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Optimization of Domestic Wastewater Treatment Using a Mixture of Coconut Shell Activated Carbon Adsorbent and Fly Ash

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ABSTRACT

Utilization of solid waste raw materials in the form of coconut shells and fly ash as adsrobents for domestic wastewater treatment. This study aims to optimize the effect of coconut shell activated carbon and fly ash with variations in mass ration and stirring time on changes in pH, COD, BOD, ammonia, TSS, and total coliform by adsorption on domestic liquid waste to meet waste quality standards. The research method includes the preparation of activated carbon from coconut shell, SEM characterization and experiments of a mixture of coconut shell activated carbon mass and fly ash (5:10, 10:5, 5:15, 15:5 grams) with variations in stirring time (30 minutes, 60 minutes). The results of the study, the most optimal mixture for changes in pH, ammonia, TSS, COD, BOD, total coliform parameters in domestic wastewater was a mixture of coconut shell activated carbon adsorbent mass of 15 grams and fly ash of 5 grams with a stirring time of 60 minutes.

Keywords: activated carbon, coconut shell, domestic liquid waste, fly ash.

INTRODUCTION

Liquid and solid waste will be produced by the activities of every human work. Small-scale waste will not cause problems, but large-scale waste will cause problems that can disrupt the balance of the environment, including solid waste in the form of coconut shell waste and coal fly ash and liquid waste, namely domestic liquid waste.

Indonesia is the world's number one coconut producer due to its tropical climate. In addition, Indonesia's diverse archipelago foods are derived from coconuts. Most people think of coconut shells as waste from the coconut processing industry, and the fact that there are so many of them is considered an environmental problem despite the fact that they are cheap and renewable. Although coconut shell charcoal can be reprocessed to produce a very profitable product, namely activated carbon or activated charcoal (Pambayun et al., 2013). Activated carbon is a carbon compound made of material having carbon, which is made in a proprietary way that produces broad dimensions on the surface. The ability of activated carbon for adsorption is due to its pores and surface area that can capture particles (Octarya & Fernando, 2016). The manufacture of activated carbon consists of 3 stages including dehydration, carbonization and activation (Stevani & Prawesti, 2014).

The increasing development of steam power plants or PLTU has resulted in the use of coal being large and the combustion or carbonization process in coal will produce by-products in the form of residues in the form of solids, namely combustion ash, coal ash consists of fly ash and bottom ash.

Domestic wastewater that has not met the standards must be treated with various methods. Therefore, there must

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be a decrease in BOD max 30 mg/l, COD max 100 mg/l, pH 6-9, TSS max 30 mg/l and total coliform max 3000 MPN/100 ml according to Permen LHK No.68 of 2016 concerning domestic wastewater quality standards (Zahra & Purwanti, 2015). One of the parameters of domestic wastewater quality standards is total coliform. Total coliform is a group of bacteria that includes various types of bacteria including Escherichia coli (E. coli) that can be found in the environment, especially in soil, water, and organic waste. The presence of total coliforms in drinking water or food is not an indicator of immediate danger, but a potential sign of pollution and sanitation problems. *Escherichia coli* is a subgroup of total coliforms that are usually identified as bacteria that live in the intestines of humans and animals. Pathogenic *Escherichia coli* can cause serious illness.

Several studies have been conducted in an effort to change the levels of pH, TSS, ammonia, BOD, COD, and total coliform including filtration systems with sengon wood activated carbon. active gravel of the Krasak river, and active sand of Indrayanti beach in well water at LPPMP UNY as drinking water (Nur Rachma, 2016), The potential of activated charcoal from durian fruit peels with NaOH activator as a well water purifier (Budiman et al., 2018). Total coliform removal in rainwater using zeolite filter media, modified activated carbon and melt blown filter catridge (Mulyatna et al., 2019). Reduction of oil, fat and organic matter in restaurant waste using activated carbon modified grease trap (Zaharah et al., 2017). And the effect of coconut shell activated carbon on domestic wastewater treatment can reduce ammonia parameters from 28.91 ppm to 8.25 ppm and total coliform from 43520 MPN/100 ml to 1100 MPN/100 ml (Oktaviansyah et al., 2024).

Considering the above problems, researchers want to investigate how coconut shell activated carbon and fly ash have an impact on changes in domestic wastewater as well as raw materials for adsorbent sources that have low costs and can be reused are the main focus of researchers regarding coconut shell and fly ash are potential waste materials for adsorption applications. With these advantages, the adsorption method using coconut shell activated carbon and fly ash for domestic wastewater treatment, especially on the parameters of pH, ammonia, TSS, BOD, COD, and total coliform is the right choice.

METHODOLOGY

Tools and Materials

The equipment used in this study are as follows: shivering 100 mesh, digital scales, sample bottles, sampling equipment, mortal, measuring cup, furnace.

And the materials used were coconut shells, domestic liquid waste, fly ash, NaOH.

Research Procedures

- Domestic liquid waste samples that have been taken are then analyzed for parameters such as pH, TSS, ammonia, BOD, COD and total coliform.
- Preparation of activated carbon from coconut shell and fly ash activation

Dehydration and carbonization process (SNI-06-3730-1995).

1. The coconut shells are cleaned and dried in the sun with 2 day until dried coconut shells will be lighter because the water content has disappeared and cut into small pieces. The dried coconut shell is put into a porcelain cup equipped with a lid so that no air enters during the carbonization process. Put the coconut shell gradually into the furnace at a temperature of ± 800ºC for 1 hour and cooled in a desiccator 30 minutes. Coconut shell charcoal is ready to use. record the results of the analysis.
2. Activation of coconut shell carbon and fly ash. Coconut shell charcoal and fly ash are crushed until smooth and sieved through 100 mesh size. Then the activation process is carried out using chemical substances, namely NaOH solution at a concentration of 0.5 M in 500 ml of solution and as much as 200 grams of bottom ash or coconut shell carbon is prepared and placed in a beaker containing an activator solution. The mixture was soaked for 24 hours. Then washed with distilled water until the pH of charcoal and fly ash was neutral.

- Coconut shell activated carbon and fly ash were characterized using Scanning Electron Microscopy (SEM) which is used to investigate the surface of solid objects directly.
- Domestic wastewater treatment process using a mixture of coconut shell activated carbon adsorbent and fly ash.

1. Coconut shell activated carbon and fly ash were weighed 5:10 grams, 10:5 grams, 5:15 grams, 15:5 grams or ratio 1:2, 2:1, 1:3, 3:1.
2. 500 ml domestic liquid waste sample and activated carbon coconut shell and fly ash that has been activated put into a glass beaker.
3. Then stirred using a magnetic stirrer with a variation of stirring time of 30 minutes and 60 minutes with a constant rotation of 1080 rpm.
4. After stirring, the sample is filtered and tested for pH, TSS, ammonia, COD, BOD, and total coliform.

RESULT AND DISCUSSION

Based on the results of SEM analysis of coconut shell activated carbon can be seen in figure 1.

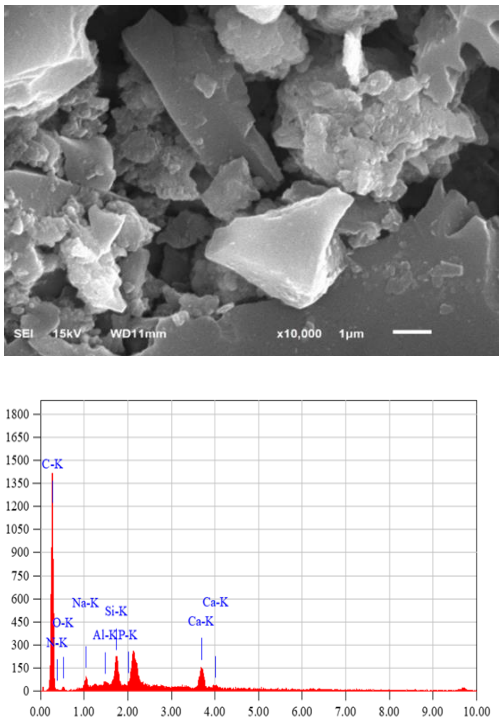

Figure 1. Surface Morphology and Composition of Coconut Shell Activated Carbon

The results of SEM analysis for fly ash adsorbent can be seen in figure 2.

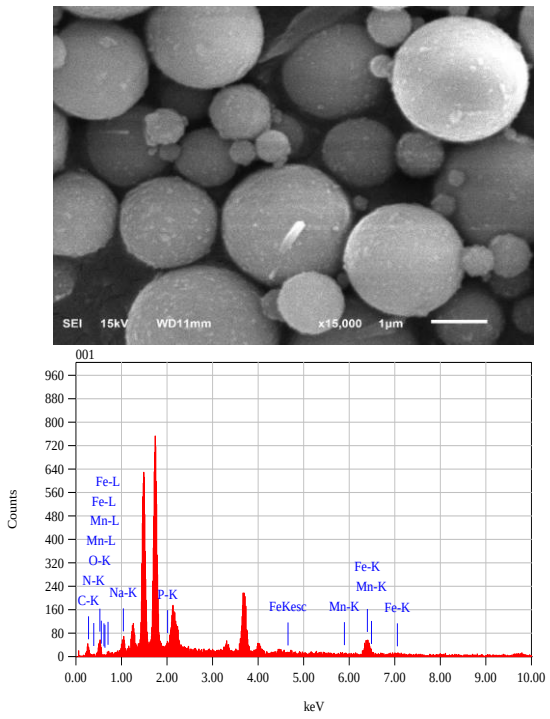

Figure 2. Surface Morphology and Composition of Fly Ash

The results of the analysis of domestic wastewater treatment using variations in mass and length of stirring on a mixture of coconut shell and fly ash adsorbents can be seen in table 1:

Table 1. Experiment Results

Parameters	Permen LHK No.68. 2016	Before Adsoprtion	Weight (gram)			
			5:10 KTK:FA	10:5 KTK:FA	5:15 KTK:FA	15:5 KTK:FA
			30 minutes		60 minutes	
pH	6-9	6.35	7.22	7.43	7.93	8.25
NH_3	Max 10	29	2.02	1.55	1.38	0.52
COD	Max 100	90	8	5	5	5
BOD	Max 30	30.12	2.65	1.72	1.73	1.72
TSS	Max 30	28	23	22	21	19
Total Coliform	Max 3000	160000	60000	200	22000	200

Notes:
KTK: coconut shell activated carbon
FA: fly ash

Surface Characterization (SEM-EDX)

The results of SEM analysis of coconut shell activated carbon in Figure 1 and fly ash in Figure 2 show that the surface of coconut shell has many cavities compared to fly ash. The cavity and pore area formed on the surface of the adsorbent is influenced by the heating that occurs and the activated carbon activating agent which results in reduced impurities on the carbon surface (Khan et al., 2018). In research (Esterlita and Herlina, 2015) using H3PO4 activator conveyed that the mechanism of activating carbon with phosphoric acid will react and form micropores on the carbon surface. The almost uniform particle distribution on the carbon surface as well as the smooth carbon surface and visible pores are due to impurities in the carbon that have been lost during the activation process.

Using NaOH activators in the activation process, the activator will react with carbon which will oxidize and erode hydrocarbons, tar, and other compounds that adhere to the surface of the charcoal so that the surface of the charcoal becomes smooth and forms new pores (Rampe and Tiwow, 2018).

The elemental composition detected in coconut shell activated carbon in Figure 1 with the dominance of the elemental constituent components are C (65.45%), N (23.39%), O (2.48%), Na (1.09%), Na (1.72%), Al (0.35%), Si (2.50%) and Ca (4.74)%. The highest elemental content is carbon (C). While the elements detected in NaOH-activated fly ash in Figure 2 with the dominance of the constituent components of the elements are successively C (23.95%), N (2.87%), O (16.83%), Na (9.46%), Mn (1.69%) and Fe (45.19%) The magnitude of the elemental content of C in coconut shell activated carbon is 65.45%

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compared to fly ash which is 23.95% resulting in the adsorption power of coconut shell activated carbon is better than activated fly ash. The magnitude of the elemental composition of activated carbon obtained is not far from the research conducted by Sulaiman et al. (2019), with a large concentration of carbon (C) of 59.31%. Coconut shell activated carbon and fly ash have excellent potential to be used as adsorbents. The elemental Na content obtained is possible due to the interaction of NaOH with coconut shell activated carbon and fly ash caused in the activation process using NaOH.

Effect of Adsorbent on pH, TSS, Ammonia, COD, BOD, Total Coliform.

Test the mixture of coconut shell activated carbon and fly ash on pH, TSS, ammonia, COD, BOD, and total coliform to determine the mixture of activated carbon with the most effective mass and soaking time for each of these parameters. Adsorption is the process of adsorbate accumulation on the surface of an adsorbent caused by intermolecular forces of attraction or a result of a force field on the surface of a solid (adsorbent) that attracts gas, vapor or liquid molecules. that attracts gas, vapor or liquid molecules. Another definition of adsorption as a phenomenon that occurring on the surface (Takarani et al., 2019). Similar to this research, there is a force field on the surface of activated carbon and activated fly ash (adsorbent) that attracts adsorbent molecules (wastewater). This causes adsorption to occur. During this process, particles or molecules of contaminants will attach to the surface of activated carbon and activated fly ash due to the weak charge difference caused by van der Waals forces. The positive charge on the activated carbon and the carboxyl group which has a negative charge on the domestic wastewater will attract each other, then form a thin layer of fine particles on the surface of the coconut shell activated carbon and fly ash.

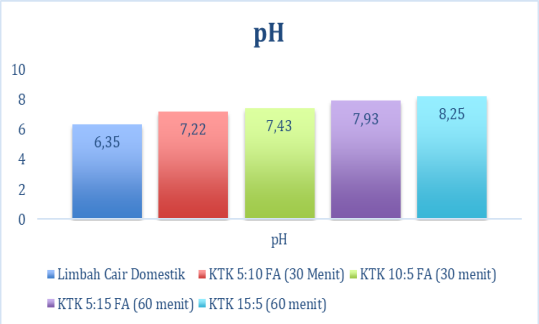

Figure 3. Effect of Adsorbent on pH

The results of the analysis can be seen in Figure 3 for the pH of domestic wastewater before being processed using a mixture of coconut shell activated carbon and fly ash which is 6.35 and for the results of domestic wastewater after being processed using a mixture of coconut shell activated carbon of 5 grams and fly ash of 10 grams with a length of stirring for 30 minutes, the pH result is 7.22. Then for a mixture of coconut shell activated carbon 10 grams and fly ash 30 grams with a stirring time of 30 minutes, the pH result is 7.43. As for the mixture of activated carbon coconut shell 5 grams and fly ash 15 grams with a stirring time of 60 minutes, the pH result is 7.93. As well as a mixture of activated carbon coconut shell 15 grams and fly ash 5 grams with a stirring time of 60 minutes obtained a pH of 8.25. The mixture of coconut shell activated carbon 15 grams and fly ash 5 grams with a stirring time of 60 minutes is the most optimal for pH. This is due to the reduction of [H +] ions and the remaining [OH-] ions in the adsorption results causing a significant increase in pH. These results are not

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different from research by Idrus et al. (2013) coconut shell activated carbon can increase the pH of peat water from 5.6 to 7.0-7.5. As well as research conducted by Amsya et al. (2021) fly ash can neutralize acid mine water from 4.8 to 7.87.

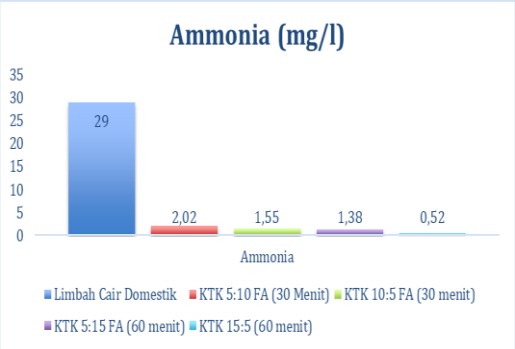

Figure 4. Effect of Adsorbent on Ammonia

The results of the analysis can be seen in Figure 4 for ammonia domestic wastewater before being processed using a mixture of coconut shell activated carbon and fly ash which is equal to 29 mg / l and for the results of domestic wastewater after being processed using a mixture of coconut shell activated carbon of 5 grams and fly ash of 10 grams with a length of stirring for 30 minutes obtained ammonia results of 2.02 mg / l. Then for a mixture of coconut shell activated carbon 10 grams and fly ash 30 grams with a length of stirring for 30 minutes obtained ammonia results of 2.55 mg / l. Then for a mixture of 10 grams of coconut shell activated carbon and 30 grams of fly ash with a stirring time of 30 minutes, ammonia results are 1.55 mg/l. As for the mixture of activated carbon coconut shell 5 grams and fly ash 15 grams with a stirring time of 60 minutes, the ammonia result is 1.38 mg/l. As well as a mixture of activated carbon coconut shell 15 grams and fly ash 5 grams with a stirring time of 60 minutes obtained ammonia results 0.52 mg/l. A mixture of activated carbon coconut shell 15 grams and fly ash 5 grams with a stirring time of 60 minutes is the most optimal against ammonia. These results are not different from research by Nurhidayanti. (2020) coconut shell activated carbon can reduce industrial wastewater ammonia with KOH activator by 87.6%, NaCl activator by 79.3%, HCl activator by 78.4%. As well as research conducted by Slamet et al. (2017) fly ash can eliminate liquid ammonia by 79%.

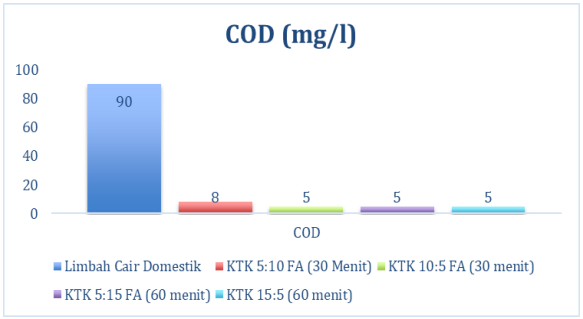

Figure 5. Effect of Adsorbent on COD

The results of the analysis can be seen in Figure 5 for COD of domestic wastewater before being processed using a mixture of coconut shell activated carbon and fly ash which is 90 mg/l and for the results of domestic wastewater after being processed using a mixture of coconut shell activated carbon of 5 grams and fly ash of 10 grams with a stirring time of 30 minutes, the COD result is 8 mg/l. Then for a mixture of coconut shell activated carbon of 10 grams and fly ash of 30 grams with a stirring time of 30 minutes, the COD result is 8 mg/l. Then for a mixture of 10 grams of coconut shell activated carbon and 30 grams of fly ash with a stirring time of 30 minutes, the COD result is 5 mg/l. As for the mixture of activated carbon coconut shell 5 grams and fly ash 15 grams with a stirring time of 60 minutes, the COD result is 5 mg/l. As well as a mixture of activated carbon coconut shell 15 grams

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and fly ash 5 grams with a stirring time of 60 minutes obtained a COD result of 5 mg/l. These results are not different from research by Wichiesa et al. (2018) coconut shell activated carbon can reduce COD of laundry wastewater from 860.16 mg/l to 272.3 mg/l with a dose of 500 grams/l. As well as research conducted by Cahyono et al. (2012) fly ash can reduce the COD content of domestic wastewater from wonorejo flats from 540 mg/l to 48 mg/l or 91.11%.

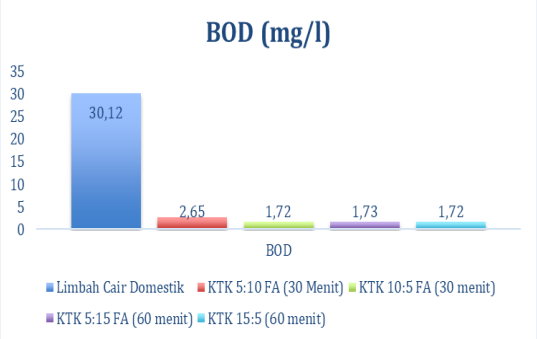

Figure 6. Effect of Adsorbent on BOD

The results of the analysis can be seen in Figure 6 for BOD of domestic wastewater before being processed using a mixture of coconut shell activated carbon and fly ash which is 30.12 mg/l and for the results of domestic wastewater after being processed using a mixture of coconut shell activated carbon of 5 grams and fly ash of 10 grams with a stirring time of 30 minutes, the BOD result is 2.65 mg/l. Then for a mixture of 10 grams of coconut shell activated carbon and 30 grams of fly ash with a stirring time of 30 minutes, the BOD result is 1.72 mg/l. As for the mixture of activated carbon coconut shell 5 grams and fly ash 15 grams with a stirring time of 60 minutes, the BOD result is 1.73 mg/l. As well as a mixture of activated carbon coconut shell 15 grams and fly ash 5 grams with a stirring time of 60 minutes obtained BOD results 1.72 mg/l. These results are not different from research by Rusdianto et al. (2022) coconut shell activated carbon can reduce BOD household detergent liquid waste by 86%. As well as research conducted by Irhamni et al. (2022) fly ash can reduce the BOD content in leachate water by 78.39%.

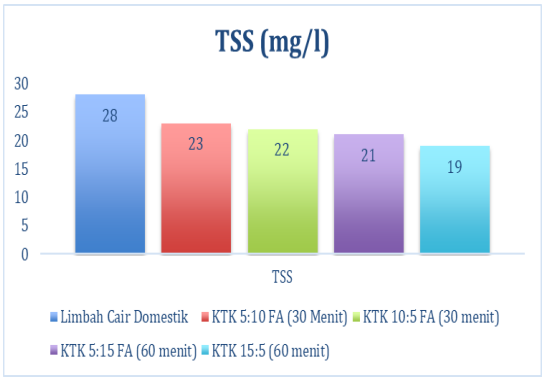

Figure 7. Effect of Adsorbent on TSS

The results of the analysis can be seen in Figure 7 for TSS of domestic wastewater before being processed using a mixture of coconut shell activated carbon and fly ash, which is 28 mg/l and for the results of domestic wastewater after being processed using a mixture of coconut shell activated carbon of 5 grams and fly ash of 10 grams with a stirring time of 30 minutes, the TSS result is 23 mg/l. for a mixture of coconut shell activated carbon of 10 grams and fly ash of 30 grams with a stirring time of 30 minutes, the TSS result is 23 mg/l. for a mixture of coconut shell activated carbon 10 grams and fly ash 30 grams with a stirring time of 30 minutes, the TSS result is 22 mg/l. As for the mixture of activated carbon coconut shell 5 grams and fly ash 15 grams with a stirring time of 60 minutes, the TSS result is 21 mg/l. As well as a mixture of activated carbon coconut shell 15 grams and fly ash 5 grams with a stirring time of 60 minutes obtained TSS results 19 mg/l. These

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results are not different from research by Rusdianto et al. (2022) coconut shell activated carbon can reduce TSS household detergent liquid waste by 69%. As well as research conducted by Diana et al. (2018) fly ash can reduce TSS content in river water by 76.45%.

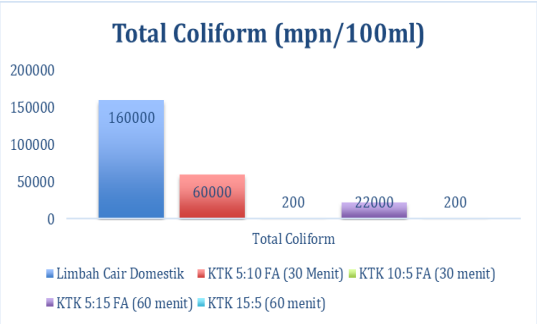

Figure 8. Effect of Adsorbent on Total Coliform

The results of the analysis can be seen in Figure 8 for total coliform domestic wastewater before being processed using a mixture of coconut shell activated carbon and fly ash which is 160000 mpn/100 ml and for the results of domestic wastewater after being processed using a mixture of coconut shell activated carbon of 5 grams and fly ash of 10 grams with a stirring time of 30 minutes, the total coliform result is 60000 mpn/100 ml. Then for a mixture of 10 grams of coconut shell activated carbon and 30 grams of fly ash with a stirring time of 30 minutes, the total coliform result is 200 mpn/100 ml. As for the mixture of activated carbon coconut shell 5 grams and fly ash 15 grams with a stirring time of 60 minutes, the total coliform result is 22000 mpn/100 ml. As well as a mixture of activated carbon coconut shell 15 grams and fly ash 5 grams with a stirring time of 60 minutes obtained a total coliform result of 200 mpn/100 ml. These results are not different from research by (Ikbal Oktaviansyah et al, 2022) coconut shell activated carbon can reduce total coliform domestic liquid waste from 43520 mpn/100 ml to 1100 mpn/100 ml. From the overall research, the most optimal adsorbent mixture in reducing the levels of pH, TSS, COD, BOD, ammonia, total coliform parameters in domestic liquid waste is a mixture of adsorbents with a mass of coconut shell activated carbon 15 grams and fly ash 5 grams with a stirring time of 60 minutes..

CONCLUSION

Based on the results of the analysis and discussion that the difference in mass mixture and the duration of stirring of coconut shell activated carbon adsorbent and fly ash gives different results on the effect of changes in domestic wastewater parameters. The most optimal mixture of changes in pH, ammonia, TSS, COD, BOD, total coliform parameters in domestic wastewater is a mixture of adsorbent mass of 15 grams of coconut shell activated carbon and 5 grams of fly ash with a stirring time of 60 minutes. Changes in pH parameters are from 6.35 to 8.25, ammonia 29 mg/l to 0.52 mg/l, COD from 90 mg/l to 5 mg/l, BOD from 30.12 mg/l to 1.72 mg/l, TSS from 28 mg/l to 19 mg/l and total coliform from 160000 to 200 MPN/100 ml.

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