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RECOVERY POSSIBILITIES OF THE PULVEROUS FERROUS WASTES THROUGH PELLETIZING IN THE AREA OF HUNEDOARA

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ABSTRACT:

Based on the study regarding the recovery possibilities of pulverous ferrous wastes in siderurgy, and also the conditions present in the area of Hunedoara, depicted in the project proposal, we consider that the processing technology through pelletizing is viable on economical basis. At the same time, we take into consideration for the future to recover pulverous ferrous wastes through briquetting and obtaining carboferrous, if we have in view the conditions provided by the area of Hunedoara.

In this paper are presented some researches and relevant results, regarding the obtaining of the pellets, through using the plant dust, agglomerate dust and ferrous powdery wastes in the pelletizing charges, resulted for the spathic iron ores processes. The resulted pellets have a sufficient resistance for uses at the charge of the electric arc furnaces and represent an excellent addition material, for the refining slag formation, at the steel elaboration. This aspect is very important for us - specialists in the steel elaboration. In this paper we presented some researches and their experimental results obtained in the processing of pulverous wastes through a pelletizing operation.

Also, this procedure can be significant for the environmental protection. The implementation in the industrial practices of the accounting technologies of these ferrous powdery wastes, now stored in the regional ponds of the nearby ferrous industry sectors, assure in time the repossession of this place occupied by the wastes, to the natural environment. Also, this technology establishes the elimination of some environment pollution sources, especially the air pollution and the earth and water contamination.

The environmental aspect is given by the considerable reduction of environmental pollution, both by the increase of recovery for pulverous wastes and reduction of depository spaces for these wastes. The economical aspect is reflected by transferring depositary expenses (55…110 €/tone of waste) to other purposes.

KEYWORDS:

ferrous pulverous wastes, pellets, environmental protection

1. INTRODUCTION

In the last decade, manufacturing technologies for metallic materials all over the world have reached a high performance level, demonstrating a high capacity to adapt to the changes due to conditions imposed on raw materials and energy, necessary to increase productivity and decrease specific use, as well as obeying to stricter environmental regulations.

The remarkable results obtained in modern iron factories were possible through implementation of management systems into industrial activity, systems which imposed the analysis, evaluation and selection on changes at the level of technologies / equipments, respectively alternative technologies, from the perspective of its specific instruments, among which one of the most complex is undoubtedly the life cycle analysis (LCA). In such a complex, this management component offers the main information, with which the engineer may establish the moment of genesis for the secondary material, namely the phase in which the problem of recycling can be put into practise and research.

LCA (from Life Cycle Analysis) appeared as a result of society’s concern for the quality of environmental factors and the obligation of governmental institutions to control the phenomenon of industrial pollution.

The administration of secondary materials must represent a problem of strategy in the internal practice of the company, taking into account the following objectives:

- reducing to the minimal level the quantity of secondary products
- minimizing through recycling the quantity of secondary products obtained from a technological process
- increasing the degree of recovery (transforming wastes in useful subproducts for other sectors of economy)
- dominating through supervising and control of problems with a negative impact upon the environment, that can occur when treating and transporting wastes.

Pulverous ferrous wastes are present in all cases in the form of oxides. For the recovery of iron, they must be objects in a reduction process, either in a furnace, case in which these wastes are components of the raw material (previously processed as pellets, briquettes or agglomerate), or in electric arc furnaces, as secondary material with a complex fusing - oxidizing character or as a slag foaming agent.

In countries with a well-developed iron industry, pulverous ferrous wastes are recovered in a proportion of over 90% through re-introduction in the siderurgical circuit. The works written of this theme state that this recovery is practised with several technologies, namely:

- recovery through agglomeration
- recovery through pelletizing
- recovery through briquetting
- recovery through reduction without initial processing
- recovery through the carboferrous method

Especially in ferrous industry, but in other industrial areas as well, a large number of dusty, pulverous wastes result and part of them are re-introduced into the economical circuit, deposited into settling ponds, thus representing pollution sources for the environment.

The economical importance of re-using ferrous scraps in ferrous metallurgy is obvious, if we consider that in most cases these scraps can be an important element of steel furnace charges, as they can replace, in a certain proportion, the iron.

Iron making requires about 2 tones ore per t of iron, 1 tone close burning coal per tone of iron, 0.5 tone limestone per tone iron which are quite large investments in cokery, agglomerating plant and blast furnace building, and also necessities high exploitation expenses.

It clearly results that any tone of re-used ferrous scraps, which are re-introduced into the siderurgical production, leads to significant investment and exploitation expense savings. Besides this economical aspect – which is primordial – in ferrous powdery scraps re-usage we can mainly solve the problem of environmental pollution (air - water - soil) through depositing these industrial scraps.

The researches and experiments presented in the paper had as objective a joining of the economical imperative of maximum recovery of a certain ferrous wastes category: dusty (pulverous) wastes, with the social aspect of eliminating pollution in the environment in order to re-establish and maintain environmental equilibrium.

The recovery through pelletizing is a technology involves using steel plant dust as unique component in the agglomeration charge, or in a mixture with pulverous ferrous ore or other pulverous wastes for producing pellets.

The obtained pellets, according to their quality, determined mainly by the processing technology, can be used:

- in furnace charges, as raw material, together with agglomerate, and, eventually, ore
- in reduction equipment charge, to obtain metallized pellets and use them as raw material in electric arc furnace
- in charge of electric arc furnace as auxiliary material to form slag and correct the chemical composition, or as foaming agent.

2. EXPERIMENTS, RESEARCHES AND RESULTS

Our researches analysed the possibilities of economical usage in siderurgy, namely in electric arc furnaces, of ferrous pulverous wastes resulting from gas purifying in steel plants, of slimes from the settling ponds resulted form of wastes from steel ore processing equipments.

The use of these wastes is important not only because the iron is recuperated and the environment is protected, but also because near by Hunedoara, they exist as:

- steel plant dust – 10,000 tones, currently resulting from technological processes;

- ferrous wastes from agglomerating plants and blast furnaces – 250,000 tones, deposited in ponds, in some areas dating from more than 15 years;
- steel ore wastes, approximately 3.5 million tones, deposited in other two ponds.

Currently, pulverous ferrous wastes are re-introduced into the economical circuit through their use as raw material (2…3%) in agglomerating charges. Steel dust is also used for producing pellets for iron making or for the charging in electric arc furnaces (metalled pellets).

Having in view the fine granulation of these ferrous wastes, we consider that the re-introduction into the agglomerating charges is the optimal solution.

The pelletizing solution is required along the integrated operational flux (raw materials – agglomeration – blast furnaces – steel plant – rolling mills) or where this flux suffered some changes.

Considering the remarks above, as well as the fact that in the area of Hunedoara there is a siderurgical company, which was restructured, we are of the opinion that the use of these pellets is the optimal solution. In this sense, the steel dust - having the finest granulation - suits the requirements for pelletisation.

Our paper presents in the following lines the experiments and the results regarding the re-introduction into the economical circuit of the following ferrous pulverous wastes: steel dust, agglomerating dust and slime and spathic concentrate.

Table 1. The variation limits of the pelletizing charges components

Applied variant	The pelletizing charges components, [%]				
	Ferrous pulverous wastes (steel dust - agglomerating slime - spathic concentrate)	Lime	Cement	Slag	Bentonite
I	70	7 - 9	7 - 9	2	2
II	25 - 45	45 - 65	6	2	2

Table 2. The chemical composition of the ferrous pulverous wastes, [%]

Materials	Chemical composition, [%]										
	SiO_2	FeO	Fe_2O_3	Fe	Al_2O_3	CaO	MgO	MnO	P	S	C
Ferrous wastes from the settling ponds	34.39	7.01	7.84	9.12	2.87	16.39	6.68	1.35	0.12	0.23	-
Spathic concentrate	19.86	9.92	18.64	21.03	3.16	20.22	7.56	2.29	0.13	0.24	-
Sterile after concentration	37.60	6.30	5.58	6.45	2.87	15.16	6.58	1.41	0.12	0.23	-
Ferrous wastes (agglomerating - host furnace)	8.41	7.12	48.45	39.61	7.11	8.43	2.02	0.71	0.11	0.11	17.7
Steel dust	1.25	2.40	86.12	63.25	0.20	0.40	0.08	4.40	0.21	0.31	-
Lime (dust)	0.8	-	0.5	0.35	0.45	96.30	1.20	0.20	0.10	0.10	-

Table 2 presents the chemical compositions of the ferrous and the pulverous ferrous wastes and of the lime dust resulting from the cleaning of gases in lime factories – all used in the pelletising process.

The analysis of the data from Table 2 notices that there is a considerable difference, from the point of view of the chemical composition, between the three types of pulverous ferrous wastes. The spathic wastes undergo to a magnetically concentrating process, following which a spathic concentrate and a sterile (secondary waste) are obtained. We consider that this sterile can be used in constructions and in agriculture.

The spathic concentrate, together with the steel dust and the agglomerating dust were subjects of the pelletizing process. The experiments were put into practice in the iron laboratories of the Faculty of Engineering in Hunedoara, using a plant with the following characteristics: the diameter of the scale – 980 mm; the height of the lateral side - 100mm; the rotation speed - 8 rot/min; bending angle - 45^o; the engine power - 1,5 kW.

Table 3 presents the recipes of the pellets produced in the case I. After pelletizing, the pellets were dried (in air stream) the process being guided in such a way as to reach a resistance of a minimal 100 daN/pellet.

In the case II the experiments put into practice during this case had in view, on one hand, the importance of the lime's dissolving process to obtain an active slag, and on the other hand, the use of lime dust resulting from gas cleaning in lime factories. The obtained pellets have a their chemical composition presented in Table 4.

Table 3. The pelletising recipes, [%]

No. recipes	Steel dust	Spathic concentrate	Ferrous scraps	Host furnace slag	Lime	Cement	Bentonite
1.	10	50	20	2	8	8	2
2.	50	10	20	2	7	9	2
3.	45	15	20	2	9	7	2
4.	40	20	20	2	8	8	2
5.	30	25	25	2	8	8	2

Table 4. The chemical composition of the obtained pellets, [%]

No. recipe	Chemical composition, [%]										
	SiO_2	FeO	Fe_2O_3	Fe	Al_2O_3	CaO	MgO	MnO	P	S	C
1.	15.18	6.62	27.83	24.76	6.86	24.31	4.55	1.74	0.11	0.18	3.54
2.	7.97	3.61	54.81	41.65	5,52	15.94	1.54	2.58	0.14	0.21	3.54
3.	8.43	3.99	51.46	39.53	5.83	12.03	1.81	2.47	0.14	0.20	3.54
4.	9.59	4.37	48.07	37.43	5.97	18.76	2.31	2.37	0.13	0.20	3.54
5.	10.86	4.98	42.81	34.13	6.46	19.76	2.78	2.08	0.12	0.18	4.42

Considering the chemical composition of the pellets it is clear that from the point of view of the iron content, the most convenient are the pellets produced with recipes 2 and 3 – is a normal fact, if we take into account the presence steel dust, which is the component with the highest content of Fe. The pellets resulting from the use of recipes 1, 4 and 5 are poorer in Fe, but richer in CaO. Besides these wastes, we cannot eliminate the possibility of introducing into the pelletising charges of a larger number of wastes.

For the compounding of the acid and neutral oxides in basic slag, limestone or lime is used. In the lime dissolving process it is very important to hinder the calcium ortho-silicate skin formation around the lime particles. This is possible only if the slag contains at least 20% FeO. This means the fastening of solution formation in the FeO-MnO-CaO system, and that is possible if the lime contains more FeO. That is not possible in the lime production, but can be put into practice by producing some complex materials with a positive effect both on de-phosphorization and de-sulphurization. According to the available data in the literature produced on this subject, the most convenient means is the utilisation of briquettes or pellets with 70%CaO, 20%Fe_2O_3 and other components.

Briquettes of other origin can be used, too, thus experimenting pellet producing from pulverous materials, such as: lime, steel plant dust, spathic iron concentrate, agglomerating and blast furnace residue, pellets that can be used as addition to melting slag, respectively to refinery slag.

Table 5 presents the recipe composition for the pelletizing charges, and the chemical composition of the obtained pellets in Table 6. The hardening was performed as in case I.

Table 5. The composition of the recipes, [%]

No. recipe	Chemical composition, [%]						
	Lime	Steel dust	Spathic concentrate	Ferrous slime	Cement	Slag	Bentonite
1	65	25	-	-	6	2	2
2	61	15	17	-	6	2	2
3	56	17	17	-	6	2	2
4	56	12	12	10	6	2	2
5	45	17	14	14	6	2	2

Table 6. The pelletising mixture (with a 7% cement and a 3% blast furnace slag addition)

No. recipe	CaO	SiO_2	FeO	Fe_2O_3	Fe	Al_2O_3	MgO	MnO	S	P	C
1	74,50	2,74	1,15	27,02	19,62	1,08	1,10	1,49	0,13	0,23	0
2	73,66	2,51	2,65	16,88	13,72	1,66	2,52	2,52	1,27	0,11	0
3	68,87	6,51	2,68	21,77	16,82	1,65	2,47	1,48	0,12	0,24	0
4	68,68	6,18	2,86	18,72	19,53	2,19	2,28	1,22	0,11	0,31	2,67
5	59,49	6,69	3,19	24,40	19,42	2,50	2,27	1,45	0,12	0,36	3,50

3. CONCLUSIONS

The researches and experiments put into practice, led to the following considerations:

- the three types of pulverous ferrous wastes can be processed through pelletising;
- according to the target had in view (recuperated iron, the slag frothing degree, correction of the slag's chemical composition) the quality of the pellets and the adequate recipe is chosen;
- the utilisation of these wastes presents an important interest considering the large quantities that are deposited in the ponds. Due to these large quantities there is the danger of their break-down, having severe consequences upon the environment;

- the results allow the re-introduction into the economical circuit of some ferrous wastes which can replace a part of the waste iron, shortly to be a deficitary raw material;
- also a decrease of environmental pollution would be possible in the vicinity of these ponds, and this would an action of considerable social impact (dust draws disappear through air streams, the risk of falling ill decreases, as well as that of soil sliding and water pollution);
- the pulverous ferrous additions can be used to produce complex additions, which are very useful for active slag formation;
- from the point of view of the pellets' chemical composition and that of the CaO content, the pellet production is recommended to be done with recipes 1 and 2;
- from the point of view of the compression resistance, the pellets are adequate to be used in electric arc furnaces.

Based on the study regarding the recovery possibilities of pulverous ferrous wastes in siderurgy, and also the conditions present in the area of Hunedoara, depicted in the project proposal, we consider that the processing technology through pelletizing is viable on economical basis. At the same time, we take into consideration for the future to recover pulverous ferrous wastes through briquetting and obtaining carboferrous, if we have in view the conditions provided by the area of Hunedoara.

At the briquetting variant, generally the briquetting charge used more ferrous wastes, adding powders with high carbon and lime dust content. The obtained briquettes can be processed in reduction aggregates.

All over the world it is used to produce cast iron in furnaces, being blasted into the mixture with coal dust through the blast inlet of the furnace, as well as casting iron in electric arc furnace, using it as a replacement for common slag foaming agents at electric arc furnaces provides both environmental and economical aspects. The environmental aspect is given by the considerable reduction of environmental pollution, both by the increase of recovery for pulverous wastes and reduction of depository spaces for these wastes. The economical aspect is reflected by transferring depositary expenses (55…110 €/tone of waste) to other purposes.

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