JU ZAVOD ZA GEOLOŠKA ISTRAŽIVANJA CRNE GORE
GEOLOGICAL SURVEY OF MONTENEGRO

UDK: 55/56 ISSN 0435-4249

GEOLOŠKI GLASNIK
GEOLOGICAL BULLETIN

JUBILARNO IZDANJE POVODOM 70 GODINA RADA
ZAVODA ZA GEOLOŠKA ISTRAŽIVANJA

KNJIGA XVI BOOK

GEOLOŠKI GLASNIK	KNJIGA XVI	Str. 319	PODGORICA, 2015

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Izdavanje ovog broja Geološkog glasnika finansijski je pomogla

INŽENJERSKA KOMORA CRNE GORE
ENGINEERS CHAMBER OF MONTENEGRO

Štampa: Grafo Group, Podgorica
Tiraž: 500 primjeraka

SADRŽAJ – CONTENTS

Dragan S. Radulović[1], *Darko Božović*[2],

USAGE OF THE FINE GRAINED LIMESTONE FOR NEUTRALIZATION OF ACID SOIL- APPLICATION OF PELLETIZING METODS

Abstract

The rapid progress of industry, worldwide, as well as here, results in increasing of acid soil. According to some researches, about 60 % of our soil is acid and requires neutralization that is done by the means of grinded limestone, what is customary. Its inconvenience for use in this shape regarding the atmospheric conditions, particularly-the wind inspired our attempts to agglomerate it. By the process of pelletizing, limestone can be successfully pelletized into size as chemical fertilizers.

Key-words: Ca-carbonate; neutralization; agriculture; agglomeration; bentonite; peletization

UPOTREBA FINO MLEVENOG KREČNJAKA ZA NEUTRALIZACIJU KISELIH ZEMLJIŠTA- PRIMENA POSTUPKA PELETIZACIJE

Apstrakt

Brzi razvoj industrije kako širom sveta, tako i kod nas, povećao je površine kiselih zemljišta. Prema nekim ispitivanjima oko 60% obradivih zemljišta kod nas spada u kisela zemljišta koja je neophodno neutralisati, što se uobičajeno izvodi mlevenim krečnjakom. Njegova nepodesnost za korišćenje u ovom obliku vezano za atmosferske uslove, pre svih vetar, nas je naterala da pokušamo da ga okrupnimo. Procesom peletiziranja, krečnjak se može uspešno peletizirati do krupnoće koja odgovara krupnoći hemijskih đubriva.

Ključne reči: Ca-karbonat; neutralizacija; poljoprivreda; okrupnjavanje; bentonit; peletizacija

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1. INTRODUCTION

The acid rains are the major cause of acid soil increase all over the World which becomes almost completely worthless due to its low fertility. The addition of Ca to the soil provides the substitution of H, Al, Fe ions with Ca ion, improving, at the same time, the soil qualities. The neutralization improves the micro-biological processes as to increase of access to the biogenic elements (N, P, K, Ca, Mg etc.) for plant feeding. The neutralization cuts down the dissolution of noxious elements and heavy metals.

The mayor problem with neutralization was the necessity of limestone being very refined in order to dissolve easily and to speed the soil pH value increase. If the limestone particles be above 0,5 mm in size then they would dissolve slowlier because of their smaller specific surface compared to their volume, affecting the neutralization, thus; the quantity of this-sized limestone would be the -0,3+0,00 mm particles.

However the troubles with the finer classes are also significant due to more difficult handling and considerable dusting in casting process, let alone constant wind threat to blow away the limestone, resulting in unequal effects of neutralization in the same field. Therefore, in order to satisfy two juxtaposed demands id est that the particles be the smallest possible (for better dissolution), as well as, as big as possible (for easier handling) the idea of the agriculturally purposed limestone peletization process agglomeration was come about. That was precisely the task we had.

2. PHYSICO-CHEMICAL AND MINERALOGICAL SAMPLE CATEGORIZATION

2.1. MOISTURE DETERMINATION:

Since the initial sample was of m=20 kg from a sampling by quartering and later by chess-field method, two specimens were taken for the moisture determination. As the bentonite was purposed for bondage, two samples of it were taken too.

The lime stone samples were of m=100g, while these of bentonite, dried in Wegeglass, m=10 g each. All samples were dried at a 105 ^{o} C temperature for t=2 h and then the mass measuring and moisture determination both in sample and bondage took place.

Sample moisture:

$$I\ Vh = \frac{100-99{,}3}{100} \cdot 100 = 0{,}7\%$$

$$II\ Vh = \frac{100-99{,}1}{100} \cdot 100 = 0{,}9\%$$

$$Vh = 0{,}8\%$$

Moisture determination:

$$I\ Vh = \frac{9{,}9964-9{,}8785}{9{,}9964} \cdot 100 = 1{,}18\%$$

$$II\ Vh = \frac{10{,}0336-9{,}8718}{10{,}0336} \cdot 100 = 1{,}52\%$$

$$Vh = 1{,}35\%$$

2.2 SAMPLE COMPOSITION GRANULOMETRIC DETERMINATION

Granulometric composition was determined by sieving of samples through the series of sieves up to 0,045 mm then in cyclosizer up to 0,010 mm while the class below 0,010 +0,000 mm was sorted in the Sartorius scales.

Table 1. Initial limestone sample granulometric composition

Size, mm	M, %	ΣM, %	ΣM, %
+0,30	3,67	3,67	100,00
-0,3 + 0,2	1,86	5,53	96,33
-0,2 + 0,1	25,53	31,06	94,47
-0,1 + 0,045	45,79	76,85	68,94
-0,045 + 0,032	3,89	80,74	23,15
-0,032 + 0,026	2,22	82,96	19,26
-0,026 + 0,017	4,49	87,45	17,04
-0,017 + 0,010	3,19	90,64	12,55
-0,010 +0,006	4,44	95,08	9,36
-0,006 + 0,004	2,22	97,30	4,92
-0,004 + 0,002	1,76	99,06	2,70
-0,002 + 0,000	0,94	100,00	0,94
Feed	100,00		

2.3 MINERALOGICAL CHARACTERISTICS OF ROW SAMPLE

Mineralogical composition and sample description was following: calcite, gray, in small quantities (limonitized) of high crystallity, no fossils, dolomite in small quantities, not many irregular granats, calcite high purity. Sharp angled calcite grains with low quartz level.

2.4 LIMESTONE SAMPLE CHEMICAL ANALYSIS

Table 2. Limestone chemical analysis

Contents	Percentage
SiO_2	2,85
Al_2O_3	0,17
Fe_2O_3	0,06
CaO	52,56
$CaCO_3$	93,85
MgO	1,70
$MgCO_3$	3,56
Total CaMg (CO_3)	97,41
Na_2O	0,05
K_2O	0,02
Red heating waste	42,87
pH	9,7
Cl	0,004
F	/
P_2O_5	0,001

From the chemical composition in table 2. it is obvious that the sample contains very high percentage of $CaCO_3$ and $MgCO_3$, and also very low of biogenic elements and noxious admixtures, on the other hand, making it suitable for acid soil neutralization. The low level of admixtures or their inexistence doesn't limit this raw material application in agriculture.

3. TECHNOLOGICAL RESEARCH

Starting specimen mass m=20 kg, out of which was approximately 1 kg taken for physical-chemical and mineral analysis, is then by chess method treated and were obtained specimens each of mass 1 kg as a starting specimens for pelletizing. Pelletizing was done on the tray for pelletizing "Eirich" tr-04 with radius 40 cm. For homogenization was used mixer with planetary moving mixing element. Formed pellets were screened on the screen with openings 4 and 2 mm. Class -4+2 mm was the final product and those green pellets went on to drying on

T=105 °C for t=30 min and t=60 min. Technological written scheme of laboratorial process is given on picture 1.

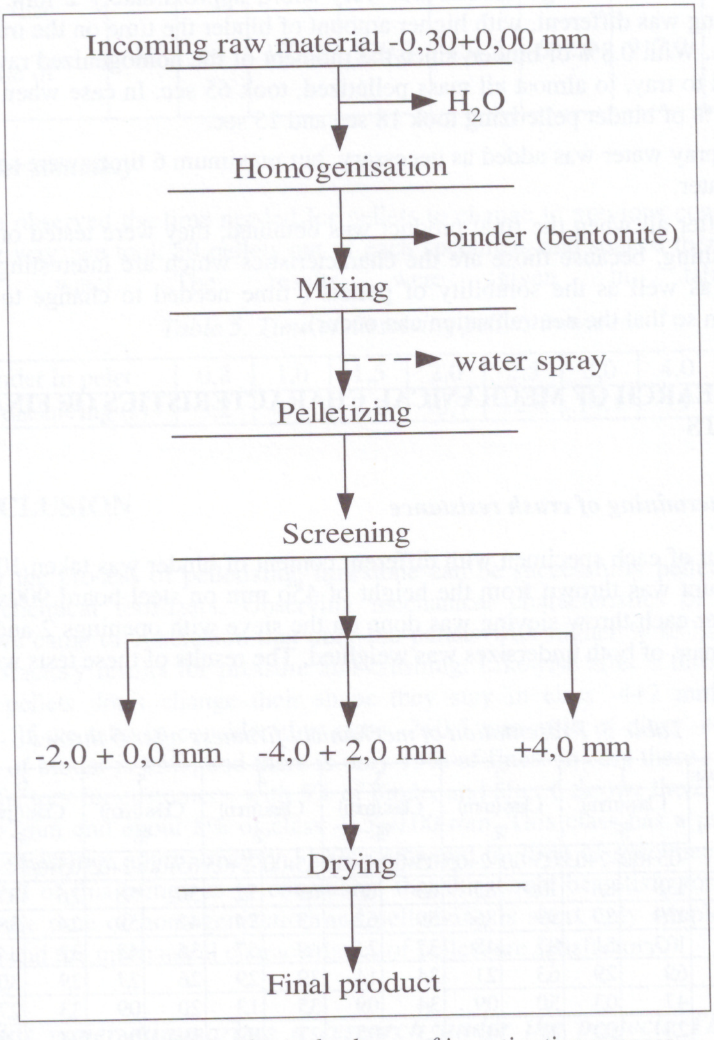

Figure 1. Technological scheme of investigation process

In industrial conditions class -2+0 mm would be taken back to mixing, while class +4 mm goes to drying and comminution and then again to feed.

Process of pelletizing and experiments were done with different amount of binder (bentonite) from 0,8; 1; 1,5; 2,5; 3; 4; to 5 % of binder upon the dry mass. Prior to that water was added, and well mixed and homogenized raw material was added to the tray. Amount of water added to the mixer depended on the amount of binder. The biggest amount of added water was 16.01% with 5% of binder, while the lowest amount was 12.9% of water with 0.8% of bentonite.

Period of homogenization was very short, approximately 2 min, period of pelletizing was different, with higher amount of binder the time on the tray needed, was less. With 0.8% of binder, since the moment of the homogenized raw material is added to tray, to almost all mass pelletized, took 65 sec. In case when we had 4 %and 5 % of binder pelletizing took 18 sec and 15 sec.

Spray water was added as necessary, but maximum 6 times were sprayed 3,9 ml of water.

After all when the final product was obtained, they were tested on pressure and crushing, because those are the characteristics which are interesting for final product as well as the solubility of pellets (time needed to change to previous condition so that the neutralization can occur).

3.1 RESEARCH OF MECHANICAL CHARACTERISTICS OF FINAL PELLETS

3.1.1 Determining of crush resistance

Out of each specimen with different content of binder was taken 100 g., and this amount was thrown from the height of 45o mm on steel board 900x600x200 mm. After each throw sieving was done on the sieve with openings 2 and 0.5 mm and the mass of both undersizes was weighted. The results of these tests were given in table 3.

Table 3. Presentation of mechanical firmness after 6 throws

number of trows	1		2		3		4		5		6		M%
% Binder	Class (mm) %		Class (mm) %		Class (mm) %		Class (mm) %		Class (mm) %		Class (mm) %		mm
	-0,5+0,0	-2+0,5	0,5+0,0	-2+0,5	0,5+0,0	-2+0,5	0,5+0,0	-2+0,5	0,5+0,0	-2+0,5	0,5+0,0	-2+0,5	-4+2
0,8	13,8	8,8	10,0	8,5	6,3	6,0	6,9	7,2	5,0	5,8	2,6	3,7	15,4
1,0	12,9	8,7	9,9	8,6	5,9	6,2	6,3	7,4	4,7	5,9	2,4	3,8	17,3
1,5	10,7	5,1	8,7	4,8	3,7	2,1	4,9	5,7	3,6	4,2	3,2	3,4	42,0
2,0	6,9	2,9	6,3	2,1	3,4	1,4	3,9	2,9	2,6	2,7	2,9	3,0	59,2
2,5	4,7	0,3	5,0	0,9	3,4	0,9	3,5	1,2	2,0	0,9	3,3	2,7	71,2
3,0	2,8	0,2	3,7	0,7	2,3	0,5	2,7	0,9	1,9	0,6	2,4	0,9	80,4
4,0	2,0	0,2	2,6	0,5	1,7	0,2	1,9	0,3	1,8	0,3	1,8	0,3	86,4
5,0	1,6	0,1	1,8	0,2	1,4	0,1	1,5		1,6	0,2	1,3	0,1	89,9

3.1.2 Determining of pressure resistance

We took 20 pellets out of each specimen, and did research on standard laboratory press, one by one pellet. The results were given in table 4.

Table 4. Presentation of pressure resistance

% Binder	0,8	1	1,5	2	2,5	3	4	5
Weight g that causes destruction of pellets	42	54	137,2	329,3	451,7	682,4	917,0	1.133, 1

3.1.3 Water solubility

We observed the time needed for pellets to change to previous condition in following way: we took 50 pellets out of each specimen, and soaked them in 100 ml of water. The results were given in table 5.

Table 5. Time of dissolving pellets in water.

% of binder in pelet	0,8	1,0	1,5	2,0	2,5	3,0	4,0	5,0
time of dissolving (s)	3,2	5	7,2	10,7	12,8	14,1	19	23

4. CONCLUSION

By the process of pelletizing, limestone can be successfully pelletized into size as chemical fertilizers. Observing mechanical characteristics of obtained pellets, we came to conclusion that only the pellets with higher % of binder, 3% give satisfactory results for pressure and crushing. Likewise after 6 throws about 80% of pellets don't change their shape they stay in class -4+2 mm as final products. If we take in consideration class -2+0.5 mm ratio of class -4+0.5 mm with 3% of binder is 85%, and there is only 15% of fines. In case these results are not satisfactory for customers, with 5% of binder and after 6 throws there is 90% of class -4+2mm and about 8% of class -0.5+0.00 mm. This class has a pretty high pressure resistance approximately 1130g compared to 700g of specimen with 3% binder. All of this brings us to conclusion that this could be satisfactory process because the time of homogenization and pelletizing is short only couple parts of seconds, and the mechanical characteristics of pellets are satisfactory.

This paper summarizes a research under the projects TR 34013, 31003 TR, funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia for the period 2011-2014.

4. ZAKLJUČAK

Procesom peletiranja, krečnjak se može uspešno peletirati u veličinu kao kod hemijskih đubriva. Posmatrajući mehaničke karakteristike dobijenih peleta, došli smo do zaključka da samo pelete sa višim % veziva, 3% daju zadovoljavajuće rezultate za pritisak i drobljenje. Isto tako, nakon 6 postupaka oko 80% peleta ne menjaju svoj oblik ostanu u klasi -4 + 2 mm, kao finalni proizvodi. Ako uzmemo u obzir klasu -2 + 0.5 mm odnos klase -4 + 0.5 mm sa 3% veziva je 85%, a postoji samo 15% od čistih. U slučaju da ovi rezultati nisu zadovoljavajući za kupce, sa 5% veziva i posle 6 postupaka postoji 90% od klase -4 + 2mm i oko 8% od klase -0.5 + 0.00 mm. Ova klasa ima prilično visoku otpornost na pritisak oko 1130g odnosu na 700g uzorka sa 3% veziva. Sve ovo nas dovodi do zaključka da bi ovo mogao biti zadovoljavajući proces, jer je vreme homogenizacije i peletiranja je kratka samo nekoliko djelića sekunde, a mehaničke karakteristike peleta su zadovoljavajući.

Ovaj rad rezimira istraživanje pod projektom TR 34013 , 31003 TR , koji finansira Ministarstvo za obrazovanje, nauku i tehnološki razvoj Republike Srbije za period 2011-2014 .

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CIP - Каталогизација у публикацији
Национална библиотека Црне Горе, Цетиње

ISSN 0435-4249 = Geološki glasnik
COBISS.CG-ID 37922

ISSN 0435-4249

9 770435 424009 >