Pengolahan Air Gambut Menjadi Air Bersih Menggunakan *Reverse Osmosis* untuk Kebutuhan Masyarakat Desa Danau Lamo

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Abstract

The village of Danau Lamo in Muaro Jambi Regency faces a serious challenge regarding water quality, where main water sources such as wells and rivers have been contaminated by peat water. This water, used for daily needs, has poor physical characteristics, such as a reddish-brown colour, unpleasant odor, and slightly oily texture, often leading to health problems, particularly diarrhea in children. This research aims to treat peat water to produce clean water suitable for daily use using reverse osmosis (RO) technology, in accordance with the clean water quality standards set by the Indonesian Ministry of Health Regulation Number 32 of 2017. The applied method includes a coagulation-flocculation process using a bio-coagulant derived from mung bean powder, followed by filtration and purification using the RO OxFIL 400 GPD unit. Test results indicate a significant improvement in water quality, with physical parameters such as pH 6.6, TDS 97 mg/L, turbidity <1.80 NTU, and watercolour <3.47 TCU approaching standard quality benchmarks. Reverse Osmosis technology has proven effective in removing contaminants and producing water suitable for daily needs, thus offering a solution to the water quality issue in Danau Lamo Village.

Keywords: *clean water, peat water, reverse osmosis, water treatment*

1. Introduction

Water is an indispensable natural resource crucial for the survival of all living organisms, particularly humans. It serves a myriad of functions, including drinking, cooking, washing, and bathing. Furthermore, water plays a vital role in industrial processes, agricultural activities, and various other sectors that underpin economic stability and growth[1]. However, the quality of water utilized must adhere to specific standards to ensure its safety for human consumption and overall health.

In several regions, the quality of raw water continues to be a significant challenge, as evidenced by the situation faced by the community in Danau Lamo Village, located in the Maro Sebo District of Muaro Jambi Regency. This village confronts serious issues related to the quality of peat water, which is typically characterized by a reddish-brown hue, unpleasant odor, and occasional oiliness, all stemming from contamination associated with the surrounding peatlands. Although the community relies on this peat water for daily activities, it is not suitable for consumption without adequate treatment[2]. Consequently, the adverse health effects of using contaminated water are evident, particularly manifested in instances of gastrointestinal diseases such as diarrhea, especially among children.

This predicament underscores the imperative for effective treatment of peat water to convert it into clean, safe water suitable for both domestic use and consumption. The Reverse Osmosis (RO) method stands out as a promising technological solution to address these water quality challenges. The operational principle of RO involves the application of a semi-permeable membrane that selectively filters dissolved solids and contaminants from the peat water, thereby producing purified water that is safe for human use. This technology has gained widespread application in diverse water treatment contexts, including desalination processes that convert saline water into freshwater[3]. The implementation of RO in Danau Lamo Village is anticipated to provide a viable solution for improving local water quality.

In Indonesia, standards for clean water are governed by the Minister of Health Regulation of the Republic of Indonesia No. 32 of 2017[4], which delineates critical parameters such as pH, turbidity, and total dissolved solids (TDS) that must be met for water to be deemed potable. The objective of employing RO technology in the treatment of peat water is to ensure that the resultant water complies with these established standards and mitigates health risks associated with the consumption of contaminated water. Through such interventions, it is possible to significantly enhance public health outcomes and overall quality of life for the affected communities.

2. Research Methods

This study utilizes reverse osmosis (RO) technology in the treatment of peat water into clean, usable water to meet the needs of the Danau Lamo Village community. The peat water treatment process is divided into four main stages: preparation, testing, data analysis, and reporting.

This research methodology is designed to provide a comprehensive solution to the clean water problems in Danau Lamo Village, with the hope that RO technology can be widely and sustainably implemented to improve the community's quality of life through the provision of safer, consumable water.

2. 1 Preparation Stage

In the initial stage, a preliminary survey and field identification were conducted in Danau Lamo Village. The village is known to have significant water issues, as the water appears brown and has an acidic taste due to its low pH, characteristic of peat water. This identification process involved discussions with village officials to understand how the community uses river and groundwater for daily needs, despite the water being unfit for consumption. Field observations were also carried out to determine strategic testing locations and assess the needs of public facilities that would benefit from the treated water.

2. 2 Testing Stage

This stage involves designing and testing a peat water treatment system using reverse osmosis technology. The testing process is conducted at two scales: laboratory and field. Initial testing is performed in laboratories, such as the Jambi Lestari International Laboratory and the Environmental Department Laboratory of Jambi City, to assess the efficiency of the equipment in treating peat water. Measurements of water quality parameters such as pH, Total Dissolved Solids (TDS), turbidity, and color are taken before and after treatment. Large-scale testing is then conducted by channeling the treated water through the RO system to public facilities in Danau Lamo Village to evaluate the technology's effectiveness in a real-world setting.

2. 3 Data Analysis Stage

After testing, the data collected during the treatment process is analyzed. The parameters analyzed include pH, TDS, turbidity, color, iron content, hardness, Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD). These data are then compared to the clean water quality standards outlined in the Indonesian Ministry of Health Regulation No. 32 of 2017. The aim of this stage is to determine whether the RO-treated peat water meets the required standards and whether the resulting water is safe for consumption by the Danau Lamo Village community.

2. 4 Reporting Stage

The results from the entire data analysis process are compiled into a written report detailing the peat water treatment, test results, and recommendations for further field implementation. The report also includes an evaluation of the effectiveness of reverse osmosis technology in treating peat water and its long-term potential benefits for the community.

3. Results and Discussion

3. 1 Water Source Conditions

The water sources in Danau Lamo Village are known to exhibit poor physical quality, characterized by a strong odor, turbid appearance, and unpleasant taste. As a result, the local community, in their efforts to meet daily water needs, often resort to collecting rainwater or purchasing bottled water due to the unsuitability of peat water for consumption. The water drawn from the river mouth typically presents a murky colour, a metallic (iron) odor, and an acidic taste. Therefore, prior to feeding the water into the reverse osmosis (RO) system, a pre-treatment process is required to extend the lifespan of the RO filters and membranes.

Figure 1. Condition of Peat Water

3. 2 Water Source Conditions

The treatment of peat water in Danau Lamo Village is carried out through a series of processes aimed at improving water quality to make it suitable for consumption. This process consists of three main stages: coagulation-flocculation, filtration, and filtration using reverse osmosis (RO) technology. The process are presented in Figure 2 below:

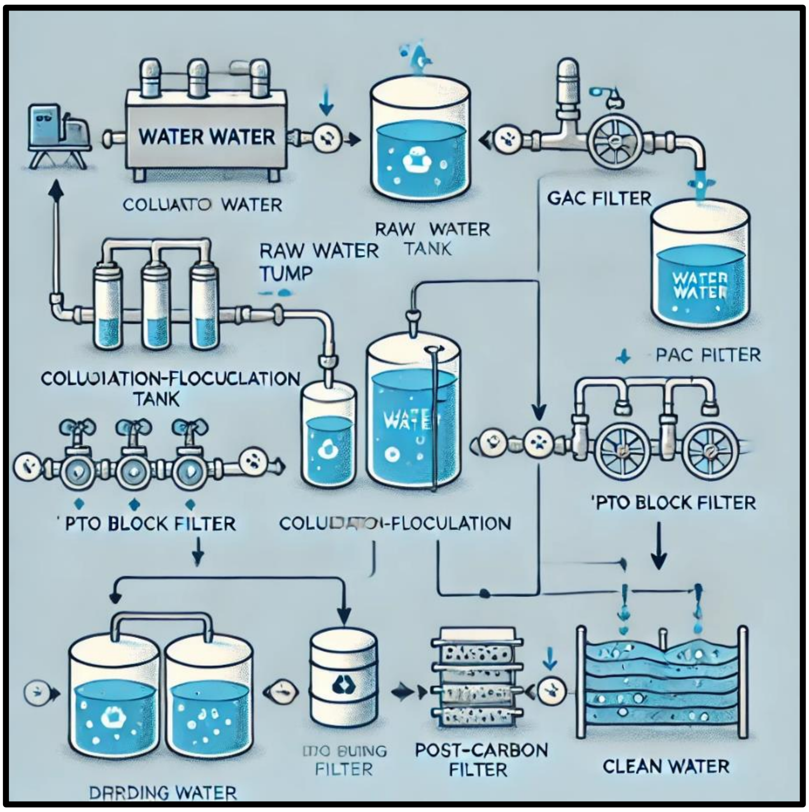

Figure 2. Flowchart for Water Treatment

3.2.1 Coagulation-Flocculation Stage

In this stage, the water enters a treatment tank operated by a pump. A bio coagulant in the form of mung bean powder is used as the coagulant at an optimum dose of 4 g/l. The mung bean powder works by binding to the negatively charged colloidal particles in the peat water, while the coagulant itself carries a positive charge. This difference in charge leads to the formation of flocs, which help reduce water turbidity. Optimal stirring is required to ensure the formation of large particles, with a recommended duration of 5 to 20 minutes. After this process, the pH of the water changes from 5.5 to 6.6, indicating that the use of mung bean coagulant successfully neutralizes the pH.

3.2.2 Filtration Stage

After passing through the coagulation-flocculation process, the water enters the filtration stage to remove any residual mung bean sludge that may remain. The filtration system uses filters of 0.1 micron, 0.3 micron, and 0.5 micron to ensure that the sludge is fully separated from the treated water. The use of small-sized filters helps to trap tiny particles, ensuring that the resulting water is cleaner.

3.2.3 Reverse Osmosis Filtration Stage

After the initial filtration, the water is channelled into a storage tank before being pumped into the Reverse Osmosis (RO) unit. The equipment used is the OxFIL 400 GPD Unit, which can produce up to 1,500 liters of potable water per day. The RO process works by separating pure water from contaminants, operating at a maximum pressure of 120-180 psi. The treatment results show significant changes in the physical properties of the water, including aroma, colour, and taste. Before and after the process, water quality parameters are observed to assess the changes.

3. 3 Water Quality Testing Results

After the completion of the treatment process, tests were conducted on the processed peat water. The parameters examined included pH, TDS (Total Dissolved Solids), water hardness, turbidity, and colour. The test data collected from various points indicated a significant improvement in water quality. The testing was performed to compare water quality before treatment, after the coagulation and filtration stages, and the result following the RO process. The results are presented in Table 1 below:

Table 1. Water Parameter Results

No	Parameter	Sample A	Sample B	Sample C	Standard	Unit*
1	pH	5,9 – 6,1	5,7	6,6 – 6,7	6,5 – 8,5	-
2	TDS	39	81	97	1000 Mg/l	mg/L
3	Water Hardness	9,90	39,60	73,27	500 Mg/l	mg/L

No	Parameter	Sample A	Sample B	Sample C	Standard	Unit*
4	Turbidity	50	70,67	< 1,80	25 NTU	NTU
5	Colour	165,96	43,83	< 3,47	50 TCU	Pt. Co

Source: Dinas Lingkungan Hidup Kota Jambi & Jambi Lestari Internasional

Description:

1) Sample A (Lake/Peat Water)
2) Sample B (Water After Coagulation)
3) Sample C (Clean Water)

*** Based on the Indonesian Minister of Health Regulation Number 32 of 2017 concerning Environmental Health Quality Standards and Water Health Requirements for Sanitation, Swimming Pools, Solus Per Aqua, and Public Baths**

Figure 3 illustrates a visual comparison of water samples before and after the treatment process. The observable differences reflect a significant change in the quality of water produced through the coagulation and filtration methods.

Figure 3. Comparison of Water Results

3.3.1 pH

Based on Table 1, it can be observed that there is a change in the pH value of peat water after the treatment process. Initially, before treatment, the pH of the peat water ranged between 5.9 and 6.1, indicating a relatively high acidity level and failing to meet the clean water quality standard, which requires a minimum pH of 6.5. After the coagulation process, the pH of the peat water decreased to 5.7. This reduction is due to the interaction between the coagulant and organic materials in the peat water. The coagulant binds to organic particles, which contain high carbon content, increasing the hydrogen ion concentration, especially if the organic material is not fully decomposed[5]. This leads to the release of organic acids into the water, lowering the pH and making the water more acidic.

However, after the peat water underwent filtration using reverse osmosis (RO) technology, the pH of the water increased significantly. The measurement results showed that the treated water had a pH value between 6.6 and 6.7, meeting the standard pH range for clean water, which is between 6.5 and 8.5. This increase in pH can be attributed to the reduction in the amount of organic matter in the water, which also lowers the amount of organic acids being released, thus bringing the water's pH closer to neutral. Therefore, RO technology has proven to be effective in neutralizing the acidity level of peat water.

3.3.2 TDS (Total Dissolved Solid) & Water Hardness

In the evaluation of Total Dissolved Solids (TDS) concentrations in peat water prior to and after treatment, it was determined that the TDS value before treatment was recorded at 39 ppm. This measurement indicates that the peat water exhibits a relatively low concentration of dissolved solids; however, it still fails to meet the requisite standards for potable water. Following the coagulation process utilizing green bean bio-coagulant, the TDS concentration increased to 81 ppm. This elevation in TDS can be attributed to fine particles from the green bean coagulant remaining suspended in the aqueous medium, despite many particles having settled as flocs at the bottom of the treatment vessel[6].

The coagulation-flocculation process employing green beans successfully reduced turbidity; however, the presence of fine particles that were not adequately bound persisted in the water, leading to an increase in the total dissolved solids. An excessive addition of coagulant may also exacerbate turbidity and result in sediment that has not completely flocculated. Therefore, stringent control over coagulant dosage is imperative to ensure that the coagulation process operates optimally without augmenting the concentration of dissolved solids[7].

Following the reverse osmosis (RO) treatment, the TDS value remained elevated compared to pre-treatment levels, despite the successful filtration of many dissolved particles. The RO process functions to remove larger particulates and contaminants, yet extremely fine dissolved particles may persist in the treated effluent. Nevertheless, RO technology is effective in mitigating harmful contaminants and enhancing water quality, rendering it suitable for human consumption.

It is noteworthy that TDS concentrations are directly correlated with water hardness. The elevated TDS level post-treatment, recorded at 73.27 mg/L, is associated with an increase in water hardness. Enhanced hardness levels indicate a greater presence of dissolved minerals in the water after treatment, although the overall water quality is improved, making it more suitable for various applications.

3.3.3 Turbidity

The turbidity testing of peat water prior to treatment revealed a turbidity value of 50 NTU. This value indicates that the peat water possesses a relatively high level of turbidity, suggesting the presence of numerous suspended particles within the water. Following the coagulation process, turbidity increased to 70.67 NTU. This increase can be attributed to the addition of the bio-coagulant in the form of green beans, which are extremely fine and capable of remaining suspended in water. These minuscule coagulant particles interact with colloidal particles in the water, thereby increasing the amount of suspended solids and leading to heightened turbidity[8].

However, after the peat water underwent treatment using reverse osmosis (RO) technology, the turbidity value significantly decreased to <1.80 NTU. This reduction in turbidity can be ascribed to the filtration process utilizing semi-permeable membranes in the RO unit. These membranes effectively filter out larger solid particles, which are subsequently discarded as wastewater. With the reduction in the number of suspended particles, the turbidity value of the water decreases drastically, resulting in water that is much clearer and compliant with potable water quality standards[9].

3.3.4 Colour

The colour parameter exhibits a significant change following treatment. Prior to processing, the peat water displayed a brownish hue with a value of 165.96 Pt. Co. After undergoing the coagulation process, the water's colour shifted to a yellowish tone with a value of 43.83 Pt. Co. This reduction in colour concentration can be attributed to the bonding between the coagulant and the acidic compounds responsible for imparting colour to the peat water. This process effectively aids in decreasing the concentration of colour-inducing compounds present in the peat water[8].

Following the reverse osmosis (RO) process, the treated water became colourless and exceptionally clear. This outcome is the result of effective filtration through activated carbon filters, which eliminate organic substances as well as compounds capable of imparting colour to the water. This process is critical, as colourless and odorless water is generally more acceptable to the public and indicative of superior quality[10]. In the context of water treatment, a significant reduction in colour also suggests that hazardous dissolved compounds have been removed, rendering the water safer for consumption.

3.3.5 Odor and Taste

In addition to the parameters, changes in odor and taste were also observed in the peat water. The initially unpleasant odor of the water was eliminated after undergoing a series of treatment stages. The removal of the odor from the peat water can be attributed to the carbon chlorine taste and odor (CTO) filter, which is designed to absorb or eliminate odors in the water.

As for changes in taste, it is assumed that there was a significant reduction in acidity in the treated peat water, estimated to decrease by up to 75%. This improvement is due to the filtration process in the post-carbon filter, which serves to modify and enhance the taste of the water after it has gone through a series of treatment stages[10].

4. Conclusion

The peat water treatment in Danau Lamo Village has demonstrated significant results in enhancing the quality of water suitable for community use in daily activities. Through a series of processes, including coagulation-flocculation using mung bean bio-coagulants and filtration with reverse osmosis technology, all water quality parameters—such as pH, TDS, turbidity, and colour—showed remarkable improvement.

The increase in water pH from 5.5 to 6.6 - 6.7 indicates that this technology successfully neutralized the acidity of the initially unsuitable peat water. The reduction in TDS from 81 ppm post-treatment and the decrease in turbidity from 70.67 NTU to <1.80 NTU provide evidence of the effectiveness of the process in removing suspended particles and contaminants. Additionally, changes in watercolour and the elimination of unpleasant odors suggest that the produced water meets the quality standards for clean water, significantly benefiting public health.

With these results, the peat water treatment not only improves community access to clean water but also contributes to the sustainability of water resources in the area. This underscores the importance of implementing modern technology in addressing water quality issues, especially in regions reliant on peat water sources that are often contaminated.

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