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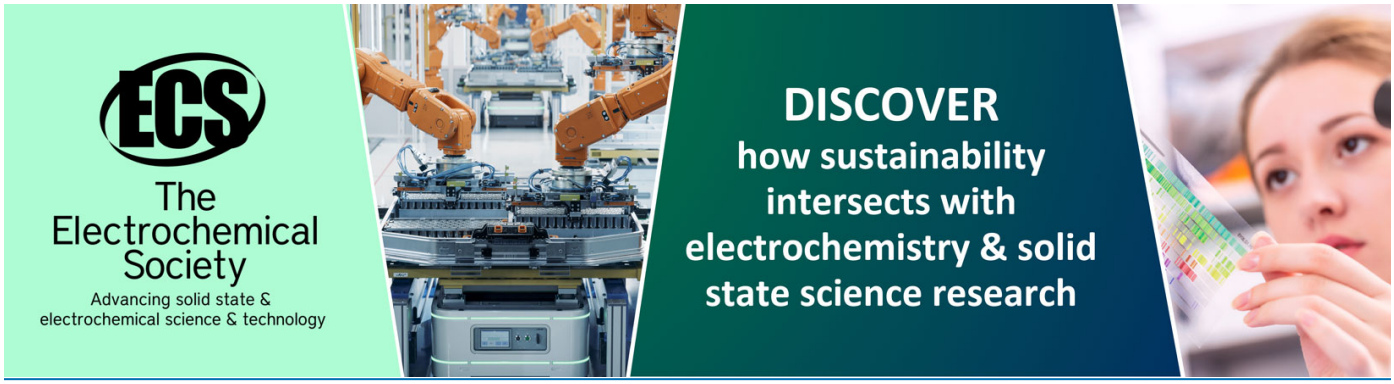

IOP Conf. Series: Materials Science and Engineering **523** (2019) 012019 doi:10.1088/1757-899X/523/1/012019

Synthesis of Kieserite fertilizer by using natural magnesite Ore as raw material

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Abstract. Magnesite ore is one kind of rare minerals that can be found in area of Aceh Besar District Province of Aceh, NTT Province and Southeast Sulawesi Province. The further treatment of this rare magnesite mineral containing mainly magnesium to form kieserite fertilizer product with composition magnesium and sulphur would be more benefit. The purpose of this study is to synthesize kieserite fertilizer from magnesite ore as raw material with addition of sulphur and to see whether the composition of prepared product meet the specification of kieserite fertilizer as stated in SNI 02-2807-1992. The synthesis was carried out by mixing the treated natural magnesite ore and the solid sulphur in a ball mill. The product of kieserite fertilizer was then analyzed according to SNI 02-2807-1992. The results showed that kieserite fertilizer can be produced from raw material of magnesite ore and a product met the SNI 02-2807-1992. The prospective product of kieserite fertilizer was obtained after mixing magnesite ore with addition 20 wt% of solid sulphur. The composition of prepared kieserite fertilizer was in range of 26.72-30.20 wt% for MgO, 20.29-23.93 wt% for S and 0.40-0.76 wt% for free water content with the prospective product composition was 30.20 wt% for MgO, 23.93 wt% for S and 0.45 wt% for free water content.

1. Introduction

Inorganic fertilizer is one type of fertilizers that commonly used in palm plantations. Kieserite fertilizer as inorganic fertilizer must contain a minimum of 25.5 wt% of magnesium in the form of MgO and 21 wt% of sulphur in the form of S as standardized in SNI 02-2807-1992 [1]. Magnesium is a macronutrient that assist in the formation of chlorophyll and assist in transport of phosphate in plants that produce more fresh fruit bunches (FFB) and high oil content [2]. Whereas, sulphur is responsible for formation of amino acids and growth of shoots, seedlings and helps the formation of root nodules and serve to increase the resistance of plants to fungi [3].

The synthesis of kieserite fertilizer can be formed from natural magnesite ore. Deposit of magnesite ore in Indonesia is only found in three provinces, namely in NTT Province, Southeast Sulawesi Province and Aceh Province. The deposit of magnesite ore in Aceh Province is found in Aceh Besar District with deposit around 84.45 million cubic meters [4].

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Nowadays, community groups or local euntepreneurs have mined magnesite ore by direct mining it from deposit location, then packed with a particular brand and sold it as a magnesium fertilizer with a high Mg content but with very low S content [5,6]. Kieserite as a natural mineral with chemical formula of MgSO4.H2O in the form of a salt deposit was first discovered in Germany [7]. Considering a huge magnesite ore deposits located in Aceh Besar District, Aceh Province and a large amount of kieserite fertilizer necessity to support the productivity of oil palm plantations, therefore this study was conducted to assess the process of kieserite fertilizer formation from magnesite ore and solid sulphur so that these produced kieserite fertilizers could conform to SNI 02-2807-1992 [1] to increase products added value. Some previous studies have been done on the process of kieserite fertilizer formation with various materials and methods [8,9]. Researchers generally use variety sources of magnesium and sulfur to form kieserite fertilizer. Several other researchers used sulphuric acid and solid sulphur [10]. The results of previous study showed that the use of different sources of sulphur would also produce different product composition and by-products generated. Therefore, in this study we use of natural resources of magnesite ore from Aceh Province as raw material to form kieserite fertilizer. This study is an innovative effort in order to increase the added value of the raw mineral of magnesite ore.

2. Methods

2.1. Materials and Equipments

Materials used in this research were the natural magnesite ore of Aceh Besar District and a solid sulphur mineral purchased from supplier in the market. The chemicals were purchased from commercial available supplier. Equipments used included mortar, ceramic bowl, milling tools, sieves (Test-Sieve BS 410-69), vibration apparatus (Fritsch), erlenmeyer, thermometers, digital scales (Acis), mixer, ball mill, oven and furnace.

2.2. Research Procedure

The formation process of kieserite fertilizer was as following phases: firstly, raw materials of magnesite ore was collected from area of Kuta Cot Glie Sub-District in Aceh Besar District. Next, raw material of magnesite ore was dried under sunlight for a couple of days in order to reduce the water content. Then, the dried magnesite ore was crushed by using a mortar in a ceramic bowl to reduce size of material before conducting milling in a ball mill apparatus and finally performed a sieving process to obtain the same size of +80-100 Mesh. The grain size of magnesite ore is then performed a calcination process at a temperature of 700 °C [11]. Finally, the certain amount of calcined magnesite ore was mixed and milled with solid sulphur in the variety of weight (KF-01 for 20 wt% of S; KF-02 for 25 wt% of S; KF-03 for 30 wt% of S and KF-04 for 35 wt% of S samples) to form kieserite fertilizer in a ball mill at milling speed of 300 rpm for around 30 minute. The produced kieserite fertilizer was then stored in dessicator for further analysis.

2.3. Analysis Procedure

Analysis procedures of raw material and final products of kieserite fertilizer was performed following the procedure in the SNI 02-2807-1992. The analysis included content analysis of magnesium as MgO, content analysis of sulfur as S and content analysis of free water. All of analysis results were subsequently processed and displayed in the form of tables and figures.

3. Results and Discussion

Recently, communities who live in surrounding of magnetite ore deposit location and or entrepreneurs had been mining the mineral by using a simple methods and equippments. After mining and cleaning from some impurities, they generally sold minerals in bulk or put in bags of 40 or 50 kg without any other treatment. Some of them named their product as kieserite fertilizer not as magnesium fertilizer [5,6]. Those products without any treatment still have composition of natural magnesite ore which is lacking of sulphur content and therefore it is not appropriate if named as kieserite fertilizer when we refers to SNI 02-2807-1992 because according to SNI "kieserite fertilizer is a mineral material containing nutrients of magnesium at least 25.5% by weight and sulfur at least 21% by weight". The detail of any composition in kieserite fertilizer referring to SNI 02-2807-1992 can be seen in Table 1.

Table 1. Requirements of kieserite fertilizer based on SNI 02-2807-1992

No	Parameter	Requirements
1	Magnesium content as MgO, %	Min. 25.5
2	Sulphur content as S, %	Min. 21.0
3	Free water content, %	Max 0.5

Based on the facts and activity in the mining site and refer to above SNI 02-2807-1992, fertilizers that mined and sold by communities/entrepreneurs are more accurately named as magnesium fertilizer rather than kieserite fertilizer. The natural magnesite ore mineral that mined by communities/entrepreneurs without any treatment was dominated by the content of MgO as much as 32.72 wt % and contained only 7.46 wt% of S as can be seen in Table 2. The composition of natural magnesite ore and other products were tested by using titrimetry and gravitymetry analysis in a known and accredited laboratory of PT Sucofindo, Medan, Indonesia. Because of the lacking of sulphur content in natural magnesite ore so that we attempted to synthesize kieserite fertilizer in accordance with the Indonesian National Standard (SNI) by utilizing natural magnesite ore minerals from Aceh Besar District, Aceh Province as a raw material.

Table 2. Composition of natural and calcined magnesite ore and composition of prepared kieserite fertilizers

No	Parameter	Natural magnesite ore	Calcined magnesite ore	Produced kieserite fertilizer			
				KF-01	KF-02	KF-03	KF-04
1	Magnesium content as MgO, %	32.72	37.8	30.20	26.74	28.08	26.72
2	Sulfur content as S, %	7.46	0.32	23.9	20.29	21.96	21.14
3	Free water content, %	na	3.5	0.45	0.76	0.47	0.40

Note: KF = kieserite fertilizers; na = not available; calcined at 700 ^{o}C

The process used to synthesize kieserite fertilizer was initiated with the size reduction process of

both raw materials namely the natural magnesite ore that contains of approximately 32.72 wt% of MgO and solid sulfur that contains of approximately 99.9 wt% of S. After milling and sieving at size of +80-100 Mesh, the natural magnesite ore was calcined at 700 ^{o}C under air atmosphere. The product of calcination was measured its composition as can be seen in Table 2.

The calcined magnesite ore contained 37.8 % of MgO and 0.32 % of sulphur. The contain of sulphur was similar to sulphur content in our previous research [12]. The calcination process has increased the content of MgO from 32.72 % of natural magnesite ore to 37.8 % of magnesite ore. During calcination process at high temperature of 700 ^{o}C under air atmosphere, some impurities in natural magnesite ore was evaporated and resulted in also increasing the content of MgO. The calcination process also decreased the content of sulphur in mineral because sulphur was changed to sulphur dioxide dan evaporated to air.

Theoretically, mixing both the calcined magnesite ore as raw material and solid sulphur would produce a product with high content of MgO and S that can be determined precisely and accurately. However in practice there are several factors that can change the content of MgO and S in the product of kieserite fertilizer. One of factors is the homogeneous mixing of raw materials and the precision of the methods of analysis of the product. The composition of all prepared kieserite fertilizer can be seen in Table 2.

Table 2 showed that magnesium content as MgO from four products of kieserite ranged from 26.72 – 30.2%, sulphur content as S ranged from 20.29 – 23.9 % and free water content ranged from 0.40 – 0.76. From these results, it can be seen that product labeled with KF-02 has fulfilled in SNI 02-2807-1992 in magnesium content only but not yet met the criteria of sulfur content and free water content.

According to SNI 02-2807-1992 the content of magnesium as MgO must be at least 25.5 wt%, content of sulphur as S must be at least 21 wt% and free water content must be a maximum of 0.5 wt%. Other products labeled as KF-01, KF-03 and KF-04 have fulfilled all requirements as stated in SNI 02-2807-1992. However, considering the price of solid sulphur is higher than the price of mineral magnesite ore then the more economical product is the product that used the lowest solid sulphur amount and product must meet all requirements of SNI 02-2807-1992. Therefore, based on the result of laboratory analysis, the prepared product labeled with KF-01 was considered as prospective product in this study.

A B C

Figure 1. Photographs of natural magnesite ore (A), after sieving of 80-100 mesh (B) and after milling with sulphur (C)

Figure 1 showed photographs of natural magnesite ore, after sieving and calcination process and after milling with solid sulphur. The figure showed clearly that the size of raw material of natural magnesite ore was still unorder with the white greyish color due to the high content of magnesium (Figure 1 (A)). The size became similar after sieving with size of +80-100 mesh and the color became brighter due to calcination at high temperature (Figure 1 (B)).

The prepared kieserite fertilizer as can be seen in Figure 1 (C) had a powdered apparent with the color of kieserite fertilizer product tend to be grey yellowish due to addition some amount of solid sulphur.

4. Conclusion

Natural mineral of magnesite ore from Aceh has a huge potential to be used as raw material for formation of kieserite fertilizer. Kieserite fertilizer can be made from milling of calcined magnesite ore and solid sulphur and the product met the Indonesian National Standard (SNI) 02-2807-1992.

The prospective composition of produced kieserite fertilizer was 30.2 wt% for MgO content, 23.9 wt% for S content and 0.45 wt% for free water content. This kieserite fertilizer product was obtained from milling of calcined magnesite ore and 20 wt% of solid sulphur product.

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