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Potential of Kaolin Jaboi in Sabang, Indonesia: As Raw Material of Alum in Water Purification Process.

Dewi Mulyati[1]*, Saisa[2], and Irhamni[3].

[1]Department Of Industry Engineering,Serambi Mekkah University, Indonesia.
[2]Department Of Chemical Engineering, Serambi Mekkah University, Indonesia.
[3]Department Of Environmental Engineering, Serambi Mekkah University, Indonesia.

ABSTRACT

In water treatment process, one of primary chemicals used is aluminum sulfate as a coagulant forming so the water becomes clean. Aluminum sulfate [Al2(SO4)3] or better known as alum is one of the chemicals that are required both in industry and in water treatment company. This research is purposes to study the operating conditions of the process of making aluminum sulfate liquid of kaolin and sulfuric acid to see the effect of temperature, time, ratio of sulfuric acid and kaolin, the concentration of sulfuric acid, the stirrer rotation and speed on the quality of liquid aluminum sulfate to be generated in order to obtain optimum operating variables conversion process to obtain optimal value. In this research, the process of mixing the sulfuric acid and kaolin, aluminum sulfate paste subsequently extracted with distilled water that has been heated to obtain aluminum sulfate. Fixed variable in this study are the weight and size of the kaolin particles each 25 grams and 250 μ, the condition of the extraction process at a temperature of 100 ° C, the ratio of sediment and hot water 3: 1, while stirring for 1 hour at 3 times the amount of leaching and bone dry conditions. While changing the controlled variable is the time of surgery for 20, 50, 90 and 110 minutes, the ratio of sulfuric acid and kaolin 1: 2; 2: 2; 3: 1 and a sulfuric acid concentration of 30%; 50%; and 70%. The results obtained were the composition of kaolin Jaboi in a preliminary test using x-ray beam, results were obtained that the highest composition is SiO2 as much as 96.9% whereas only 1.26% alumina. Judging from the influence of sulfuric acid concentration on reaction time obtained a yield of 92,13% at 50% concentration sulfuric acid at reaction time 110 minutes.

Keywords: water treatment, aluminum sulfate, alum, kaolin, kaolin Jaboi, extraction.

Corresponding author

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INTRODUCTION

Kaolin is a rock mass composed of clay material with a low iron content. Classified as non-metallic mineral kaolin and clay soil types (clay) primer that has a coarse-grained soils, fragile, is plastic when moist, harden when dry and harden when heated. In general, grayish white, there are also yellow, orange and reddish gray. Kaolin chemically formulated Al2O3.2SiO2.2H2O as minerals, kaolin nothing is pure, usually mixed with other oxides such as calcium oxide, magnesium oxide, sodium oxide, iron oxide and sometimes also mixed with titanium oxide [3]. Kaolin is a mineral whose presence is quite abundant in Indonesia, especially in Aceh province. It is mainly containing silica (45%) and alumina (38.5%). Other content is ferry oxide (0.98%), calcium oxide (0.49%), sodium oxide (0.48%), as well as other materials that are discharged by burning (13.78%). Kaolin is referred to by the public as white clay that it is a residual sludge or brittle rocks that occur as a result of hydrothermal processes. Based on research conducted by Wicaksono et al [14] in the production of aluminum sulphate using bauxite as raw materials that containing Al2O3 (alumina) 57.5%, stage of the process is done by modifying the Bayer process and Gaulini. The first stage is digestion process that operates at a temperature of 160 oC, 1 atm with the addition of 55% of NaOH solution. The second stage is the precipitation process which operates at a temperature of 70 oC, 1 atm to produce Al(OH)3. Furthermore, the addition of 66% wt sulfuric acid solution into the reactor at a temperature of 170 oC and 5 atm pressure to produce liquid aluminum sulfate. The third stage is the crystallization of molten aluminum sulfate in crystalizer belt to obtain crystals of aluminum sulphate. Utilization of kaolin as raw material for production alum was also studied by Ismayanda (2011) with the best conversion of dissolved aluminum in the reaction between kaolin and sulfuric acid was obtained by 82%, namely under conditions with a temperature of 180 oC, 90 minutes, and stirrer rotation speed of 350 rpm. The degree of acidity (pH) of aluminum sulfate products produced in this study was 3.15 to 3.2. According to statistical data of kaolin (1995), in the province of Aceh are kaolin reserves of not less than 450 million tons. Finding the location of the backup is spreading in several areas, including Southeast Aceh district (District of Badr, long Kuta, Blang Kejeren) the number of 448 million tons, the town of Sabang (Subdistrict like work and Suka Jaya) with the amount of 2.88 million tons, Central Aceh District (District of Silih Nara) and Aceh Barat (area Krueng Seunangan). The highly using of alum in the water treatment industry, this study sought to obtain optimal results using a variety of research and explore the potential of natural resources in Indonesia, especially in province of Aceh.

RESEARCH METHOD

Kaolin is used in this study was kaolin from Sabang, yellowish white and mashed until passing 250 micron. Kaolin which is still in the form of chunks of dried kaolin which is still in the form of chunks until its water content decreases. And then put kaolin into a ball mill until the particle size kaolin passing 250 micron sieve. Poured kaolin and sulfuric acid into beaker glass with ratio of 1:2 ; 2:2 and 3:1, respectively. While simultaneously stirring using a stirrer to reach perfect mixing and the solution temperature is checked while the temperature is kept constant. Stirring speed and temperature variation used is 150 ; 200; 250 rpm and 130 ; 160 ; 190 ; 200; 210 oC, respectively. While sulfuric acid concentration used is 30; 50 ; 70% wt. The result from the reaction is a pasta and the length of reaction time that varied is 20; 50; 70 ; 90 and 110 minutes. Pasta that has been produced is extracted with hot water to dissolve aluminum sulfate is formed. And dissolve aluminium analyzed with complexometric titration method. In the water treatment industry, alum can be used as a water purifier such as in sedimentation process because alum is dissolved in water is able to bind impurities and precipitate impurities in the water making the water becomes clear and we will see the performance of the alum that produced against sedimentation velocity of impurities.

RESULT AND DISCUSSION

Analysis of Kaolin Jaboi Kaolin is a rock mass composed of clay material with a low iron content, and generally white or slightly whitish. Kaolin has a hydrous aluminum silicate composition (2H2O.Al2O3.2SiO2), along with accompanying minerals. Based on the Ministry of Energy and Mineral Resources [2], kaolin is a mineral whose presence is quite abundant in Indonesia, particularly in Aceh Province. Kaolin mainly containing silica (45%) and alumina (38.5%). Other content is ferry oxide (0.98%), calcium oxide (0.49%), sodium oxide (0.48%), as well as other materials that are discharged by burning (13.78%) [1]. Based on analysis of the composition of kaolin originating from Sabang precisely in the Jaboi village presented in Table 1.

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Table 1. Analysis component result of kaolin Jaboi

Component	%
SiO_2	96,9
Al_2O_3	1,26
Fe_2O_3	0,15
CaO	0,83
MgO	0,22
SO_3	0,13
K_2O	0,1
Na_2O	0,08
TiO_2	1,124
Mn_2O_3	0,008

Resulting from Laboratorium Analysis of LCI,Lhoknga (2015)

The results obtained are the highest composition is SiO2 as much as 96.9% whereas only 1.26% of alumina. This is consistent with the theory of reviews early that the main content of kaolin is silica. Geologically, the first forming of kaolin because the weathering process and hydro-thermal alteration in igneous rocks felspatik. Aluminum potash minerals silica and feldspar transformed into kaolin. Kaolinisasi process takes place in certain conditions, so that elements other than silica, aluminum, oxygen and hydrogen will experience exchange as shown in the following equation: 2KAlSi3O8 + 2H2O → Al2 (OH) 4 (SiO5) + K2O + 4SiO2 (Felspar kaolinite).

Figure 1. Sampling location in Jaboi village, Sabang

The weathering process occurs at or near the soil surface, mostly occurs in igneous rocks. While the process of hydrothermal alteration occurs as hydrothermal solution flows through fractures, faults, and other permeable areas while converting limestone into sediment kaolin. According to Hendri [8], differences in the composition of minerals and metals in the process of soil formation is influenced by water, air, sunlight, live in the soil and bodies of living things that exist around the region. Jaboi volcano crater area is one of the manifestations of geothermal energy that can be formed as a result of geothermal activity beneath the surface. Conditions sampling sites kaolin Jaboi presented in Figure 1. Jaboi is a name of the village located in the district of Sukajaya in Sabang which has an area of approximately 490.14 hectares.

Production of Kaolin Pasta Manufacture of alum can be carried out by dissolving materials containing Al2O3 in nature contained in kaolin soil. Manufacture of pasta kaolin kaolin chunk begins with drying to reduce the moisture content. Chunks of dried kaolin was then performed downsizing. Heating process as much as 25 grams of kaolin with the solvent in a stirred reactor operating conditions at a temperature of 190 oC, for 20

minutes; 50 minutes; 70 minutes; 90 minutes and 110 minutes as well as kaolin and solvent ratio is 1: 2; 2: 2; and 3: 1. The solvent used is sulfuric acid (H2SO4) with a concentration of 30; 50 and 70% wt, respectively. Kaolin which has been grinded by the ball mill and then mixed with sulfuric acid in various concentrations, the mixing is done with a magnetic stirrer with a variation it that preceed. Pasta aluminum sulfate resulting from the mixing process subsequently extracted with hot water aimed at dissolving aluminum sulfate formed. Extraction results obtained were then screened using a vacuum filter and then analyzed for levels of dissolved aluminium were formed. Content analysis conducted by the complexometric titration using a standard solution of ethylene diamine tetra acetic (EDTA) in each predetermined variation. The results also will be tested performance in agglomerate or speed the formation of flocs foreign material in the water produced by the Regional Water Company like PDAM, especially in the area of Banda Aceh.

Reaction Mechanism and Effect of Sulfuric Acid Concentration Kaolin with chemical formula Al2O3.2SiO.2H2O reacted with sulfuric acid will produce aluminum sulfate (alum) with the formation reaction as follows: 2Al(OH)3 + 3H2SO4 + 8H2O.Al2(SO4)3.14H2O the endothermic reaction conditions with the enthalpy of formation -156 kJ/mol [6]. Aluminium sulphate is produced in a batch reactor equipped with a stirrer is resistant to heat and acidity of the reaction. Dealumination process involves sulfuric acid and alumina. The concentration of sulfuric acid is one of the factors that affect the rate of conversion of alumina into aluminum sulfate. In research of Ismayanda [9], the process of the formation of aluminum sulphate by using a concentration of 25, 45 and 65% with the best concentration of sulfuric acid for reacting kaolin is 65% with a yield of nearly 80%. While Al Azzahrani [1] states leaching process to produce the best aluminum sulfate obtained at concentrations sufficient dilute sulfuric acid that is 40% with a conversion of 90.9%.

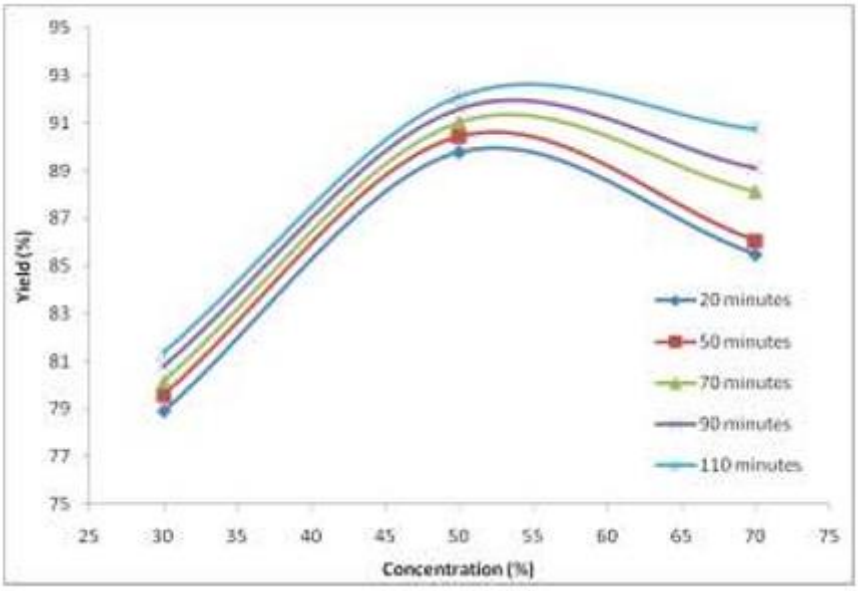

Figure 2. Chart effect relationship sulfuric acid concentration vs time at stirring speed of 200 rpm, 190 °C and sulfuric acid and kaolin ratio of 3: 1

Sulfuric acid which acts as a reactant that convert alumina into aluminum sulfate is generally used sulfuric acid and dilute concentrations. It is also explained by Jibril [11] which produces alum from Nigeria with mempreparasikan kaolin kaolin through the crystallization process and using sulfuric acid at low concentrations in degrading the alumina into aluminum sulfate. Yield obtained was 90% by using acid solvent to a concentration of 25%. Based on Figure 2. can be seen in 30% sulfuric acid concentration at the time 20, 50, 70, 90 and 110 minutes respectively obtained yield 78.91; 79.57; 80.16; 80.78; and 81.34. Graphs are formed obtained maximum points at a concentration of 50% and the operating time 110 minutes obtained a yield of 92.13%. Conversion of aluminum sulfate dissolved along with the increasing concentration of sulfuric acid. But decreases when the concentration of sulfuric acid increased by 70%. According Ismayanda [9] it is influenced by the low volume of fluid that is not capable of dissolving the entire surface of kaolin powder so that the mixing disrupted due to one cavity in kaolin reacted with sulfuric acid in large numbers, but instead with another cavity, even no sulfuric acid nothing at all.

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CONCLUSION

Based on the research and observations that have been made can be concluded that composition kaolin Jaboi obtained main composition of silica (SiO2) as much as 96.9% wt, while the composition of alumina (Al2O3) by 1.26% wt. The concentration of sulfuric acid is best obtained at a concentration of 50% with a yield of 92, 13%. Maximum operating time obtained during 110 minutes with a yield range of 78-94% on each review concentration of sulfuric acid.

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