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MANUFACTURE OF SILICA GEL FROM COCONUT WASTE WITH THE INFLUENCE OF EXTRACTION TIME AND SODIUM HYDROXIDE CONCENTRATION

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ABSTRACT

Silica gel is a material known for its high thermal and chemical stability, good selectivity and resistance, and can be used repeatedly so that it is more economically advantageous. So far, quartz sand is a raw material used in producing silica, but for the process of processing quartz sand requires a fairly high temperature, high cost, and a complicated process. Therefore, it is necessary to find alternative raw materials to obtain silica with a cheap and simple process. Coconut coir ash can be used as an alternative material that contains silica. This research was conducted to determine the effect of extraction time and concentration of NaOH on silica gel produced from coconut coir ash. In addition, the vapor absorption capacity at that condition was 800 mg/g.

KEYWORDS: Silica Gel, Coconut Coir Ash, Silica, Extraction, Water Vapor Absorption, Silica Content.

1. INTRODUCTION

(1) BACKGROUND

Silica gel is used as a desiccant in food and non-food products (Amarakoon and Senevirathne, 2015). A desiccant is a material or substance that can absorb water vapor. There are several types of desiccants such as silica gel, zeolites, molecular membranes, activated alumina, carbon, and synthetic polymers (Katejanekarn and Boonrit, 2014). Silica gel is inert, non-toxic, non- flammable, and does not cause a chemical reaction when it

absorbs moisture. Silica gel can also be reused, the moisture contained in it can be removed again by heating (Amarakoon and Senevirathne, 2015).

Silica gel is a material known for its high thermal and chemical stability, good selectivity and resistance, and can be used repeatedly so that it is more economically advantageous (Koner et al., 2012). Silica gel is widely used in the chemical industry, one of the uses of silica in the chemical industry is as an effective metal adsorbent (Koner et al., 2011). Silica gel is more expensive in the market so that the operational costs related to the use of silica gel in laboratories and industry will increase (Nascimento et al., 2009).

The potential of natural resources as a source of silica has been widely studied and known. For example, rice husk ash contains 80- 95% silica (Sharifnasab and Mohammad, 2017), Sinabung volcanic ash 45.76% (Latif et al., 2016), quartz sand as much as 98% (Boulus et al., 2017) and 64.97% fly ash (Sulistiyo et al., 2017). So far, quartz sand is a raw material that is always used in producing silica, but in the process of processing quartz sand requires a fairly high temperature, high cost, and a complicated process. Therefore, it is necessary to find alternative raw materials to obtain silica with a cheap and simple process. Coconut coir ash can be used as an alternative material which has a silica content of 43.90% (Setiawan et al, 2013).

Yuanita (2020) made silica gel from coal fly ash using NaOH solvent and variations in aging time. The highest silica gel yield was obtained at 15 hours of aging of 49.61% with a mass of silica of 24.94 grams. Yusrin et al (2014) used silica gel from coconut coir ash (ASK) and rice husk ash (ASP). ASK and ASP raw materials were added with NaOH solution by heating and melting at 5000C for 30 minutes to produce sodium silicate solution, then each sodium silicate solution was acidified with 3 M HCl to pH 7 and dried to produce coconut coir ash silica gel (SG-ASK) and rice husk ash silica gel (SG-ASP).

Based on the description above, in this study, variations in extraction time and concentration of NaOH solvent will be carried out to obtain silica gel in coconut fiber.

(2) Formulation of the problem

Along with the need for using coconuts in daily life, the waste from coconut coir can be used to become a more useful form. In this study, we want to know how the potential of coconut fiber as a raw material for the manufacture of silica gel is by looking at the effect of solvent

concentration and extraction time so that it can increase the absorption of water vapor from the silica produced.

(3) Research purposes

The aims of this research are as follows:

1. To determine the effect of extraction time and sodium hydroxide concentration on the amount of silica gel produced from coconut coir waste.
2. To determine the effect of extraction time and sodium hydroxide concentration on silica content.
3. Knowing the effect of absorption of silicawater vapor produced.

(4) Benefits of research

The benefits of this research are as follows:

a. Increase the value of functions and benefits as well as the economy ofcoconut coir waste.
b. Reducing coconut coir waste in the environment and providing additional information for the community about the use of coconut coir as a raw material for the manufacture of silica gel which can beused as a reference for further research

2. RESEARCH METHODOLOGY

The research on the manufacture of silica gel was carried out by the extraction method. The extraction method is used because it is more efficient and easier to manufacture products in the form of silica gel. Several parameters used in the manufacture of silica gel are solvent concentration, extraction temperature, stirring speed andextraction time.

(1) Materials and tools used

Materials used include: Coir coconut, aquadest, NaOH and HCl.

The tools used in this study include: pH paper, electric heater, Magnetic stirrer, oven, porcelain dish, analytical balance, beaker, Erlenmeyer, measuring flask and filter paper, measuring pipette,stirrer, spatula and separating funnel.

(2) Sample Preparation Process

The coconut husks are cleaned and burned in afurnace at a temperature of 6000C for 4 hours. The ash was filtered using a 180/200 mesh sieve and then soaked in hot water. The ash is filtered and dried in the oven to a constant weight.

(3) Extraction of Sodium Silicate Solution

Coconut coir ash that has dried as much as 50 g was dissolved with 500 ml NaOH with variations of 1, 2, 3, 4 and 5 M. Then the coconut coir ash which had been dissolved with NaOH was then heated at 1050C and stirred at a stirring speed of 300 rpm for 60, 90, 120 and 150 minutes. Then the solution was filtered with filter paper to separate the residue and the filtrate in the form of sodium silicate. The resulting filtrate is taken asraw material for the manufacture of silica gel.

(4) Silica Gel Manufacturing

The filtrate in the form of sodium silicate was put into a glass beaker. The solution was dripped with 3 M HCl until a white gel was formed up to pH 7. Then the gel that had been formed was allowed to stand (aging) at room temperature for 15 hours. Furthermore, the silica gel is filtered and rinsed with distilled water to remove excess acid. Silica gel was dried in an oven to a constant weight, then crushed using a mortar and pestle.

(5) Result Analysis

1. Silica Gel Purity

From this research, the silica was weighed into 1 g, and put into a plastic bag for analysis. The samples were then brought to the laboratory to be checked for the purity of the silica gel.

2. Water Absorption

In the water vapor absorption test procedure (Amarakoon and Senevirathne, 2015), the water is put in the dryer until it reaches the buffer limit and left for 24 hours so that the desiccatoris is saturated with water vapor. Then 1 gram of dried silica gel and petri dish was weighed and recorded as the initial mass. Furthermore, the petri dish is put into a desiccator that has been saturated with water vapor and allowed to stand for 24 hours. After 24 hours, the petri dish removed from the desiccator and then weigh thefinal mass.

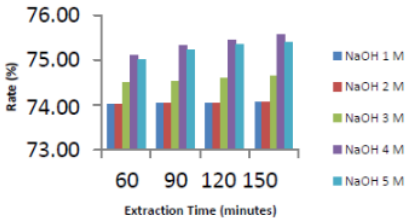
The absorption of water vapor can bedetermined using Equation 3.1.

$$\text{Water vapor absorption}\left(\frac{mg}{g}\right) = \frac{\text{m water}}{\text{m adsorbent}}$$

Description

Water = mass of water absorbed by silica gel (mg)

Madsorbent = mass of adsorbent used (g)



Picture 4.1 Rate Silica with variation concentration of NaOH in the extraction time of 60, 90, 120 and 150 minutes Based on the curve in Figure 4.1 can be.

3. RESULTS AND DISCUSSION

(1) Results

Based on the experiments that have been carried out, the manufacture of silica gel from coconut fiber uses variations in extraction time of 60, 90, 120 and 150 minutes as well as variations in the concentration of NaOH 1, 2, 3, 4 and 5 M. Furthermore, the silica produced was analyzed for SiO2 content and water absorption.

(2) Discussion

1. Extracted Silica Content

The difference in NaOH concentration and extraction time is very influential in the process of silica formation. At the extraction time of 60 minutes with 1 M NaOH concentration the silica content obtained was 74.01 % and continued to increase at 2 M NaOH concentration; 3 M and 4 M, which are 74.02 %, respectively; 74.51% and 75.10%. The same thing happened at the extraction time of 90, 120 and 150 minutes, the silica content obtained from the extraction continued to increase along with the increasing concentration of NaOH used in the extraction process. However, there was a decrease in the 5 M NaOH concentration, this was due to the solution being too concentrated so that it was not optimal in extracting silica in the ash.

In addition to the concentration of NaOH, the extraction time also plays an important role in the silica formation process. As can be seen in table 4.1, when the concentration of 1 M NaOH, the silica content obtained from the extraction was 74.01 % and continued to increase at the extraction time of 90 minutes, 120 minutes and 150 minutes, respectively 74.04 %, 74.05% and 74.06 %. The same thing happened at a concentration of 2 M; 3M; 4 M and 5 M, the levels obtained continued to increase with increasing time used in the extraction process. The effect caused by the two variables will be presented in more detail in graphical

form in Figures 4.1 and 4.2:

The silica content resulting from the extraction process will increase along with the increase in NaOH. A significant increase occurred at the concentration of NaOH 4M with the extraction time used for 150 minutes resulting in a rate of 75.58% from the previous one, while at the concentration of NaOH 3 M with the same extraction time then the resulting content was only 74.64%. This happened possible because the use of NaOH solution with a higher concentration at the same extraction time of 150 minutes, the amount of silica in the extracted sodium silicate solution was increasing so that the silica content increased quite large compared to the previously used NaOH concentration of 3 M.

The amount of NaOH concentration and the length of extraction time affect the process of silica formation. The higher the concentration of NaOH used in the extraction process, the higher the silica content produced. The longer the time used in the extraction process, the higher the silica content produced. The highest silica content was obtained at a concentration of 4 M NaOH with an extraction time of 150 minutes, which was 75.58%. The level is closely related to the level of purity, from the calculation results obtained it can be said that the level of silica purity in the ash is quite good.

2. Water Absorption

The water vapor absorption test aims to determine the adsorption capacity of silica gel from coconut coir ash to water vapor. Silica gel has a silanol functional group (Si-OH) and a siloxane functional group (Si-O-Si) which is the active site of silica gel. Water vapor absorption of silica gel from coir ash can be seen in Table 4.2 which shows that the absorption of silica gel from coconut coir ash against water vapor.

In this study, the lowest adsorption capacity was obtained at a solvent concentration of 1 M with an extraction time of 60 minutes, namely 400 mg/g and the highest absorption at a concentration of 4 M NaOH with an extraction time of 150 minutes at 800 mg/g.

Increased concentration of NaOH will cause the particle size to be smaller. The smaller particle size has a larger contact area, so it can increase the adsorption capacity more than the larger particle size (Susilo et al., 2016). In this study, silica gel obtained at a concentration of 5 M has a very brittle physical form. This is because the solvent concentration of 5 M is very concentrated so that the silica gel obtained is easily destroyed and much along with the

increase in the time used in the extraction process, namely 5.75 grams at 90 minutes extraction time, 5.84 grams at 120 minutes extraction time and 6.01 grams at 150 minutes extraction time. This increase also occurred at a concentration of 2 M; 3M; 4M and 5M. This happened because the longer the time that used in the extraction process, the more filtrate will be produced, so the possibility of formation of a precipitate is also greater. Based on the results of the analysis above, when it is associated with the literature, it shows that the factors that influence the extraction process here are the length of the extraction time. The number of deposits obtained in the extraction process with variations in NaOH concentration and extraction time, so that the difference is clearer will be presented in the formof a curve in Figure 4.3:

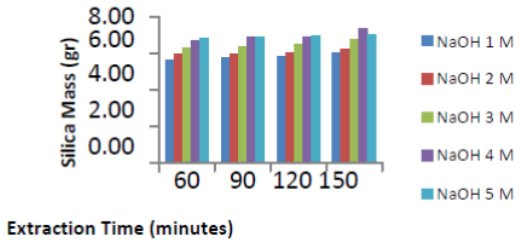


Figure 4.3 Mass of silica extracted with various concentrations within 60, 90, 120 and 150 minutes.

This leads to a decrease in the absorption of water vapor in silica gel. (Iswar et al. 2017).

According to the requirements issued by the Indonesian National Standard (SNI) No. 06-2477- 1991 the minimum absorption of silica gel is 750 mg/g. In table 4.3 shows silica that meets the SNI standard for silicaabsorption.

Table 4.3 Extracted silica that meets absorptionstandards.

Sample	Absorption
NaOH 4 M, 90 min	760.00
NaOH 3 M, 120 min	770.00
NaOH 4 M, 120 min	790.00
2 M NaOH, 150 min	770.00
NaOH 3 M, 150 min	790.00
NaOH 4 M, 150 min	800.00
Kiesel Gel	880.00

3. Effect of NaOH Concentration and Extraction Time

At the extraction time of 60 minutes with a concentration of 1 M NaOH, the result of silica was 5.62 grams. The mass of silica obtained will increase along with the increase in the concentration of NaOH used is at a concentration of 2 M NaOH; 3M; 4 M and 5 M silica produced respectively 5.95 grams; 6.31 grams; 6.71 grams and 6.82 grams. The same thing happened at 90 minutes of extraction; 120 minutes and 150 minutes. This happens because the greater the concentration of NaOH used in the extraction process, the more the amount of silica in the extracted sodium silicate solution so that more HCl is needed to form a precipitate in the pH range of 6.5-7. This is what causes the precipitate formed in the extraction process to also increase. In addition, the data in table 4.4 also shows that the silica precipitate produced at a concentration of 1 M is getting higher.

The curve of Figure 4.3 shows that the coarse silica precipitate produced by varying the concentration of NaOH and the extraction time used is balanced. The amount of silica precipitate produced continues to increase along with the increase in the NaOH concentration. This proves that the concentration of NaOH is quite influential on the formation of the extracted silica precipitate. Most of the precipitate in this process was obtained at a concentration of 5 M.

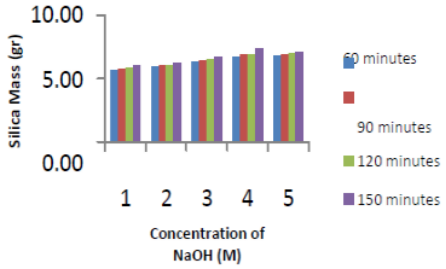


Figure 4.4 Mass of extracted silica with variations in extraction time at concentrations of NaOH 1, 2, 3, 4 and 5 M.

The curve in Figure 4.4 shows that the extraction time also influences the process of forming the extracted silica precipitate. The longer the time used in the extraction process, the more sediment produced. The most coarse precipitated silica as seen in Figure 4.4 was obtained at an extraction time of 150 minutes. If associated with the literature, extraction time is one of the factors that influence the extraction process, namely the longer the time used in the extraction process, the more extracts produced. The longer the extraction time can also

produce more filtrate, so that the resulting precipitate is also large. Stirring also plays an important role in addition to the extraction time because stirring will speed up the reaction between the extractant and solute. (Ubay, 2011).

Based on the two curves presented in Figures 4.3 and 4.4, it can be concluded that the amount of NaOH concentration and the length of time used in the extraction process are affected in the process of forming the extracted coarse silica precipitate. The greater the concentration of NaOH used in the extraction process, the more coarse silica deposits produced. The longer the time used in the extraction process, the more coarse silica deposits produced.

4. CONCLUSION

From the results of research on the manufacture of silica gel from coconut coir waste with the effect of extraction time and sodium hydroxide concentration, it can be concluded that:

1. The higher the concentration of NaOH and the extraction time, the more silica is produced.
2. The higher the NaOH concentration and the extraction time, the higher the silica content of the extraction.
3. There is a decrease in the absorption of water vapor in the extracted silica with a concentration of NaOH 5 M because the silica produced is easily destroyed so that it reduces the ability to absorb water.

5. SUGGESTIONS

Further research can be carried out using XRD and FT-IR analysis to determine the composition contained in silica. In addition, other variables can be added, such as pH conditions, the effect of temperature and stirring on the extraction process.

BIBLIOGRAPHY

1. Amarakoon, AMSH and S. Navaratne. Evaluation of The Effectiveness of Silica Gel Desiccant in Improving the Keeping Quality or Rice Crackers. International Journal of Science and Research, 2015; 6(1): 2163-2168.
2. Katejanekarn, T. and B. Prasartkaew. Performance Test of a Silica Gel Dehumidifier. The 6th International Conference on Science, Technology and Innovation for Sustainable Well-Being. August 28-30. Apsara Angkor Resort and Conference, 2014; 531-538.
3. Kurniati, Eli. Extraction of Silica White Powder from Solid Waste Dieng Geothermal

Power Plant. Surabaya: UPN Press Publisher, 2009.

4. Latif, DO, A. Rifa'i, and KB Suryollono. Chemical Characteristics of Volcanic Ash in Indonesia for Soil Stabilization: Morphology and Mineral Content. International Journal of GEOMATE, 2016; 11(26): 1606-2610.
5. Pujiana, N. Adsorption of Methylene Blue Using Coconut Shell Ash Activated Sodium Chloride (NaCl) as an Adsorbent. Essay. Malang: Department of Chemistry, Faculty of Science and Technology, UIN Maulana Malik Ibrahim Malang, 2014.
6. Retnosari, Agustin. Extraction and Determination of Silica (Sio2) Levels Extracted from Coal Fly Ash. Jember: Faculty of Mathematics and Natural Sciences, 2013.
7. Sharifnasab, H. and MY Alamooti. Preparation of Silica Powder from Rice Husk. *Agriculture Engineering International: CIGR Journal,* 2017; 19(1): 158-161.
8. Sembiring, MT and Sinaga. TS 2003. Activatedcharcoal (Introduction and Manufacturing Process). Medan: Department of Industrial Engineering: Faculty of Engineering, University of North Sumatra.
9. Setiawan, Andika, Arief Bayu Risman, Juliyatna, Reza Fathurachman and Silva Octaviani S. Coconut Fiber Ash Geopolymer Concrete. Jakarta: Department of Civil Engineering, University of MuhammadiyahJakarta, 2013.
10. Sulastri, S. and S. Kristenngrum. Various Silica Compounds: Synthesis,Characterization and Utilization. Proceedings of the National Research Seminar. Yogyakarta State University. Yogyakarta, 2010.
11. Sulistiyo, YA, N. Andriana, B. Piluharto, and Z. Zulfikar. Silica Gel from Coal Fly Ash as Methylene Blue Adsorbent: Isotherm and Kinetic Studies. Bulletin of *Chemical Reaction Engineering &Catalysis,* 2017; 12(2): 263-272.
12. Susilo, H., A. Putra, and Astuti. Effect of NaOH Concentration on Nanosilica Synthesis from Silica Sintered at Central Hot Springs, South Solok, West Sumatra with Coprecipitation Method. Journal of Physics Unand, 2016; 5(4): 334-338.
13. Utama, PS, R. Yamsaengsung, and C. Sangwichien. Silica Gel Derived from Palm Oil Mill Fly Ash. Songklanakarin Journal of Science and Technology, 2016; 40(1): 121-126.
14. Yansyah, F. Silica Gel from Fly Ash (Fly Ash) Steam Power Plant (Determining Optimum Time to Get the Best Results). Thesis. Sriwijaya Polytechnic. Palembang, 2015.
15. Yuanita, Trisna Putri. Effect of Solvent Concentration and Aging Time on Silica Gel Preparation from Coal Fly Ash. North Sumatra : University of North Sumatra, 2020.
16. Yusrin, AF, EB Susatyo and FW Mahatmanti. Comparison of the Ability of Silica Gel from Coconut Coir and Rice Husk Ash to Reduce Cd2+ Metal Content. Semarang:

16 Department of Chemistry, Faculty of Mathematics and Natural Sciences, Semarang State University, 2014.

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