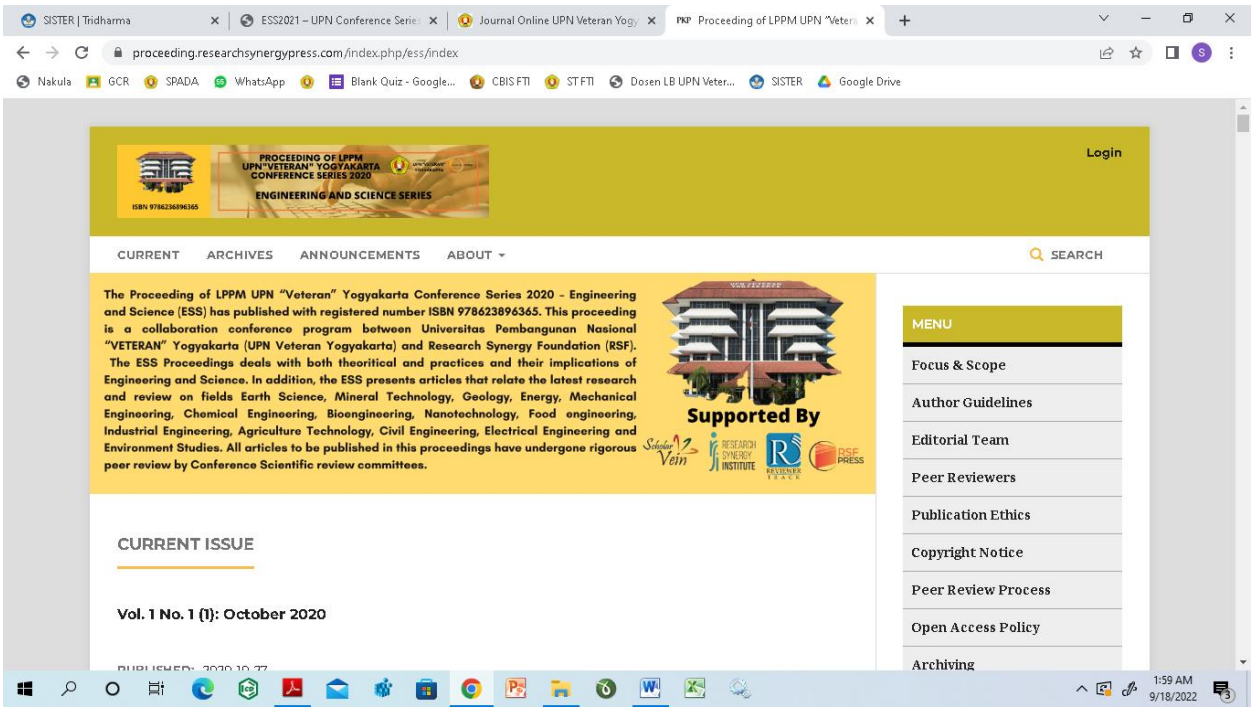
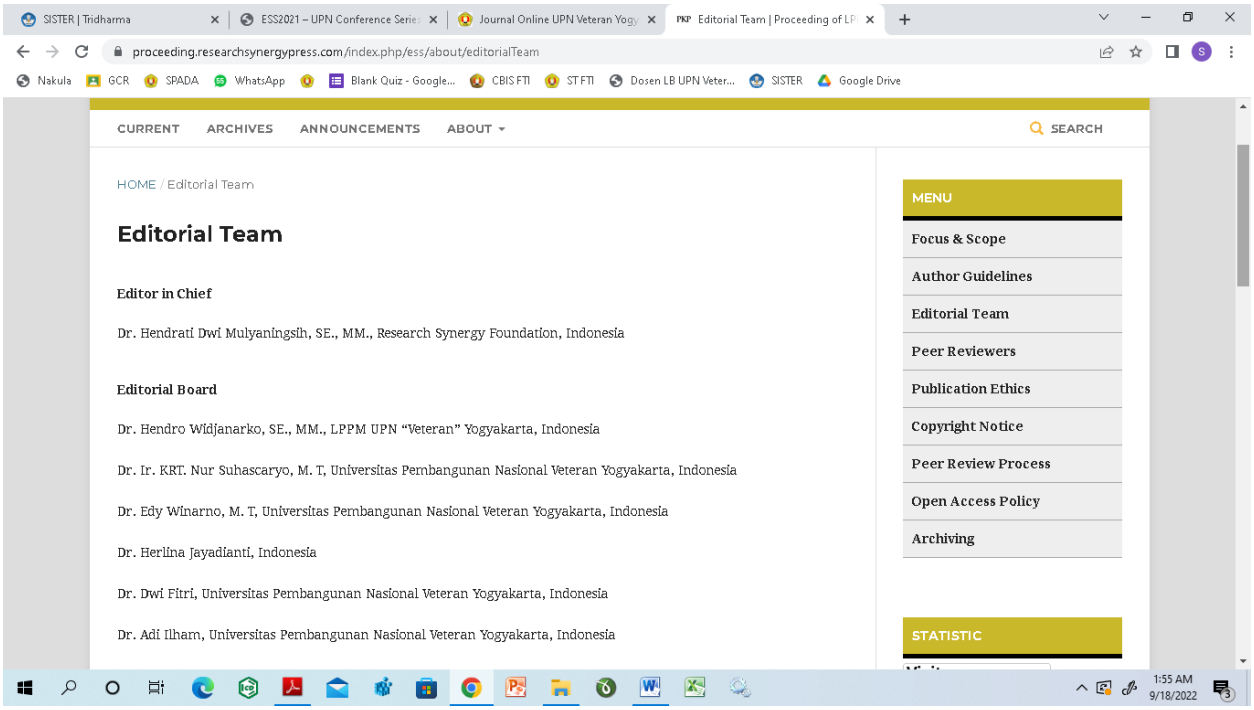
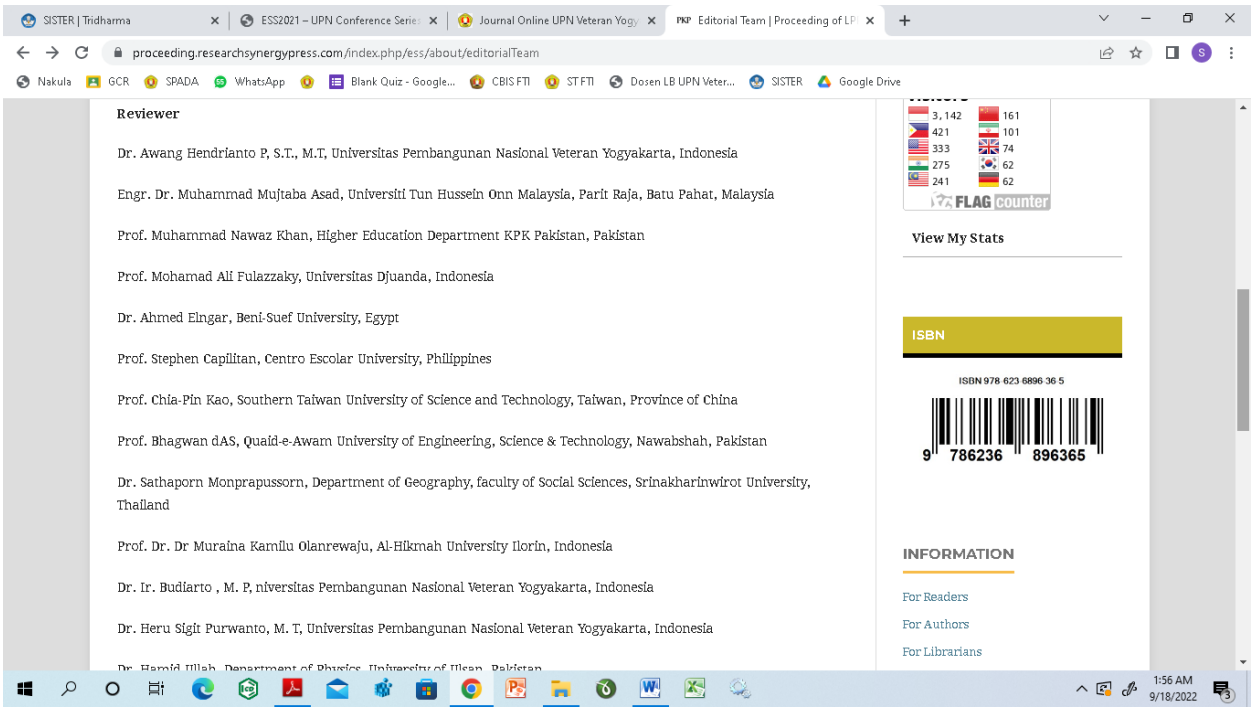
## Cover




## Editorial Team



# Reviewer



Reviewer

Dr. Awang Hendrianto P, S.T., M.T, Universitas Pembangunan Nasional Veteran Yogyakarta, Indonesia

Engr. Dr. Muhammad Mujtaba Asad, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Malaysia

Prof. Muhammad Nawaz Khan, Higher Education Department KPK Pakistan, Pakistan

Prof. Mohamad Ali Fulazzaky, Universitas Djuanda, Indonesia

Dr. Ahmed Elngar, Beni-Suef University, Egypt

Prof. Stephen Capilitan, Centro Escolar University, Philippines

Prof. Chia-Pin Kao, Southern Taiwan University of Science and Technology, Taiwan, Province of China

Prof. Bhagwan dAS, Quaid-e-Awam University of Engineering, Science & Technology, Nawabshah, Pakistan

Dr. Sathaporn Monprapussorn, Department of Geography, faculty of Social Sciences, Srinakharinwirot University, Thailand

Prof. Dr. Dr Muraina Kamilu Olanrewaju, Al-Hikmah University Ilorin, Indonesia

Dr. Ir. Budiarto , M. P, niversitas Pembangunan Nasional Veteran Yogyakarta, Indonesia

Dr. Heru Sigit Purwanto, M. T, Universitas Pembangunan Nasional Veteran Yogyakarta, Indonesia

Dr. Harold Ullah, Department of Physics, University of Ilesan, Pakistan

3,142 161
421 101
333 74
275 62
241 62

FLAG Counter

View My Stats

ISBN

ISBN 978 623 6896 36 5

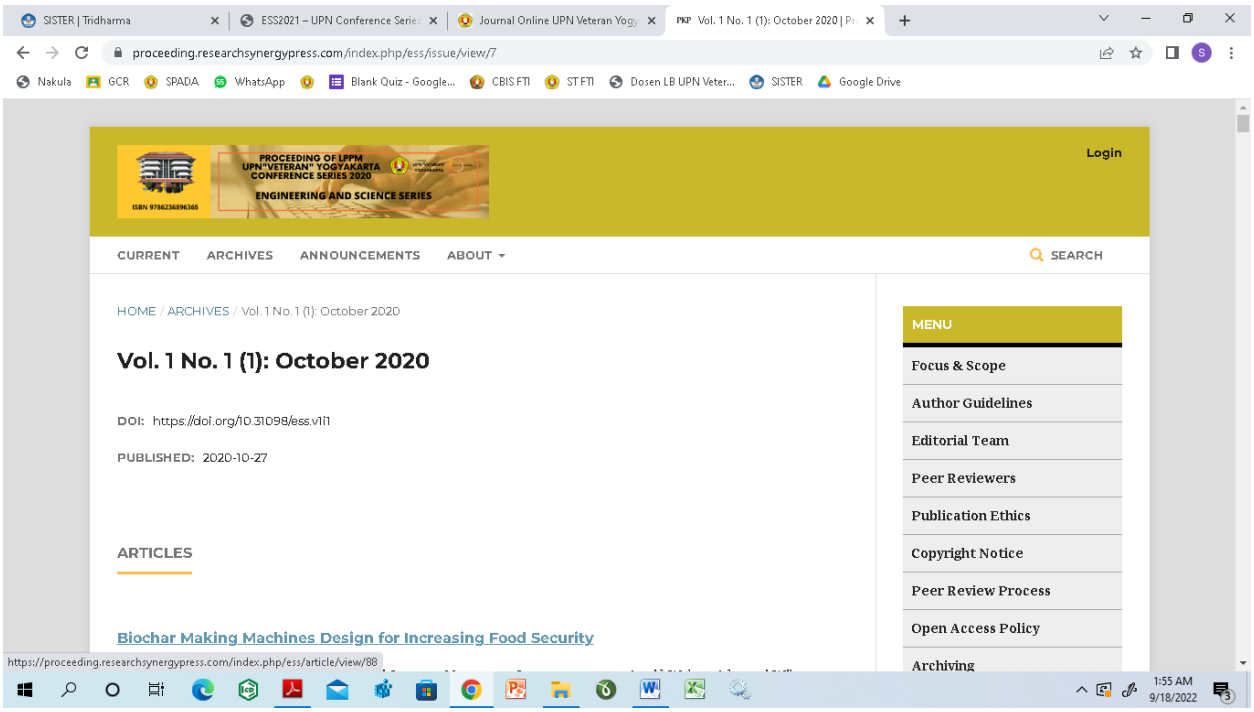
INFORMATION

For Readers

For Authors

For Librarians

# Daftar Isi



PROCEEDING OF LPPM UPN "VETERAN" YOGYAKARTA CONFERENCE SERIES 2020

ENGINEERING AND SCIENCE SERIES

Login

CURRENT ARCHIVES ANNOUNCEMENTS ABOUT SEARCH

HOME / ARCHIVES / Vol. 1 No. 1 (1): October 2020

Vol. 1 No. 1 (1): October 2020

DOI: https://doi.org/10.31098/ess.v1i1

PUBLISHED: 2020-10-27

ARTICLES

Biochar Making Machines Design for Increasing Food Security

MENU

Focus & Scope

Author Guidelines

Editorial Team

Peer Reviewers

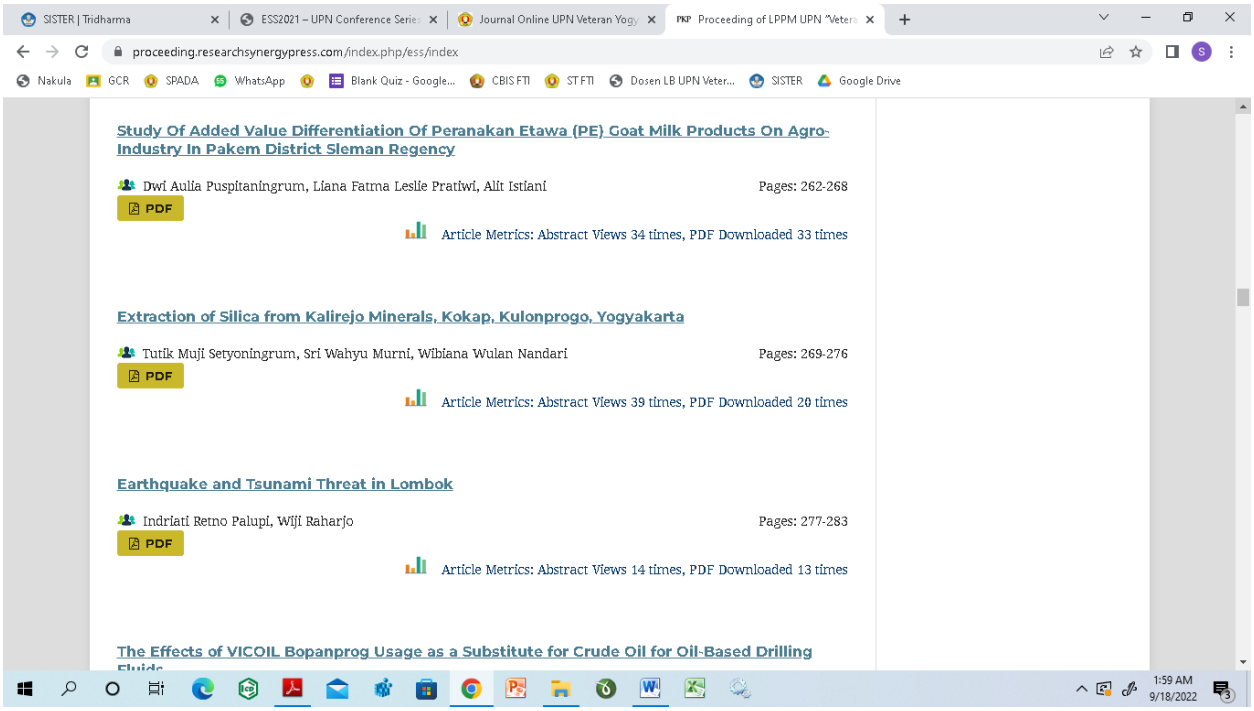
Publication Ethics

Copyright Notice

Peer Review Process

Open Access Policy

Archiving


SISTER | Tridharma
ESS2021 – UPN Conference Series
Journal Online UPN Veteran Yogy
Proceeding of LPPM UPN "Veter
proceeding.researchsynergypress.com/index.php/ess/index
Nakula
GCR
SPADA
WhatsApp
Blank Quiz - Google...
CBIS FTI
ST FTI
Dosen LB UPN Veter...
SISTER
Google Drive
Study Of Added Value Differentiation Of Peranakan Etawa (PE) Goat Milk Products On Agro-Industry In Pakem District Sleman Regency
Dwi Aulia Puspitaningrum, Liana Fatma Leslie Pratiwi, Alit Istiani
Pages: 262-268
PDF
Article Metrics: Abstract Views 34 times, PDF Downloaded 33 times
Extraction of Silica from Kalirejo Minerals, Kokap, Kulonprogo, Yogyakarta
Tutik Muji Setyoningrum, Sri Wahyu Murni, Wibiana Wulan Nandari
Pages: 269-276
PDF
Article Metrics: Abstract Views 39 times, PDF Downloaded 20 times
Earthquake and Tsunami Threat in Lombok
Indriati Retno Palupi, Wiji Raharjo
Pages: 277-283
PDF
Article Metrics: Abstract Views 14 times, PDF Downloaded 13 times
The Effects of VICOIL Bopanprog Usage as a Substitute for Crude Oil for Oil-Based Drilling
1:59 AM
9/18/2022

Available online at: http://proceeding.rsfpress.com/index.php/ ess/index
**LPPM UPN "Veteran" Yogyakarta Conference Series**
**Proceeding on Engineering and Science Series (ESS)**
Volume 1 Number 1 (2020): 269-276

# Extraction of Silica from Kalirejo Minerals, Kokap, Kulonprogo, Yogyakarta

**Tutik Muji Setyoningrum, Sri Wahyu Murni, Wibiana Wulan Nandari**

Universitas Pembangunan Nasional Veteran Yogyakarta
E-mail address tutikmuji@upnyk.ac.id,E-mail address sriwahyumurni@upnyk.ac.id;
[3] E-mail address wibianawulan@upnyk.ac.id

**Abstract**

*In the industrial world, silica is widely used, such as in the tire, rubber, glass, cement, concrete, ceramics, textiles, paper, cosmetics, electronics, paint, film, toothpaste, healthcare, and other industries. The commercial value of silica determinant by its purity. In this study, silica extraction from minerals taken from the Kokap area, Kulonprogo, was carried out. The extraction of silica from minerals aims to increase silica content. In this research, the effect of NaOH concentration and particle size in silica extraction from minerals was studied. The variation in particle size is 100 mesh and 150 mesh, while the variation in NaOH concentration is from 0.5 N to 5 N with a difference in concentration of 0.5 N. The product of this research is silica gel. The experimental results show that the greater the NaOH concentration, the greater the silica that can be extracted. When viewed from the particle size, a smaller particle size results in a larger conversion. The largest extract was obtained at a particle size of 150 mesh with a concentration of NaOH 5 N, which is 4.73 grams of silica gel or 1.6979 grams of silica.*

Keywords: extraction, silica, particle size, NaOH



## I. INTRODUCTION

In the industrial sector, silica is quite widely used, for example, in the tire industry, rubber, glass, cement, concrete, ceramics, textiles, paper, cosmetics, electronics, paint, film, toothpaste, healthcare, and others. However, silica is difficult to obtain as an element with high purity. The refining process of silica can be carried out by solid-liquid extraction. $Na_2CO_3$ or NaOH solutions can be used as a silica solvent. Cornellis. *et* al. (2011) stated that the extraction using $Na_2CO_3$ stated that extraction using Na2CO3 was less able to dissolve silica crystals. Codama and Roos (1991) stated that NaOH has a better ability to dissolve silica. Anna Georgiadis *et al.* (2015) studied optimizing amorphous silica extraction from the soil by using NaOH. Based on the result of this test series, a method for quantifying amorphous silica in soil from temperate-humid climate is proposed.

To exploit the potential of mineral rocks containing silica from the villages of Kalirejo, Kokap, Kulonprogo, this research extracts Si in the form of SiO2 (Silica gel) and analyzes the rock composition using the X-Ray Fluorescence method. Qualitative and quantitative analysis using the X-Ray Fluorescence method, which does not damage the material with the principle that the collision of atoms on the sample surface by X-rays The aim of this research was to study the effect of NaOH concentration and particle size in extraction silica from mineral.

# II. LITERATURE REVIEW

Solid-liquid extraction is a process that involves the mass transfer between phases. The difference in chemical activity between the solid phase and the solvent phase reflects how far the system is from equilibrium, so it will also determine the rate of solute between the phases. This process is a physical process because the dissolved components are then returned to their original state without experiencing chemical changes (Lucas, 1949). In the solid-liquid extraction process, a very long contact between the solvent and the solid is required. This process is most commonly found in efforts to isolate a substance contained in a natural material so that what plays an important role in determining the completeness of this extraction process is the properties of natural materials and also the material to be extracted. The extraction rate of a material is determined by the particle size of the material. The extracted material should be of a uniform size to facilitate contact between the material and the solvent so that the extraction takes place well (Sudarmadji & Suhardi, 1996).

Silica is formed through strong covalent bonds and has a structure with four oxygen atoms bonded in a tetrahedral angle position around the central atom, namely the silica atom; figure 1 shows the structure of tetrahedral silica.


Fig 1. Tetrahedral silica structure

In general, silica is hydrated amorphous form, but if combustion continues at temperatures above 650 ° C, the crystallinity level will tend to increase with the formation of quartz, cristobalite, and tridymite phases (Hara, 1986). The structural forms of quartz, cristobalite, and tridymite, which are the main types of silica crystals, have different stability and density (Brindley and Brown, 1980). Based on thermal treatment, at temperatures <570 ° C, low quartz is formed; for temperatures 570-870 ° C, high quartz is formed, which changes its structure to cristobalite and tridymite, while at temperatures of 870-1470 ° C, high tridymite is formed, at > 1470 ° C high cristobalite is formed, and at 1723 ° C liquid silica is formed (Wikipedia A, 2006).

Silica can react with bases, especially with strong bases such as sodium hydroxide. The reaction of silica with bases is shown as follows.

$SiO_{2(s)} + 2NaOH_{(aq)} \rightarrow Na2SiO_{3(aq)} + H_2O_{(l)}$(Vogel, 1985)

According to Srivastava *et al*. (2013), the percentage of silica obtained from the extraction is influenced by the concentration of the NaOH solution as the extractor, the $SiO_2$ content in the raw material, the variation in reaction time, and the reaction temperature. Silica rock is reacted with NaOH with various concentrations to form a solution of sodium silicate. This solution is then added with a solution of HCl to form a silica precipitate.

## III. RESEARCH METHODOLOGY

### III.1.Material

The sample was taken from Kalirejo, Kokap, Kabupaten KulonProgo, Yogyakarta. The sample was washed, cleaned, filtered, and dried prior to crushing, ball milling, and sieving. The sample used has various particle distribution at 150 and 200 mesh. The prepared sample is characterized by X-ray Diffraction (XRD) and X-Ray Fluorescence (XRF). All reagents used in this study were analytical grade.

### III.2. Methods

#### III.2.1. Extraction

All experiment was conducted in a mechanically 1-L stirred three-neck bottle reactor. A total of 50 grams of the sample is extracted with 100 ml of NaOH solution at a certain concentration fill in the reactor, then heated at a temperature of 100 $^oC$ – 105 $^oC$ for 60 minutes while stirring using a magnetic stirrer. The variation in NaOH concentration is from 0.5 N to 5 N with a difference of 0.5 N. After the process of the mixture, after the mixing process, the solution is then cooled and filtered using filter paper.

#### III.2.2.Silica Formation and Drying stage

The filtrate was added by the solution of 2 N HCl until pH less than 7. The precipitates of silica then filtered using filter paper and dried at 100 $^oC$. The silica is then weighed until a constant weight is obtained. The experiment was repeated with different concentrations of NaOH and also different particle sizes. They analyzed XRD and XRF.

#### III.2.3.Analysis

The silica obtained is calculated from the amount of conversion using the equation.

$$\text{yield} = \frac{\text{weigth of silica}}{\text{weigth of sample}} x100\%$$

To ensure the silica content in the product, the dried precipitate was analyzed using X-Ray

Fluorescence analysis on the product with the greatest conversion.

# IV. FINDING AND DISCUSSION

### IV.1. Raw Material Analysis

Material is taken from Kalirejo, Kokap, Kulonprogo was analyzed using X Ray-Fluorescence at the National Nuclear Energy Agency. The elements contained in the sample are shown in table 1.

Table 1. elemental content in the sample

| Element | Composition | Element | Composition |
|---|---|---|---|
| Si | 23.376 % | Mn | 428,000 ppm |
| Al | 3.098 % | Cu | 36,000 ppm |
| S | 2.792 % | Zn | 282,000 ppm |
| Cl | 0.140 % | Ga | 21,400 ppm |
| K | 2.929 % | Rb | 148,600 ppm |
| Ca | 1.123 % | Sr | 149,000 ppm |
| Ti | 0.385 % | Y | 143,300 ppm |
| Fe | 7,262 % | Sr | 107,600 ppm |
| As | 0,299 % | | |

From the XRF analysis, the sample contains several dominant elements, such as Al, Si, S, Cl, K, Ca, Ti, and Fe. The Si content in minerals is 23.376%, assuming the rocks are of uniform size and have been homogeneously mixed so that they have the same properties.

### IV.2, The results of the extraction, precipitation, and drying processes

The silica extraction process uses NaOH solvent with various concentrations ranging from 0.5 N to 5 N. The experiment was carried out by varying two mineral sizes, 100 mesh, and 150 mesh.

The results obtained from the experiment in the form of silica gel ($SiO_2.H_2O$) and the resulting silica conversion calculations are presented in Table 3, with the raw materials presented in table 2.

Table 2. The raw materials used

| | | |
|---|---|---|
| Raw material | : | Mineral rock from Kalirejo, Kokap, Kulonprogo |
| Initial silica content | : | 23,376 % |
| Sample weight | : | 50 grams |
| Extraction temperature | : | 100 $^oC$ – 105 $^oC$ |
| Extraction time | : | 60 minutes |

Table 3. Silica gel dry weight and silica conversion resulted in variations in particle size and NaOH concentration

| **the concentration of** | **particle size (mesh)** | **silica weight (grams)** | **conversion (%)** |
|---|---|---|---|

| NaOH (N) | | | |
|---|---|---|---|
| 0,5 | 100 | 0,174 | 0,5348 |
| | 150 | 0,294 | 0,9189 |
| 1 | 100 | 0,418 | 1,2846 |
| | 150 | 0,9065 | 2,786 |
| 1,5 | 100 | 0,6671 | 2,0503 |
| | 150 | 1,0991 | 3,3779 |
| 2 | 100 | 0,6926 | 2,1287 |
| | 150 | 1,2 | 3,6881 |
| 2,5 | 100 | 0,7667 | 2,3563 |
| | 150 | 1,2512 | 3,8464 |
| 3 | 100 | 1,19 | 3,6601 |
| | 150 | 1,305 | 4,0081 |
| 3,5 | 100 | 1,28 | 3,93 |
| | 150 | 1,525 | 4,68 |
| 4 | 100 | 1,81 | 5,56 |
| | 150 | 1,61 | 4,94 |
| 4,5 | 100 | 2,04 | 6,27 |
| | 150 | 2,64 | 8,1 |
| 5 | 100 | 2,27 | 6,97 |
| | 150 | 4,73 | 14,52 |

Figure 2 shows the relationship between the variation in NaOH concentration and the weight of silica at particle sizes of 100 mesh and 150 mesh.

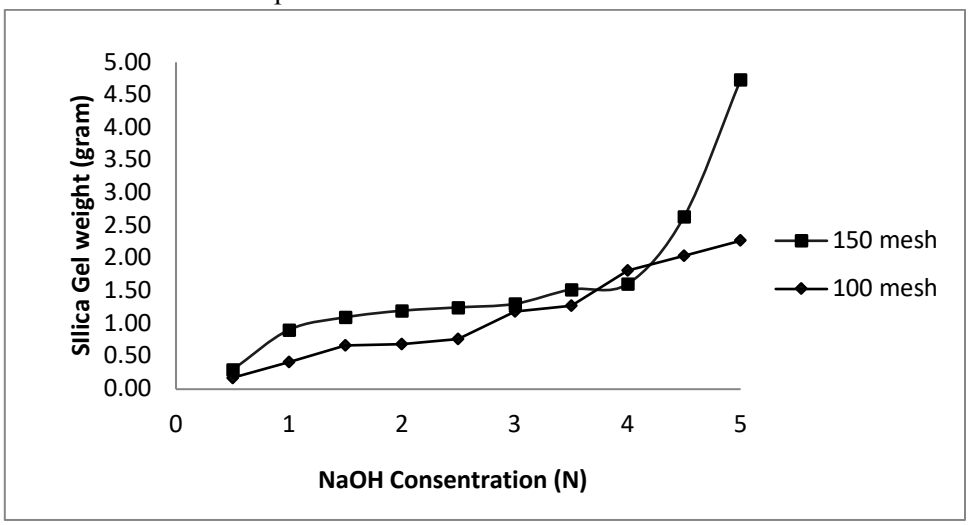



Figure 2. The graph between the weight of silica and the concentration of NaOH

Figure 3 shows the relationship between the variation in NaOH concentration and the resulting conversion at particle sizes of 100 mesh and 150 mesh.

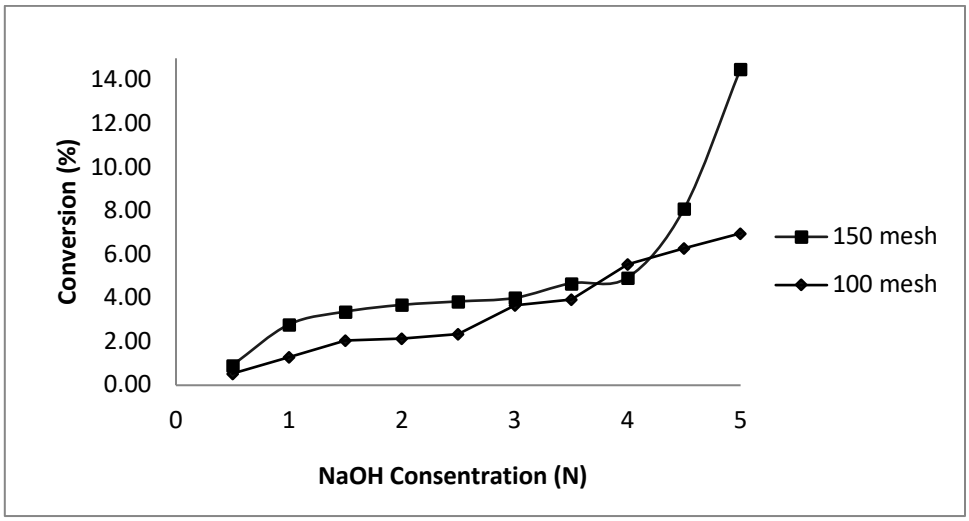



Figure 3. The graph between the conversion of silica and the concentration of NaOH

From the tables and figures, it can be seen that the largest silica that can be taken is at a particle size of 150 mesh with a concentration of 5 N NaOH. The weight of extracted silica gel was 4.73 grams ($H_2SiO_3$) or 1.6979 grams of Si with the silica content in the sample of 11.688 grams, so that the percentage of silica taken is 14.52%.

The experimental results showed that the greater the NaOH concentration, the greater the conversion and weight of silica gel obtained at the same particle size. This is because the greater the concentration of NaOH solvent, the more silica contained in the sample dissolved in the solvent. When viewed from the mineral particle size (100 mesh and 150 mesh), then the smaller size can take more silica so that the conversion becomes large. This is because the smaller the particle size, the larger the surface area of the material, thereby increasing the extraction speed. The capillary path of the area that must be passed by diffusion becomes shorter, thereby reducing its resistance.

The extracted silica is still too small. In order to increase the amount of silica taken up, it is necessary to study a larger NaOH concentration, a smaller particle size, and higher extraction temperature.

# V. CONCLUSION

More silica gel is obtained when extracted using a larger concentration of NaOH solvent and a smaller sample particle size. The highest extracted silica yield in this experiment was 4.73 grams of silica gel ($H_2SiO_3$) at a concentration of 5 N NaOH and a sample size of 150 mesh.

The resulting silica does not have very high purity yet due to the limitations of the research tool in heating the sample. In research, heating was only up to a temperature of 100 $^oC$, so that there was still a lot of water content, meaning that the product produced was not pure silica but silica gel.

# VI. REFERENCES

Bragmann, C.Pand Goncalves, M.R.F.2006. Thermal Insulators Made With Rice Husk Ashes: Production and Correlation Between Properties and Microstructure. Department of materials, school of engineering, federal university of Rio Grande do Sul, Brasil.

Brindley, G.W, and Brown, G 1980.Crystal Structures of Clay Minerals and Their X-Ray Identification. Mineralogical Society. No. 5,pp.312-316, 378380.

Castro, M. D. L., and Capote F. P., 2006. *"Techniques and Instrumentation in Analytical Chemistry*." Analytical Applications of Ultrasound. 26, 99-137.

CetinKurt,JürgenBittner(2005),"SodiumHydroxide", *Ullmann's Encyclopedia of Industrial Chemistry*,Weinheim:

Fahmiati, Nuryono dan Narsito, 2004, Kajian Kinetika Adsorpsi Cd(II), Ni(II) dan Mg(II) pada Silika Gel Termodifikasi 3-Merkapto-1,2,4-triazol, Alchemy, 3(2),22-28

Georgiadis, A., Daniela Sauer, JörnBeuer, LudgerHemann, ThiloRinert and Karl Stahr, 2015, Optimising the extraction of amorphous silica by NaOH from soils of temperature- humid climate, Soil Research, 53, 392-400

Hara. 1986. Utilization of Agrowastes for Building Materials. International Research and Development Corporation Division. Tokyo. Japan

Iler, R.K., 1979. Silica gels and powders. In: The Chemistry of Silica. John Wiley and Sons, New York. pp. 462–599

Laksminta Prima Santi, Joko Mulyanto dan Didiek Hadjar Goenadi, 2017, Double Acid-Base Extraction of Silica acid from Quartz Sand, Journal Mineral and Material Characterization and Engineering, 5, 362-373

Lucas, Howard J, David Pressman. 1949. *Principles and Practice In Organic Chemistry*. New York: John Wiley and Sons, Inc.

K. G. Patel, N. M. Misra, dan R. R. Shetiggar. Preparation and Characterization Of Silica Gel From Wheat Straw. Journal of Chemical Engginering and Application. (October 2016), Vol. 7, No. 5

Kirk, R.E., and Othmer. 1984. Encyclopedia of Chemical Technology, Fourth Edition Vol. 21.
John Wiley and Sons, Inc., New York.

Patterson, Robert E.(ed). "Silica (Introduction)". Kirk-Othmer Encyclopedia of Chemical Technology, vol 21, pp 977–1022. New York: Wiley – Interscience Publication. 1997.

Smallman, R. E. and Bishop, R. J. 2000.MetalurgiFisik Modern danRekayasa Material. Edisi keenam. Terjemahan Sriati Djaprie. Erlangga. Jakarta

Soeparman.(1967). Teknologi Kimia Tekstil. Bandung: ITT.

Sudarmadji, S., Haryono, B., Suhardi. 1996. *Analisa Bahan Makanan dan Pertanian.145 Liberti*. Yogyakarta.

Suratmandan Sri Andayani, 2014, Beneficiation of Sambiroto Silica Sand by Chemical and Biological Leaching, Indonesian Minning Journal, Vol. 17, No. 3, pp. 134-143

Surdia, T dan Saito, S. 2000. PengetahuanBahanTeknik. PradnyaPramita. Jakarta.

SuryaIndah (1996). Pengaruh Konsentrasi NaOH dan Waktu Penguapan pada Proses Kostisasi terhadap Kualitas Kain Rayon Viskosa. Skripsi: UII Yogyakarta

Vlack Van and H.Lawrench. 1992. Ilmu dan Teknologi Bahan (Ilmu Logam dan Non Logam). Edisikelima. AlihBahasa: Sriati Djaprie. Fakultas Teknik Metalurgi, Universitas Indonesia. Erlangga.Jakarta.

Waddel, Walter H., Evans, Larry R. "Silica (Amorphous)". Kirk-Othmer Encyclopedia of Chemical Technology, vol 21, pp 1005–1032. New York: Wiley – Interscience Publication. 1997.

Wilson I. D, Michael C, Colin F P, Edward R A. 2000. "Encyclopedia of Separation Science". *Academic Press*. 118-119.

Worr'al. W. E., 1986. Clays and Ceramics Raw. London. Applied Science Publisher, Vol. 4, No. 7, pp. 3-7.

https://id.wikipedia.org/wiki/Silikon_dioksida