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Extraction Of Silica Dioxide (SiO_2) From Mount Sinabung Volcanic Ash with Coprecipitation Method

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Abstract. Mount Sinabung volcanic ash is a basic material that can be used to produce silicon dioxide (SiO_2). SiO_2 can be used as a building raw material as well as in food and beverage packaging. To produce SiO_2, the volcanic ash of Mount Sinabung must be synthesized using the coprecipitation method. The result of this process produces SiO_2 content as much as 48%, a formed function group that states the existence of SiO_2 namely Si-O-Si and Si-O at absorption of 1095.57 cm-1 and 798.53 cm-1. From the results of SEM can be seen the morphology of SiO_2 formed. In the XRD results, the phase of SiO_2 is amorphous.

1. Introduction

Indonesia is an archipelago which is crossed by the equator and located between the continents of Asia and Australia and between the Pacific Ocean and the Indian Ocean. It is surrounded by the Eurasian, the Indo-Australian and the Pacific plate. In addition, this region is also the path of the Pacific Ring of Fire (Ring of Fire), which is a series of lines of active volcanoes in the world[1]. Mount Sinabung, which is called *Deleng Sinabung* in Karonese, one of active volcanoes in Indonesia. Located in the province of North Sumatra withcoordinates the summit of Mount Sinabung is 03° 10' N and 98° 23' E with the highest peak 2,460 meters above sea level the highest peak in North Sumatra[2][3]. Mount Sinabung eruption increased to the level of 4 (Alert) on November 24, 2013 since it spat out black, thick smokescreen, followed by sand rain and volcanic ash which covered thousands of hectares of farmers' crops under the radius of six kilometers so that more than 20 thousand people had to be evacuated[4].

The abundance of volcanic ash material as a result of the eruption of Mount Sinabung is an interesting thing to study. According to tests that have been done using Spektroskopi Serapan Atom (Atomic Absorption Spectrophotometry – AAS) showed that the volcanic ash from Mount Sinabung contains 78,3 % SiO_2 , 2,91 % Fe_2O_3 , 4,56 % Al_2O_3 1,07 % MgO, 4,84 % CaO, and 0,46 % Na_2O[5]. SiO2 is one of the most abundant compound in the Volcanic Ash Sinabung has the potential to be used a variety of needs[6]. One of the ways used to obtain high-purity SiO2 can be obtained by synthesis of SiO2-based nature with relatively high Si element content using coprecipitation method.The

coprecipitation (deposition) method is a type of fabrication technique using a chemical method that brings a solute downward to form the desired precipitate[7][8][9].

Research that has been done using volcanic ash material , namely extraction volcanic ash of sinabung mount silica to production silica gel. This research tries extraction volcanic ash of sinabung monnt with sol-gel method[10].

2. Methods

In this study, the manufacture of extraction silica dioxide (SiO_2) using Volcanic ash of Sinabung mount ,Cholride acid (HCl) 2 M, distilled water , Natrium Chloride and Natrium Hidroxide (NaOH) 7M. This research using coprecipitation method.

Mount Sinabung volcanic ash was sieved with a 200 mesh filter.Put it in a container of 300 grams of Mount Sinabung volcanic ash that has been sifted.Add HCl 2 M with a ratio (1:10) and stirred for 12 hours.Settling for one night until the ash settles, the precipitate was washed with distilled water until pH = 7.Add 7 M NaOH (1:10);Then heated at a temperature of 100-130^oC while in stirrer for 24 h. After reaction was complete, allowed to stand to separate.Furthermore, the filtrate is filtered with a paper filter Results whattman No. 42 in tittrasi with 2 M HCl until pH neutral.Settling up a separate deposition. Dried sludge by using an oven at 70-80^oC to dry.Precipitated silica dioxide obtained weighing 68.58 grams of 300 grams of volcanic ash Mount Sinabung

3. Results and Discussion

3.1 XRF analysis of SiO_2 from Sinabung Volcanic Ash

The Mount Sinabung volcanic ash content has been extracted through the coprecipitation process can be seen in table 1. Based on the results of XRF shows the content of SiO_2 compounds as much as 48%, the content of elements Si 26.9 %, and the content of elements Cl 22.8 %. From the test results showed the content of SiO_2 has a fairly high content. It can also be observed with discoloration occurring. The Mount Sinabung volcanic ash color is gray, after the coprecipitation process turns white[11].

Table 1. Composition of SiO_2 from Sinabung Volcanic Ash used XRF

Composition	Percentage (%)
SiO_2	48
Si	26.9
Cl	22.8
P_2O_5	0.5
K_2O	0.17
CaO	0.66
Cr_2O_3	0.058
Fe_2O_3	0.61
BaO	0.28

SiO_2 content can be used in the field of industry, among others cement industry, ceramic industry, ferosillicone manufacturing industry. SiO_2 can not stand alone so it must bind to oxygen to form a compound that is silicon dioxide compound (SiO_2). So if the oxide level is getting smaller then it is expected that SiO_2 levels will be greater anyway. This means that the purer SiO_2 levels, so that it can be used in various fields. Examples of food and beverage packaging such as bottles and glasses[12].

3.2 Morphology analysis of SiO_2 from Sinabung Volcanic Ash

SiO_2 morpology from Mount Sinabung volcanic ash was observed using Scanning Electron Microscope (SEM). Test results using SEM can be observed in figure 1.

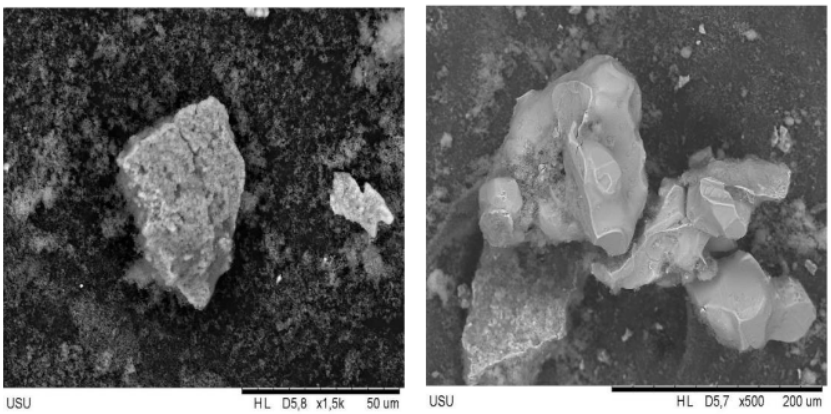

Figure 1. SEM image of SiO_2 from Sinabung Volcanic Ash.

In figure 1, the surface structure of SiO_2 is seen. SiO_2 shape looks like granules that appear that the surface has not seen the presence of grain boundry, with the size of pores large enough to form unevenly distributed blobs. These results indicate that SiO_2 has low stability[13]. Then from the results SEM seen other minerals that still cover the surface of SiO_2. It can also be linked to the XRF test hail which shows the still high content of Cl in the process to obtain SiO_2 from the Mount Sinabung volcanic ash.

3.3 FTIR Analysis

To find out the chemical bonds present in SiO_2 using FTIR. The FTIR test results for SiO_2 can be seen in figure 2. There are seven absorption tapes from the FTIR test results, the results of which are presented in table 2.

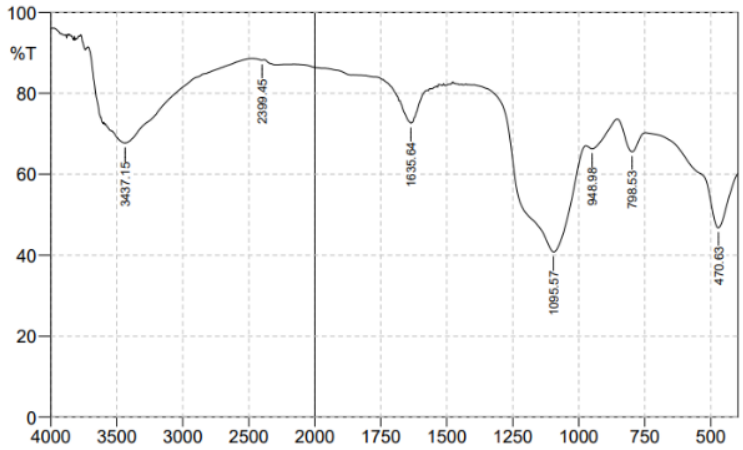

Figure 2. FTIR spectrum of SiO_2 from Sinabung Volcanic Ash

Bonds that appear on wave numbers 470.63 cm^{-1}, 798.53 cm^{-1}, 948.98 cm^{-1}, 1095.57 cm^{-1}, 1635.64 cm^{-1}, and 2399.45 cm^{-1}. The absorption band at 470.63 cm^{-1} is a bond of O-Si-O from siloxy group. Absorption at 1635.64 cm^{-1} and 3437.15 cm^{-1} is a hydroxyl function group of-OH stretching and -OH bending [14]. At absorption 798.53 cm^{-1} ,948.98 cm^{-1} and 2399.45 cm^{-1} is a hydroxyl function group of Si-O, Si-OH dan Si-C[15]. At absorption 1095.57 cm^{-1} is a siloxan function group of Si-O-Si[16].

Table 2. Chemical bonding on SiO2 from Mount Sinabung volcanic ash

No	Bands in SiO_2	Wavenumbers (cm^{-1})
1	O-Si-O (Bending)	470.63
2	Si-O (Bending)	798.53
3	Si-OH (Stretching)	948.98
4	Si-O-Si (Stretching)	1095.57
5	-OH (Bending)	1635.64
6	Si-C (Stretching)	2399.45
7	-OH (*Stretching*)	3437.15

XRD analysis

To find out the phase on SiO_2 of volcanic ash Mount Sinabung used XRD. The XRD measurement results can be seen in figure 3. SiO_2 has this amorphous properties can be seen in $2\theta = 22.16^{o}$. In addition to the formation of phases of SiO_2 formed another phase due to the coprecipitation process. The phase that appears is the phase of NaCl. This is in accordance with the XRF results that indicate the presence of C element in the SiO_2 content of Mount Sinabung volcanic ash.

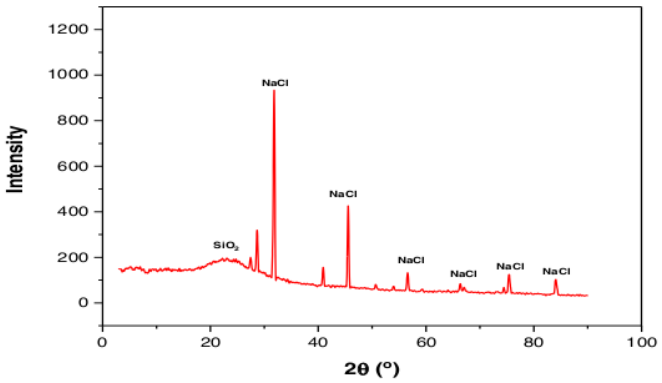

Figure 3. XRD image of SiO_2 from the Mount Sinabung volcanic ash.

4. Conclusions

Mount Sinabung Volcanic ash can produce Silicon dioxide (SiO_2) by coprecipitation method. SiO_2 obtained from the process as much as 48 %. From the results of SEM seen SiO_2 morphology that is still sequined with other minerals. Characterization using XRD obtained phases from SiO_2 which is amorphous. The characterization that indicates the existence of SiO_2 can be seen with the formation of Si-O-Si and Si-O function groups.

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