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POSIBILITY TO RECYCLING OF DEFERRIZED STEELSHOP SLAGS IN AGRICULTURE

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ABSTRACT:
The use in agriculture of the deferrized slag allows the development of some existing methods regarding the influence of the slag addition in the soil upon the plant growing and development.
The proposed technology does not generate other pollution sources and it is efficient from the economic point of view, it can be implemented in practice either by the producers of such wastes or by other firms using deferrized slag. The use in other sectors of the steel shop slag leads to release the surfaces occupied by these wastes and to render them to the respective natural landscape, there takes place a reduction of the pollution degree in the regions having steel industry.
KEY WORDS:
slag, recycling, agriculture, pollution, industry

1. INTRODUCTION

The siderurgic industry produces a series of specific wastes (slags, iron scales, dust and furnace slime, electro filter dust from steel plants, et.) which are recovered in a very reduced proportion, the remainder being deposited in dumps and clarifying) settling ponds. Considering the iron contents and the fact that without recovery, they are a source of pollution for the environment (water, air, soil), there is a need to find solutions to process them, in order to be brought to a favorable state for use as raw or auxiliary material in the metallurgical field or in other sectors of economy. The most adequate solution adopted for ferrous waste extraction from slags is the electromagnetic ore, after a proper sequence of crushing and sorting of the slag. At the present moment, these slags are successfully used in siderurgy, agriculture and constructions.

Processing steel plant slags is beneficial for environment protection, community and agricultural welfare as well as from the technical point of view: metallurgical slags are non-toxic materials, with physical and chemical properties that are similar to rocks, so they represent a viable alternative, sometimes preferable to the natural variants for usage in constructions.

The activity of metallurgical slag processing meets the requirements of environment protection and the European Directives related to environment protection, stipulated in Law 73/2000, republished with the further alterations and completions. From this point of view, metallurgical slag processing aims, directly and indirectly, at two targets included in the community acquis: the control and reduction of soil pollution by using clean technologies involving the turning of metallurgical slag wastes into recycled materials to be used in several domains: road and railway construction, hydro-technical and civil constructions, in the cement, glass and refractory materials industry, as well as in agriculture (improving soil acidity and re-mineralizing it).

According to the available data related to the slag dump at Buituri, the first deposits were made in year 1967 the in the area known as “the old slag dump”, and reached an average elevation of 255 m (fig.1). The latest information shows that, at this moment, the maximum dumping elevation at the slag dump in Buituri (fig.2), in on average 340 m, and its area of about 80 ha, which sums up to about 100 million ton of slag deposited next to the old dump. The chemical composition of steel plant slag from Buituri is presented in fig.3.


Fig.1. The old slag dump   Fig.2. The slag dump in Buituri

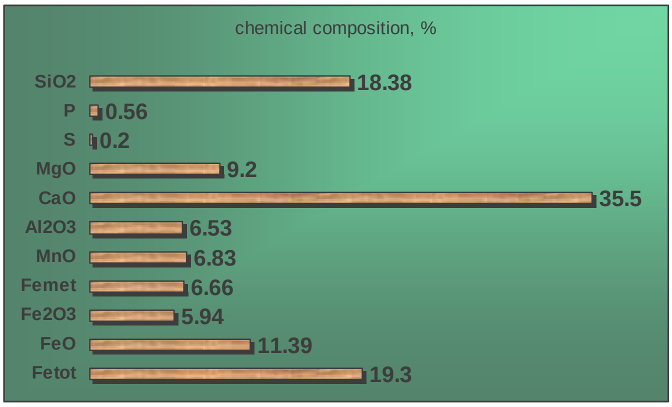

Fig.3. Chemical compositions of slag from slag dump Buituri

The experiments, which are to be put into practice, aim a use of de-ferromized slag in the agricultural area. Following the industrially obtained results and the economic calculi, the producer may choose either the proposed technologies to be put into practice or to co-operate and support other metallic waste processors.

2. THE STUDY

In order to obtain the slag powder needed in the pilot experiments, the ferrous slag was processed in the laboratory of the Faculty of Engineering of Hunedoara.

Fig.4 The screening installation „Analysette 3" Fritsch, the grain size 25μm-2mm

Laboratory experiments have been carried out in the Laboratory of Ore Preparation, which is endowed with an installation of screening, grinding, and magnetic separation.

The steel plant slag was screened, using the jigger for the grain size of 10-50mm respectively the screening installation shown in fig.4. The steel plant slag was crushed in the Kollergang mill and for the magnetic separation we used the belt-type magnetic separator.

Figure 5 shows the percentage distribution for the types of metallic waste, ferrous, respectively non-ferrous slag, resulted from the processing of the steel plant slag.

The slag powder obtained by crushing the non-ferrous slag (the grain size fractions 0-0,4 mm) was packed in sacks and shipped to the experimental lots in Commune Peştişul Mic.

As to the quality characteristics of the products we obtained, the chemical structure of the resulting slag powder is given in figure 6.

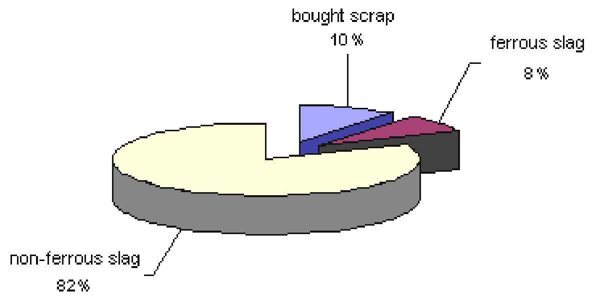

Fig.5. The percentage distribution for the types of metallic waste, ferrous, respectively non-ferrous slag

In parallel with the slag processing operations, we decided upon two experimental lots (one experimental lot – plowing land, respectively one experimental lot – grazing area). Also, depending on the quality of the soil and its destination, we decided upon the surface of the experimental lots, which is given in table 1. The limits of the agro-chemical plots were determined according to the degree of complexity of the relief and the top soil.

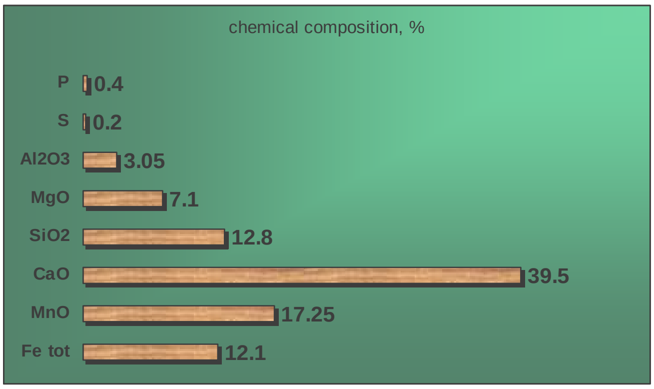

Fig. 6 The chemical structure of the slag powder

Table 1.

No.	Experimental lot	Area	The surface [m^2]
1	Experimental lot – plowing land	Peştişul Mic	400
2	Experimental lot – grazing area	Peştişul Mic	100

The experimental lots have a slightly acid pH reaction. It is required that they should be treated and acidity reduced. In order to do that, calcareous addings are necessary. Taking into consideration the theme of the project, we will use powdered non-ferrous steel plant slag. The dosage of the addition quantities has been calculated by the project research team and the result consisted of three experimental values: 0,4kg/m^2, 0,5kg/m^2 and 0,6kg/m^2. As ammonium nitrate favors the increase of soil acidity, it is recommended that fertilization should be done with chemical fertilizers based on nitro-limestone or with complex ternary ones. As to the content in phosphorus of the experimental lots, the chemical analyses showed that they have an average content. The administration of phosphorus has to be associated with nitrogen and potassium. It is recommended that acid soils be fertilized with phosphorus on an annual base. The content of potassium is in deficit on the surfaces under study, its values being extremely low. According to experts, pastures are great potassium consumers. For maximum efficiency, it is recommended to apply potassium alongside with nitrogen and phosphorous. The lots under analysis have average amounts of humus.

The content of nitrogen, established according to NI (nitrogen index) calculated according to the content of humus and the saturation degree of bases shows average values.

Table 2 shows the experimental recipes (the doses of additive – slag powder) and the doses of chemical fertilizers needed by the experimental lots in order to grant their productive potential. For comparison reasons we also considered a witness lot (with no slag additive).

Table 2.

No.	Experimental lot	Slag powder, kg/m^2				Chemical fertilizers, kg/ m^2		
		Recipes 1	Recipes 2	Recipes 3	Recipes 4	P	K	N
1	plowing land -A	0	0,4	0,5	0,6	0,0058	0,007	0,0142
2	grazing area - P	0	0,4	0,5	0,6	0,0054	0,008	0,0147

3. ANALISES, DISCUTIONS, APPROACHES, INTERPRETATIONS

Pilot Researches – plowing land

In order to enable the pilot researches, the experimental lot – a plowing area of 400m^2 was divided into four plots: A1-A4 shown in fig.7.

A1	A2	A3	A4
Surface 100m^2	Surface 100m^2	Surface 100m^2	Surface 100m^2
Slag powder 0,4kg/m^2	Slag powder 0,5kg/m^2	Slag powder 0,6kg/m^2	Slag powder 0kg/m^2

Fig.7. The experimental lot – a plowing area

Plots A1, A2 and A3 were added a quantity 0,4 kg/m^2, 0,5 kg/m^2 respectively 0,6 kg/m^2 of slag powder. Plot A4 was used for comparison during the experiments, so it was not added any slag.

After the addition of slag, the adequate agricultural works were done (plowing, chisel plowing, seeding, fertilizing, mechanic and hand weeding). For the experimental plot, the culture of choice was maize.

During the experiments, we monitored the effect of slag addition upon the development of the plants. The results obtained two months after tilling and seeding are given in figure 8. One can notice the positive influence of slag addition upon the growing and blooming of the maize.

A1	A2	A3	A4

Fig.8. The experimental lot – a plowing area, after two months adding the slag

A1	A2	A3	A4

Fig.9. The experimental lot – a plowing area, after four months adding the slag

During the experiments, we monitored the effect of slag addition upon the development of the plants. The results obtained four months after tilling and seeding are given in figure 9. One can notice the positive influence of slag addition upon the growing and blooming of the maize.

Pilot researches – pasture

The experimental lot – pasture, was divided into four plots: P1-P4 shown in fig.10.

P1	P2	P3	P4
Surface 25m^2	Surface 25m^2	Surface 25m^2	Surface 25m^2
Slag powder 0,4kg/m^2	Slag powder 0,5kg/m^2	Slag powder 0,6kg/m^2	Slag powder 0kg/m^2

Fig.10. The experimental lot – pasture

The quantity of slag powder added to plots P1, P2 and P3 was 0,4 kg/m^2, 0,5 kg/m^2 respectively 0,6 kg/m^2. Plot A4 was used for comparison along the experiments, so it was not added any slag. The state of the pasture at the moment of adding the slag is shown in fig.11. The way in which slag powder addition influenced the development of the plants after two months is shown in fig.12. The way in which slag powder addition influenced the development of the plants after four months is shown in figure 13.

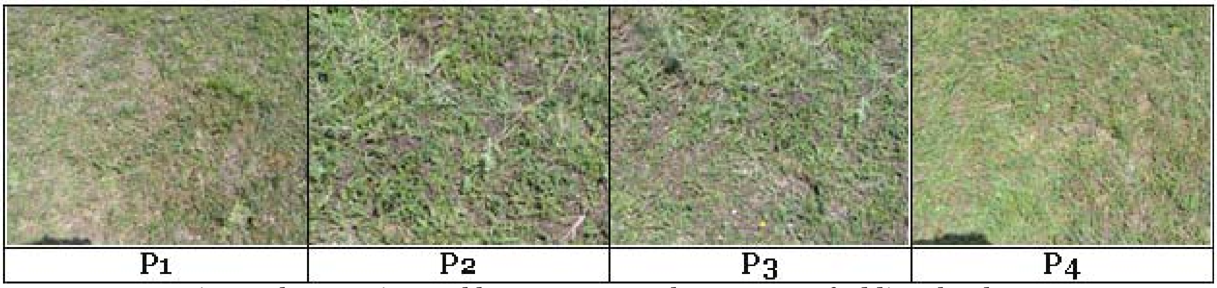

Fig.11. The experimental lot – pasture at the moment of adding the slag

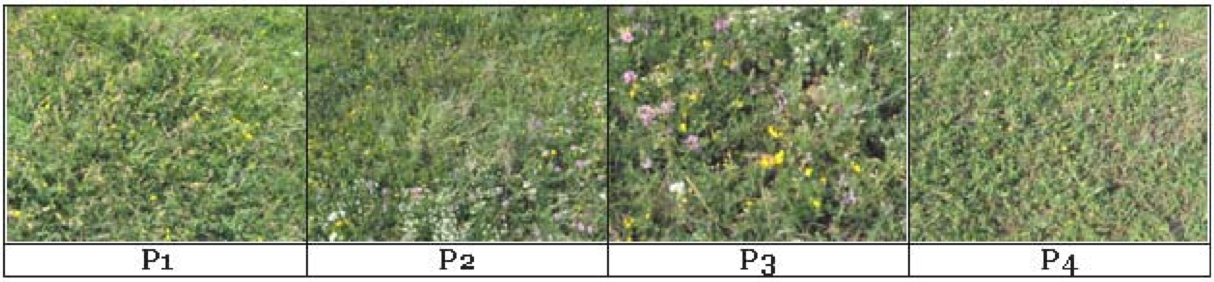

Fig.12. The experimental lot – pasture after two months adding the slag

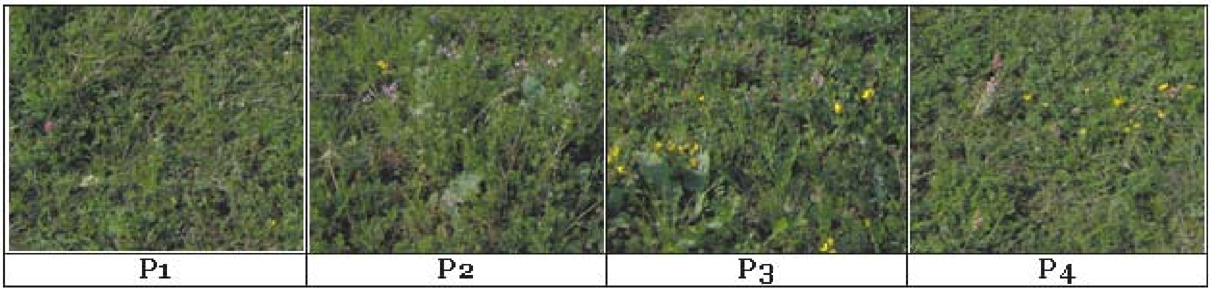

Fig. 13 The experimental lot – pasture after four months adding the slag

The steel plant slag used in the experiments comes from the Martin steel plant, particularly in the smelting phase, a slag that is rich in CaO (35-46%) and P (0.2-0.9%). To the total content of iron in these slags, we should add crusts, splashings and other metallic inclusions, which, in virtue of the production flow, reach the slag taps and end up on the dump. Thus, one can notice that the total quantity of iron in a dump is practically equal with that in the slags existing in the furnace, but the amount of iron increases in the detriment of FeO and Fe2O3 as well as other components of the slag.

After processing, the total content of iron in the non-ferrous slag obtained is about 13,4% where FeO, Fe_2O_3 and metallic iron are prevailing. The iron content of the non-ferrous slag is still quite high, as there are metal inclusions, missed by the metal separator, within the slag lumps. The other components of the non-ferrous slag have approximately the same level as in the non-processed slags. The non-ferrous steel plant slag (slag powder) has a basic character. It contains about 42% calcium oxide. This element is a lot more active from the chemical point of view, than any other lime additive. Added to the soil, it reduces its acid character and leads to its re-mineralization.

4. CONCLUSIONS

The proposed technology does not generate other pollution sources and it is efficient from the economic point of view, it can be implemented in practice either by the producers of such wastes or by other firms using deferrized slag.

The use in other sectors of the steel shop slag leads to release the surfaces occupied by these wastes and to render them to the respective natural landscape, there takes place a reduction of the pollution degree in the regions having steel industry.

From this point of view, metallurgical slag processing aims, directly and indirectly, at two targets included in the community acquis: the control and reduction of soil pollution by using clean technologies involving the turning of metallurgical slag wastes into recycled materials to be used in several domains: road and railway construction, hydro-technical and civil constructions, in the cement, glass and refractory materials industry, as well as in agriculture (improving soil acidity and re-mineralizing it).

Processing steel plant slags is beneficial for environment protection, community and agricultural welfare as well as from the technical point of view: metallurgical slags are non-toxic materials, with physical and chemical properties that are similar to rocks, so they represent a viable alternative, sometimes preferable to the natural variants for usage in constructions.

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