Application of Natural Filtration Media to Reduce the Turbidity Levels of Raw Water Sources for the Community

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Abstract. This study examines the application of natural filtration materials in clean water installations for the community of Labak Suren Village. The clean water source comes from a river, with water that tends to be turbid, especially during the rainy season. The main objective of this research is to improve the quality of the water used by the community through environmentally friendly and effective filtration methods. The activities involved the installation of filters and filter media using materials such as sand, gravel, and activated charcoal, as well as laboratory testing of water samples before and after the filtration process. Based on the test data, after filtering with two filtration media, a reduction in Chemical Oxygen Demand (COD) from 15,360 mg/L to 3,840 mg/L was observed, Biological Oxygen Demand (BOD) decreased from 8,064 mg/L to 1,008 mg/L, Total Dissolved Solids (TDS) decreased from 810,000 mg/L to 670,000 mg/L, and turbidity showed a substantial reduction from 1,016.161 mg/L to 126.365 mg/L. Referring to national quality standards, particularly for river water, the test results classify the water as first-class, meaning it can be used as raw water for drinking water.

Keywords: Community, Filtration, Raw Water, Turbidity

1 Introduction

The supply of clean water is a crucial foundation for sustainable development and improving the quality of life in villages. Adequate and sustainable access to clean water enables village communities to live healthier, more productive, and prosperous lives. Clean water is an essential resource for health, well-being, and the sustainability of human life. Water can be used for human needs, and its quality must meet the specified standards (Armansyah et al., 2022; Julaikah & Astuti, 2023) In addition to meeting the quantity and quality of water sources, the use of water sources must also meet the quality criteria according to its intended use (Aryandini et al., 2023; Syuhada et al., 2021). Biologically and chemically contaminated clean water, or water that does not meet standards, can endanger public health or residents in a short period. One of the

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common methods of water purification is filtration. Filtration-based water purification has proven effective in improving the quality of well water, making it suitable for daily use, including consumption and cooking (Coenraad & Karelius, 2019; Syafitri et al., 2023). Proper management, technological innovation, and public awareness are key to ensuring the availability of clean water for everyone in the future . However, the facts on the ground show that the availability of clean water has not yet met the needs of the population evenly throughout Indonesia, particularly in Bali. The difficulty in obtaining clean water is a serious challenge faced by rural communities due to limited water sources and inadequate infrastructure. For example, in Labak Suren village, located in Tabanan Regency, the geographical condition of the village is hilly and surrounded by rivers in valleys at a depth of approximately 100 meters from residential areas or rice fields. The rivers, which are the source of irrigation for the rice fields, are rain-fed. During the dry season, the river water flow decreases drastically, making it unable to irrigate the rice fields in Labak Suren village. During the dry season, the economic condition of the community is very concerning because agricultural income declines due to crop failure. This situation impacts the difficulty in purchasing clean water for consumption. Based on this situation, it is crucial to create a clean water installation in Labak Suren village that can flow from the water source to each household.

Figure 1. River conditions as a water source for the Labak Suren Village Community

The use of river water, which is considered surface water, tends to be murky due to the presence of fine silt, especially during the rainy season. The installation of simple filtration devices using natural materials such as silica sand, zeolite stones, and activated carbon is intended to clarify the water before it is distributed to individual households. Filtration devices are installed at four points along the pipeline to capture solid particles that flow into the water system. The personnel managing the water system are provided with technical training on how to maintain the clean water installation and the natural filtration system, which requires regular cleaning and maintenance.

2 Methodology

The purpose of water treatment is to reduce the concentration of pollutants in the water so that it is safe for use. Tailoring water treatment to the specific conditions of the water source is a viable approach to meeting demand and addressing water availability issues. These activities require processing technology adapted to the characteristics of the raw materials, water sources, socio-cultural conditions of the community, and local human resources. The specific objectives of this first phase of the study were to conduct the following investigations:

1. Assess the performance of a slow silica sand-gravel-activated carbon filter (natural media filter) and its ability to function as a single filter system.
2. Evaluate the performance of a natural media filter system (with activated carbon in the upper layer, gravel in the middle layer, and silica sands in the lower layer, each in a separate filter box), with a view to comparing the advantages and disadvantages of this system against the single-filter system.

The investigation method involved assessing the influence of raw water turbidity and filtration rates on the quality of treated water (including turbidity and coliform removal) and the duration of filter runs, based on observations of head-loss development.

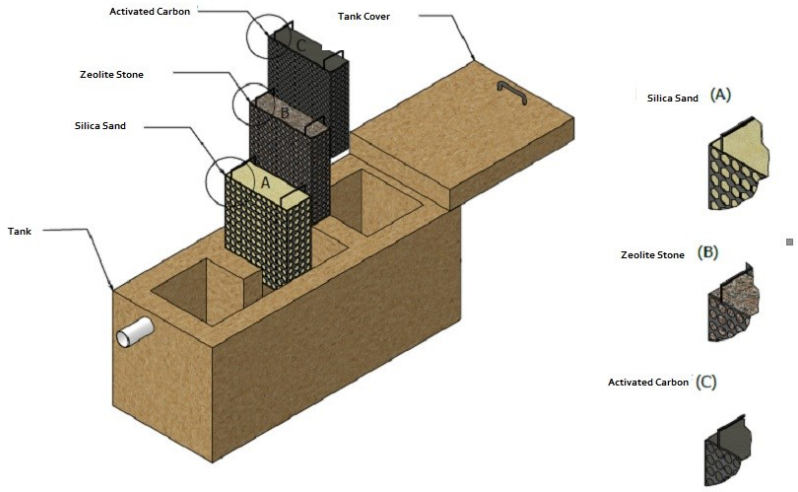

Figure 2. Filter construction design with natural media

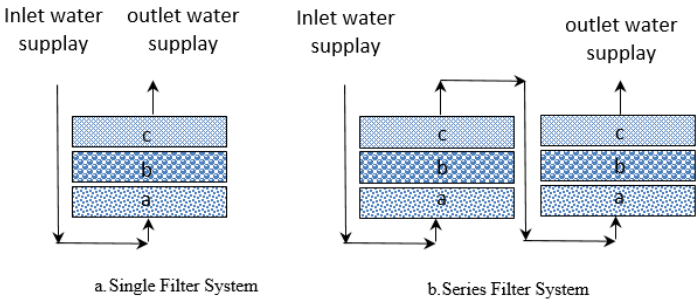

Figure 3. Filter system

3 Result and Discussion

3.1 Result

The results obtained from this research and community service activity are shown in the following figures.

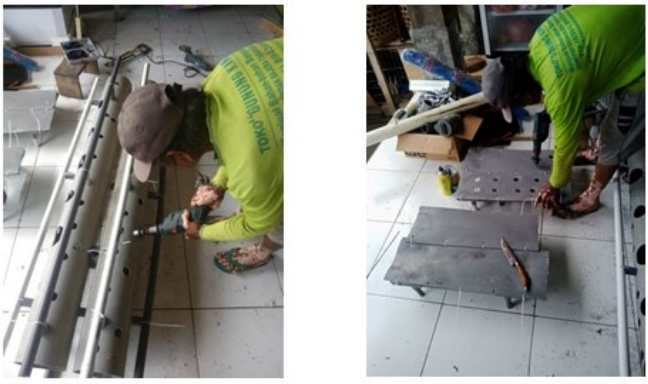

Figure 4. Construction of filtering equipment

Figure 5. Installation of filters and filter media

Figure 6. Filtered water sample

The filtered water sample is then tested at the analytical laboratory of Udayana University. The parameters tested include Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), and turbidity.

Table 1. Laboratory test results

No	Parameter	Method	Unit	Filtration result			Allowed maximum limit*
				Before	1 Layer	2 layer	
1	COD	Titrimetry	mg/L	15,360	9,600	3,840	10
2	BOD	Titrimetry	mg/L	8,064	5,040	1,008	2
3	TDS	Titrimetry	mg/L	810,000	790,000	670,000	1000
4	Turbidity	Spectrophotometry	mg/L	1,016.161	910.411	126.365	1

3.2 Discussion

The construction of natural-material water filters and filtration systems has been completed. The filtration process utilizes gravity flow with a height difference of only 0.6 meters, which requires regular cleaning of sediment deposits from the river water collected in the settling tank, especially during the rainy season when the river water becomes more turbid. Currently, the drain channels for the settling tank and the filter tank need to be replaced with clean-out plugs that use threaded connections, making it easier to remove the sediment deposits at the bottom of the storage tank. The water produced from the filtration process appears clearer compared to the water that has not undergone filtration.

Based on laboratory testing of the clean water source that has undergone natural filtration, the physical parameters generally meet the standards. However, in terms of chemical parameters, some chemical elements exceed the maximum allowable limits, such as Nitrite as N. For bacteriological parameters, the E. coli content is below the permitted standard, but the total coliform content exceeds the maximum allowable limit. The source of this clean water is river water, which is surface water and thus highly susceptible to contamination from waste in the river basin area. For households using this water as clean water, if it is to be used for drinking, it must be boiled to a boiling point of 100°C for 5 to 20 minutes.

Based on the research data, the application of natural filtration materials in the water treatment process has shown significant improvements in water quality. The Chemical Oxygen Demand (COD) levels were reduced from 15,360 mg/L to 3,840 mg/L after passing through two filtration layers, which is still above the allowed maximum limit of 10 mg/L. The Biological Oxygen Demand (BOD) levels decreased from 8,064 mg/L to 1,008 mg/L with two layers of filtration, though it remains higher than the permissible limit of 2 mg/L. Total Dissolved Solids (TDS) slightly decreased from 810,000 mg/L to 670,000 mg/L, staying within the allowed maximum limit of 1,000 mg/L. Turbidity, measured by spectrophotometry, showed a substantial reduction from 1,016.161 mg/L to 126.365 mg/L, but it still exceeds the maximum allowed limit of 1 mg/L. Overall, while the filtration system significantly improves water quality, the results indicate that further refinement is needed to ensure all parameters meet the required health standards.

The application of natural materials as filtration layers is an environmentally friendly approach that shows significant results in improving water quality, especially in reducing COD, BOD, TDS, and turbidity levels. This innovation is important in the context of water treatment in rural or remote areas that may have limited access to advanced technology. The novelty of this research lies in its holistic approach, combining simple gravity-based technology with natural materials to improve the quality of water from surface water sources. Although the water quality test results have not fully met the standards, this system offers a practical solution with great potential for further development, especially in regions with limited resources.

4 Conclusion

The implementation of the natural material filter in the clean water installation for the Labak Suren village community was carried out smoothly and on schedule through the active participation and collaborative efforts of the executing team consisting of lecturers, students, and the “Toya Amerta” clean water group. The participation was extremely helpful in executing the activities, including the creation of design drawings for the natural material filter, the construction of the filtering device, the transportation of equipment and materials to the project site, the cleaning of sediment from the water reservoir, and the installation of the filtering device and natural material filter in the sedimentation tank. Based on the water quality test results, the water that has undergone the filtration process meets the requirements for use as raw drinking water, although further refinement of the filtration media is still needed.

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