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The Characterization of West Sumatera Iron Sand as a Raw Material to Synthesize Magnetic Nanoparticles

Syamsi Aini[a], Fajriah Azra[2], Agung Cahyadi[a]
Department of Chemistry, FMIPA, Universitas Negeri Padang, Padang, Indonesia
Email: syamsiaini@fmipa.unp.ac.id

Abstract: This research has followed some steps taking, purification, and characterization of iron sand sampling from four places in West Sumatera. The iron sand purification is processed by physically and chemically process. The iron sand is examined by using X-ray fluorescent spectroscopy, X-ray diffractometer and magnetic susceptibility. The result of purification and examining by using the iron sand XRF data from four taking areas,(1) Sunua Pariaman, (2) Batang Masam Gadang Pasaman, (3) Padang Sibusuak Sijunjuang, 4). Batumbuak Solok. The result shows that Padang Sibusuak Sijunjuang Iron sand has the highest magnetic seeds percentage around 69.18% with the highest elemental content of Fe around 76.365%. This percentage is supported by the dissolution data of Sijunjuang iron sand with HCl to produce FeCl3, FeCl2 solution about 82%, with Mg(OH)2 and SiO2 insoluble impurities about 18%, and the highest magnetic sensitivity of 1998.7 x 10-8 m3/kg.

Keywords: Iron sands, nanoparticles magnetic

INTRODUCTION

Iron sand is sand with percentage of Fe in the form of mineral magnetite (Fe3O4), hematite (α-Fe2O3) and maghemite (γ-Fe2O3) high and impurity elements in the form of Ti, Si, Mn, Mg, Ca and V with blackish gray color [1,3]. Research on the synthesis and modification of magnetite nanoparticles continues to be improved, because magnetic nanoparticles are materials that have unique optical, magnetic and chemical properties. The unique properties of magnetic nanoparticles are most prominent for very small particles, around 10-20 nm, and in general the unique properties will be lost for magnetic sizes up to 40-50 nm [2, 4]. Because of its unique properties, magnetic nanoparticles can be used in various fields. Research on the synthesis and characterization of Fe3O4 nanoparticles generally uses expensive commercial sources of Fe, such as; 1) Iron salt; FeCl3, FeCl2, FeSO4, Fe(NO3)3, Fe(ClO4)3.6H2O. Iron complex; [Fe(CO)5], [Fe{N-(SiMe3)22] and La0.5Sr0.5FeO3 [4-7]. For this reason, efforts to obtain material containing magnetic material continue to be carried out, especially in finding sources of Fe that are available in regions with more suitable and more economical synthesis methods.

West Sumatra is one of the richest regions with natural resources. Some of the natural resources are iron sand and iron rock. Pariaman and Pasaman iron sand have been exploited (Mining Authorization), while in Solok, Pesisir Selatan and Sijnjuang have not been exploited (Suhala, 1997, Pemprop. Sumbar, 2004). All of these natural resources need to be researched, improved in quality and price. Several studies have been carried out to use Pariaman and Pasaman iron sand as material to synthesize magnetic nanoparticles. Desirable sand and iron rock as a raw material for nanoparticles synthesis are easier to be separated with their impurities to have high Fe content. However, no one has reported the best chemical and physical quality of iron sand as a raw material for synthesizing magnetic nanoparticles[6.7]. Therefore, this study is focused in characterization and refining of iron sand from four regions, Pasaman, Pariaman, Sijunjuang and Solok a physically and chemistry.

Experimental Section

Chemical, Merck, HCl p.a Merck, aquades, Iron sands from Pariaman, Pasaman, Solok and Sijunjuang; Instruments, We use X-ray fluorescence (XRF) to identify the chemical composition of iron sand, X-ray Diffractometer (X-Ray Diffraction X'Pert PRO) uses Cu-Kα radiation at wavelength λ = 1.541

Å, voltage 40 kV, and current 30 mA with angular ranges of 2θ = 10-70°) for identify crystallinity of Fe3O4, Fe2O3 and impurity oxide. The magnetic susceptibility have been measured by using Magnetic susceptibility Motor Bartington type MS2B dual Frequency Sensor.

PROCEDURE

Separation a physically

Grinded sand sieved (140 mesh sieves) and pulled with a magnet. The chemical composition of each iron sand before and after separated by magnets was characterized using XRF. (b). Iron sand that has been smoothed, sieved, and separated with magnets identified the crystallinity of Fe3O4, Fe2O3 and its impurities oxide using X-ray diffractometer. (c). Physically cleaned iron sand has been tested for its magnetic susceptibility.

A chemically identification

Iron sand with the highest percentage of Fe was reacted with concentrated HCl to produce of greenish brown FeCl3, FeCl2 solution, SiO2(s) and other oxide deposits.

RESULTS AND DISCUSSION

Sampling place for iron sand, Iron sand is natural resources found abundantly in West Sumatra, which is spread over several regions. Because of many Mount Merapi in West Sumatra, the iron rock and iron sand are formed naturally by the vomiting of Mount Merapi larvae. Partially iron in the form of piles of rock around the mountain called the iron stone. Some of the material contains washed iron and is carried by water until it reaches a low area in the form of iron sand that is not soluble with water. Iron sand and iron stone in theory can be processed and used as a raw material for making magnetic nanoparticles with a higher selling price. However, to be used as raw material, it needs to be purified and tested for its chemical composition and magnetic properties. Therefore, in this study four samples were taken from different regions as follows.

Figure 1. Iron Sand from a). Padang Sibusuak Sijunjuang, b).Gunuang Talang Solok c). Sunua Pariaman, and d. Pasaman

Iron sand in the Pariaman and Pasaman areas is increasing every year, due to the continued deposition of iron sand from the rock washing products that contain iron from the mountain area. Even the land formed by the deposition of sand is already wide and has become a housing area for local people.

Iron rocks/sand are taken from Sijunjuang and Solok areas. Iron sand from Sijunjuang area is waste from mining activities carried out by the community. Meanwhile, black sand like dull coal they produce is just thrown away to the nearest land or river. The selection of the Mount Talang Solok iron rock was chosen because the area is a primary source of un-mined iron rock. Therefore, iron sand and iron rock from the four regions need to be purified physically and chemically, and to be investigated for their crystallinity, chemical composition, and magnetic susceptibility. Until the information obtained iron sand / iron rock with the highest Fe content with a simple processing method.

Chemical Composition, Magnetic susceptibility and color of iron sand after being separated with magnets

From Table 1 it can be seen that the iron rock from the Sijunjuang area after being mashed and separated by magnet has the most chemical composition with iron oxide or ferrous metal, which is 76,365%. Sijunjuang iron sand has the same black color as Fe3O4 magnetic commercial and has the highest magnetic susceptibility. While other iron sand contains lower iron oxide in the order of Fe% as follows: Pasaman 69,548 > Solok 66,475> Pariaman 53,997, and with high silica and calcium impurity. These two impurity oxides are difficult to be separated chemically.

Figure 2 shows that the highest peak at 2Ө in 35.454 owned by all iron sand, in accordance with the main magnetic peak / Fe3O4 standard (JCPDS no.01-071-6766). The highest peak intensity of 35.454 belongs to Sijunjuang iron sand. While other iron sands are lower with impurities in the form of SiO2 or CaHPO4, it is quite high at 2Ө 26,547 (JCPDS standard pattern no. 46-1045 & JCPDS No.01-070-1425). This is consistent with XRF data and sample colors. The results of measurements with XRF, XRD and magnetic susceptibility were continued with chemical tests.

Table1. Chemical Composition, Susceptibility magnetic and the color of iron sand

Oksida	Sijunjung	Solok	Pariaman	Pasaman	Commercial magnetic
MgO	1.886	4.061	7.456	3.285	CAS Number: 1309-38-2
Al_2O_3	6.406	7.156	8.928	7.403	
SiO_2	**8.058**	**17.318**	**28.886**	**22.411**	
P_2O_5	1.460	1.030	0.975	0.987	
K_2O	0.022	0.269	0.277	0.163	
CaO	0.305	**1.061**	**1.216**	**3.599**	
TiO_2	9.49	8.721	7.869	0.250	
V_2O_5	0.442	0.417	0.350	0.013	
Cr_2O_3	0.098	0.059	0.043	0.000	
MnO	0.230	0.333	0.251	0.288	
$FeOFe_2O_3$	**69.813**	57.054	42.435	59.717	
Fe	**76.365**	66.475	53.997	69.548	
Susceptibility magnetic (x $10^{-8} m^3/kg$)	1998.7	1289.15	1307.34	1585.51	
The color of Iron Sand					

The results of this characterization with XRF are supported by Fe3O4 crystallinity data using X-ray diffractometer as shown in Figure 2.

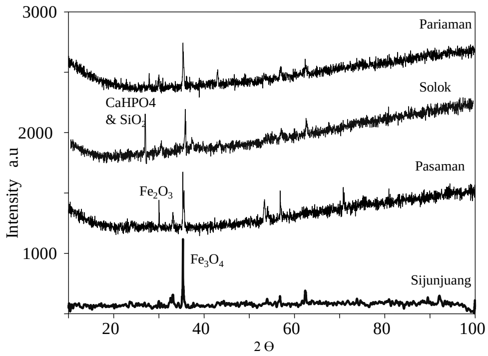

Figure 2. The X-Ray diffraction pattern the iron sand from, a). Sijunjuang b). Pasaman, c). Solok, and d) Pariaman.

Sijunjuang iron sand is dissolved in high concentrated HCl; a greenish brown FeCl3 solution will be obtained, with the remaining insoluble component in the form of acid SiO2 and CaO as much as 18%.

CONCLUSION

From the research data and the discussion above can be concluded that iron sand and iron rock from West Sumatera can be separated by magnetism. Sijunjuang iron sand has the highest percentage of Fe, the highest magnetic susceptibility. Pasaman, Pariaman, and Solok sand have a lower percentage of Fe, and have impurities in the form of CaHPO4 and SiO.

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