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Reducing Salt Levels in Sea Water Using Active Carbon Adsorbent from Coconut Shell Charcoal, Silica Sand, and Palm Fiber

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ABSTRACT

This study aims to evaluate the effectiveness of various combination of adsorbents in reducing salt content in seawater through the adsorption method. Four variations in the ratio of adsorbent materials, namely activated charcoal, silica sand and palm fiber, were tested with different amounts. activated charcoal, silica sand, and palm fiber, were tested with different amounts. Results showed that the 1:2 ratio (800 grams of activated charcoal and 400 grams of silica sand) resulted in a decrease in salt content from 20% to 3%, which was the highest reduction compared to the other comparison. In addition, the pH test showed that the pH value of the water after the adsorption process remained in the neutral range, namely 7 to 7.5, which indicating that the filtration process successfully improved the water quality. This study indicates that the use of local materials such as activated charcoal and silica sand can be an effective and environmentally friendly solution to reduce the effective and environmentally friendly solution to reduce seawater salinity, as well as increase public awareness of the importance of clean water. public awareness of the importance of clean water. These results are expected to contribute to the development of a more affordable and sustainable desalination technology. technology that is more affordable and sustainable.

Keywords: Adsorption, Activated Charcoal, Silica Sand, Salt Content, Desalination

1. INTRODUCTION

Indonesia is an archipelagic region where each region has different air and different land conditions. In Indonesia, coastal areas are often faced with the problem of limited air resources. In terms of quantity, coastal

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areas generally have abundant water, but it is often difficult to get air for various uses, because the quality is inadequate. Limited water resources in coastal areas are related to the scarcity of fresh water that can be used as clean water. Wulan et al reported that sea water is water that comes from the sea, has a salty taste, and has a high salt content. On average sea water has a salinity of 3.5%, which means for every one liter of sea air there is 35 grams of dissolved salt in it. Meanwhile, fresh water is water with a salt content below 0.5 ppt[1].

A simple technology that can process sea water into fresh water is a filtration process using adsorbents. Dhumal and Sadgir have reported adsorption is a promising technology for the dissociation and exclusion of salts and some other ions from water due to its minimal development costs, flexibility, and ease of process design, operation, and maintenance. The diversity and properties of materials used as adsorbents have a significant impact on adsorption technology and processes[2]. La Ifa et al have reported that adsorption is actually a surface phenomenon. This process forms a thin layer of adsorbate (absorbed component) of the liquid phase (solvent) on the surface of the adsorbent (substance that absorbs) the solid phase. The absorption or adsorption process by an adsorbent is influenced by many factors and also has certain specific adsorption isotherm patterns[3]. Wijayanti et al have reported factors that influence the adsorption process, including the type of adsorbent, type of substance being absorbed, surface area of the adsorbent, concentration of the substance being adsorbed and temperature. Due to these factors, every adsorbent that absorbs one substance with another substance will not have the same adsorption isotherm pattern[4].

Widi Astuti has reported A good adsorbent must fulfill three requirements, namely having pores, cavities and active sites. According to IUPAC, pores are classified into three, namely micropores (less than 2 nm in diameter), mesopores (2-50 nm in diameter) and macropores (more than 50 nm in diameter)[5]. Activated charcoal is the most popular adsorbent used as an adsorbent in the liquid waste adsorption process. Coconut shell is a hard layer consisting of lignin, cellulose hemicellulose methoxyl and various minerals, therefore activated charcoal or activated carbon is the most effective as an adsorbent. We can use charcoal from activated coconut shells. Apart from activated charcoal, silica sand can be used as a combined adsorbent in the adsorption process. Silica sand is a type of sand that contains silica. Silica is the largest part of sand and sandstone. Fibers can also be used in the filtering process, even though they have small pores, they can filter dirt in water. The combination of activated charcoal, silica sand and palm fiber can be used as an adsorption medium that is easy to find and not too expensive to filter sea water in order to reduce the salt content, not only focusing on salt, but the three adsorbents are able to increase the pH so that the filtering results are more alkaline and the water getting clearer.

Ariyani et al have reported the results obtained show that the filtration process with activated carbon has proven to be effective in improving the pH quality of water so that it meets clean water quality standards in accordance with the Republic of Indonesia Minister of Health Regulation No. 416/MENKES/IX/1990, namely 6.5-9. This is because during the filtration process, metal elements in water will be broken down into metal ions and hydroxide ions [OH-]. Metal ions will be attracted by activated carbon with Van der Waals forces so that what is left behind are [OH-] ions[6].

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2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

This research uses a simple experimental method to design and test the salinity of sea water made from activated carbon charcoal, silica sand and palm fiber adsorbents to reduce salt levels This research was carried out in a home environment using tools and materials that were easy to find. The sample used in this experiment was sea water taken from the coast of Belawan.

A. Tools

1. Refractometer
2. Scissors
3. Mineral bottles
4. Glass cup
5. pH Meter

B. Material

1. Sea Water : 1L
2. Charcoal Activated carbon: 3kg
3. Silica sand : 3kg
4. Palm fibers : 1,2kg

2.2. Research Procedure

Some things that need to be prepared before conducting research are:

1. Cut 6 1-liter bottles at the ends and then join them using tape to form a tube, make 6 tubes.
2. Insert the absorbent material in the first 1:1 comparison test starting from the bottom of the coconut fiber as much as 90g, then continued with the second layer of Silica sand as much as 250g, the third layer of Activated Carbon Charcoal as much as 250g, and the fourth layer of coconut fiber again as much as 90g,
3. Prepare 900ml of sea water then measure the pH and percentage of salt content using a refractometer.
4. Prepare a measuring cup as a container for the absorption results, then pour the sea water into the first 1:1 comparison bottle that has been filled with 150 ml of absorbent. then measure the pH and salt content of the absorption results.
5. In the second 1:1 comparison test, reinsert the adsorbent into the bottle according to the order and amount in bottle 1 except for activated charcoal and silica sand which are added as much as 100g to a total of 350g each. Then we calculate the pH and percentage of salt content after adsorption.
6. In the third 1:1 comparison test, reinsert the adsorbent into the bottle according to the order and amount in bottle 2, add 100g of activated carbon and silica sand until the total is 450g each. Then we calculate the pH and percentage of salt content after adsorption.
7. In the fourth 1:1 comparison, reinsert the adsorbent into the bottle according to the order and amount in bottle 3, add 150g of activated carbon until the total is 600g and the remaining 600g of silica sand. Then recalculate the pH and percentage of salt content after adsorption.
8. Next, for the 1:2 comparison test, insert 90g of coconut fiber, 400 grams of silica sand, 800g of

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activated carbon, then 90g of coconut fiber into the prepared bottle. Add 150ml of salt water into the bottle, then measure the percentage of salt content and pH.

9. Next, for a 2:1 comparison test, put 90g of coconut fiber, 800g of silica sand, 400g of activated carbon, then 90g of coconut fiber into the prepared bottle. Put 150ml of salt water into the bottle, then measure the percentage of salt content and pH.

3. RESULTS AND DISCUSSION

3.1. Analysis of Characterization Results

The testing procedures carried out on seawater adsorption innovations are divided into:

Physical Observation

Observation of adsorption of salt content reduction was carried out during the filtration process. Observations include % salt content before and after, turbidity in seawater before and after adsorption.

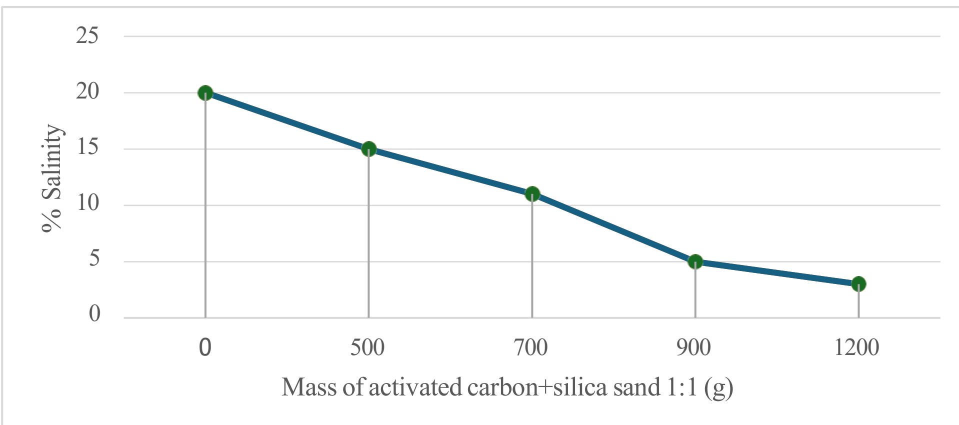

Figure 1. Salt content test ratio 1:1

From the results of the 1:1 adsorption test, there was a change in the salt content and clarity of the adsorbed seawater. The salt content before adsorption was 20%. In the first 1:1 test with a small amount of adsorbent, the salt content could be reduced by 5%. When the adsorbent in the test was continuously added to the 1:1 test with 1200g of activated carbon + silica sand adsorbent. Then there was a very big change in the fourth 1:1 test. Where the salt content decreased by 17%. This shows that the seawater filtration procedure is quite effective with the adsorbent being continuously added so that the water is suitable for use.

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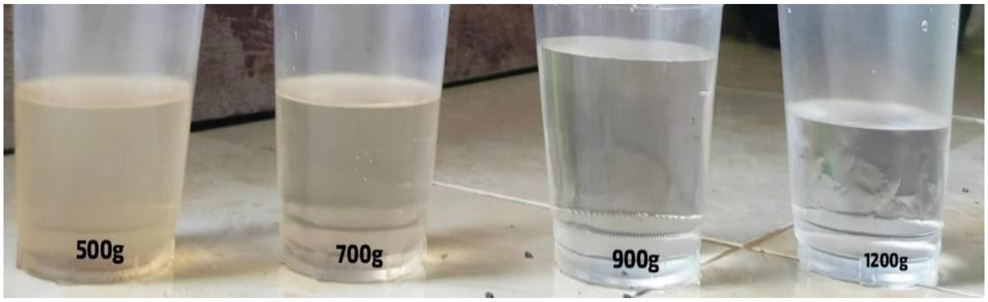

Figure 2. Result of 1:1 comparison test (Activated carbon+Silica sand)

From the results of the 1:1 adsorption test, there was a change in the color of the sea water which was previously cloudy to clearer. In the first 1:1 adsorption test, the filtered water looked cloudy like the sample before adsorption. With the addition of Adsorbent in increasing amounts in the second to fourth 1:1 test, the water became clearer and not cloudy. The fourth 1:1 test showed that the Activated Carbon Adsorbent + Silica Sand can affect the quality of the filtration so that the sample results are clear. The mechanism carried out by the adsorbent removes solid particles and dissolved substances by trapping them between the adsorbent layers so that after being filtered the sea water can be clear properly.

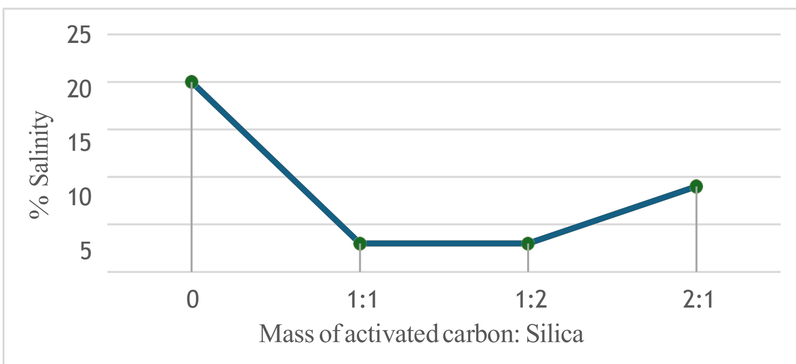

Figure 3. Salt content test ratio 1:1, 1:2, and 2:1

Because in the 1:1 comparison test using four tests and the salt content is decreasing, the adsorbent in the 1:1 test was tested using the 1:1, 1:2, 2:1 test to determine the adsorbent that most affects the decrease in salt content. From the results of the experiment, a decrease in % salt was seen in the 1:2 test. When the amount of activated carbon adsorbent added was reduced and silica sand was reduced, the % salt decreased significantly. Conversely, in the 2:1 test, the activated carbon

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adsorbent was reduced and silica sand was added, the % salt decreased slightly. This is because in the filtration process, the metal elements in the water will decompose into metal ions and hydroxide ions [OH-]. Metal ions will be attracted to activated carbon by the Van der Waals force so that what is left is the [OH-] ion.

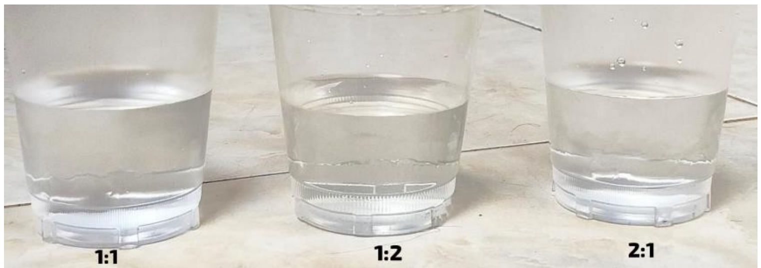

Figure 4. Results of comparison tests 1:1, 1:2, and 1:3

The filtering results look clear with a combination of 1:1, 1:2, and 2:1 comparison test. With a large amount of sand in the 1:1 and 2:1 comparison test, the filtered seawater produces good sample color clarity. The 1:2 comparison test with a reduced amount of silica sand can be seen that the water is slightly cloudy after filtering, this means that silica sand greatly affects the clarity of seawater adsorption. Low water turbidity will cause high oxygen that can be bound to water so that water has high Dissolved Oxygen (DO). The charcoal activation process aims to enlarge the pores by breaking hydrocarbon bonds or oxidizing surface molecules so that the charcoal experiences changes in properties, both physical and chemical, namely its surface area increases and affects adsorption power.

Determination of pH

The degree of acidity or pH is a measure of the acidity or alkalinity of a solution expressed on a scale of 0 to 14. A pH value below 7 indicates that the solution is acidic, a pH value of 7 is neutral, while a pH value above 7 is alkaline. In seawater salinity, the neutral pH value is in the range of 7 to ensure that the water is fresh. In this study, a pH test was conducted to determine the effect of the comparison of salinity results with previous salinity, namely the fourth 1:1 comparison test, 1:2 test, and 2:1 test.

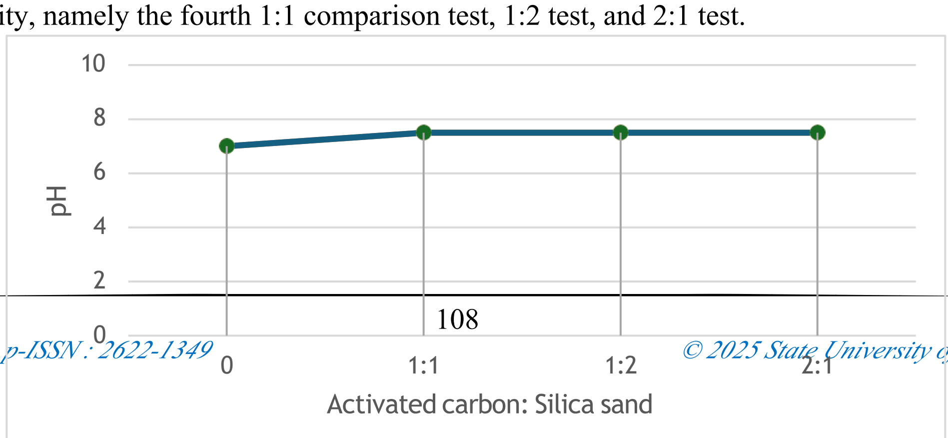

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Figure 5. Comparison of pH Values

The pH level of seawater after filtration was measured using a pH meter that had been calibrated at a constant temperature. pH is an important parameter in measuring the acidity or alkalinity of a solution to make it suitable for consumption. The pH test of seawater samples before adsorption had a pH value of around 7 which is classified as neutral (neither acidic nor alkaline). In the fourth 1:1 comparison test, the pH value increased by 0.5% more alkaline. In the 1:2 and 2:1 test, the pH was also 7.5%, meaning that the addition of adsorbent affects the increase in pH so that the filtered water is proven to be effective and meets the quality standards for clean water according to the Regulation of the Minister of Health of the Republic of Indonesia No. 416/MENKES/IX/1990, namely 6.5-9.

4. CONCLUSION

This study successfully achieved its objectives by showing that the combination of activated charcoal and silica sand adsorbents is effective in reducing the salt content in seawater from 20% to 3% with a ratio of 1:2. In addition, the quality of the water produced is maintained with a pH in the neutral range (7-7.5), making it safe for consumption. This study also emphasizes the importance of utilizing local resources as an affordable and sustainable alternative in water management, as well as providing a practical solution to increase the accessibility of clean water in coastal areas. These findings open up opportunities for further research in the development of more effective and efficient water treatment methods.

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