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PULVEROUS FERROUS WASTE PROCESSING BY PELLETIZATION

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Abstract: From the iron and steel industry always results a series of waste that are not capitalized enough with the rest of them being stored in stockpiles and ponds. Considering the fact that these waste contain iron and that – being unrecycled – they represent a polluting factor to the environment, it is imperial to find solutions to process them in a manner that will make them useful as raw or auxiliary material in manufacturing or other branches of the economy. The current paper presents the experimental research made in laboratory regarding the processing of pulverous ferrous waste through pelletizing with the purposes of making a new product that can be used as raw material in the iron and steel industry.
Keywords: waste, sludge, capitalizing, pellets

INTRODUCTION

The handling of industrial waste lies in capitalization, stockage, final storage and incineration. In Romania, the storage of waste on an open surface represents the most important means to eliminate industrial waste. In this manner, over the years a huge quantity of waste has been reached [1,2].

From the total amount of industrial waste landfills, a great deal do not have any facilities for protecting the environment and in most times, they are just cornered through fences. Some of these landfills have one or more of the special facilities (waterproofing, drainage, culvert, supervision drilling), but very few can be deemed as benefiting from all the conditions necessary to protect the environment. The cinder waste dumps are the storages that have most facilities: waterproofing with mineral layer, a drainage system that collects leachate, stability terraces, supervision drilling for the phreatic waters, splutter systems for surfaces.

Generally, as a consequences of the lack of facilities and the lean exploitation, the landfills also count as risk and impact generators for the environment and public health. The main impact and risk forms are (in the order perceived by the population):

- scenery modification and visual discomfort,
- the pollution of air and water,
- the decrease of soil fertility and
- the alteration of biocenosis composition in the neighbouring terrains [3].

The problems that waste management in Romania is dealing with can be summarized in the following way [4–7]:

- the storage on an open terrain being the most important way to eliminating waste;
- the existing waste being stored in inappropriate locations (near housing units, surface waters and vacation land);
- the landfills are not facilitated properly for environmental protection and lead to the pollution of water and soil in that area;
- the area occupied by the landfills now is considered a degraded area that cannot be used anymore in agricultural purposes; currently, in Romania, more than 12000ha of land are affected by the storage of domestic and industrial waste.

All these lead to the conclusion that the waste management sector needs to adopt certain specific measures that are fitting to each phase of waste elimination into the environment. Following these specific measures must be the objective of environmental risk factor monitoring that are related to wastes [8–10].

In this sense, the pelletizing is a method of agglomeration, or particle size enlargement, in which material fines are processed into pellets or granules. Pelletizing is used throughout a multitude of industries to process thousands of materials from difficult to handle powders and fines, into easy to handle pellets. Unlike pressure methods of agglomeration, such as compaction granulation or briquetting, pelletizing is considered a wet process, because moisture (in the form of a binding agent) is used to agglomerate the fines into larger particles, as opposed to the extreme pressure used in compaction or briquetting. Pelletizing a material can offer a number of benefits. Because of this, it has become a popular method of improving product performance, easing handling challenges, and even targeting desired product characteristics. In fact, the pelletizing is an incredibly diverse and flexible process, lending itself to thousands of materials, and nearly any material in powder or slurry form can be transformed into a dry, granular product.

Pelletizing, particularly on a disc pelletizer, is a highly flexible process, allowing for a significant amount of product customization to occur. Additives can be included to improve product formulations, and a number of variables can be adjusted to target specific end product parameters, such as particle size distribution, crush strength, flowability, and more. In essence, pelletizing allows producers to create a granular product that suits their exact needs.

For the many reasons (reduced dust, reduced attrition, faster product breakdown, and customization), products created via pelletizing are considered a premium product. With many benefits, and a highly customizable process, pelletizing has become a staple in many industries, with new applications for this valuable process constantly on the rise.

LABORATORY EXPERIMENTS

In this paper, there are presented the capitalization methods of pulverous ferrous waste that are the result of water depuration, this being: ferrous sludge (10.02.2018 – waste from the cooling water depuration). It comes from a plant that produces metallic powders. Choosing the procedure and technology of capitalization must have in view the features of the waste, the destination of the resulting product and the existing processing facilities in the waste area [11].

The ferrous sludge samples have been put laboratory research. The chemical composition presented in table 1 and the granulometric composition have been determined. Analysing the chemical and granulometric composition of the pulverous ferrous waste we determined it can be processed through classic technologies like: briquetting, pelletizing and agglomeration.

Table 1. The chemical composition of ferrous sludge

Chemical composition [%] ASTM E 1479/2016						
Al	Cd	Cu	Cr	Mg	Mn	Ni
0.003	0.003	0.70	0.54	0.003	0.079	0.046
Pb	Fe	Sn	Sb	Zn	Other	
0.008	84.40	0.016	0.003	0.003	14.196	

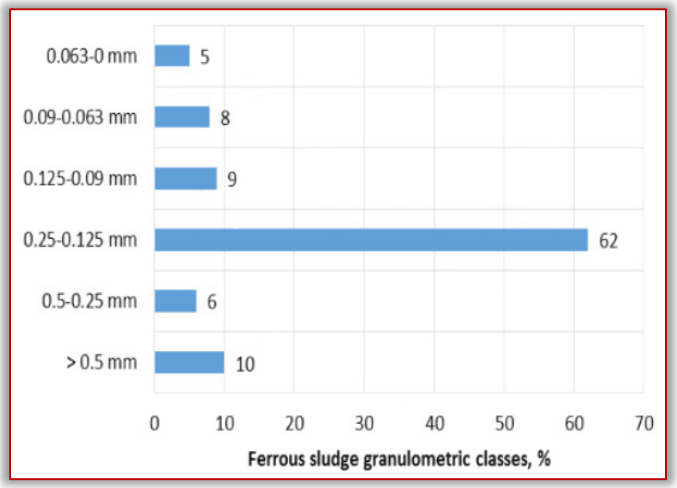

Figure 1. Ferrous sludge granulometric classes

In this paper there are presented the processing through pelletizing (micro–pelletizing). A processing method was chosen that requires the addition of bonding materials in order to capitalize the waste as pellets/micro–pellets and as raw materials in the steel ovens [11,12].

There has been an experiment of 5 recipes and as bonding materials bentonite 5–10% and slag LF 5–10%. The flow sheet of processing the pellets/micro–pellets is presented in figure 2.

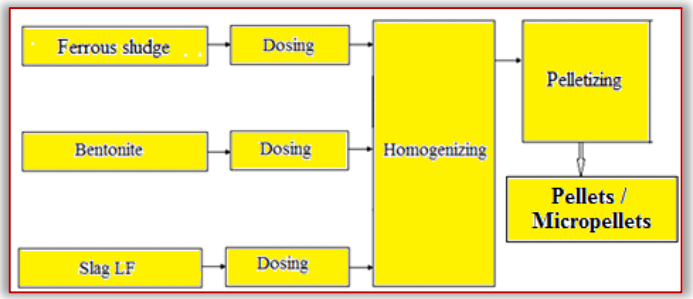

Figure 2. Technological flux of pelleting/micro–pelleting

Figure 3. Aspects during laboratory experimentation

The steps from the processing procedure and the procurence of sub–products are presented in figure 3. The experimental pellets/micro–pellets were put under hot–tempering in the oven according to figure 4. The chemical composition of the obtained pellets/micro–pellets is shown in table 2.

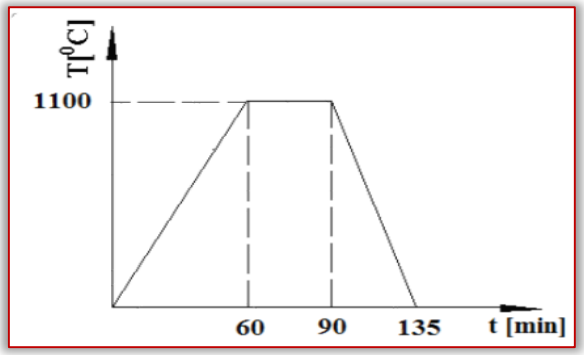

Figure 4. The pellets hardening diagram
(T– hardening temperature, [°C]; t – hardening time,[min])

Table 2. The chemical composition of the pellets

Chemical composition, [%] ASTM E 1479/2016						
Al	Ca	Cu	Cr	Mg	Mn	Ni
1.16	3.44	0.13	0.06	0.63	0.41	0.03
Si	Fe	W	S	Na	Anothers	
3.13	75.18	1.68	0.13	0.26	13.76	

From each batch of pellets we chose pellets sized 12–15 mm in diameter for which we tested compression strength of pellets. The result of the experiment are presented in table 3.

Table 3. Compressive strength of pellets

Compressive strength of pellets [daN/pellet]				
R1	R2	R3	R4	R5
178	172	167	157	175

The results show that compressive strength of pellets for raw and burnt pellets confirm the fact that the waste can be capitalized through pelletizing since the obtained pellets have the necessary astriction for manipulation and transportation from the manufacturing agent to the ovens at the steel plant.

FINAL RESULTS AND CONCLUSIONS

This paper present the obtained by–products (pellets/micro–pellets) while processing the analysed waste. After laboratory experiments a balance pan device was used and as binding agent bentonite and slag LF (max 10%).

The pulverous, small sized waste can be capitalized in the contemporary iron and steel industry and there is a need to continue research in order to establish the most performing procedures, capitalization methods that are good both from an economical and an ecological point of view.

The constant preoccupation to respect legal norms regarding the environmental protection and the need to harmonize them with the requirements of economic progress, the reasonable segmentation of material and energetic resources should lead to the capitalization of waste through technologies that can be deemed as the optimal solution economically and ecologically.

The laboratory experiments we performed lead to the procurance of experimental by–products – pellets that can be used as raw material in the siderurgy.

The main benefit of a granular product over raw fines is the improved product performance. In this sense, the pellets performance can be improved in a variety of ways as a result of agglomeration. Granular soil amendments, for example are more likely to deliver targeted results over their powdered form, because they do not become windblown and are much easier to accurately apply. Also, the pelletized products are much easier to handle and apply over raw material fines. Pellets are easier to feed, due to improved and more consistent flowability. Moreover, the pellet products are also much less dusty. Some materials may even be pelletized prior to landfilling in order to reduce dust loss during transport and handling, as well as to avoid material becoming windblown.

The production of pellets from different wastes can be made according to the range of recyclable waste available, the addition of binding substances, water and the granulometric finesse of the waste. The values obtained at the test for resistability at astriction for the raw and burnt pellets show that the product has the necessary resistance for being manipulated and transported to the iron processing plant. Reintroduction these ferrous materials in the economic circuit represents an advantage from an economic and ecological point of view.

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