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Research Paper

The Filtering System Modification on Rainwater Harvesting Technology with Centrifugal System for Reduce TDS

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Abstract
Rainwater harvesting technology is needed today. The development fast that occurs has the impact of increasing the use of ground water. Rainwater harvesting technology is the main solution in this case. Apart from being a water source, it can also restore the groundwater level to its original condition. Rainwater harvesting technology currently still needs a lot of development to produce better rainwater quality. For this reason, in this study, the modification will be made to the initial filter to separate the initial sediment from pure rainwater when it rains. The system of centrifugal in this case will be used to take part in separating sediment from rainwater. Centrifugal filtration systems are made using several tools and easily available materials. Based on the results of this study, it is known that the level of TDS reduction from before the use of centrifugal filters to after use is 62.2%. This decrease can be seen from the TDS value before the use of an average of 12.2, while after the use of centrifugal filter the average TDS is 4.6.

Keywords
Rainwater Harvesting, Sentrifugal System, Dissolved Solid Level

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1. INTRODUCTION

The clean water crisis has become one of the problems in Bandar Lampung, Indonesia. In 2019, several regions were hit by a shortage of clean water. According to the Head of the Emergency and Logistics Division of BPBD Bandar Lampung City, the four month drought that occurred in 2019 has caused the area to be hit by a clean water crisis. Several sub districts that need clean water supplies from the government are Kepeacean, Kedaton, Sukabumi, Sukarame, Panjang, Rajabasa, Wayhalim, and Telukbetung Timur. In 2015 three villages in Lampung, water conditions have been polluted with sewage, namely Way Galih Village, Lubuk Bais Lematang Village, and Siranjia (Yasland, 2019). This pollution has been going on for years due to waste from several factories around the village (Yasland, 2015). One technology that can be developed by the community in overcoming this is by applying rainwater harvesting (Jamali et al., 2020).

Rainwater harvesting technology is one of the potentials of good clean water for the community (Novak et al., 2014). Rainwater Harvesting (RH) or rainwater harvesting technology is used to collect rainwater in the rainy season and then use it to meet water needs during the dry season (Kim, 2011). RH is an old technology that has developed in many countries (Kinkade-Levario, 2007). However, the development of RH has not been optimally used by the people of Indonesia (Keithley, 2012). The Utilization of rainwater as the community's main water source is very important considering the availability of groundwater is getting depleted (Brown et al., 2001). A lifestyle that focuses on environmental sustainability is currently a priority. The continuous use of groundwater sources must be reduced due to the very limited availability of groundwater (Subramanya, 1995). The hydrological condition of a region also affects the quality of rainwater in the region (Buttler and Davies, 2004; Usace, 1998). This is because the level of pollution in the atmosphere will damage the quality of rainwater (Mahmoud et al., 2015). The quality level of water TDS is one of the factors of clean water parameters (Qin et al., 2015). For this reason, the development of rainwater harvesting technology is currently needed as an effort for academics to improve the quality of water produced from this technology (Usace, 2000). To produce better and ready to drink water quality, a more complex and faster filtration system is needed. With a high speed in filtering, the quantity of water produced will be faster and the quality of the water will also increase (Huang et al., 2020). For this reason, the development of a filtering system based on a centrifugal system is something worth trying in this regard (Carbajal et al., 2017). The centrifugal system is a system for separating fine sediments in the water by using the centrifugal force of the flow that occurs. This centrifugal force can be generated by using an adjustable flow path so that the water can flow in a rotating manner. Therefore, the effectiveness of using this centrifugal system should be tried in rainwater harvesting technology. In this case, the author proposes to the Institute for Research and Community Service research related to knowing the solution to this problem.

2. EXPERIMENTAL SECTION

The data collection process is the rainwater data from the system output. Furthermore, the data will be tested in the laboratory or by using a water quality measuring instrument. The results of the centrifugal system will be analyzed for the level of water sediment and then compared with the system before the modification. Observations are made directly on the tool made. The observation process can be carried out as many as 5 or 7 trials. The results of these observations became the basis for the successful development of the filter of centrifugal in rainwater harvesting. The data obtained from the quality of rainwater from the tool will be processed using statistics in general. The calculation method used in this data processing is the calculation of the average, standard deviation, bar graph, line graph, and comparative test analysis (Te Chow, 2010). Mean aritmatic formula in Equation 1:

$$\bar{X} = \frac{\sum_{i=1}^{n} xi}{n} \tag{1}$$

Deviation standard formula in Equation 2:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (xi - \bar{x})^2}{n-1}} \tag{2}$$

With: $\bar{x}$ = mean aritmatic, n = number of sample, xi = i-th tds data, and σ = deviation standard

This research was conducted in several stages, namely the process of collecting information related to the rainwater harvesting system. In this process, several reference sources related to rainwater harvesting systems are reviewed, both from books and journals. Furthermore, the information obtained is used as the basis for ideas in developing existing technologies. Focusing on basic research, therefore the development of the initial filter is taken which is the first filter in the rainwater harvesting system (Simmons, 2018).

The activity begins with the tool design process. The design process is carried out either in two dimensions or three dimensions in the developed part. Next is the process of preparing tools and materials and the manufacturing process. Furthermore, the finished tool is tested for its success rate through a water quality test from the output of the tool. In the test of water quality product output is used TDS meter measuring instrument. The process of testing the level of TDS in the water is carried out with the following procedures: (1) calibrate the TDS meter measuring instrument using pure water (aqua dest), (2) prepare the water to be tested in a glass container, (3) test the level of TDS using a TDS meter by putting the tool in water and waiting for ± 1 minute or until the number TDS stops moving, (4) Perform 5 tests by repeating steps 1 to 3.

In this case, the results obtained from the development with the results from before the development were carried out by a comparison test. This comparison test was conducted to determine the difference before and after development. From these results will be known the level of success of the development carried out. Furthermore, the process of writing the final research report and the use of finance.

3. RESULTS AND DISCUSSION

The centrifugal filter in this study is part of the core of the research. The manufacture of centrifugal filters is a modification of the rainwater harvesting technology itself. This development technology focuses on adding a sediment filtration system to the input of rainwater entering the reservoir. In this study, the additional system was made by requiring some simple tools and materials as shown in the following Table 1.

Table 1. Tools and Materials

No.	Tools and Materials	Quantity
1	PVC 2”	2
2	PVC bend 2”	6
3	pipe glue	1
4	Pipe Saw	1
5	Small Tank	1
6	Fine Filter	25
7	Wire Mesh	1 m^2
8	Plastic Glue	1
9	3” to 2” PVC Pipe Joints	1
10	Stop Faucet	1

Some additional simple filters are made as in the Figure 1.

This technology has been applied to the rainwater harvesting system as shown in the Figure 2.

Based on the results of the development of this rainwater harvesting technology, the output results in the form of TDS data are obtained. In this case, the rainwater TDS data resulting from technology development is compared with the rainwater TDS data from before the use of centrifugal filters. This is done to find out how big the change in rainwater yields is from the use of a centrifugal filter. Before using the

Figure 1. Centrifugal Filter

Figure 2. Centrifugal System Installed in Rainwater Harvesting

centrifugal filter, the rainwater TDS value was obtained as shown in Table 2.

Table 2. TDS Data Before used The Centrifugal Filter

No.	pH	TDS (ppm)	Information
1	7.65	13	Worth drinking
2	7.45	12	Worth drinking
3	6.95	11	Worth drinking
4	7	13	Worth drinking
5	6.98	12	Worth drinking
Mean	7.206	12.2	

After using a modified centrifugal filter into rainwater harvesting technology, the rainwater TDS data is obtained as shown in the following Table 3.

Based on the TDS values before and after it can be seen that there is a decrease in the TDS level by using additional centrifugal filters. In this case, it can be seen that the effect of using a centrifugal filter is very large in reducing the TDS level of rainwater in rainwater harvesting technology. The average value of TDS before the use of a centrifugal filter is 12.2 while the average value of TDS after the use of a centrifugal filter is 4.6. Based on this value, the percentage of TDS reduction can be calculated after the use of a centrifugal filter. The percentage decrease in TDS after the use of a centrifugal filter in Equation 3 is:

Table 3. TDS Data After used The Centrifugal Filter

No.	pH	TDS (ppm)	Information
1	7.5	5	Worth drinking
2	6.55	4	Worth drinking
3	7.02	4	Worth drinking
4	7.35	5	Worth drinking
5	6.7	5	Worth drinking
Mean	7.024	4.6	

Table 4. Statistic Calculation Result

		mean	N	Std. Deviation	Std. Error Mean
Pair 1	TDS before	12.2	5	0.83666	0.37417
	TDS after	4.6	5	0.54772	0.24495

$$
\begin{aligned}
\Delta\ \text{TDS}\ (\%) &= \frac{TDS_{before} - TDS_{after}}{TDS_{before}} \times 100\% \\
\Delta\ \text{TDS} &= \frac{12.2 - 4.6}{12.2} \times 100\% \\
\Delta\ \text{TDS} &= 0.622 \times 100\% \\
\Delta\ \text{TDS} &= 62.2
\end{aligned}
\tag{3}
$$

It can be seen that the TDS level decreased by 62.2% with the use of a centrifugal filter. This shows that the use of a centrifugal filter has been able to reduce the TDS level of water. Based on the results of the statistical test, namely the t-test, the results are as shown in the following Table 4.

Based on the Table above, it can be seen the difference in the average value of TDS before to TDS after. This is also indicated by the value of the standard deviation of the TDS data after which is much smaller which indicates that the data values are almost uniform.

4. CONCLUSIONS

The use of centrifugal filters is very effective in reducing TDS levels in water. This is evidenced by the decrease in TDS levels from this study. Making a centrifugal filter is very simple and inexpensive. This of course can be applied by the community in the treatment of drinking water for daily consumption. Thus, it can be said that the centrifugal filter is an effective modification in helping to reduce the TDS level in the water.

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