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The use of Iron Sand as Filtration Media for Slaughterhouse Wastewater Treatment

Penggunaan Pasir Besi sebagai Media Filtrasi untuk Pengolahan Limbah Cair Rumah Pemotongan Hewan

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ABSTRACT

An increase in slaughtering animals will have an impact on increasing the liquid waste produced. The resulting RPH liquid waste can damage the environment if it is not treated, so it is necessary to conduct research to reduce pollutant levels so that it is suitable for disposal into the environment. The technique used in processing RPH wastewater is iron sand filtration method. Iron sand filtration is a filtering process using renewable media, namely iron sand. Iron sand is known to contain the mineral magnetite (Fe3O4) which has the ability to absorb colloidal solids, so it has the potential to be used to remove pollutant content of RPH liquid waste. This research objective to determine the effect of variations in the thickness of the filtration media (cm) and grain size (mesh) on pollutant parameters. The thickness variations used were 20, 25, and 30 cm, with grain sizes of iron sand 40, 60 and 100 mesh. The experimental results showed that the iron sand filtration method was able to reduce Chemical Oxygen Demand (COD) and Total Suspended Solid (TSS) levels, increase the Dissolve Oxygen Meter (DO) value, and change the pH value. The highest reduction in COD was in the thickness variation of 30 cm with 100 mesh. the percentage of decrease in the value of Chemical Oxygen Demand (COD) was 95.05%, the highest decrease in Total Suspended Solid (TSS) value was in the media thickness variation of 30 cm with 100 mesh, the percentage of TSS value reduction was 97.11%, the pH value increased in the thickness variation media 30 cm with a mesh number of 100 from 5.8 to 7.4, and the value of Dissolve Oxygen Meter (DO) increased with variations in thickness of 30 cm with 100 mesh, increased from 1.2 to 15.2. Based on the parameter test results, it was concluded that iron sand filtration is effective in reducing pollutant levels below the quality standard, so that it is expected to be applied directly on a larger scale.

***Keywords**: RPH Liquid Waste, Filtration, Iron Sand, Magnetite (Fe3O4)*

ABSTRAK

Peningkatan pemotongan hewan akan berdampak pada peningkatan limbah cair yang dihasilkan. Limbah cair RPH yang dihasilkan dapat merusak lingkungan jika tidak diolah, sehingga perlu dilakukan penelitian untuk menurunkan kadar pencemar agar layak dibuang ke lingkungan. Teknik yang digunakan dalam pengolahan limbah cair RPH adalah metode filtrasi pasir besi. Filtrasi pasir besi merupakan proses penyaringan dengan menggunakan media terbarukan yaitu pasir besi. Pasir besi diketahui mengandung mineral magnetite (Fe3O4) yang memiliki kemampuan menyerap padatan koloid, sehingga berpotensi digunakan untuk menghilangkan kandungan pencemar limbah cair RPH. Penelitian ini bertujuan untuk mengetahui pengaruh variasi ketebalan media filtrasi (cm) dan ukuran butir (mesh) terhadap parameter pencemar. Variasi ketebalan yang digunakan adalah 20, 25, dan 30 cm, dengan ukuran butir pasir besi 40, 60 dan 100 mesh. Hasil percobaan menunjukkan bahwa metode filtrasi pasir besi mampu menurunkan kadar Chemical Oxygen Demand (COD) dan Total Suspended Solid (TSS), meningkatkan nilai Dissolve Oxygen Meter (DO), dan mengubah nilai pH. Penurunan COD tertinggi pada variasi ketebalan 30 cm dengan 100 mesh. persentase penurunan nilai Chemical Oxygen Demand (COD) sebesar 95,05%, penurunan nilai Total Suspended Solid (TSS) tertinggi pada variasi ketebalan media 30 cm dengan 100 mesh, persentase penurunan nilai TSS sebesar 97,11%, nilai pH meningkat pada variasi ketebalan media 30 cm dengan nomor mesh 100 dari 5,8 menjadi 7,4, dan nilai Dissolve Oxygen Meter (DO) meningkat pada variasi ketebalan 30 cm dengan 100 mesh, meningkat dari 1,2 menjadi 15,2. Berdasarkan hasil uji parameter disimpulkan bahwa filtrasi pasir besi efektif dalam menurunkan kadar polutan di bawah baku mutu, sehingga diharapkan dapat diterapkan secara langsung dalam skala yang lebih besar.

Kata Kunci: Limbah Cair RPH, Filtrasi, Pasir Besi, Magnetite (Fe3O4)

1. INTRODUCTION

The Central Statistics Agency (BPS) states that the number of slaughtered animals in Aceh Province continues to increase every year. The number of slaughtered animals was recorded at 12,000 in 2017, in 2018 there were 12,083 heads and in the following year it increased to 12,245 heads. In 2020, the number of slaughtered animals in Aceh Province decreased to 10,272 due to the COVID 19 outbreak, in 2021 the number of slaughtered animals again increased to 10,780 (Central Bureau of Statistics). The large demand for meat is an indicator of the development of the meat industry which has an impact on the increase in the industrial sector of the Animal Slaughterhouse (RPH) business. However, this positive impact also triggers other problems. Slaughterhouses have the potential to produce liquid waste which is feared to pollute the surrounding environment and can damage the ecosystem (National Statistics Agency).

In Aini's research (2017), RPH wastewater contains a Chemical Oxygen Demand (COD) level of 286.2 mg/l, at a Biological Oxygen Demand (BOD) level of 145.2 mg/l, in Total Suspended Solid (TSS) get a figure of 612.00 mg/l and on organic parameters it has a value of 74.48 mg/l. The parameter values exceed the quality standard limits set by the government. The results obtained show that RPH waste requires processing before being discharged into the surrounding environment (Aini et al., 2017).

Liquid waste from slaughterhouses contains a lot of high concentrations of various organic compounds, as well as colloidal materials such as cellulose, protein and fat. The organic material produced can cause environmental problems if the waste is directly disposed of into the environment without specific management that is beneficial to the environment and the surrounding community. Waste from abattoirs comes from many sources such as urine, blood, stomach contents, faeces, fat and meat. Waste also comes from RPH washing water (Padmono, 2018). These sources can become pollutants if they are not properly managed when they are discharged into the surrounding environment (Ali and Widodo, 2019). If the RPH liquid waste exceeds the quality standard limits, it will have an impact on the environment both in terms of aquatic flora and fauna, so it is necessary to treat the waste in a good and profitable method for the surrounding community. Based on the data above, it can be concluded that it is necessary to process and manage RPH liquid waste so that it meets the established quality standards (Ali and Widodo, 2019).

The optimal alternative in processing RPH liquid waste is by using the filtration method. Filtration is a wastewater treatment technique that is used in both small and large industrial scales. Filtration is also very profitable and can use natural ingredients that are easily available (Mastian and Apriani, 2022). Filtration is used in reducing the levels of contaminants in water so that it can be reused with the help of various filtration media such as silica sand, quartz sand and activated carbon. Types of filtration media can be divided into three (3) types, such as single media types, dual media types, and multimedia types (Santi et al., 2021). The potential filtration media used is iron sand because it is relatively easy to obtain in terms of the environment and is economical (Verma et al., 2019).

Iron sand is one of the media that is formed naturally by nature and is abundantly available in the coastal areas of Indonesia. Iron sand has the advantage of being able to absorb colloidal solids. The ability to filter or bind particles comes from the magnetite ability of iron sand (Marik et al., 2019). The ability of iron sand to bind pollutant content comes from the mineral Magnetite (Fe_3O_4) contained in iron sand. Magnetite has the ability to attract pollutant compounds, due to the interaction between magnetite (Fe_3O_4) and liquid waste (Widianto et al., 2018). The grain size of iron sand in a media determines the effectiveness of the filtration. If the size of the grains of sand gets smaller, the better the processing of the liquid waste produced from the RPH (Husaini et al., 2020). The performance of iron sand in absorbing suspended solids in waste to form a film on the surface of iron sand (Marik et al., 2019). Magnetite from iron sand attracts the attention of researchers to study it, both theoretically and experimentally. The magnetite content in iron sand as an adsorbent has been used to adsorb pollutants due to its surface ability to absorb organic substances (Mahmudah et al., 2017). However, there has been no comprehensive research related to its use in adsorbing organic waste from slaughterhouses (Oktavia and Andre, 2019). Iron sand can be found in several areas in Aceh Province, one of which is at Syiah Kuala Beach, Banda Aceh City. According to Maulinda's research (2022), Shia Kuala Beach's iron sand has 87.45% magnetite per kilogram. (Fe_3O_4). To determine whether iron sand media is a reliable choice for a filter media that may be used directly in the community, an analysis of its efficacy is required. The effectiveness of iron sand in lowering waste pollutant pollutants has been investigated in earlier studies (Marik et al., 2019), and the findings support this. (Fajri et al., 2017). Iron sand filtration has the potential to be used in the removal of organic content from RPH waste based on these qualities and capabilities. To determine whether iron sand media is a reliable choice for a filter media that may be used directly in the community, an analysis of its efficacy is required. The effectiveness of iron sand in lowering waste pollutant pollutants has been investigated in earlier studies (Marik et al., 2019), and the findings support this. (Fajri et al., 2017). Iron sand filtration has the potential to be used in the removal of organic content from RPH waste based on these qualities and capabilities. Analysis of the effectiveness of iron sand media as a filtration medium in the RPH wastewater treatment process is required. Because iron sand media is a reliable choice for a filter media that may be used directly in the community, an analysis of its efficacy is required. The effectiveness of iron sand in lowering waste pollutant pollutants has been investigated in earlier studies (Marik et al., 2019), and the findings support this. (Fajri et al., 2017). Iron sand filtration has the potential to be used in the removal of organic content from RPH waste based on these qualities and capabilities. To determine whether iron sand media is a reliable choice for a filter media that may be used directly in the community, an analysis of its efficacy is required. The effectiveness of iron sand in lowering waste pollutant pollutants has been investigated in earlier studies (Marik et al., 2019), and the findings support this. (Fajri et al., 2017). Iron sand filtration has the potential to be used in the removal of organic content from RPH waste based on these qualities and capabilities. The goal of this study was to analyze the effectiveness of iron sand media as a filtration medium in the RPH wastewater treatment process (Hamdan et al., 2022).

2. RESEARCH METHODS

Materials

The tools used in this study 4-inch diameter PVC pipe, a water faucet, a tape measure, a stop faucet, a beaker glass, and a bucket or container were the tools utilized in this study.

This study used palm fiber, iron sand, gravel, and wastewater from a slaughterhouse (RPH) as its materials.

Experiment procedure

The working procedure in this study is that the RPH liquid waste that has been taken is deposited for 10 hours with a time span of 1 hour to get the effectiveness of settling in how many hours, tools and materials are prepared to design iron sand filtration in processing RPH liquid waste, filtration media filled in the filtration unit in the order of filling starting from the bottom, first, palm fiber with a thickness of 5 cm, followed by wood charcoal with a thickness of 15 cm, then filled with iron sand with variations in grain size of 40, 60 and 100 mesh with a thickness of 20, 25 and 30 cm and in continue filling gravel with a thickness of 15 cm. The precipitated RPH liquid waste was flowed as much as 1 liter into the reactor so that 9 treatments were obtained, the waste that was ready to be processed was collected and the discharge was measured, and then the parameters COD, TSS, pH, and DO were checked.

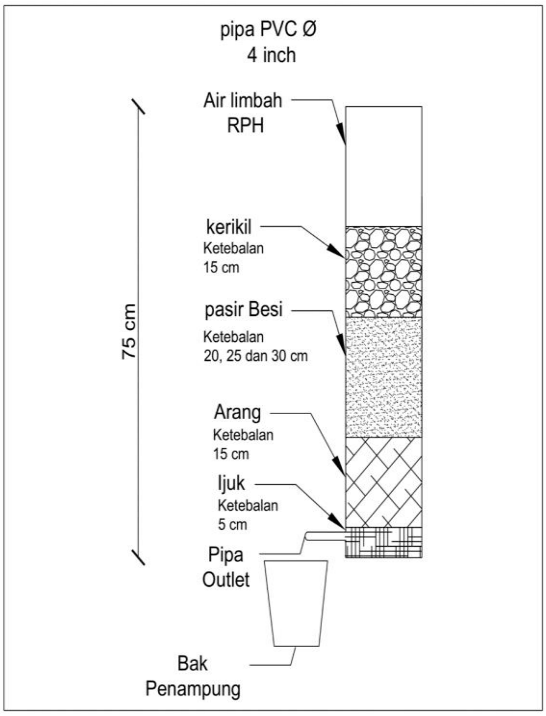

Figure 1. Iron sand filtration reactor design with a thickness of 20.25 and 30 cm

pH measurements were carried out with a Hanna pH meter that had been calibrated with a buffer solution. After drying with a tissue, the electrodes were rinsed with distilled water. The waste sample is put into a 25 ml beaker glass. The electrode is dipped into the waste sample. Wait for the pH meter reading to stabilize before proceeding. The results of reading these numbers are displayed on the pH meter screen. After measuring, rinse the electrode again with distilled water. The pH measurement method is carried out in accordance with SNI 6989.11: 2019.

COD measurement using the Hanna brand COD meter. A total of 2.5 ml of sample was put into a test tube, followed by the addition of $K2Cr2O7$ and 3.5 ml of $H2SO4$ solution. The test tube is then sealed. Place the tube on a heater that has been heated to 105 degrees Celsius, and allow it to reflux for two hours. After bringing the sample and refluxed working solution to room temperature, a COD analyzer measurement is performed on the sample. COD measurement method based on SNI 6989.2:2009 (Hamdan et al., 2023).

Vacuum filtering for TSS measurement. Water devoid of minerals that has been moistened filter paper. The waste sample was quantitatively quantified and deposited in filter media after 100 ml of the test sample had been agitated until it was homogenous. It is necessary to turn on the suction system. Three times, use 10 mL of demineralized water to rinse the filter media. After each rinse, vacuum the filter until all the water has been removed. Carefully place the fiberglass filter into the weighing medium after removing it from the filter kit. Before to weighing, dry the weighing medium or the cup containing the filter media for at least one hour in an oven set to 103°C to 105°C, then let it cool in a desiccator. The findings of the calculation used to determine the TSS are provided. On SNI 6989.3:2019, the 2019 TSS measuring methodology is based.

3. RESULTS AND DISCUSSION

After conducting an initial analysis of the pollutant parameters for liquid waste from slaughterhouses (RPH) in Lambaro, Kec. Want Jaya, Aceh Besar District, Aceh Province, it was discovered that the pollutant parameters exceeded the quality standards outlined in the Regulation of the Minister of Environment of the Republic of Indonesia Number: 05 of 2014..

As a result, processing is required before the effluent from slaughterhouses in Lambaro, Kec. Ingin Jaya, Aceh Besar District, and Aceh Province may be released into the environment. Filtration using iron sand media is one method to lower pollution levels. A reliable and affordable liquid waste treatment method is iron sand filtration (Marik et al., 2019).

According to testing results, the RPH liquid waste's COD level can be reduced to below the quality standard per the Republic of Indonesia's Regulation of the Minister of Environment Number 5 of 2014 by using an iron sand deposition and filtration process. High levels of pollution coming from animal slaughtering activities are the reason why the COD content of RPH liquid waste exceeds the quality limit.

During the processing of RPH liquid waste, large particles, such as cow dung residue, cutting residue, and other organic wastes that can precipitate, are precipitated in order to allow further processing (Aini et al., 2017).

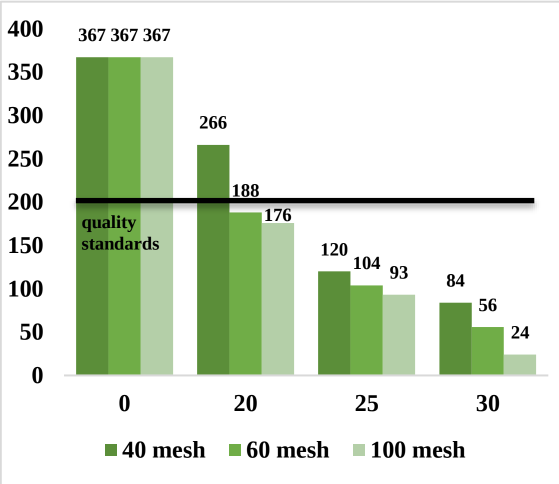

Figure 2. Graph of decreasing COD content for variations in media thickness of 20, 25, 30 cm and grain sizes of 40 mesh, 60 mesh and 100 mesh.

Based on Figure 2, the preliminary parameter analysis's findings are known to surpass the quality standards established in Table IV.2 of the regulation of the Republic of Indonesia's Minister of Environment Number: 05 of 2014, specifically the COD standard of 435 mg/l. The initial parameter content dramatically decreased following processing utilizing the sand sedimentation and filtering method for iron with media thickness variations of 20, 25, and 30 cm for grain sizes in mesh form, namely 40, 60, and 100. Using a mesh number of 100 and a constant media thickness of 30 cm, COD fell continuously to a level of 37 mg/l with a degradation efficiency of 95.05%.

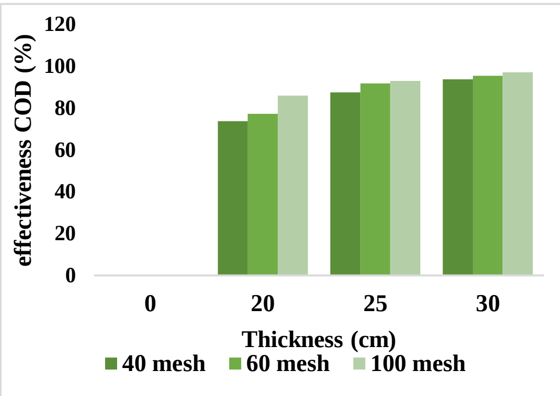

Figure 3. Graph of the percentage of COD content for variations in media thickness of 20, 25, 30 cm and grain sizes of 40 mesh, 60 mesh and 100 mesh.

During the iron sand filtration experiment, magnetite (Fe_3O_4)-containing iron sand can theoretically absorb colloidal materials, depending on the size of the particles. This is because the particle size decreases with increasing adsorption rate. If the adsorbent is smaller, the adsorption process will go more quickly. This is comparable to Suziyana's study (2017). This is due to the fact that the adsorbent's contact surface area with the solid increases with decreasing adsorbent diameter. The number of holes per unit of adsorbent particles is likewise directly proportional to the surface area. The reduction in the TSS number may be influenced by the iron sand media's thickness. The efficacy of adsorption is influenced by the mass of the adsorbent, according to theory. The effectiveness of lowering pollution levels increases with more media use. This is due to the fact that when the adsorbent's mass increases, more of its surface area becomes available, increasing the adsorbent's active area (Suziyana et al., 2017).

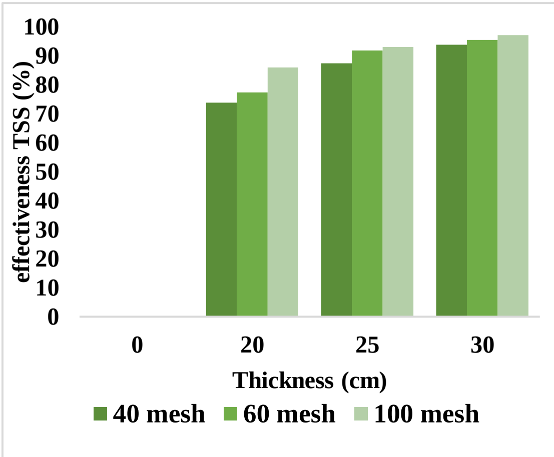

Figure 4. Graph of the percentage of TSS content for variations in media thickness of 20, 25, 30 cm and grain sizes of 40 mesh, 60 mesh and 100 mesh.

Based on the media's thickness and grain size (mesh). First pH testing came back at 5.8. The pH of RPH liquid waste that is allowed to be discharged into the environment is 6-9. This is in accordance with Republic of Indonesia Environment Minister Regulation Number 5 of 2014. The pH of RPH liquid waste is below acceptable levels. The RPH wastewater is acidic, as seen by the low pH value (Ali and Widodo, 2019). The waste sample's low pH value suggests the presence of microbes that are active in deteriorating organic materials, which readily break down into acid. The presence of organic contaminants from slaughtering processes contributes to the RPH liquid waste's acidity as well (Luh et al., 2019).

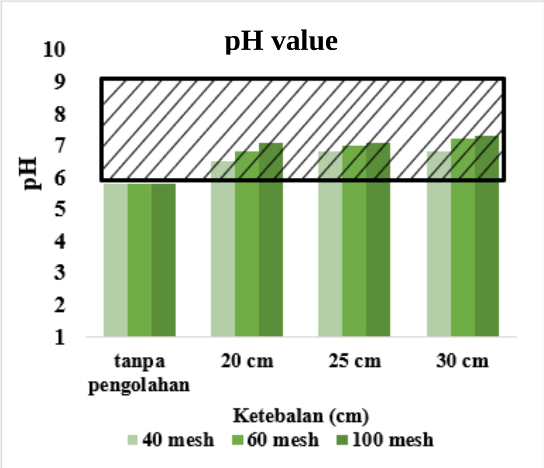

Figure 5. Graph of reduction in TSS content for variations in media thickness of 20, 25.30 cm and grain sizes of 40 mesh, 60 mesh and 100 mesh.

Figure 5 demonstrates how the pH level may always be raised by using the iron sand filtration method. The pH value increased noticeably from 5.8 to 7.3 for a 30 cm thickness variation with a 100 mesh particle size.

4. CONCLUSION

The processing of liquid waste from RPH houses using the iron sand filtration method can reduce the COD parameter levels with variations in media thickness of 20, 25, 30 cm with grain sizes of 40, 60, and 100 mesh, and that the iron sand filtration method obtained the most optimal results at a thickness variation of 30 cm with a mesh number of 100 reaching 24 mg/L with an effectiveness of. Based on the findings of the study and analysis, it can be concluded that the method's most optimal results were obtained at The iron sand filtering method may lower TSS parameter levels from variations in media thickness of 20, 25, and 30 cm with grain sizes of 40, 60, and 100 mesh. It achieved the most effective thickness variation of 30 cm with a mesh number of 100 reaching 14 mg/L with a 97.11% efficiency. While RPH liquid waste can discharge up to 120 l/hour, iron sand filtration can modify the pH value of RPH wastewater from 5.8 to 7.4 in variations of thickness of 30 cm with a grain size of 100 mesh. The processing efficiency at the COD parameter is 95.05% and the TSS parameter is 97.11%.

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