ISIRR 2003

FERROUS POWDERY WASTES IN SIDERURGY – POSSIBILITIES HAVE TURNING INTO ACCOUNT THROUGH ONE OF THE NEW TECHNOLOGIES

[1]HEPUT Teodor, [1]KISS Imre, [1]RATIU Sorin

[1] UNIVERSITY "POLITEHNICA" – TIMISOARA,
FACULTY OF ENGINEERING - HUNEDOARA

SUMMARY/ABSTRACT

The experiments - which were carried out by a group of teaching personnel from the Faculty of Engineering of Hunedoara (Romania) - will form the basis of new technologies meant to reduce environment pollution by using the powders resulting in siderurgical processes and the materials already existing in the dumps of the power stations.

Siderurgical industry uses large quantities of raw materials, both in the primary and secondary process of steel making. The basic raw materials for the primary elaboration consists in iron ores, used, as a rule, in a processed form, or as agglomerate, in the form of pellets.

The paper introduces the results obtained in the laboratory experiments carried out at the Faculty of Engineering of Hunedoara, on the use of powdery ferrous wastes meant for pellet making. As wastes, we chose the electrofilter dusts from the steel plant and the iron concentrate obtained out of power station ashes, to be found in the existent dumps.

KEY WORDS:

environment pollution, new technologies, ferrous powdery wastes, power station dumps, pellets

1. INTRODUCTION

In order to cut costs and reduce the specific consumption of expensive or rare raw materials on the one hand, and for diminishing the pollution of the ecological system air-water-soil on the other hand, there is a worldwide preoccupation with respect to the use of ferrous powdery wastes, resulting from industrial activities like: the metallurgical, chemical, energetic industry, etc. These wastes have a high content in iron, ranging between 28 and 65%, the sterile being close to the ore, from the point of view of its chemical structure. It is therefore natural that studies and experiments should be carried out in order to find ways of reusing such wastes in siderugy.

Siderurgical industry uses large quantities of raw materials, both in the primary and secondary process of steel making. The basic raw materials for the primary elaboration consists in iron ores, used, as a rule, in a processed form, or as agglomerate, in the form of pellets. At present, except for the chemical structure, the quality of the pellets used in the blast furnace in order to obtain pig iron is determined mainly according to the following characteristics [1, 2]: the grain size, its crush and drum resistance, the reducibility, as well as the free growth and porosity index.

Industrial experiments demonstrated that in case of using pellets in blast furnaces it is recommendable that their diameter be ranging between 9,5 and 25 mm and the fraction 10…15 mm should represent a minimum of 85% of the entire quantity. The crush resistance is expressed in daN/pellet and represents a factor depending on the mineralogical structure of the material in use, on its grain size, the binding addition, the work conditions and the dimensions of the pellets. The drum resistance is expressed in %. It is being used to determine the grinding (abrasion) index, as well as the crushing index. Values of 6% for crushing and 5% for grinding are considered to be acceptable.

The reducibility (R) is expressed in %/min. It is considered representative enough if reducibility is expressed according to the mean reduction rate dR/dT, reached when the reduction degree is 40%. A reducibility of 0,7…0,8%/min, for acid pellets and 1,2…1,3%/min for basic ones is considered to be quite good. The free growth index of pellets is expressed in %. The test is to take place at a temperature of 1050^0C, for about 30 min in a CO blow, and represents the percentage increase in volume of the pellet, as compared to the initial volume. This should not exceed the value of 14%. Porosity is expressed in percents and its values should range between 20 and 30%.

2. EXPERIMENTAL RESULTS

The paper introduces the results obtained in the laboratory experiments carried out at the Faculty of Engineering of Hunedoara, on the use of powdery ferrous wastes meant for pellet making. As wastes, we chose the electro-filter dusts from the steel plant and the iron concentrate obtained out of power station ashes, to be found in the existent dumps, their chemical structures being given in table 1, respectively table 2.

One of the basic conditions to be met by the powdery materials in order to be fir for the pelletising process is connected to their grain size. Thus, it is recommended that the percentage of the fraction of size below 40 μm be 35…60 % for hematite and limonite.

As the result of the tests we considered that from this point of view both categories of wastes can be used in order to make pellets. The grain size structures of these wastes are given in tables 3 and 4 respectively.

Table1. The chemical structure of the iron concentrate resulting from power station ashes [%]

SiO_2	Fe_2O_3	Al_2O_3	FeO	CaO	MgO	MnO	P_2O_5	Other oxides	Fe
11,89	51,96	8,85	13,39	7,31	3,85	1,25	0,07	1,93	46,71

Table 2. The mean chemical structure of the steel works powder [%]

FeO	Fe_2O_3	MnO	SiO_2	CaO	Al_2O_3	P_2O_5	Other oxides	Fe
1,50	90	4,4	1,25	0,4	0,2	0,3	1,95	64,71

Table 3. The grain size structure of the iron concentrate resulting from power station ashes

Grain size fraction [μm]	over 150	100…150	40…100	below 40
[%]	0,02	12,41	44,05	43,52

Table 4. The grain size structure of the steel works powder

Grain size fraction [μm]	over 1,5	1,5-1,0	1,0-05	below 0,5
[%]	8,77	67,48	12,52	11,23

The production of crude pellets was carried out on a plate-type installation, with the following characteristics: the diameter of the plate 980 mm, the height of the lateral part 100 mm, rotation rate 8 rot/min, the inclination angle 45^0 and the power of the driving motor 1.5 kW. The experiments carried out at the Faculty of Engineering of Hunedoara had in view the obtaining of pellets according to 7 different recipes, given in table 5. As a binder we used bentonite, in a proportion of 0,5…3% and lime in a proportion of 2%.

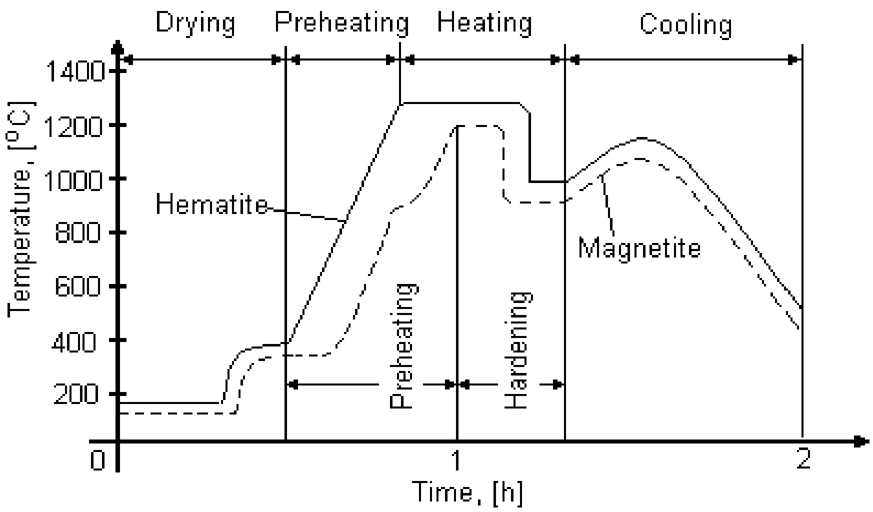

Figure 1. The diagram of the hardening of pellets

The hardening of crude pellets, in the laboratory was carried out in an electric oven, with electrodes made of silicon carbide, where we obtained temperatures above 1200^0C and temperature levels being given in the diagram of figure 1.

Table 5 – Recipes used in the experiments

Recipe no.	Total mixture	Ashes concentrate		Electro-filter powder	
	[kg]	[kg]	[%]	[kg]	[%]
I	2,0	2,0	100	-	-
II	2,0	1,5	75	0,5	25
III	2,0	1,0	50	1,0	50
IV	2,0	0,8	40	1,2	60
V	2,0	0,6	30	1,4	70
VI	2,0	0,5	25	1,5	75
VII	2,0	0,4	20	1,6	80

In order to appreciate of the quality of the pellets we made the following analyses: the chemical structure (table 6), the crush resistance (table 7) and the reducibility of hardened pellets.

Table 6. The chemical structure of hardened pellets

Recipe no.	FeO	Fe_2O_3	MnO	SiO_2	CaO	Al_2O_3	P_2O_5	Other oxides	Fe	I_b
V	5,07	78,55	2,51	4,44	4,18	2,84	0,28	1,93	59,42	0,94
VI	3,88	82,41	3,41	3,49	2,61	1,98	0,27	1,94	61,08	0,75
VII	3,28	84,29	4,32	2,91	1,51	1,49	0,26	1,95	62,05	0,52

The determination of reducibility has been done for the pellets obtained according to recipes V, VI and VII, as for the pellets obtained according to the other recipes the minimum value requested by the norms of crush resistance has not been reached.

Table 7 - The crush resistance of pellets [daN/pellet]

Recipe no.	Sample no.										Mean
	1	2	3	4	5	6	7	8	9	10	
I	45	35	29	25	45	40	35	30	20	35	33,9
II	55	60	30	65	60	70	70	55	60	60	58,5
III	110	85	105	90	105	110	120	115	130	130	110
IV	160	180	190	210	195	175	170	155	190	190	181,5
V	185	225	230	245	280	250	250	210	200	190	229,5
VI	330	185	335	245	495	620	655	675	675	140	368
VII	320	610	325	195	190	250	275	450	520	650	378,5

As the result of the tests carried out, we obtained the following values for the reduction degree:

- recipe V ……… 0.725%/min;
- recipe VI ……… 0.783%/min;
- recipe VII …….. 0.765%/min.

In order to have a basis for comparison we established the chemical structure, crush resistance and reducibility of pellets coming from a different source (Krivoirog – Ukraine and Turnu Măgurele – Romania). We tested three sets of pellets coming from Ukraine, each of them made of 10 pellets and we also tested two sets of 10 pellets coming from Turnu Măgurele (Romania).

Table 8. The chemical composition of the pellets coming from Krivoirog (Ukraine)

Al_2O_3	CaO	MgO	MnO	S	SiO_2	Fe_2O_3	FeO	Fe	I_b
5,30	1,40	1,20	0,10	0,12	9,0	79,20	2,90	58,22	0,11

Table 9. The chemical composition of the pellets coming from Turnu Măgurele (Romania)

Al_2O_3	CaO	MgO	MnO	S	SiO_2	Fe_2O_3	FeO	Fe	I_b
5,60	8,10	1,60	0,20	0,22	10,70	69,70	3,88	51,81	0,59

Table 10. The crush resistance of the pellets coming from Krivoirog and Turnu Măgurele

	Pellets Ukraine			**Pellets Turnu Măgurele**	
	Series 1	**Series 2**	**Series 3**	**Series 1**	**Series 1**
Minimum	150	100	75	110	80
Maximum	450	450	430	260	500
MEAN	259	243	230,5	247	225

The reducibility index for these pellets was 0.90% / min. The reducibility tests were carried out on a laboratory installation, at the temperature of 900^0C, the reducibility index being 0.71% / min.

3. CONCLUSIONS

The concentrates obtained out of power station ashes are very similar from the point of view of their chemical structure to other powdery ferrous wastes, they are acid and as compared to other wastes they do not contain elements that might influence the quality of pig iron or steel in a negative way.

These concentrates are better fir for processing by pelleting then by agglomeration, due to their fine grain.

Taking into consideration the good results obtained with recipes V, VI and VII, we consider that it is possible to produce the pellets according to any of these three recipes, according to the available material.

We aimed at introducing in the siderurgical circuit of the electro-filter powder and thus use the dumps of power station dusts, within a program of reduction of environment pollution.

REFERENCES/BIBLIOGRAPHY

1. ASTIEN, J., BARRY, C. - L'atelier d'pelletion de Ijmuiden, CIT 4/1993.
2. HĂTĂRĂSCU, O.V. - *Peletizarea minereurilor de fier şi utilizarea peletelor la elaborarea fontei în furnal. Procedee noi şi tendinţe*, Bucureşti, Centrul de documentare şi publicaţii tehnice al industriei metalurgice, 1972.
3. DOBROVICI, D. and others - *Intensificarea proceselor din furnal*, Editura Tehnică, Bucureşti, 1983.
4. HEPUŢ, T., SOCALICI, A., ARDELEAN, E. - *Cercetări privind reducerea gradului de poluare în industria energetică şi siderurgică*. Simpozion Internaţional de Cercetare Multidisciplinară ISIM - Timişoara 2000.
5. HEPUT, T., KISS, I., GAVANESCU, A., ARDELEAN, E., SOCALICI, A. – *Cercetări şi experimentări privind reintroducerea in fluxul siderurgic a unor deşeuri feroase pulverulente*, at: The National Conference of Metallurgy and Materials Science, Bucharest, Romania, 2002.
6. HEPUŢ, T., SOCALICI, A., KISS, I. – *Experiments on the production and testing lubricating powders obtained out of industrial wastes on steel continuous casting*, V^th International Symposium of Interdisciplinary Regional Research – ISIRR 2001, at Szeged Regional of the Hungarian Academy Of Sciences, Szeged, Hungary, 2001
7. HEPUŢ T., KISS I., RAŢIU S. – *Possibilities of turning into account the ferrous powdery wastes in siderurgy*, V^th International Symposium of Interdisciplinary Regional Research – ISIRR 2001, , at Szeged Regional of the Hungarian Academy Of Sciences, Szeged, Hungary, 2001
8. HEPUŢ, T., IOAN, R., KISS, I., RATIU, S., PUTAN, V. - *Research And Experiments Regarding The Environment's Ecology, Through The Accounting Of Ferrous Powdery Wastes, Stored In The Ponds*, at VI^th International Symposium Of Interdisciplinary Regional Research – ISIRR 2002, Novi Sad, Yugoslavia.
9. HEPUŢ, T., KISS, I., ARDELEAN, E., ARDELEAN, M., GĂVĂNESCU, A., MIHUŢ, G. – *Study regarding the environmental protection in the areas of the dolomite and lime plants*, at VI^th International Symposium Of Interdisciplinary Regional Research – ISIRR 2002, Novi Sad, Yugoslavia.