

Recovery and Valorification of Iron From Industrial Waste

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Abstract. In order to apply the concepts regarding sustainable development a balance needs to be established between the raw materials used and the volume of capitalized wastes, the aim being to reduce the level of pollution. An emphasis must be made on the technologies that allow the capitalization of waste that can be revaluated after the manufacturing and storage processes. This paper presents the results obtained after laboratory testing the processing of ferrous waste with the aim of obtaining raw material that can be reused in the ferrous metallurgy. Processing and capitalizing such waste may result in recovering iron.

1. Introduction

Currently, the issue of handing waste through capitalization is an ecological and economical priority. Circular economy (fig.1) stimulates the growth of economic value at the same time that the consumption of natural resources decreases [1].



Figure 1. Circular Economy [1]



The capitalisation of waste is an essential part of recycling and it answers the connection between the vital and final point of the process in the economic circuit of waste. This dynamic offers circularity for economy. The capitalisation of industrial waste leads to the minimization of natural resource consume, the development of businesses, the optimization of costs and the creation of new jobs. The European Union must transform the linear economical model into a circular one which favours reuse and recycling of materials and existing products. By generating less waste the economy becomes more competitive, reducing the pressure of limited natural resources and the impact of the environment [2].

The European Commission integrated aspect related to circular economy in the Reference Documents about best techniques available (BREF). This thing will contribute to the reduction of waste generation, will stimulate recycling and the reduction of resource use thus leading to a greater durability and competitiveness in industrial sectors. Among the best available techniques for the metal industry we have: techniques of best raw material use and techniques of reduction the generation of compost by alternating process residue [3].

2. Experimental researches

The paper presents the capitalization of pulverous ferrous waste [4]:

- Electric steel plant dust (10.02.08 – solid waste from gas clearance);
- Ferrous sludge (10.02.12 – waste from cooling water clearance).

The pulverous ferrous waste come from a plant of making and producing metallic powders. Choosing the procedure and technology for capitalization must have in view both the characteristics of waste and the destination of the waste, plus the processing installation existing in the west area.

It has been determined the chemical composition (table 1 and 2) and granulometric classes (figure 2 and 3) of the waste used in laboratory testing.

Table 1. Chemical composition of ferrous sludge

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

Table 2. Chemical composition of steel plant dust

Chemical composition, [%] ASTM E 1479/2016															
Al	Cd	Cr	Cu	Fe	Mg	Mo	Mn	Ni	P	Pb	Si	Sn	Ti	Zn	Other elements
0.7	0.01	0.04	0.085	65.5	2.3	0.005	0.87	0.03	0.013	0.1	3.45	0.006	0.02	3.1	23.77

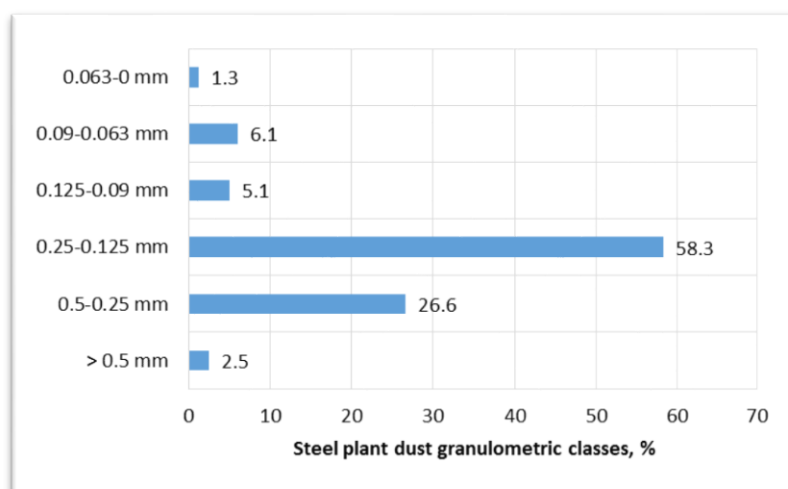


Figure 2. Steel plant dust granulometric classes

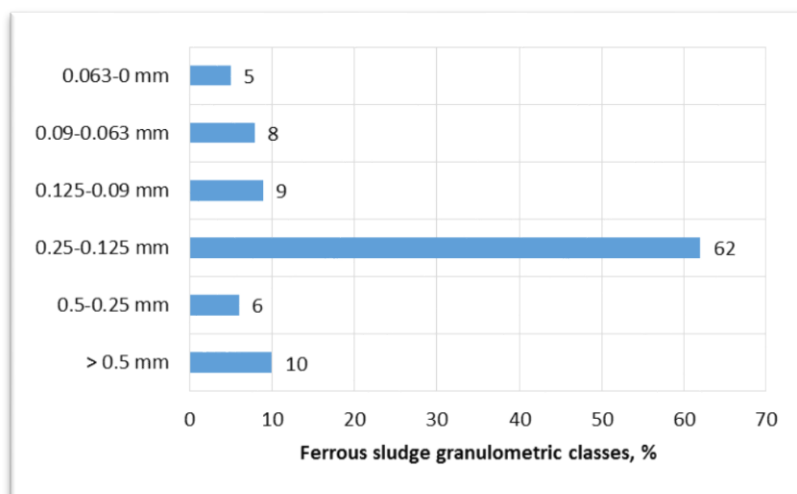


Figure 3. Ferrous sludge granulometric classes

In this case, we chose to process small wastes through briquetting processing with different binders adding so that we could their capitalization as raw material for steel making furnace [5,6]. At choosing the processing way we had in view the granulometric class determined in laboratory conditions, the balance of size between 0.25 mm being 87% from steel plant dust and 77% from ferrous sludge.

Also, at recipes composing we tried using exclusive waste with small add-ons of binder (bentonite, cement and slag LF). We obtained briquettes after 8 recipes, the compoense of experimental recipes are presented in table 3. Technological flux of briquettes processing is presented in figure 4.

Table 3. Component of recipes

Components, %	Recipes							
	R1	R2	R3	R4	R5	R6	R7	R8
Steel plant dust	0	0	0	0	35	40	40	40
Ferrous sludge	95	95	100	90	60	60	50	50
Bentonite	5	0	0	0	0	0	0	0
Cement	0	0	0	0	5	0	10	0
Slag LF	0	5	0	10	0	0	0	10

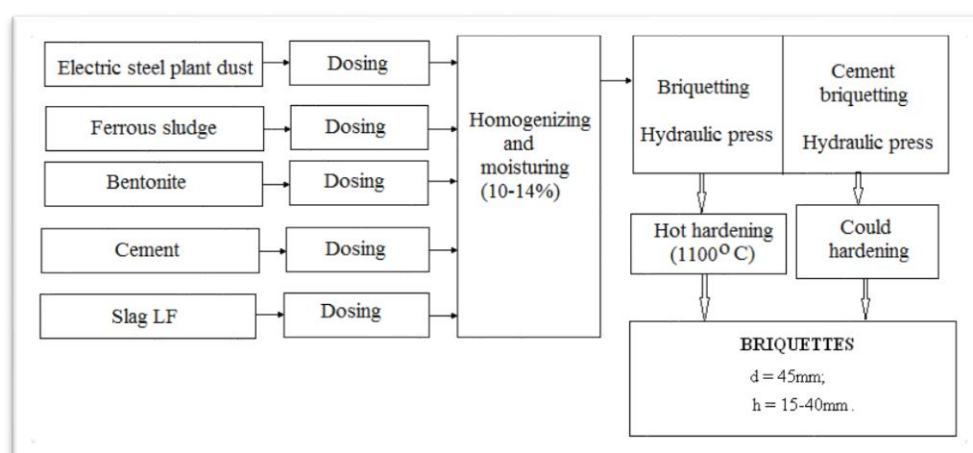


Figure 4. Technological flux

According to this, wastes are proportioned, smoothened and slightly wet: after words the mix is briquetted with the help of the installation from the laboratory of Energetic and raw material basis of the Faculty of Engineering from Hunedoara. The briquetting was made in a cylinder mould with forces varying between 200-350kN. The experimental briquettes that have bentonite component and slag as binder were hardened in the oven according to figure 5. The aspect during waste processing are presented in figure 6.

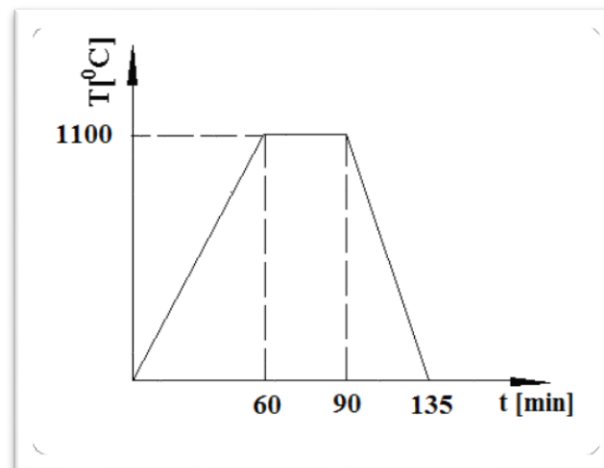


Figure 5. The briquettes hardening diagram
(T- hardening temperature, [°C]; t- hardening time,[min])



Figure 6. Material and equipment used for experiments, and the resulting briquettes

The chemical composition of usual briquettes is presented in table 4.

Table 4. Chemical composition of briquettes

Chemical composition, [%]												
Fe ₂ O ₃	SiO ₂	CaO	Al ₂ O ₃	MgO	MnO	ZnO	Na ₂ O	SO ₃	K ₂ O	MoO ₃	Cr ₂ O ₃	Other oxides
85.09	9.60	0.80	1.85	0.78	0.25	0.33	0.44	0.15	0.18	0.06	0.05	0.42

3. Conclusions

After preliminary examination of waste processing of some pulverous ferrous waste with the purpose of reintroducing them in the economical circuit: the following were discovered:

- Analyzing the chemical and granulometric components of ferrous waste from a metallic powders plant results show that this can be capitalized through recycling;
- The procedures through which pulverous ferrous waste can be recycled in the iron industry are: briquetting, aggregation and pelleting. The first two are recommended for wastes with a varied granulometric compenence material;
- This makes the experimental procedure easy and cost effective by companies which process and recycle these types of waste.

Analyzing the chemical and granulometric composition of pulverous ferrous waste resulted from a metallic powders production can be capitalized through recycling. The experimental briquettes obtained are destined to use as raw material at manufacturing steel in electric arc furnace.

An important interest is shared in non-conventional recycling of waste in order to obtain a product with high metal iron composite. The experimental briquetting obtained have a high amount of iron 60%Fe. It is necessary to intensify the capitalization process of these waste for both economical (they represent a source of iron), technological and ecological reasons.

4. References

- [1] <http://ec.europa.eu/environment/circular-economy>
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- [6] Crisan A, Vilceanu L, Ardelean M and Putan V 2013 Research regarding the compression behaviour of ferrous briquettes *Technical Gazette* **20**(4): 581-586