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VARIATIONS IN THE FLOW RATE OF ACTIVATED CARBON FILTRATION ARE IMPLEMENTED TO REDUCE THE AMOUNT OF BIOCHEMICAL OXYGEN DEMAND IN A GRAY WATER CANTEEN

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ABSTRACT

Variations in the Flow Rate of Activated Carbon Filtration are implemented to reduce the amount of biochemical oxygen demand in a Gray Water Canteen. Domestic liquid waste stemming from cooking and cleaning activities poses a significant environmental concern. Initial tests revealed a high Biochemical Oxygen Demand (BOD) level of 376 mg/L, far exceeding the permissible limit of 30 mg/L, according to Ministry of Environment and Forestry Regulation No. 68 of 2016. Failure to treat this waste could have detrimental effects on the environment. This study aims to evaluate the efficacy of varying flow rates in reducing BOD levels in canteen liquid waste, employing activated carbon derived from coconut shells. Employing an experimental design without control, the research encompassed three flow rate treatments: 1.2, 1.3, and 1.4 liters per minute, each repeated six times. Thirty-six samples, equivalent to 54 liters of waste, were analyzed, exhibiting a normal data distribution. Results indicated a notable reduction in BOD levels across all flow rate variations. Specifically, the average decrease was 109.68 mg/L, 107.57 mg/L, and 99.52 mg/L for flow rates of 1.2, 1.3, and 1.4 liters per minute, respectively. These findings underscore the effectiveness of varying flow rates in mitigating BOD in domestic liquid waste. Further research includes investigating activated carbon media's saturation point to optimize its adsorption capacity and determining reactivation timelines. Such endeavors are crucial for refining waste treatment processes and minimizing environmental impacts.

INTRODUCTION

Liquid waste refers to the residual waste product of activities or production processes in liquid form, typically consisting of water and other waste materials mixed, suspended, or dissolved in water. Liquid waste, or wastewater, typically comes from households, trade, offices, industry, and other public places. (1). If unused waste material that has a negative impact on society if it is not managed or processed before being disposed of by environmental agencies. (2). According to laboratory examinations of domestic canteen liquid waste at PT. X, the results obtained for the Biochemical Oxygen Demand (BOD) parameter were still above the required quality standard, namely 376 mg/L. According to Minister of Environment and Forestry Regulation No. 68 of 2016 concerning Domestic Wastewater Quality Standards, the

BOD level is determined to be 30 mg/l [3]. BOD is the amount of oxygen needed by microorganisms in the water environment to break down (degrade) organic waste materials in the water into carbon dioxide and water. [4]. BOD can express the amount of oxygen, but it can also be interpreted as a description of the amount of biodegradable organic matter in the water. [5]. The overall condition of domestic wastewater is classified as wastewater containing organic materials originating from food waste and dishwashing residue containing proteins, carbohydrates, etc. [6].

If the parameters of liquid waste exceed the quality standards, it can lead to significant consequences for both the environment and humans, particularly in terms of pollution and infectious diseases. [7]. Pollution and health effects come from germs in household waste that cause disease in living things, such as bacteria, viruses, protozoa, and parasites. [8]. Without proper treatment, wastewater can also reduce water quality to a certain point, which makes the water not function as it should [9]. Liquid waste with high BOD that is disposed of without processing contains a lot of organic material that has been overgrown by pathogenic bacteria and their metabolic products, giving rise to an unpleasant odor and endangering humans and animals in the surrounding waters. [10]. Before being discharged into the environment, BOD in domestic waste from canteens must be treated. This is done to reduce waste while also eliminating or reducing pollution in the water. Processing liquid waste in production aims to reduce the amount of waste produced and the number of pollutants in the waters [11].

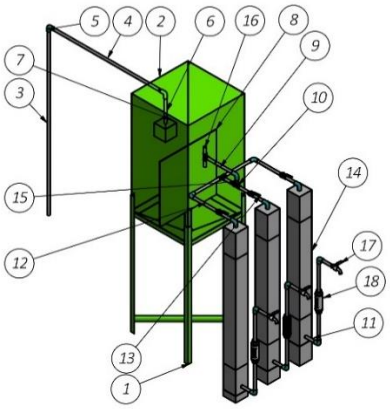
Techniques for reducing BOD levels in water can be adjusted to existing field conditions so that the BOD reduction process runs optimally [12]. Physical waste processing lowers the amount of biochemical oxygen demand (BOD) in liquid kitchen waste. This can be done by filtering or adsorbing the waste using adsorbent media, like activated carbon from coconut shells, while changing the flow rate so that the adsorbate and adsorbent come into contact with each other. Additional studies state that the use of activated carbon technology can reduce liquid waste BOD levels by up to 30% [13]. Research on this medium is based on several previous studies that stated that processing domestic canteen liquid waste using coconut shell activated carbon media was able to reduce BOD by 90% [14]. Activated carbon is a porous solid that contains 85–95% carbon compounds. Coconut shell activated carbon has a high ability to absorb particles and is easy to find, making it easier for industry to maintain these tools [15]. According to research by Hidayat et al. [16], the use of media that pays attention to flow rate causes a decrease in BOD of 87.08%. This research employs a downflow system, which aligns with prior studies that demonstrate the effectiveness of such a system in lowering BOD levels [17]. In several studies, the use of activated carbon measuring 6–12 mesh to reduce BOD, TSS, and turbidity levels in sugar waste resulted in an 80% reduction in BOD levels. The flow rate variation used in this research is greatly influenced by contact time, so that the reduction in BOD levels is optimal [18]. Based on this background, researchers are interested in studying how 6–12 mesh coconut shell activated carbon media, at a specific flow rate, can reduce the BOD levels of domestic liquid waste in PT canteens. X[19].

MATERIALS AND RESEARCH METHODS

This type of research is experimental, with a pre-test and post-test design without control. The sample used in this study was some of the liquid waste produced by the PT canteen. X will be given treatment with the aim of knowing the effectiveness of reducing BOD levels using variations in flow rate with coconut shell activated carbon media at PT. X. Grab sampling is used to collect waste samples. This research used flow rate variations of 1.2 liters per minute, 1.3 liters per minute, and 1.4 liters per minute. This study was carried out on domestic PT.X canteen waste, and the results were examined at the Bandung Laboratory.

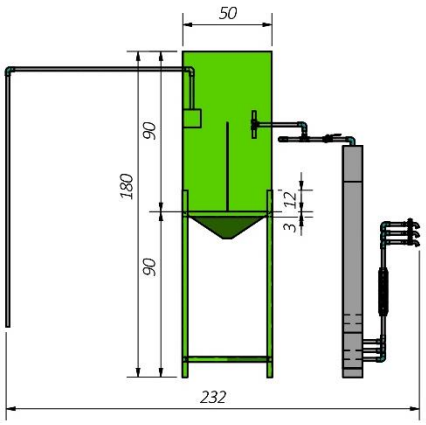
This study conducted a pre-test and post-test three times with six repetitions. The pre-test was carried out by taking samples of canteen domestic liquid waste before being treated

(contacted) with coconut shell activated carbon, while the post-test was carried out by taking samples after being treated (contacted) with coconut shell activated carbon [20]. Testing was carried out for two days, with three repetitions each day. The number of samples required for this research is 36.



PARTS LIST		
ITEM	QTY	PART NUMBER
1	1	Frame
2	1	Bak
3	1	Pipa 1
4	1	Pipa 2
5	12	elbow 3/4 inch
6	1	Pipa 3
7	1	Bak Pengendap
8	1	Sekat Pengendap
9	8	Pipa 4
10	3	tee 3/4 inch
11	10	Pipa 5
12	1	Pipa 6
13	2	valve 3/4 inch
14	1	Penyaring
15	1	Pipa 7
16	1	Pipa 8
17	3	Kran air
18	3	Flowmeter Tube

Picture1 Design of active carbon filtration research equipment to reduce BOD levels in PT canteen domestic wastewater. X



Picture2 Dimensional design of active carbon filtration research equipment in reducing BOD levels of PT canteen domestic wastewater. X

RESULTS OF RESEARCH AND DISCUSSION

The results of checking BOD levels before and after passing through the coconut shell activated carbon media can be seen in table 1.

Table1PT. Canteen Domestic Liquid Waste BOD LevelsX Before and After Processing

Repetition	BOD inspection results for each flow rate variation					
	1.2 Liters/minute		1.3 Liters/minute		1.4 Liters/minute	
	Pretest (mg/L)	Posttest (mg/L)	Pretest (mg/L)	Posttest (mg/L)	Pretest (mg/L)	Posttest (mg/L)
1	120.9	10.4	122.4	13.6	121.8	22.4
2	116.2	9.0	120.8	12.5	120.5	22.3
3	119.4	9.8	119.3	12.1	122.7	21.1
4	119.0	9.3	118.7	12.3	122	21.0
5	120.2	10.2	120.3	13.2	119.3	21.2
6	121.7	10.6	121.0	13.4	120	22.2
Average	119.57	9.88	120.42	12.85	121.05	21.7
Min	116.2	9.0	118.7	12.1	119.3	21.0
Max	121.7	10.6	122.4	13.6	122.7	22.4

According to Table 1, the average BOD level in domestic canteen liquid waste before treatment was 119.57–121.05 mg/L. The average BOD level after treatment with varying flow rates was 9.88–21.7 mg/L. Furthermore, the reduction in BOD levels at each flow rate variation using activated carbon filtration can be seen in Table 2.

Table2PT.X Canteen Domestic Liquid Waste BOD Levels Before and After Flow Rate Treatment

Repetition	Reduction of BOD Levels at Each Flow Rate Variation		
	Flow Rate (1.2 L/m)	Flow Rate (1.3 L/m)	Flow Rate (1.4 L/m)
	Decreased (mg/L)	Decreased (mg/L)	Decreased (mg/L)
1	110.5	108.8	99.4
2	107.2	108.3	99.2
3	109.6	107.2	101.6
4	109.7	106.4	101.0
5	110	107.1	98.1
6	111.1	107.6	97.8
Average	109.68	107.57	99.52
Min	107.2	106.4	97.8
Max	111.1	108.8	101.6

Table 2 shows the average BOD level at a flow rate variation of 1.2 liters/minute of 109.68 mg/L, a flow rate variation of 1.3 liters/minute of 107.57 mg/L and a flow rate of 1.4 liters/minute. minutes of 99.52 mg/L.
Results of pH measurements in PT. canteen domestic liquid waste. X can be seen in table 3.

Table 3 Measurement of pH of Domestic Liquid Waste PT.X Canteen

Repetition	Results of pH Measurement of Domestic Canteen Liquid Waste					
	1.2 Liters/minute		1.3 Liters/minute		1.4 Liters/minute	
	Pre	Post	Pre	Post	Pre	Post
1	6.9	6,7	6,7	6,7	6,7	6,8
2	6.5	6,8	6,8	7	6.6	6,8
3	6,7	6,8	6.5	6.5	6.5	6,7
4	6.5	6.6	6.6	6,7	6.5	6,7
5	6.5	6.5	6,7	6,8	6.5	6,7
6	6,8	6,8	6.5	6.6	6,7	6,8

The results of the pH measurements in the domestic liquid waste from the PT. canteen ranged from 6.5–6.9 before treatment, while the results after treatment were 6.5-7. The pH measurement aims to determine the pH before and after a flow rate treatment using activated carbon. The average pH value tends to be normal, ranging between 6.5-7, according to the measurement results. pH has an influence on the adsorption process because it determines the solution's ionization level, and in general, the adsorption of organic materials from liquid waste will increase as the pH decreases. pH is not a disturbing factor in the research carried out because the data measured is correct and does not show fluctuating values. If the pH value in the adsorption process is abnormal, chemicals such as mineral acid should be added to lower the pH level, or alkali should be added if necessary to increase the pH. However, the adsorption process will be reduced as a result of the formation of salt will reduce the adsorption process.

We measured the temperature of the domestic liquid waste from the PT canteen. We conducted the X test both before and after the filtration flow rate treatment using coconut shell activated carbon. The temperature of domestic canteen liquid waste, as shown in Table 4, ranges between 23 and 25 °C.

Table3PT.X Canteen Domestic Liquid Waste Temperature Measurement

Repetition	Results of Domestic Canteen Liquid Waste Temperature Measurements					
	1.2 Liters/minute		1.3 Liters/minute		1.4 Liters/minute	
	Pre (◦ C)	Post (◦ C)	Pre (◦ C)	Post (◦ C)	Pre (◦ C)	Post (◦ C)
1	25.4	25.6	25.3	25.5	25.3	25.3
2	25.5	25.5	23.9	23.9	25.1	25.2
3	23.7	23.7	23.5	23.7	23.2	23.3
4	25.7	25.8	23.6	23.9	23.5	23.6
5	23.6	23.6	23.7	23.7	25.2	25.3
6	25.5	25.7	25.6	25.8	23.4	23.5

It is known that the temperature of domestic liquid waste has increased, but it is not significant. When the adsorbate molecules stick to the adsorbent's surface, a certain amount of energy is released, so the adsorption is classified as exothermic. Exothermic is a reaction that produces heat, causing the liquid waste that passes through the medium to experience an increase in temperature, even though it is not significant.

When activated carbon is absorbed, an adsorption process occurs, namely the absorption of substances that will be removed by the surface of the active carbon. Freundlich isotherm adsorption was used in this study. In this type of adsorption, organic molecules from liquid waste stick to the surface of the medium using Van der Waals bonds. This makes weak bonds between the adsorbate and the adsorbent. This allows the adsorbate to move freely, facilitating the multilayer adsorption process. As a result, the adsorbate is easily released, highly reversible, and allows desorption to occur at the same or constant temperature [21]. Freundlich isotherm adsorption is a process in which the bonds are weak and the adsorption site is heterogeneous, resulting in several layers [22].

Processing liquid waste in the canteen aims to reduce the BOD levels contained therein by using active carbon media. The coconut shell activated carbon filter operates by filtering domestic liquid waste that has been deposited first, thereby reducing the levels of TSS and fatty oil when it passes through the active carbon filter media. The flow rate influences the duration of contact between domestic liquid waste and the carbon media, leading to a reduction in BOD levels in the canteen's domestic liquid waste. Further research revealed that the slowest flow rate is the most effective in reducing ammonia levels in liquid waste [23]. Pandia found in his journal that a flow rate of 24 L/minute was the most effective in reducing BOD levels. The flow rate of 24 L/minute achieved a reduction percentage of 60%. This also aligns with Sarasdewi's research, which found that the slowest flow rate, with a reduction percentage of up to 50%, is the most effective flow rate for reducing pollution in domestic wastewater treatment plants. [25].

Table 5Analysis Data Results

Variables	Univariate Analysis				Bivariate Analysis	
	Mean	Min-Max	elementary school	Shapiro Wilk (P Value)	Statistics	Sig
Pre test flow rate 1.2 liters/minute	119.57	116.2-121.7	1.92	0.588	0.931	0.588
Post test flow rate 1.2 liters/minute	9.88	9.0-10.6	0.63	0.647	0.938	0.647
Pre Test flow rate 1.3 Liter/minute	120.42	118.7-122.4	1.31	0.924	0.975	0.924
Post test flow rate 1.3 liters/minute	12.85	12.1-13.6	0.63	0.388	0.902	0.388
Pre Test flow rate 1.4 Liters/minute	121.05	119.3-122.7	1.32	0.712	0.947	0.712
Post test flow rate 1.4 liters/minute	21.70	21.0-22.4	0.66	0.057	0.798	0.057

Thus, in this research, the use of activated carbon filtration equipment using variations in flow rate was effective in reducing BOD levels in canteen liquid waste.

CONCLUSIONS AND RECOMMENDATIONS

The study's findings showed that the amount of BOD in liquid waste from the kitchen decreased after it was treated with coconut shell activated carbon media at a flow rate. The average decrease in BOD levels at a flow rate of 1.2 liters/minute was 109.68 mg/L; at a flow

rate variation of 1.3 liters/minute, it was 107.57 mg/L; and at a flow rate of 1.4 liters/minute, it was 99.52 mg/L. The most effective flow rate for reducing BOD levels in canteen liquid waste is 1.2 L/m.

The research results could be used as an alternative way to process household liquid waste in industry. This can be done by paying close attention to the saturation period of activated carbon media as an adsorption medium to find out how long to reactivate the activated carbon and how long to replace it so that the highest reduction in BOD levels is achieved. in the canteen's domestic liquid waste.

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