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TEKNOLOGI PENCEGAHAN PENCEMARAN INDUSTRI

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FOCUS AND SCOPE

Jurnal Riset Teknologi Pencegahan Pencemaran Industri (Research Journal of Industrial Pollution Prevention Technology) seeks to promote and disseminate original research as well as review, related to following area:

Environmental Technology : within the area of air pollution technology, wastewater treatment technology, and management of solid waste and harzardous toxic substance.

Process Technology and Simulation : technology and/or simulation in industrial production process aims to minimize waste and environmental degradation.

Design Engineering : device engineering to improve process efficiency, measurement accuracy and to detect pollutant.

Material Fabrication : environmental friendly material fabrication as subtitution material for industry.

Energy Conservation : process engineering/ technology/ conservation of resources for energy generation.

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PREFACE

Thanks to Allahu Robbie 'Alamin, Journal of Industrial Pollution Prevention Technology (JRTPPI) again will publish scientific articles, especially in the field of environmental technology for volume 11 no 2. Our high appreciation is directed to the authors and editorial board who have actively participated so as to maintain consistency of quality and punctuality of our periodic publications. We would like to acknowledge our high appreciation to the head at center of industrial pollution prevention technology, The agency of Industial Research and Development of Indonesia, Ministry of Industry.

This edition of the issue is fifth series published that in full-text English. This continous policy is an attempt of the editorial board to improve the author's performance in delivering the results of their researches. Articles in full-text English are more likely to be read by broader audience so that it will increase the number of citations. This policy is also applied in order to actualize our hope of being a globally indexed international journal.

The articles contained in this edition consist of wastewater technology and renewable energy. The wastewater treatments are destined for batik and pharmacheutical industries, while membraneless microbial fuel cell and battery articles as renewable energy. The six manuscripts accepted and published in this edition are from researcher and lecturer in Lembaga Ilmu Pengetahuan indonesia, Universitas Lampung, Institut Teknologi Indonesia, Badan Tenaga Atom Nasional, Balai Besar Bahan dan Barang Teknik, Institut Teknologi Bandung, Balai Besar Teknologi Pencegahan Pencemaran Industri, and Institut Ilmu Kesehatan Bhakti Wiyata. The duration of submission, review, and editing of the manuscripts ranged from 2-5 months.

Hopefully, these scientific articles may be new source of knowledge and experience for readers from academic, researcher, industry, and society at large. We realize that nothing is perfect until the improvement of all parties involved is continuously done.

Semarang, November 2020

Chief Editor

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ABSTRACT

Published on 19 November 2020

Fery Eko Pujiono[1*], Tri Ana Mulyati[1], Miftakhul Nor Fizakia[1] ([1]Departement of Chemistry, Institut Ilmu Kesehatan Bhakti Wiyata Kediri, Indonesia)

Activated Carbon of Coconut Shell Modified TiO_2 as a Batik Waste Treatment

Jurnal Riset Teknologi Pencegahan Pencemaran Industri, November 2020, Vol. 11, No. 2, p. 1-10, 4 ill, 4 tab, 27 ref

Research about the modification of activated carbon of coconut shell with TiO_2 as a waste treatment Batik has been done. The purpose of this study was to determine the effect of modified TiO_2 on activated carbon characteristics and the effect of TiO_2 concentration on the adsorption power of activated carbon in batik waste. The method utilized was activated carbon soaked in TiO_2 with 5% and 10% concentrations in a ratio of 1: 5, then stirred with a magnetic stirrer for 2 hours. Next, the mixture was placed in an autoclave bottle and an oven (200°C for 30 minutes). The results were then washed with distilled water and dried (100°C for 5 hours), then the material was characterized by FTIR, XRD, SEM-EDX, and application to batik waste. FTIR results indicated the presence of Ti-O-Ti groups after modification at wave number 682 cm^{-1}, XRD indicated the presence of a combination of amorphous KA and crystalline TiO_2 at 25,2°; 37,7°; 48,1°; 53,8°; and 55°, and SEM results of TiO_2 agglomeration on the surface of the railroad. Adsorption of batik waste showed KATiO_2-10 (0,052) lower than KA (0,059) and KATiO_2-5 (0,057), as well as the presence of COD KA results = 705,6 mg / L (pH = 8), KATiO_2-5 = 504,0 mg / L (pH pH = 7) and KATiO_2-10= 403,2 mg / L (pH = 7). Based on this research, the activated carbon modified TiO_2 can be used as a material for processing batik waste with the most significant concentration of TiO_2 represent 10%.

(Author)

Keywords: Activated carbon, Coconut shell, TiO_2, Batik waste

Tri Hadi Jatmiko[1] ([1]Balai Penelitian Teknologi Bahan Alam, Lembaga Ilmu Pengetahuan Indonesia)

Optimization of Production Activated Carbon for Removal of Pharmaceuticals Wastewater Using Taguchi Method and Grey Relational Analysis

Jurnal Riset Teknologi Pencegahan Pencemaran Industri, November 2020, Vol. 11, No. 2, p. 11-18, 1 ill, 4 tab, 27 ref

The development of the pharmaceutical industry has led to increased environmental pollution by pharmaceutical wastewater. This encourages efforts to develop effective and inexpensive pharmaceutical wastewater management. One effort to handle pharmaceutical wastewater is to use activated carbon. In the manufacture of activated carbon there are several factors that affect the quality and performance of activated carbon produced. This research seeks to determine the optimum factors in making activated carbon and study its application in adsorbing pharmaceutical wastewater contain carbamazepine, sulfamethoxazole, and paroxetine. Multi-response analysis based on the Taguchi Grey relational analysis method was used to determine the optimum conditions. The most influential factors in the production of activated carbon, respectively, were pyrolysis temperature (800°C), ratio of precursors and activating agents (1:1), residence time (150 minutes) and finally the type of activator (KOH).

(Author)

Keywords: Activated carbon, Taguchi, Grey Relational Analysis

Aris Mukimin[1], Nur Zen[1], Hanny Vistanty[1], Agus Purwanto[1] ([1]Centre of Indutrial Pollution Prevention Technology, Jl. Ki Mangunsarkoro No. 6, Semarang 50241, Indonesia)

High Electric Production by Membraneless Microbial Fuel Cell with Up Flow Operation using Acetate Wastewater

Jurnal Riset Teknologi Pencegahan Pencemaran Industri, November 2020, Vol. 11, No. 2, p. 19-27, 8 ill, 27 ref

Microbial fuel cell (MFC) is a new proposed technology reported to generate renewable energy while simultaneously treating wastewater. Membraneless microbial fuel cell (ML-MFC) system was developed to eliminate the requirement of membrane which is expensive and prone to clogging while enhancing electricity generation and wastewater treatment efficiency. For this purpose, a reactor was designed in two chambers and connected via three pipes (1 cm in diameter) to enhance fluid diffusion. Influent flowrate was maintained by adjusting peristaltic pump at the base of anaerobic chamber. Carbon cloth (235 cm2) was used as anode and paired with gas diffusion layer (GDL) carbon-Pt as cathode. Anaerobic sludge was filtered and used as starter feed for the anaerobic chamber. The experiment was carried out by feeding synthetic wastewater to anaerobic chamber; while current response and potential were recorded. Performance of reactor was evaluated in terms of chemical oxygen demand (COD). Electroactive microbe was inoculated from anaerobic sludge and showed current response (0.55-0.65 mA) at 0,35 V, range of diameter 1.5-2 μm. The result of microscopics can showed three different species. The microbial performance was increased by adding ferric oxide 1 mM addition as acceptor electron. The reactor was able to generate current, voltage, and electricity power of 0.36 mA, 110 mV, and 40 mWatt (1.5 Watt/m2), respectively, while reaching COD removal and maximum coulomb efficiency (EC) of 16% and 10.18%, respectively.

(Author)

Keywords: ML-MFC, Carbon cloth, GDL carbon-Pt, Acetate, Renewable energy

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Susanto Sigit Rahardi[1], Muhamad Ilham Bayquni[1], Bambang Sunendar Purwasasmita[2] ([1]Balai Besar Bahan dan Barang Teknik (B4T), Ministry of Industry, Sangkuriang Street No.14 Bandung City 40135, Indonesia, [2]Program Studi Teknik Fisika, Institut Tekologi Bandung, Ganesha Street No.10 Bandung City, Indonesia)

Preliminary Study of Synthesis of Sodium Manganese Oxide using Sol-Gel Method as Sodium Ion Battery Material

Jurnal Riset Teknologi Pencegahan Pencemaran Industri, November 2020, Vol. 11, No. 2, p. 28-34, 4 ill, 3 tab, 25 ref

Sodium ion battery is one of the promising alternatives to lithium ion battery. Sodium manganese oxide as the sodium ion battery catode material has been synthesized by modifying the sol-gel method used to obtain lithium manganese oxide. The precursors used were table salt and manganese chloride. The sol-gel process used was water solvent, citric acid as a chelating agent and chitosan as the template. Thermal decomposition and formation zone obtained from simple thermal analysis using furnace and digital scales. Calcination was carried out at 600°C and 850°C for 2 hours. Crystal properties and morphology were analyzed using XRD and SEM. Based on the analysis of XRD pattern, sodium manganese oxide crystals ($Na_{0.7}MnO_{2.05}$ JCPDS 27-0751) have been formed at both of the calcination temperature. Observed morphology of the sample showed the domination Mn_3O_4 JCPDS 18-0803 in accordance with crystalline phase identification. These results demonstrate that the modified sol-gel method could be used to obtain sodium manganese oxide as sodium ion battery cathode material.

(Author)

Keywords: Sodium manganese oxide, Sol-gel method, Salt

Ratnawati[1], Marcelinus Christwardana[1], Sudirman[2], Enjarlis[1] ([1]Chemical Engineering Department, Institut Teknologi Indonesia, [2]Badan Tenaga Atom Nasional, Kawasan Puspiptek, Serpong)

Zinc Removal from ZnO Industrial Wastewater by Hydroxide Precipitation and Coagulation Methods: The Role of pH and Coagulant Dose

Jurnal Riset Teknologi Pencegahan Pencemaran Industri, November 2020, Vol. 11, No. 2, p. 35-42, 4 ill, 2 tab, 22 ref

Liquid waste from the ZnO industry must be treated to meet the quality standards of wastewater into water bodies, according to the Minister of Environment Regulations No.5, 2014. It still contains 79 mg/L of Zn metal, cloudy with turbidity above 500 NTU, and COD value around 222 mg/L. This study aims to determine the effect of pH on reducing Zn metal and the coagulant dose to minimize turbidity and COD in liquid waste produced by the ZnO factory in Depok, West Java. The waste treatment has been carried out by adding alkaline to neutralize the acid conditions in the equalization basin. However, the results have not met the requirements. It is necessary to vary the pH (8.5; 9.0; 9.5; 10.0 and 10.5) to precipitate of Zn optimally, modify the dose of coagulants (50; 100 and 150 mg/L) and reaction times (10; 15 and 20 minutes) to reduce its turbidity and COD concentration. The best results were obtained at a pH of 9.5 with a coagulant dose of 50 mg/L and a reaction time of 10 minutes. This condition can reduce Zn concentration (79 to 3.71 mg/L), turbidity (557 to 1.42 NTU), COD (222 to 68 mg/L) with a removal efficiency of 95.3%; 99.7%; and 69.4% respectively. These values have met the standard requirements according to government regulations.

(Author)

Keywords: Zn, pH, Coagulant, Turbidity, COD

Muhammad Amin[1], Slamet Sumardi[1], Roniyus Marjunus[2], Frista Clarasati[2], David Candra B[1], Muhammad Al Muttaqi[1],
Kusno Isnugroho[1], Yusup Hendronursito[1] ([1]Research Unit for Mineral Technology, Indonesian Institute of Sciences (BPTM-LIPI), [2]Department of Physics, Faculty of Mathematics and Natural Sciences, University of Lampung)

Processing of Granite Quarry Solid Waste into Industrial High Silica Materials using Leaching Process with HCl Concentration Variation

Jurnal Riset Teknologi Pencegahan Pencemaran Industri, November 2020, Vol. 11, No. 2, p. 43-50, 9 ill, 7 tab, 21 ref

This study was aimed to increase granite's silica content using the leaching process with HCl concentration variation. The granite used in this study came from Lematang, South Lampung. This study aims to determine the effect of variations in HCl concentration, particle size, and rotational speed on the crystalline phase and chemical elements formed in the silica product produced from granite. The HCl concentration variations were 6.0 M, 7.2 M, 8.4 M, and 9.6 M, the variation in particle size used was 270 and 400 mesh. Variations in rotational speed during leaching were 500 and 750 rpm. Granite powder was calcined at 1000 °C for 2 hours. Characterization was performed using X-Ray Fluorescence (XRF), X-Ray Diffraction (XRD), and Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-

OES). The results showed that the silica content increased with increasing HCl concentration, the finer the particle size, and the higher the rotational speed. XRF analysis showed that the silica with the highest purity was leached with 9.6 HCl with a particle size of 400 mesh and a rotational speed of of 750 rpm, which was 73.49%. Based on the results above, by leaching using HCl, the Si content can increase from before. The XRD diffractogram showed that the granite powder formed the Quartz phase.

(Author)

Keywords: Granite, Silica, Leaching, HCl

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Processing of Granite Quarry Solid Waste into Industrial High Silica Materials using Leaching Process with HCl Concentration Variation

Muhammad Amin[1], Slamet Sumardi[1], Roniyus Marjunus[2], Frista Clarasati[2], David Candra B[1], Muhammad Al Muttaqi[1], Kusno Isnugroho[1], Yusup Hendronursito[1]

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ABSTRACT

This study was aimed to increase granite's silica content using the leaching process with HCl concentration variation. The granite used in this study came from Lematang, South Lampung. This study aims to determine the effect of variations in HCl concentration, particle size, and rotational speed on the crystalline phase and chemical elements formed in the silica product produced from granite. The HCl concentration variations were 6.0 M, 7.2 M, 8.4 M, and 9.6 M, the variation in particle size used was 270 and 400 mesh. Variations in rotational speed during leaching were 500 and 750 rpm. Granite powder was calcined at 1000 ºC for 2 hours. Characterization was performed using X-Ray Fluorescence (XRF), X-Ray Diffraction (XRD), and Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP- OES). The results showed that the silica content increased with increasing HCl concentration, the finer the particle size, and the higher the rotational speed. XRF analysis showed that the silica with the highest purity was leached with 9.6 HCl with a particle size of 400 mesh and a rotational speed of of 750 rpm, which was 73.49%. Based on the results above, by leaching using HCl, the Si content can increase from before. The XRD diffractogram showed that the granite powder formed the Quartz phase.

1. INTRODUCTION

Lampung Province, with an area of ± 3,528,835 ha, has a very diverse natural resource potential, especially mineral resources. The diversity of mineral resources in Lampung Province includes metal minerals, industrial minerals, energy minerals, and construction minerals. Lampung Province produces industrial excavation of 117,184 m³ andesites, 234,375 m³ feldspars, and 62,232,727 m³ granite (ESDM, 2019). These data show that industrial granite excavation has the potential to be developed. One of the potential granite rocks in Lampung Province is in the Lematang Village area, Tanjung Bintang, South Lampung Regency.

Granite is a deep igneous rock (intrusive). The mineral is coarse-grained to medium light, has many colors, generally white, gray, pink, or red. This color is caused by the color variation of the mineral feldspar. Granite is formed from magma (Judson, Deffeyes & Hargraves, 1978). So far, in Lematang Village, granite is only used as a foundation stone. Silica is refined from granite to increase granite value, which can be used as an advanced material application. So far, small granite quarries measuring 50 mm and below have been discarded, so they are not used because they are used as foundation stones which are larger than 100 mm in size. Therefore mineral silica can be obtained from pumice stone

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(Mourhly, Khachani, Hamidi, Kacimi Halim & Arsalane, 2015), diatomite (Puntharo, Sankram, Chantaramee & Pokmanee, 2013), and quartz sand (Saleh, Ibrahim & Salman, 2015). Apart from quartz sand, granite is a mineral with a high silica content of up to 72.04% (Harvey & Tracy, 1997). Some researchers using several methods to synthesize silica, including combustion (Rozainee Ngo, Salema, Tan, Ariffin & Zainura, 2008), sol-gel (Le, Thuc & Thuc, 2013), leaching acid (Umeda & Kondoh, 2010), the precipitation (Yuvakkumar, Elango, Rajendran & Kannan, 2012). The method leaching and deposition have the advantage that the resulting silica is higher than the silica synthesized by other methods from some of the above methods. The leaching and deposition method is a simple and economical method for silica purification (Ha, Akhtar & Malik, 2014).

Leaching is the extraction of certain materials to remove material impurities by dissolving it (Matori, Haslinawati, Wahab, Sidek, Ban & Ghani, 2009). Inorganic impurities can be removed through a process leaching using an acid solution to obtain high purity silica before the combustion process. Researchers have carried out the process leaching before conducting the thermal process using HCl, H_2SO_4, HNO_3 (Matori, Haslinawati, Wahab, Sidek, Ban & Ghani, 2009), citric acid (Umeda & Kondoh, 2010), and oxalic acid (Kalapathy, Proctor & Shultz, 2002). The use of HCl because HCl is a strong acid and is more reactive than other acids.

Several studies have been conducted to obtain large amounts of silica using the method leaching. For example, Darwis et al. (2017) purified silica from quartz sand using the method leaching with HCl. From XRF results showed that 99.90% of silica obtained from 5 hours-milled sample [14]. Abdellaoui et al. (2013), synthesizing silica with diatomite by method leaching using HNO_3 (Abdellaoui, Islam, Sakurai, Hamzaoui & Akimoto, 2018). Lahsen et al. (2016) also synthesized silica from granite using the method leaching with the solvent HCl. From this experiment, Lahsen et al. (2016) showed the maximum leaching efficiency was 92.4% and about 93.8% the leached can be separated (Lahsen, Mohamed, Cheira, Zaki & Allam, 2016). Therefore this study was aimed to purification of silica from granite quarry solid waste with different HCl concentration into industrial high silica.

Table 1. Variations in HCl concentration, particle size and rotational speed.

Sample	HCl (M)	Size (mesh)	Rotation speed (rpm)
1	6	270	500
2	7.2	270	500
3	8.4	270	500
4	9.6	270	500
5	6	270	750
6	7.2	270	750
7	8.4	270	750
8	9.6	270	750
9	6	400	500
10	7.2	400	500
11	8.4	400	500
12	9.6	400	500
13	6	400	750
14	7.2	400	750
15	8.4	400	750
16	9.6	400	750

Table 2. Result of Granit Stone before leaching

Compounds	Percentage (wt%)
SiO_2	62.806
Al_2O_3	18.365
P_2O_5	0.764
K_2O	10.112
TiO_2	0.623
Fe_2O_3	6.951

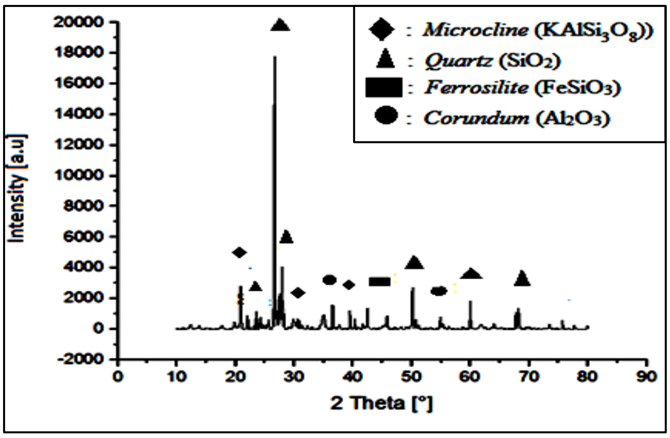

Figure 1. XRD analysis for granite

Table 3. The results of XRF Analysis *Leaching* Granite Stone with Particle Size 270 Mesh and Rotation Speed 750 rpm.

Compounds	% Leaching			
	6.0 M	7.2 M	8.4 M	9.6M
SiO_2	69.31	71.55	72.229	72.29
Al_2O_3	16.38	15.30	15.068	14.95
Fe_2O_3	-	2.373	2.361	2.413
TiO_2	0.528	0.515	0.500	0,491
K_2O	8.166	9.180	8.95	-
P_2O_5	0.661	0.073	0.711	0.716

2. METHODS

2.1. Material

Material used in this study included granite from Lematang-Tanjung South Lampung, 12.06 M HCl, and aquades.

2.2. Method

The powder preparation process refers to the research conducted by Lahsen et al. (2016), which started with washing granite stones using aquades until they were cleaned, then drying them for 2 hours at 120°C using an oven. Furthermore, the granites was refined using ball milling for 5 hours to produce granite powder, which was still in a rough state. Then the granite powder was dried using an oven for 2 hour at temperature of calcination. After drying, the granite powder is sieved with a 270 mesh and 400 mesh sieves to obtain a fine granite powder. Furthermore, granite's fine powder is weighed as much as 5 grams as a sample to be tested using XRD and XRF.

This refining process is a process carried out to obtain pure silica from granite with various treatments, as shown in Table 1.

This granite process leaching referred to research that has been conducted by Lahsen et al. (2016). First, the preparation of 100 mL of HCl, with concentration variations of 6.0 M, 7.2 M, 8.4 M, 9, 6 M. After the solution has been prepared, 10 grams of granite powder was dissolved into each of the HCl solutions that have been prepared. Each solution was then stirred for 7 hours while stirring at a rotational speed as in Table 1 and heated to purify the silica contained in granite powder. The next stage was the result stirrer used filtered with filter paper Whatman No. 41. The filtered residue was then oven-dried for 2 hours at a temperature of calcination. Then it was calcined with furnace at for 2 hours, then characterized by XRD and XRF.

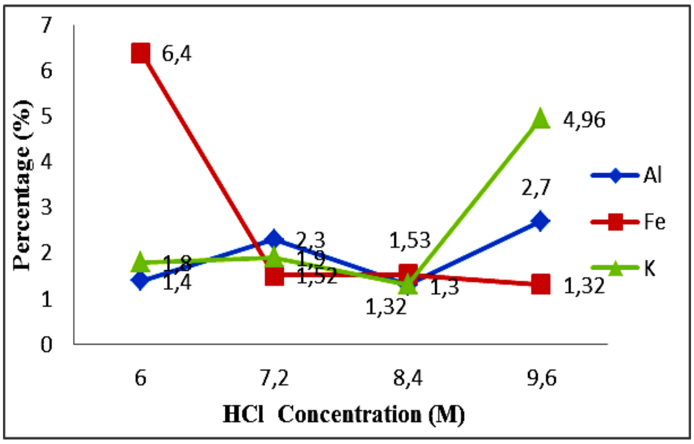

Figure 2. The graph of the relationship between HCl concentration and the solubility of Al, Fe, and K, the graph of a particle size of 270 mesh and a rotating speed of 750 rpm.

3. RESULT AND DISCUSSION

Granite structures were analyzed using XRF Analysis. Leaching process were conducted using HCl 6.0 M; 7.2 M; 8.4 M and 9.6 M for 7 hours at 110 °C. After that it was filtered with Whatmann filter paper no. 2, then calcined for 2 hours at a temperature of 1000 °C. Last tested with XRD and XRF. The results of the XRF analysis of granite are as in Table 2.

The results of XRD analysis for granite as shown in Figure 1. The phases formed are Quartz (SiO_2), Microcline ($KAlSiO_2$), Corundum (Al_2O_3), and Ferrosilite ($FeSiO_3$). The highest peak is at 2θ = 26.6251° Quartz (SiO_2).

The analysis results of XRF leaching granite with 270 mesh particle size and 750 rpm rotation speed are as in Table 3.

Based on Table 3, XRF analysis results showed that the percentage of SiO_2 compound after leaching was higher than before leaching. The SiO_2 highest produced was found in samples leached with a concentration of 9.6 M. In this study, the silica obtained continued to increase the concentration of HCl was used. The concentration of HCl affects the hydrolysis's speed and condensation reactions of the material, which affects the silica gain and the crystallinity of the material (Hilmy, 2007).

Leaching using HCl can dissolve other metals, including Fe, Al, and K, so that after leaching, the levels of other metals such as Fe, Al, and K decreased, and the silica content in the sample increased, as the concentration of HCl is used (Hasbi, Sigit, Indah, Septian & Efendi Bintang, 2016). Analysis the solution sample was leaching analyzed using ICP-

OES to detect chemical elements dissolved during the process leaching. Graph of analysis results from ICP-OES leaching granite with a particle size of 270 mesh, and a rotating speed of 750 rpm is presented as in Figure 2. Dissolving with HCl on elements Al, Fe, and K does not have trend the same due to HCl's ability, which is not completely dissociated so that it cannot dissolve the metal completely (Fitri, 2013).

The XRD analysis results for leaching granite stone with a particle size of 270 mesh and a rotating speed of 750 rpm are as shown in Figure 3.

Table 4. The results of XRF Analysis for Leaching Granite with Particle Size 400 Mesh and Spin Speed 750 rpm.

Compounds	% Leaching			
	6.0 M	7.2 M	8.4 M	9.6M
SiO_2	71.25	71.49	72.81	73.49
Al_2O_3	15.1	14.38	14.29	13.1
Fe_2O_3	2.89	2.64	2.53	267
TiO_2	0.50	0.44	0.42	0.48
K_2O	9.29	9.08	8.90	9.22
P_2O_5	0.73	0.73	0.74	0.78

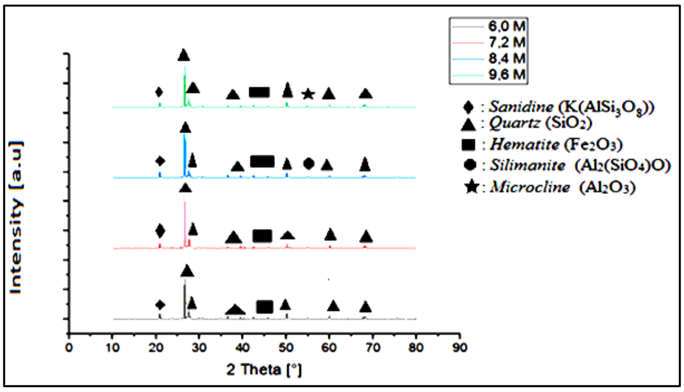

Figure 3. The XRD analysis results for granite with a particle size of 270 mesh and a rotational speed when leaching 750 rpm.

Based on Figure 3, it can be seen that the results of XRD characterization on variations samples leaching of granite with variations in HCl concentrations of 6.0 M, 7.2 M, 8.4 M, and 9.6 M indicate that the phase that dominates the diffraction peaks is Quartz (SiO_2), Sanidine ($K(AlSi_3O_8)$), Hematite (Fe_2O_3), Sillimanite ($Al_2(SiO_4)O$) and Microcline (Al_2O_3) consecutively. Phase Quartz (SiO_2) is the phase that dominates the diffraction peaks because SiO_2 is calcined at temperatures of 800 and 1000 °C (Wibawa, Eko & Anggoro, 2015). The XRF analysis results for leaching granite with a particle size of 400 mesh and a rotation speed of 750 rpm are as in Table 4.

Based on Table 3. and Table 4. it can be seen that the resulting silica content in leaching granite with a particle size of 400 mesh is higher than the silica produced in leaching granite with particle size 270 mesh. This result agreed with the theory of particle size, namely the smaller the particle size, the larger its surface area. Hence, reaction will be faster, and the resulting product will be more and more (Bentz, Garboezi, Haecker & Jensen, 1999).

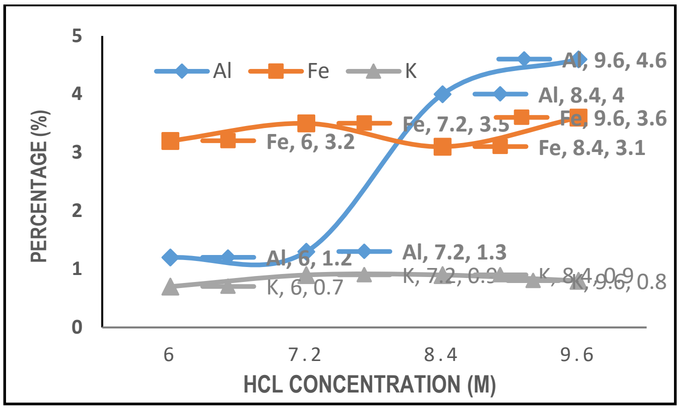

Figure 4. The relationship between HCl concentration and the solubility of Al, Fe, and K, at a particle size of 400 mesh and a rotational speed of 750 rpm.

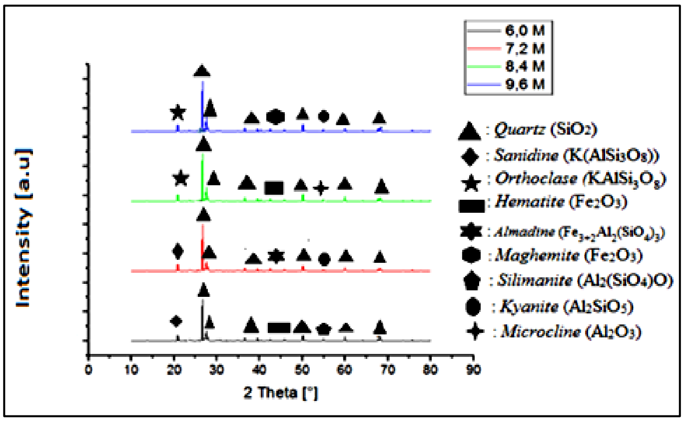

Figure 5. The XRD analysis of granite with a particle size of 400 mesh and rotational speed *leaching* of 750 rpm.

The analysis sample of the solution was leaching analyzed using ICP-OES to detect chemical elements dissolved during the process leaching. Graph of analysis results from ICP-OES leaching granite with a particle size of 400 mesh and a rotating speed of 750 rpm is presented as in Figure 4.

The XRD analysis results leaching stone granite with a particle size of 400 mesh and rotation speed 750 rpm are shown in Figure 5.

Based on Figure 5, it can be seen that the phase that dominates the diffraction peaks is Quartz (SiO_2), Sanidine ($K(AlSi_3O_8)$), Orthoclase ($KAlSi_3O_8$), Hematite and Maghemite (Fe_2O_3), Almandine ($Fe_{3+2}Al_2(SiO_4)_3$), Kyanite (Al_2SiO_5), Mullite ($Al_{2.35}Si_{.64}O_{4.82}$), Sillimanite ($Al_2(SiO_4)O$) and Microcline ($Al_2O_3$). Phase Quartz ($SiO_2$) is the phase that dominates the diffraction peaks.

The resuls of XRF of leaching granite with 270 mesh particle pize and 500 rpm rotation speed are as in Table 5.

Table 5. The results of XRF Analysis for Leaching Granite with 270 Mesh Particle Size and 500 rpm Rotation Speed.

Compounds	% Leaching			
	6.0 M	7.2 M	8.4 M	9.6M
SiO_2	68.33	69.05	69.05	69.14
Al_2O_3	16.76	16.57	16.59	16.36
Fe_2O_3	3.08	2.66	2.77	2.73
TiO_2	0.71	0.70	0.70	0.72
K_2O	10.06	9.96	9.84	9.99
P_2O_5	0.79	0.8	0.78	0.8

Table 6. Results of XRF analysis for Leaching Granite with Particle Size 400 Mesh and Rotation Speed 500 rpm.

Compounds	% Leaching			
	6.0 M	7.2 M	8.4 M	9.6M
SiO_2	68.57	68.92	70.17	70.24
Al_2O_3	17.55	17.73	16.6	16.20
Fe_2O_3	2.44	2.23	2.22	2.35
TiO_2	0.65	0.62	0.65	0.66
K_2O	9.87	9.60	9.44	9.37
P_2O_5	0.71	0.7	0.71	0.77

Based on Table 2 and Table 5, it can be seen that the silica produced in leaching granite with a particle size of 270 mesh with a rotating speed of 750 and 500 rpm, the greater the silica made at speed turn 750 rpm. This is following the stirring speed's effect, the faster the stirring of a particle. When the faster stirred, the contact between the granite powder and the HCl will occur, and the more product is produced at the highest stirring speed (Fitri, 2013).The solution's analysis sample was leaching analyzed using ICP-OES to detect chemical elements dissolved during leaching. Graph of analysis results ICP-OES leaching granite with a particle size of 270 mesh, and a rotating speed of 500 rpm is presented as in Figure 5.

The results of XRD analysis leaching stone granite with a particle size of 400 mesh and rotation speed 750 rpm are shown in Figure 6.

Based on Figure 6, it found that the phase dominates the diffraction peaks such as Quartz (SiO_2), Sanidine ($K(AlSi_3O_8)$), Hematite (Fe_2O_3), Ferrosilite and Clinoferrosilite (Fe_2SiO_3), Kyanite (Al_2SiO_5), Mullite ($Al_{4.75}Si_{1.25}O_{9.63}$), Corundum ($Al_2O_3$) and microcline ($Al_2O_3.K_2O.6SiO_2$). Phase Quartz ($SiO_2$) is the phase that dominates the diffraction peaks.

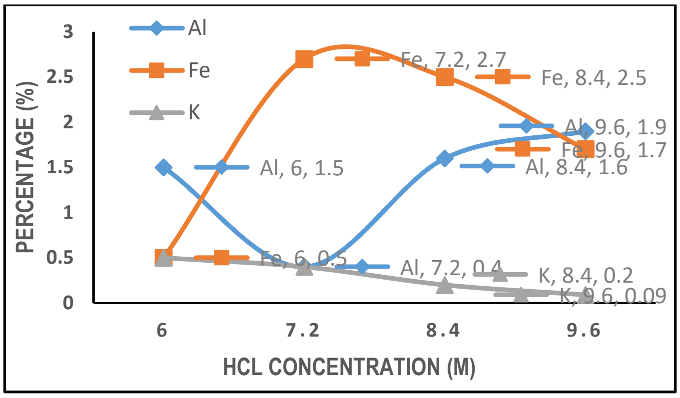

Figure 5. The graph of the relationship between HCl concentration and the solubility of Al, Fe and K, a particle size of 400 mesh and a rotational speed of 750 rpm.

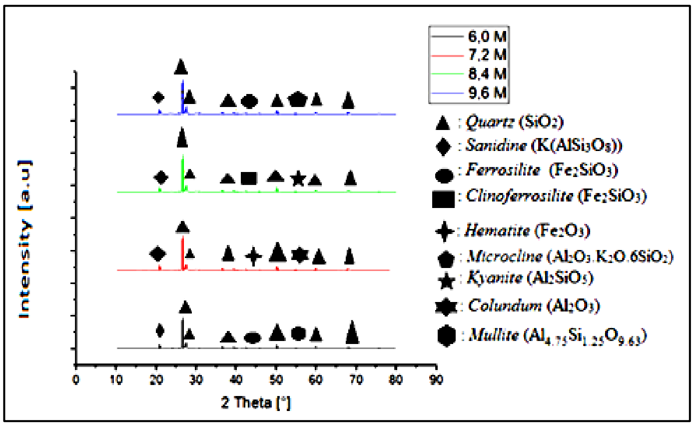

Figure 6. The results of XRD analysis of granite with a particle size of 400 mesh and rotational speed leaching of 750 rpm.

The XRF analysis results of Leaching Granitewith a Particle Size of 400 Mesh and Rotation Speed of 500 rpm are as in Table 6.

Based on Table 5 and Table 6, it can be seen that the silica produced in leaching granite with a particle size of 270 mesh with particle size of 400 is greater than the resulting silica when the particle size is 400 mesh. The silica produced when the particle size is 270 mesh with a rotating speed of 750 rpm as in Table 3 bigger than the silica when particle size is 270 mesh with a rotating speed of 500 rpm as shown in Table 6. So that, the highest silica results at the particle size 400 mesh and leaching at 750 rpm rotational speed.The solution sample was leaching analyzed using ICP-OES to detect chemical elements dissolved during the process leaching. Graph of analysis results ICP-OES leaching granite with a particle size of 400 mesh, and a rotating speed of 500 rpm is presented as in Figure 7.

The results of XRD analysis leaching stone granite with a particle size of 400 mesh and rotation speed 750 rpm are shown in Figure 8.

Based on Figures 9, it can be seen that the silica produced in leaching linear granite rises upward along with the large concentration of HCl used and the fine particle size. Silica with a particle size of 400 mesh is larger than the silica produced in leaching granite with a particle size of 270 mesh. Based on rotation speed, it can be seen that the silica produced in leaching linear granite rises upward along with the amount of HCl concentration used and the rotational speed used. The silica produced in leaching at a rotational speed of 750 rpm is greater than the silica produced in leaching granite at a rotational speed of 500 rpm.

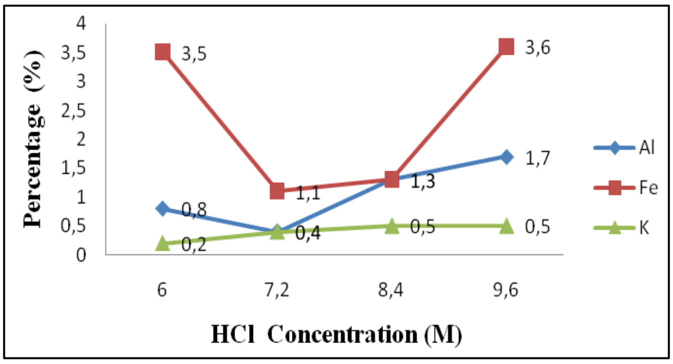

Figure 7. The Graph of the relationship between HCl concentration and the solubility of Al, Fe and K, at a particle size of 400 mesh and a rotational speed of 500 rpm.

Table 7. Phases and types of minerals formed.

Type of mineral	Phase	Percentage (%)
Quartz	SiO_2	67
Sanidine	$K(AlSi_3O_8)$	8
Orthoclase	$KAlSi_3O_8$	1.13
Hematite	Fe_2O_3	8
Maghemite	Fe_2O_3	1.13
Almadine	$Fe_{3+2}Al_2(SiO_4)_3$	1.13
Ferrosilite	Fe_2SiO_3	3.4
Clinoferrosilite	Fe_2SiO_3	1.13
Silimanite	$Al_2(SiO_4)O$	1.7
Microcline	Al_2O_3	1.13
Kyanite	Al_2SiO_5	1.7
Mullite	$Al_{2.35}Si_{.64}O_{4.82}$	0.56
Colundum	Al_2O_3	0.56
Mullite	$Al_{4.75}Si_{1.25}O_{9.63}$	0.56
Microcline	$Al_2O_3.K_2O.6SiO_2$	0.56
Andalusite	$Al_2(SiO_4)O$	0.56

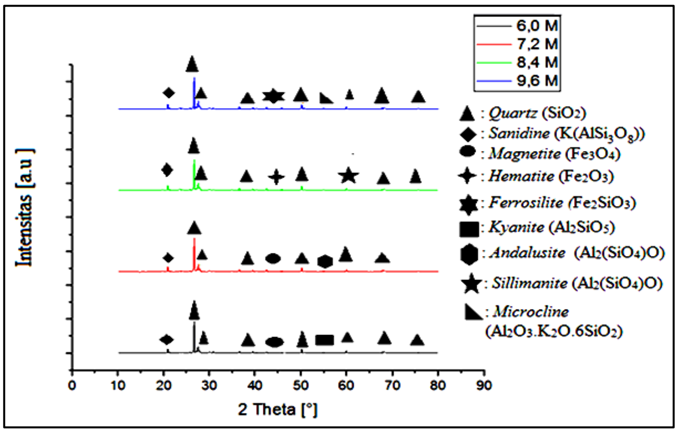

Figure 8. The results of XRD analysis of granite leaching with a particle size of 400 mesh and rotational speed of 500 rpm.

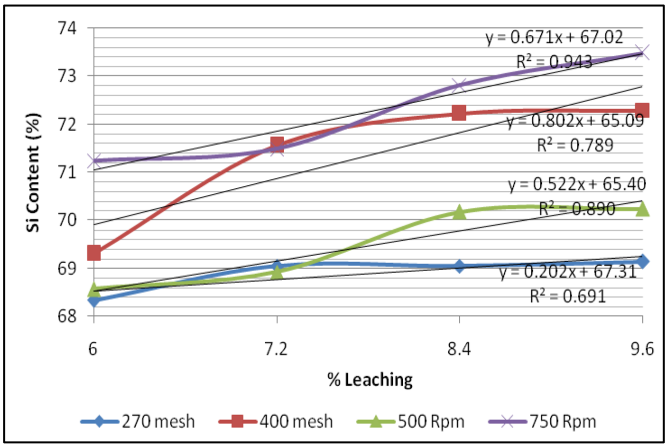

Figure 9. The relationship between silica concentration and various parameters

Several phases and minerals formed in the diffractogram pattern in the XRD analysis are presented in Table 7.

4. CONCLUSION

The highest silica obtained at a concentration of 9.6 M. Thus, the higher the concentration of HCl is used, then the higher the SiO_2 obtained. So that the concentration of the HCl solution affects the solubility of impurity oxides other than SiO_2. The silica obtained at a particle size of 400 mesh is higher than that of 270 mesh. This shows that the finer the particle size, the higher the silica is obtained. This is due to the wider the surface area of the particles, the faster the HCl solution will reduce impurity oxides other than SiO_2. Silica obtained during leaching at a rotational speed of 750 rpm is higher than at 500 rpm. This shows that the higher the rotational speed when leaching, the higher the silica will be obtained. This is because the rotational speed affects the friction that occurs, so the higher the rotational speed or, the faster the stirring, the faster the HCl solution will dissolve other impurity particles besides SiO_2.

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