be reduced to meet quality standards so it does not pollute the environment. The quality standard of fish market wastewater is based on Permen LHK Number: 05 2014 concerning Wastewater Quality Standards. The quality standard of business wastewater and/or fishery product processing activities is shown in Table 1:

Table 1. wastewater quality standard of Fish Market

No	Parameter	Maximum Concentration	Unit
1	TSS	100	mg/L
2	Amonia	10	mg/L
3	BOD	100	mg/L
4	COD	200	mg/L
5	Oil and Grease	15	mg/L
6	pH	6-9	-

Source: Permen LHK Number: 05 Year 2014, regarding wastewater quality standard

Total Suspended Solid (TSS) and Total Dissolved Solid (TDS) are solids contained in liquid waste. According to Pinem (2019), Total Suspended Solid (TSS) is a solid that can cause water turbidity but is insoluble and cannot settle directly. pH (degree of acidity), which has a small value or is said to be acidic, will interfere with life in water if discharged into waters. Suspended solids consist of particles that are smaller in size and weight than sediment, such as clay, certain organic materials, and cells of certain microorganisms.

Organic substances in wastewater require oxygen and microorganisms to decompose them. Organic matter in wastewater is in the form of BOD (Biochemical Oxygen Demand) and COD (Chemical Oxygen Demand) (Saptati & Himma, 2018). BOD is the amount of oxygen required by microorganisms in aerobically decomposing the organic content in wastewater (Pinem, 2019). Meanwhile, COD is the amount of oxygen needed by microorganisms to oxidize organic content in wastewater through chemical reactions.

One method that can be used to treat fish-washing wastewater is the filtration method. Filtration is a very common method used to treat water, both waste and raw water. Filtration is a waste treatment system that is a process of separating solids from ethe fluid that carries them using a porous medium to remove as many suspended solids, colloids, and other substances as possible. The purpose of filtration is to remove suspended and colloidal particles by filtering them with filter media. In addition, filtration can effectively remove bacteria and also help with the removal of color, taste, odor, iron, and manganese (Said, 2005). Filtration is a process of separating a mixture of solids and liquids by passing the solids through a filter medium. The filtration process is widely practiced in industry, for example, in drinking water purification, separation of salt crystals from the parent liquid, paper mills, and others. In the filtration process, the feed flows due to the thrust in the form of a pressure difference, for example, due to gravity or rotary power. In general, filtration is done when the number of solids in suspension is relatively smaller than the liquid (Oxtoby, 2016).

Filtration technology is divided into two types, namely Slow Sand Filtration (SSF) and Rapid Sand Filtration (RSF). The RSF method is easier to use because it takes less time, and filter materials are easily obtained. RSF can reduce suspended solids, COD, BOD, and turbidity in water. Filter media that can be used include silica sand, fibers, and gravel. Furthermore, the RSF also requires light maintenance. In addition, RSF also has high

effectiveness. Oktavia et al. (2019) tested the effectiveness of BOD pollution in fish-washing wastewater using RSF in the Sidoarjo fish market. Results were obtained with a filter unit efficiency level of 95.58%. Then Rafiandy's research (2016) on the effectiveness of gray water treatment using RSF in reducing Turbidity, TSS, BOD, and COD was able to reduce TSS to 48.32 mg/L, turbidity 9.39 NTU, COD 143.25 mg/L, and BOD 104.18 mg/L.

This study aims to determine how effective the use of RSF is in removing COD, TSS, and turbidity in Lambaro fish wastewater with variations in residence time (HRT). This research is expected to be used to reduce the impact of environmental pollution from fish market wastewater.

2. Research Methodology

Sampling is by grab sample method where wastewater is taken only at that time, namely at 10:30 WIB. This research uses a quantitative approach, namely the experimental method, by analyzing TSS, COD, and Turbidity in fish washing liquid waste from Lambaro Market Aceh Besar before and after the study.

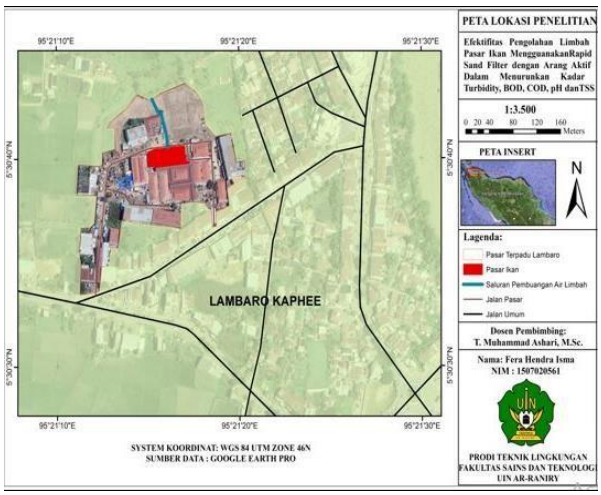

Figure 1. Sampling location map

The tools used in this research are pipe saws, containers, drills, jerry cans, gullets, and cutters.

The materials used in this study are a 3-inch PVC pipe, 0.5-inch PVC pipe, 3-inch pipe cap, pipe glue, faucet, Karsa wire, silica sand, activated carbon, gravel, and fibers.

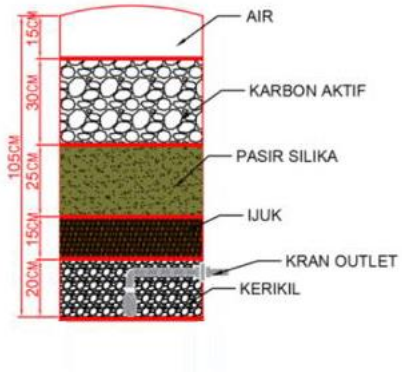

Figure 2. Sketch of the RSF Method Using Activated Carbon, Silica Sand, Palm Fiber, and Gravel Media

The work procedure carried out is firstly preparing a Rapid Sand Filter tub with 3-inch diameter PVC pipe material. Wastewater is put into the container filter unit, and then the wastewater is passed to a filter unit that already contains filter media. The RSF reactor has been prepared with a media height of 90 cm and a reactor height of 105 cm. The thickness of each filter media is as follows: 30 cm activated carbon, 25 cm sand, 15 cm palm fiber, and 20 cm gravel. Residence time in the RSF for 15, 30, and 45 minutes. Tests were conducted on COD, TSS, and Turbidity parameters before and after the study.

Figure 4. Rapid Sand Filter (RSF) Filtration Unit

The decrease in TSS, Turbidity, and COD levels is calculated by comparing the values before flowing into the RSF and after leaving the RSF. Expressed in percent (%). Determination of efficiency can use the Calculation:

$$EF = \frac{(Yi - Yf)}{Yi} \; x \; 100 \; \% \qquad (1)$$

3. Results and Discussion

Based on the results of laboratory examinations on the Lambaro Aceh Besar fish market wastewater sample, the parameter values of COD, BOD, TSS, and Turbidity are obtained, as shown in Table 2.

Table 2 Fish Market Liquid Waste Before Treatment

No.	Parameters	Testing Results	Quality Standard* (mg/L)	Description
1	COD	3224 (mg/L)	200	Does not meet
2	TSS	910 (mg/L)	100	Does not meet
3	Kekeruhan	311 NTU	-	-

Source: * Minister of Environment and Forestry Regulation Number: 05 of 2014 concerning Wastewater Quality Standards

From Table 2, it can be seen that the COD, BOD, and TSS parameters are above the wastewater quality standards based on the 2014 PERMEN LHK. Wastewater that is above this quality standard will endanger and pollute the environment if left in the environment. Therefore, the Lambaro fish market wastewater needs to be treated first to meet quality standards before being discharged into the environment.

3.1 COD Removal

Table 3 Results of RSF Treatment of Lambaro Fish Market Waste on COD Removal

Nr.	HRT (minutes)	COD (mg/L)	Percentage removal (%)
1	0	3224	-
2	15	898	72,14
3	30	647	79,93
4	45	191	94,07

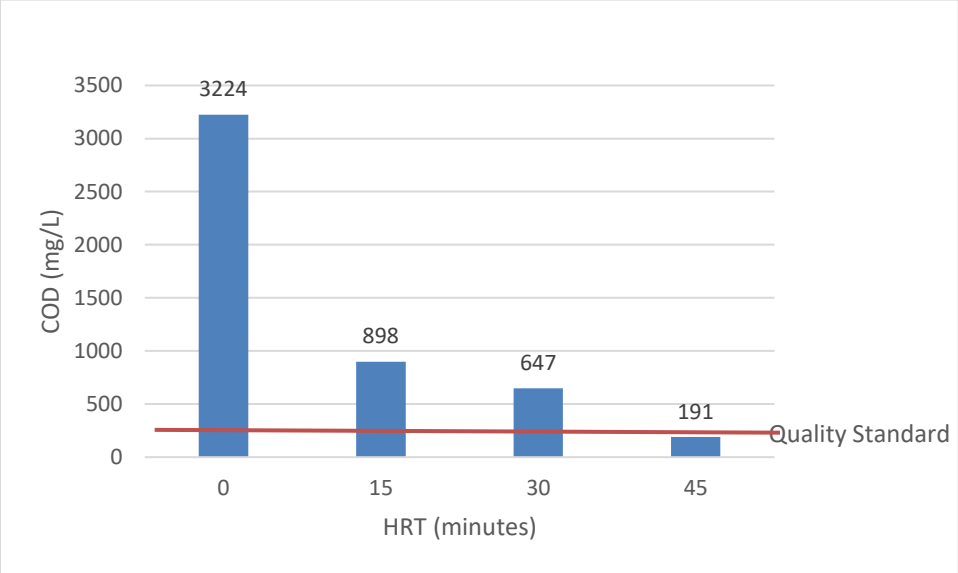

Figure 5 COD Removal in Lambaro Fish Market Liquid Waste

The COD value in Lambaro fish market wastewater with the RSF filtration process, COD decreased until it reached a concentration below the quality standard of 191 mg/L at minute 45 with an effectiveness of 94.07%. The COD concentration that has reached 191 mg/L indicates that the filter media in the RSF has successfully retained particles and organic substances contained in the wastewater. Organic substances and particles will be trapped on the surface of the activated charcoal. Similarly, in other media, impurities in the wastewater are retained in the media. According to Ahmad Nur (2016), the ability of silica sand
is used as a filtration medium to filter out passing substances. The sand is also able to attract particles that pass as a result of electrostatic attraction, namely between particles that have opposite electrical charges. Supradata (2005) also suggested that the tendency to decrease COD concentration in line with BOD concentration indicates that the organic matter contained in wastewater is mostly *biodegradable* organic matter.

Figure 2 shows that the longer the retention time in the filtration column, the higher the effectiveness of COD reduction. At a retention time of 15 minutes, the effectiveness of the decrease was 72.14% and the most effective at minute 45, which decreased to 94.07%. According to Wicheisa et al. (2018), the decrease in COD levels occurs because the particles begin to descend and settle due to the earth's gravitational force. The particles that descend and settle are all materials that are not completely soluble in water due to the presence of hydrocarbon chains. Wastes are easily suspended in water because they form micelles (aggregates). This suspended organic material is not dissolved and can settle. The longer the residence, the more particles settle to the bottom of the filtration column. The process leads to a reduction in the COD value.

3.2 TSS Removal

Table 4 Results of RSF Treatment of Lambaro Fish Market Waste on TSS Removal

No.	HRT (minutes)	TSS (mg/L)	Percentage removal (%)
1	0	910	-
2	15	213	76,59
3	30	162	82,19
4	45	97,2	89,86

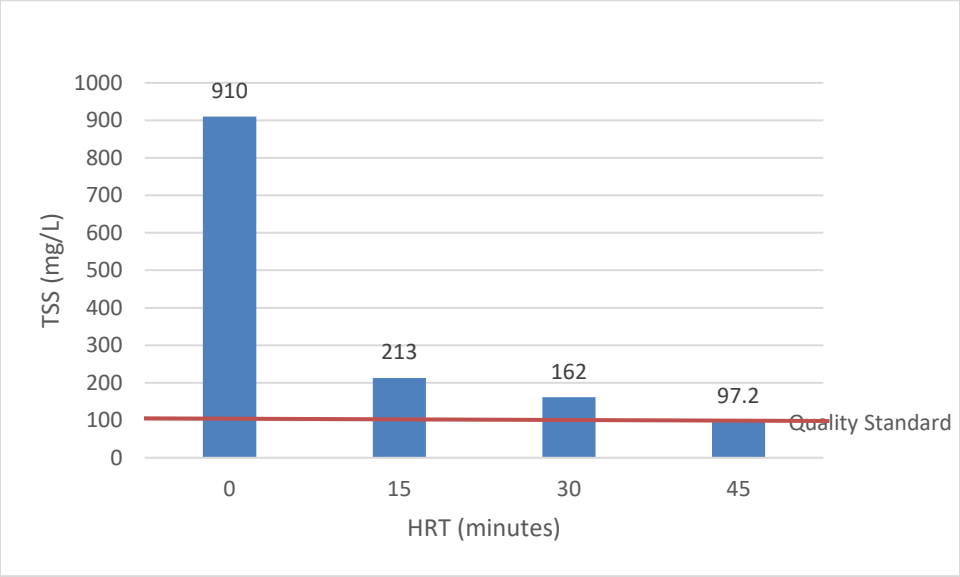

Figure 6 TSS Removal in Lambaro Fish Market Liquid Waste

Total Suspended Solid (TSS) is one of the physical parameters of pollutants in water; TSS is organic substances or suspended solids that float and take a long time to settle. According to Ibrahim (2009), suspended solids are solids that cause water turbidity that are not dissolved and do not settle directly. From the results of the study, it was found that after passing through the filtration column for 15 and 30 minutes, it was able to reduce TSS to 213 and 162 mg/L from the previous 913 mg/L. The value is still above the quality standard, but the reduction percentage was quite high, 76.59% and 82.19%. While at the 45th minute the efficiency of the decrease reached 89.86%. Based on Table 4, it can be seen that in the 45th minute, TSS dropped from 910 mg/L to 97.2 mg/L. This result has reached the quality standards based on Permen LHK Number 05 of 2014 concerning Quality Standards for Wastewater Conducting One Type of Processing Activity, which is 100 mg/L. The decrease at minute 45 has the greatest efficiency because the long residence time will produce the lowest TSS. The longer the wastewater is in the filtration column, the longer the contact time with the filter media, and the more organic substances and suspended solids will be retained in the filter media as the residence time gets longer. According to Nugraha (2019), silica sand, palm fiber, activated charcoal, and gravel that inhibit the flow rate in the filtration column will cause high precipitation.

The presence of suspended residue in water is undesirable for reasons of decreasing the aesthetics of water. In addition, suspended residue can be a place of absorption of chemicals or biology, such as disease-causing microorganisms (Pramudya, 2001). According to Rosdiansyah (2019), sediment in water bodies can be measured by several parameters, such as *turbidity*, water clarity, and total suspended solids (TSS). Water conditions can be affected by high concentrations of TSS because many solids will block sunlight from entering the water and inhibit the photosynthesis process of plants.

3.3. Turbidity Reduction

Table 4 Results of RSF Treatment of Lambaro Fish Market Waste on Turbidity Reduction

Nr.	HRT (minutes)	Turbidity (NTU)	Percentage removal (%)
1	0	311	-
2	15	120	61,41
3	30	113	63,66
4	45	112	63,98

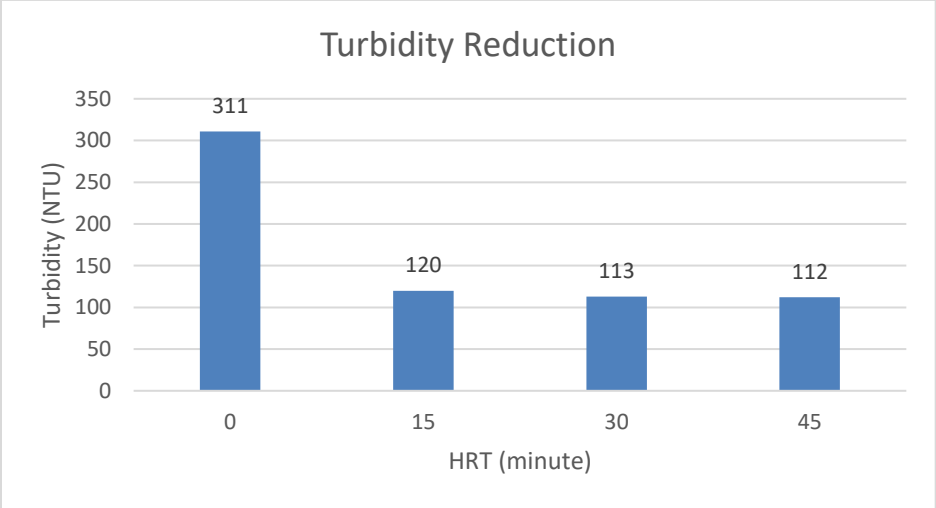

Figure 7 Turbidity Reduction in Lambaro Fish Market Liquid Waste

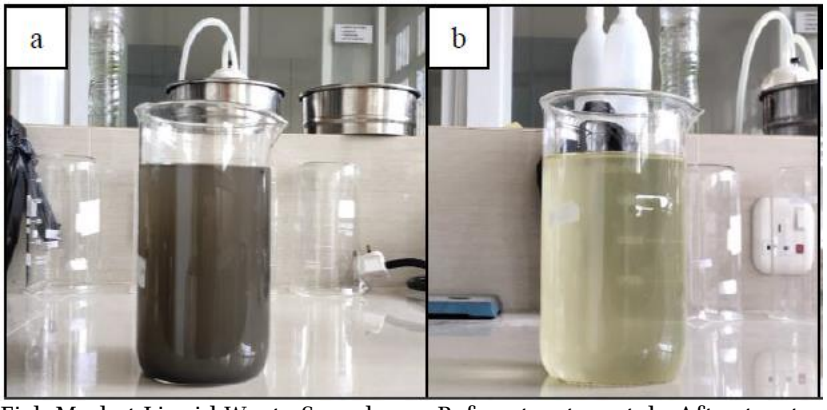

Figure 8. Lambaro Fish Market Liquid Waste Samples, a. Before treatment, b. After treatment for 45 minutes

Turbidity is generally caused by chemical reactions that cause microorganisms to die and the degradation of organic substances themselves (Hadi, 2014). Turbidity parameters are not listed in the established effluent quality standards. Turbidity parameters are important to analyze to determine the removal of organic substances and small particles suspended in waste. In addition, the turbidity parameter is also important because it is related to aesthetics. Water that has high turbidity is dark in color and appears to have many particles suspended in it. Water that has low turbidity tends to have a clearer color and appears to have no suspended particles. In this study, wastewater from the Lambaro fish market can be seen in Figure 5a. The color

of the water is dark blackish and very disturbing aesthetically. After the filtration process, in Figure 8b the water becomes clear and better in terms of aesthetics. Turbidity in this study using a Turbidimeter tool.

From the results obtained, the 45th minute was the most effective time in reducing turbidity. Turbidity dropped from 311 NTU to 112 NTU with an efficiency of 63.98%. Long contact time will affect the removal of turbidity, through the diffusion process and the attachment of particles in the activated charcoal media (Hamzani et al., 2012). The turbidity reduction phenomenon is similar to the phenomenon of COD and TSS reduction. Suspended particles, such as colloidal particles and organic substances contained in wastewater, will be retained in the filter media. The longer the residence time will produce lower turbidity. The adsorption process of particles on the activated charcoal used is one of the causes of the decrease in turbidity value. In addition, precipitation in the filtration column is one of the factors that can reduce turbidity values. In this study, There were few differences between 30 and 45 minutes. The filter media has reached almost its maximum value in 30 minutes, so that at 45 minutes there is only a slight decrease in turbidity value.

According to Makhmudah and Notodarmojo (2010), turbidity removal in filtration columns can occur due to three factors, specifically, mechanical straining, sedimentation, and adsorption. Mechanical straining is the process of retaining small particles in liquid waste on filter media. The filter media will only be passed by water and hold the impurity particles.

4. Conclusion

The use of RSF-type filtration columns using activated charcoal, sand, palm fiber, and gravel media is able to remove impurity particles in Lambaro fish market wastewater. COD parameters can be removed up to 94.07%, TSS parameters up to 89.86% and Turbidity 63.98%. After being treated with RSF, wastewater from the Lambaro fish market wastewater is safe to flow into water bodies because it is below environmental quality standards.

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Author Involvement

TMA analyzed the data, wrote the original manuscript, and wrote the revised manuscript. FHI developed tools and instruments, and AR and JH presented ideas and revisions.

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