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Article

Manufacture of Phosphate Fertilizer from Cow Bones Waste

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Abstract

Cow bone waste was the fundamental problems that occur in several abattoirs (slaughterhouses) in Indonesia that untapped optimally. Intention of this research studied of making phosphate fertilizer from cow bone wasted by granulation process with the effect of concentration phosphoric acid and sulfuric acid to the quality of phosphate fertilizer. The process of making phosphate fertilizer was by preparation of cow bone waste until became into powder and filtered it with 80 mesh of sieve. Pan granulator ran with cow bone powder and sprayed with sulfuric acid-phosphoric acid solution according to specified variable. Then the results of granulation taken from a pan granulator and dried using an oven with a temperature of 70°C for 3 hours. The chemical composition of dried products were analyzed using XRF (X-Ray Fluorescence) analysis. Analysis results showed that phosphate fertilizer can be produced by cow bone waste deliver the highest P_2O_5 was 30.7% with addition H_2SO_4 5% and H_3PO_4 45%.

Keywords: Cow bone waste, phosphate fertilizer, XRF.

1. Introduction

Cow bone waste is one of the fundamental problems that occur in several abattoirs (slaughterhouses) in Indonesia that untapped optimally. Sinaga et al have researched cow bone waste that can be processed into fertilizer which is can fertilize plants and supply organic material needs. Besides it should be can also be made into bone meal for fodder mix as a source of calcium (Ca) and phosphorus (P) [1]. Cow bone contains mineral elements of calcium and phosphorus. Calcium contained in cow bones is 7.07% in the form of $CaCO_3$ compounds, 1.96% in the form of CaF_2 compounds, as much as 2.09% phosphorus in the form of $Mg_3(PO_4)_2$ compounds, and 58.30% in the form of $Ca_3(PO_4)_2$ compounds [2]. Yuliana, R, et al treat cow bone waste by synthesizing hydroxyapatite using the wet method at various stirring times and sintering temperatures [3].

Production and demand for phosphate fertilizer are increase every year along the increasing demand from the agricultural sector. According to a survey conducted in 2018 it reached 7,444.99 tons per year [4]. Phosphate is widely available in nature as a phosphate rock containing tri calcium phosphate which is insoluble in water. In order to be used by plants, natural phosphate rocks must be converted into phosphate compounds that can soluble in water. Usually the main raw material used should be to make phosphate fertilizers is phosphate rock [5]. Phosphate fertilizers can be produced by granulation process.

Granulation or the process of forming granules is an enlargement of the particles by agglomeration process. Agglomeration is a

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process in which soft particles stick together to form larger grains [6]. Granulation process which involves the aggregation small particles into larger particle which is carried out in the presence of a moisturizing liquid (adhesive) [7].

Therefore, a research was carried out on the manufacture of phosphate fertilizer made from cow bones using a pan granulator to treat cow bone waste as well as to help reduce the need for imported fertilizers in Indonesia. It should be can also be reduce the use of phosphate rock available in nature.

2. Material and Method

2.1. Material

Cow bone waste were obtained from slaughterhouse in Probolinggo (Jalan Ahmad Yani, Probolinggo), and three analytical grade chemicals (MerckTM) were used for the experiments, namely NaOH, H_2SO_4 and H_2PO_4.

2.2. Raw material preparation

Clean cow bone waste (0.5 kg) then cut into small pieces and boiled for 2 hours. Soaked in 1 L of 0.2% NaOH solution for 7 hours to remove bone grease. Wash cow bones with distilled water and dried with the sun. Mashed cow bones with a grinding machine until they become bone powder and sieved with a size of 80 mesh.

2.3. Granule fertilizer process

Cow bone powder (0.3kg) put into a pan granulator. Then sprayed it with compound substance (sulfuric acid solution and phosphoric acid solution) according to specified variable during the running of pan granulator. Then the results of granulation taken from pan granulator and dried using an oven with a temperature of 70°C for 3 hours. After dry up, analysis chemical composition of samples using XRF (X-Ray Fluorescence) analysis. The XRF testing method were shot with the sample placed underneath or XRF attached to the built-in support then the sample were placed on it.

3. Results and Discussion

3.1. Raw Material Analysis (cow bone powder)

The chemical composition contained in bone powder as a raw material by XRF analysis as shown on Table 1.

Raw material (cow bone powder) contains calcium(Ca) element 82.01%, calcium oxide (CaO) 73.5%, difosfor pentaoxide(P_2O_5) 21.5% , and phosphat (P) 12.1%. This results indicate that cow bone powder potentially can be treated for phosphate fertilizer accordingly SNI standard [8].

Table 1. The results of component cow bone powder by XRF analysis

Component	Concentration (%)
P_2O_5	21,5
SO_3	0,68
CaO	73,5
TiO_2	0,07
Fe_2O_3	2,19
P	12,1
S	0,37
Ca	82,01
Ti	0,07

Compo-nents	H_3PO_4 5%	H_3PO_4 15%	H_3PO_4 25%	H_3PO_4 35%	H_3PO_4 45%
CaO	68.3	66.725	65.15	63.575	62
TiO_2	0.32	0.3	0.28	0.26	0.24
Fe_2O_3	4.04	3.9725	3.905	3.8375	3.77
P	11.3	13.025	14.75	16.475	18.2
S	3	2.6	2.2	1.8	1.4
Ca	77.4	76.525	75.65	74.775	73.9
Ti	0.33	0.315	0.3	0.285	0.27

3.2. Phosphate Fertilizer Analysis

The results of XRF (X-Ray Fluorescence) analysis of the product (phosphate fertilizer), were obtained on table 2.

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Table 2. The results of component phosphate fertilizer by XRF analysis

Concentration (%)		P_2O_5 (%)
H_2SO_4 5%	H_3PO_4 5%	19.70
	H_3PO_4 15%	22.45
	H_3PO_4 25%	25.20
	H_3PO_4 35%	27.95
	H_3PO_4 45%	30.70
H_2SO_4 15%	H_3PO_4 5%	20.60
	H_3PO_4 15%	20.80
	H_3PO_4 25%	25.60
	H_3PO_4 35%	26.00
	H_3PO_4 45%	28.20
H_2SO_4 25%	H_3PO_4 5%	26.00
	H_3PO_4 15%	26.55
	H_3PO_4 25%	27.10
	H_3PO_4 35%	27.65
	H_3PO_4 45%	28.20
H_2SO_4 35%	H_3PO_4 5%	22.30
	H_3PO_4 15%	22.90
	H_3PO_4 25%	23.50
	H_3PO_4 35%	24.50
	H_3PO_4 45%	25.10
H_2SO_4 45%	H_3PO_4 5%	23.40
	H_3PO_4 15%	23.98
	H_3PO_4 25%	24.55
	H_3PO_4 35%	25.13
	H_3PO_4 45%	25.70

Based on table 2, the greater concentration of phosphoric acid (H_3PO_4) can make a concentration of P_2O_5 on fertilizer becoming greater than the concentration of phosphoric acid (H_3PO_4) before at the same concentration of sulfuric acid (H_2SO_4). The greatest P_2O_5 is 30.7% with addition of 45% phosphoric acid (H_3PO_4) and 5% sulfuric acid (H_2SO_4). This results reinforce of Budi F, et al research on 2009 about an increasing P_2O_5 on fertilizer were proportionate with increasing addition concentration of phosphoric acid (H_3PO_4) in spraying process [9].

Table 3. Components of phosphate fertilizer on 5%H_2SO_4 by using XRF analysis

Compo-nents	H_3PO_4 5%	H_3PO_4 15%	H_3PO_4 25%	H_3PO_4 35%	H_3PO 45%
SO_3	5.49	4.7175	3.945	3.1725	2.4

Other components were also obtained by using XRF analysis (Table 3).

Based on this results, the greatestcomponent on this fertilizer is calcium (Ca). It is reinforce theory from previous research that cow bones has more calcium (Ca) [7]. The greater concentration of phosphoric acid as used in spraying process, can decrease calcium in fertilizer. It cause of calcium react with phosphoric acid form (P_2O_5). As it relates with decreasing calcium oxide (CaO) component in fertilizer.

The best fertilizer with 30.7% P_2O_5 has a big form than others. It cause of a big granule in consolidation process influenced by two factors, density and viscosity solution. Using phosphoric acid solution cause of density of granule biggert han using distilled water. So that make granule consolidation process bigger[6]. The water content of fertilizer can be reduced by increasing temperature and time on drying process.

From the research, the quality of phospate fertilizer was obtained the highest with 30.7% P_2O_5. These result have met standard of the phospate fertilizer for the quality of grade-A phosphate fertilizer at least 28% P_2O_5 [8].

4. Conclusions

Phosphate granule fertilizer can be produced by cow bone waste with a granulation process and phosphoric-sulfuric acid for the solution of spraying. At the same concentration of sulfuric acid (H_2SO_4), increasing concentration of phosphoric acid (H_3PO_4) can make a concentration of P_2O_5 on fertilizer becoming greater than the concentration of phosphoric acid (H_3PO_4) before. The greatest P_2O_5 is 30.7% with addition of 45% phosphoric acid (H_3PO_4) and 5% sulfuric acid (H_2SO_4), so it can be categorized as a phosphate fertilizer in grade-A is about minimum 28% according to standard of the phospate fertilizer.

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