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Dissemination of Portable Water Treatment for Providing Clean and Fresh Water for People Living in the Coastal Area of Meuraxa District, Banda Aceh

[1]Darwin*, [1]Ramayanty Bulan, [1]Bambang Sukarno Putra
[1]Universitas Syiah Kuala, Indonesia

*Corresponding author
E-mail: darwin_ae@usk.ac.id

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Abstract

Purpose: This community service aims to introduce and disseminate the portable water treatment that can be used for people living in the coastal area specifically in the Meuraxa District, Banda Aceh.

Method: The implementation method of the Community Service Program activities uses descriptive analysis methods, demonstrations, and direct practice by group partners and community members. For the operation of the water treatment unit installation, community group partners will emphasize the demonstration method based on operational control by prioritizing operator safety.

Practical Application: This integrated clean water treatment plant can desalinate water and separate organic and inorganic solid particles. This clean water treatment system is portable and has a working capacity of around ± 1000 liters. This installation is equipped with a sorting system and an automatic transfer system on the piping and pumping. This installation is needed to accelerate the process of cleaning and purifying water from brackish water to fresh water that is suitable for use and consumption.

Conclusion: This product-based community service has produced a product in the form of a portable water treatment installation for filtering and cleaning water from pollutants, contaminants and/or impurities. Hence, this technology would help people living in the coastal area provide fresh water and clean water for their lives.

Introduction

This community service activity involved partners from the Cot Lamkuweueh community group, Meuraxa District, Banda Aceh City. The main targets of this service are the general/ordinary community and community groups that are not yet economically productive but plan to open and develop productive businesses. This service program focuses on the management and processing of coastal groundwater sources that have been affected by the tsunami through technology transfer by the community service team. The main focus of this activity is on efforts to develop skills for processing and providing clean water and building entrepreneurial management through the development of a narrow-land organic farming system. This is prioritized because in general the people of Cot Lamkuweueh Village live in a fairly strategic coastal area and are close to the center of Banda Aceh City, but the development of independent businesses and community groups is difficult to develop due to the constraints of the availability of sufficient and sustainable clean water.

Cot Lamkuweueh Village is one of the villages in Meuraxa District, Banda Aceh City which was quite severely affected by the tsunami disaster. The location of the village in the coastal area and the impact of the tsunami disaster that occurred in Cot Lamkuweueh have made the groundwater in this village unusable for consumption or other needs such as washing household equipment and home industry. The availability of clean water has received a response from the local government with the supply of clean water from the regional drinking water company (PDAM). However, clean water distributed by PDAM is not always smooth or blocked and sometimes the water received by the community has low water quality, either with a high level of turbidity or an unpleasant odor.

The availability of clean water cannot accommodate all the needs of the local community, both for household needs and independent business needs. This lack of clean water can certainly hinder individuals and/or community groups from establishing and developing businesses that require clean water in large and sustainable quantities (Flint, 2013). Therefore, serious attention and handling are needed from various parties to provide effective, economical, and sustainable clean water installations to support the community's economic activities in Cot Lamkuweueh Village.

Although several areas have been built into residential areas, the limited clean water is one of the inhibiting factors in the economic growth of the village. Some people who have empty land prefer not to use their land either for planting or for opening new businesses. This happens because the use of empty land to open a business requires sufficient and continuous water availability so that it can reduce operational costs.

The limited clean water also requires residents of Cot Lamkuweueh Village who want to open a business to have a source of clean water from a well. As complained by the residents of Cot Lamkuweueh Village that the groundwater from the wells that were built has poor water quality, where the water obtained on average contains high salinity or is brackish water. Thus, the water obtained from the dug wells also cannot meet the clean water needs of the villagers. By looking at the potential of Cot Lamkuweueh Village which has a very strategic location where one of the advantages of this village is that it is close to the Ulee Lheu Beach tourist area and the center of Banda Aceh City, the facilities and infrastructure of water treatment units or clean water treatment installations are the main thing and must be prioritized. The development of clean water infrastructure is very necessary to encourage the development and economic growth of the local community.

Some solutions offered by the Community Service Program Based on Products include building an integrated water treatment unit or portable clean water treatment installation. The community service chose this type of technology because the integrated water treatment unit technology is a clean water treatment technology that is very effective in treating water, both contaminated with organic waste and brackish water with high salinity (Ang et al., 2015). This clean water installation technology is very much needed because Cot Lamkuweueh Village

has turbid and brackish groundwater which is known to contain high salinity and organic materials. Water conditions like this cannot be used by the community either for consumption or washing purposes because high levels of salinity and organics can damage metal layers and household appliances.

To reduce the salinity and organic material content in water, effective and efficient clean water treatment installation technology is needed. In this community service activity, an integrated water treatment unit installation will be built that integrates several separation systems, including a filtration system consisting of several filtration system units using zeolite packs and activated carbon packs which are then continued with a water purification system through a purified system and membrane separation unit. The entire water separation and purification installation system is integrated into one portable clean water treatment installation system so that it can be easily operated and moved (Loo et al., 2012). Thus, this system is designed so that the community can easily use it in normal and emergency disaster conditions.

Method

The implementation method of the Community Service Program activities uses descriptive analysis methods, demonstrations and direct practice by group partners and community members. For the operation of the water treatment unit installation, the demonstration method based on operational control will be emphasized on community group partners by prioritizing operator safety.

At this stage, field observations are carried out to identify the quality of groundwater obtained from community water sources such as wells. At this stage, water quality analysis is also carried out to determine the condition of groundwater and the condition of the soil and water channels in the environment around the water source, especially the condition of water channels (drainage), water sources and catchments, and soil conditions in residential areas. This stage also includes an analysis of the level and potential for pollution that occurs due to organic material contamination and salinity content, total dissolved solids and electrical conductivity in groundwater in residential areas.

Design and construction of clean water treatment installations by implementing Integrated Water Treatment Unit technology. This clean water treatment installation consists of several water purification system units consisting of a screening system, sedimentation unit, activated filter media consisting of activated carbon & zeolite, and a membrane separation system (i.e. reverse osmosis). This integrated clean water treatment plant is capable of desalinating water and separating solid particles, both organic and inorganic particles (Shaffer et al., 2012). This clean water treatment system is portable and has a working capacity of around ± 1000 liters. In the water treatment installation system, aerobic digesters are also needed to accelerate the decomposition process of organic materials contained in the water (Im et al., 2001).

This installation is equipped with a sorting system and an automatic transfer system on the piping and pumping. This installation is needed to accelerate the process of cleaning and purifying water from brackish water to fresh water that is suitable for use and consumption. This installation is a pilot scale installation towards an industrial scale and is not a bench or lab. Scale, therefore the design, construction, and operation follow the safety standards of factory-scale operators.

Monitoring and evaluation activities are carried out to ensure that the community service programs and activities that have been carried out can continue to be carried out sustainably. In this activity, the community service will also evaluate and respond quickly in overcoming obstacles for both group partners and community members involved so that all activities can continue to be carried out independently and sustainably.

Result

This community service program was preceded by the design of filtration units for portable clean water treatment installations. The filtration units consist of sediment filter cartridge packs, activated carbon packs, and zeolite packs. The results of the design of this clean water treatment installation can be seen in Figure 1.

Figure 1. Water Treatment Unit Installation Design

This clean water treatment installation equipment is equipped with an additional membrane unit, namely a reverse osmosis double pack. This unit is needed to increase the effectiveness of separating pollutants, dissolved solids, and salt content in water. So that the brackish water that is processed can become water that is suitable for use. The results of the design of a clean water treatment installation equipped with a membrane separation system can be seen in Figure 2.

Figure 2. Results of the Design of a Clean Water Treatment Installation with a double pack RO

After the design of the tool, the next step is to test the performance of the portable water treatment unit installation before it is used in the field. The results of the performance test show that this clean water treatment equipment is very effective for carrying out the water cleaning process. With the construction of this clean water treatment installation equipment, water that is not suitable for use, such as water with salinity and dissolved pollutants, can be cleaned into water that is suitable for use. Hence this equipment is very useful for people living in coastal areas and areas close to final disposal sites and can be used as clean water installation equipment for disaster response.

This product-based community service activity received a very good response from partners and the community of Cot Lamkuweuh Village. This was proven by the enthusiasm of partners and community members in participating in the demonstration and explanation of

the clean water treatment system using portable water treatment. During this community service activity, the implementing team received many questions regarding the design process and operation of clean water treatment installation equipment (Figure 3).

Figure 3. Presentation and demonstration of the operation of the portable water treatment installation in Cot Lamkuweuh Village

During the community service activities in the field, the Village Head and the Cot Lamkuweuh Village apparatus were also directly present so that the question-and-answer process regarding the installation and production process of water treatment equipment was more comprehensive. This is because the village apparatus hopes that in the future the equipment that has been tested for its success in processing clean water can be mass produced so that all members of the village community can utilize the products from the development of this technology to meet their daily clean water needs. The community service activities in the field were also visited by the monitoring and evaluation team (MONEV) from LPPM USK to monitor, assess and carry out the evaluation process of the community service activities that have been carried out by the community service team and community group partners (Figure 4).

Figure 4. Monitoring and evaluation activities and discussions with the community

Discussion

This product-based community service program has successfully designed and built clean water treatment installation equipment with hybrid power. The equipment that was successfully designed and built is the work and creative idea of the community service implementation team. This clean water treatment installation equipment integrates several filtration methods both physically and chemically. The physical filtration system applied is by flowing brackish water through a sediment filter cartridge pack to reduce dirt, pollutants, and dissolved solids contained in the water. Water from the results of the filtering process will pass

through the next filtration system involving the chemical adsorption method, namely through the activated carbon and zeolite pack filtration unit (Yu et al., 2019; Nasir and Titah, 2024).

This filtration unit will clean the water by reducing contaminants, and organic and inorganic materials. In addition, this filtration unit can also reduce odors and tastes in the water. To reduce impurities and solid matters including both total suspended solids and total dissolved solids in the water, zeolite was used and installed as a filter in the water treatment system (Aziz et al., 2020). Therefore, the brackish water purification system installed becomes more environmentally friendly and could reduce toxic and non-toxic materials in the water.

In addition, this water treatment installation is also equipped with a membrane separation operating unit. This unit is needed to increase the effectiveness of cleaning and purifying brackish water into usable water (Richards et al., 2014; Curcio et al., 2015; Honarparvar et al., 2021). This filtration unit is a very important part because this membrane separation system is very effective in reducing the salt content in water and can eliminate pathogens in the form of microorganisms found in water (Nasir et al., 2022).

This clean water treatment installation is also equipped with a differential pressure gauge which is needed to measure the pressure of the water flow. With this pressure gauge, this clean water treatment installation can regulate the water pressure and water flow rate in the pipe (Okolie et al., 2023). Hence, users can regulate the effective pressure needed to carry out the pollutant cleaning process and the brackish water desalination process.

Conclusion

This product-based community service has produced a product in the form of a portable water treatment installation that can be used for filtering and cleaning water from pollutants contaminants and/or impurities. This equipment is also equipped with a membrane separation system with double-pack reverse osmosis which is very effective for brackish water desalination processes. Since the installation is a portable pilot-scale clean water treatment installation, it needs to be further developed to integrate a portable hydroponic farming system. So that the water treatment installation equipment produced can support the development of narrow-land agriculture in coastal areas.

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