FOAMING SLAG USING DUST WASTES ON ELECTRIC ARC FURNACE

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Abstract

Foaming slag is a complex phenomenon used for producing electric arc steel because it has the many advantages.
The usual foaming agents have been replaced with a product obtained from different dust wastes generated by an integrated iron and steel works.
The used dust wastes were: coal dust, coke dust, blast furnace dust, lime dust and millscale.
The experiments on laboratory and pilot scale have demonstrated that the product obtained from dust wastes can successfully replace the usual foaming agents.

Introduction

Dust wastes from siderurgical sector have unsatisfactory grain sizes and contain heavy metals, therefore recycling is difficult.
Worldwide, the spcific quantities of dust wastes from integrated steel plants are between 36 and 96 kg wastes / steel tone.
In Romania the specific quantities of dust wastes is 89 kg wastes / steel tone. These wastes are partially recycled at agglomeration and the rest are stored.

Aim of Study

Processing dust wastes (coal dust, coke dust, blast furnace dust, lime dust and millscale) trough micropelletising in order to obtain by-products.
Superior recycling of dust wastes from siderurgical sector, having ecological and economical advantages.

Experiments

The authors experimented the obtaing by-products using dust wastes from SIDEX S.A. Gala i Romania.The wastes were: coal dust, coke dust, blast furnace dust, lime dust and millscale. The wastes were analysed from a physical – chemical point of view and homogenized. The wastes processing was made through micropeletising. Micropeletising is a flexible process as it offers the possibiliy of using one or more dust wastes. The authors were made 10 charges, they are presented in the ***table 1.***
The grain sizes must be between 1 and 3 mm for using the micropelets for slag foaming agents în the electrical arc furnace. For his, the content of Fe, Ca and C must be between:

- Fe → 45 – 65 % of blast furnace dust and millscale;
- Ca → 5 – 15 % of lime dust and blast furnace dust;
- C → 10 – 30 % of coal dust, coke dust and blast furnace dust.

The obtaining of micropelets, their distribution into grain sizes and the resistance to manipulation are influenced by:

- quantity of water used in the process;
- the Ca content în the dust lime which is the binder and the element offering resistance to the micropelets;
- the C content, given by dust coal and coke dust.

Charges 5 – 8 are optimal, the characteristics of these charges are shown în ***table 2***.

The optimal charges cover almost the entire range of Fe, Ca, C, proving the flexibility of micropeletising process. The optimal micropelets were used at agglomeration and as slag foaming agent for steel production in EAF.

Using micropelets as slag foaming agent

Materials

The following materials are used:

- steel bath with carbon content of 0,2%;
- syntetic slag with i_b = 2;
- micropellets as tehnological addition for slag foaming (charges 5 and 8).

Picture 1 shows slag aspect before adding the micropellets before adding the micropellets into the slag (base slag) and pictures 2 – 4 show slag aspect afteradding micropellts (3 experiments). /2/

Conclusions

The 3 experiments showed that micropellets added to a slag with good foaming capacity conduct to a foaming process:

- the bubbles are small and uniform in experiment 2 for the same quantity of micropellets as in experiment 1;
- when the process was forced (by adding four times the quantity of micropellets used in experiment 1), the size of the bubbles was much bigger than in experiment 1 and the slag had an unhomogenous aspect.

Micropellets obtained from dust wates from siderurgical sector – coal dust, coke dust, blast furnace dust, lime dust and millscale – can succesfully replace normal foaming agents.

REFERENCE

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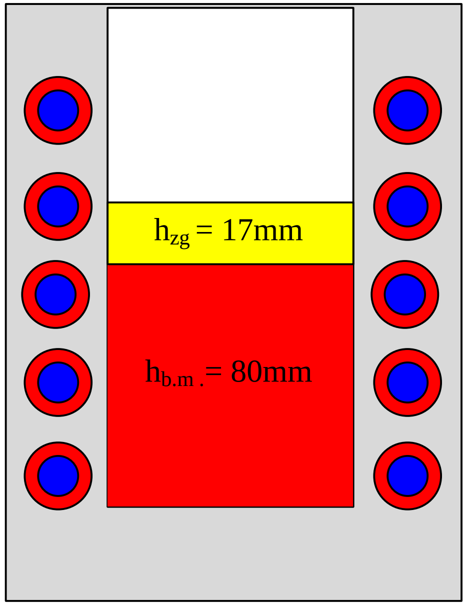
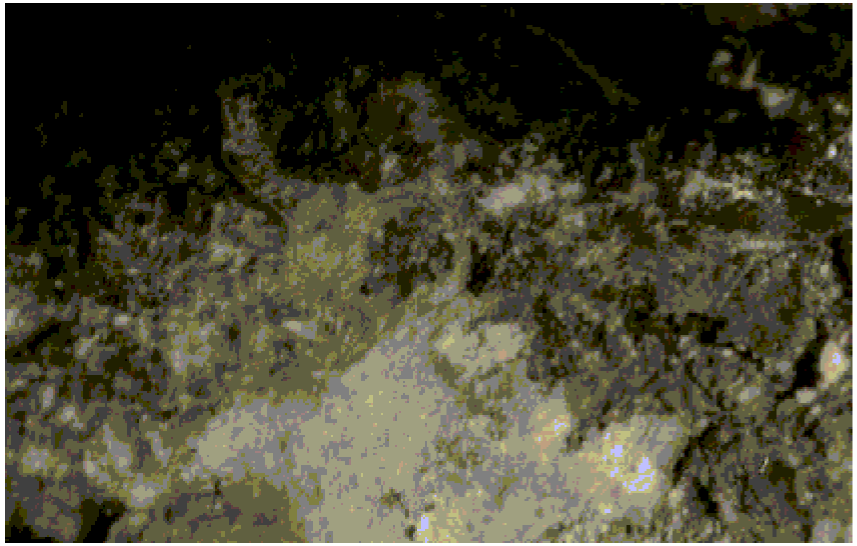
2. Aura Ilie, Dorina Savin – ***The Capitalisation of Dust Wastes From Roumanian Siderurgical Sector***, 28 – 30 Apr. Roumanian Metallugical Society, Bra ov, Roumanien.





Natural size

Macroscopic slag aspect

X 10

Microscopic slag aspect

Steel: C = 0,2%;
quantity = 2 kg;

Slag: CaO = 50%;
SiO_2 = 25%;
FeO = 25%;
$I_B = 2$;
quantity = 0,2 kg;

RESULTS

m = 1,4613g

$V_a = 0,6\ cm^3$; $\rho_a = 2,4385\ g/cm^3$;

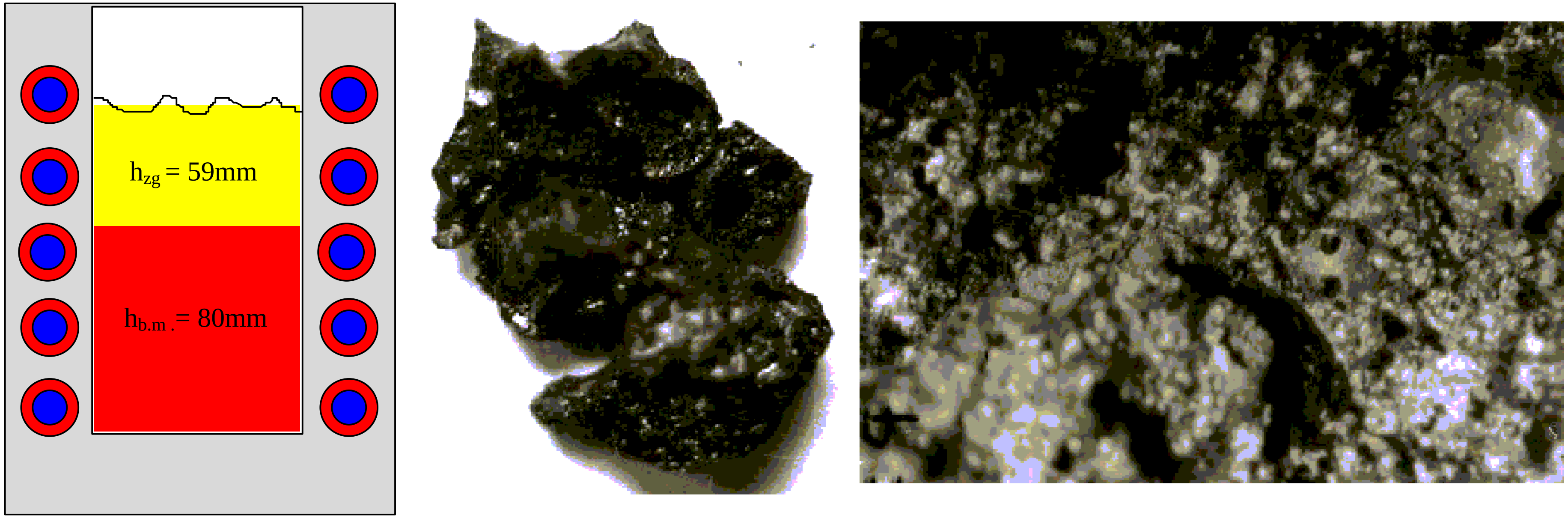
$V_s = 0,45\ cm^3$; $\rho_s = 3,2513\ g/cm^3$;

holes percentage = 25%;

REFERENCE SLAG

Compact, homogenous material with small bubbles ($\phi_{bubbles} < 2mm$)

Figure 1 Reference slag.



Natural size
Macroscopic slag aspect

X 10
Microscopic slag aspect

Steel: C = 0,2%;
quantity = 2 kg;

Slag: CaO = 50%;
SiO_2 = 25%;
FeO = 25%;
I_B = 2;
quantity = 0,2 kg;

Micropellets: C = 10%
Fe = 65%
Ca = 10%
quantity = 12,5g

RESULTS

m = 2,4599g

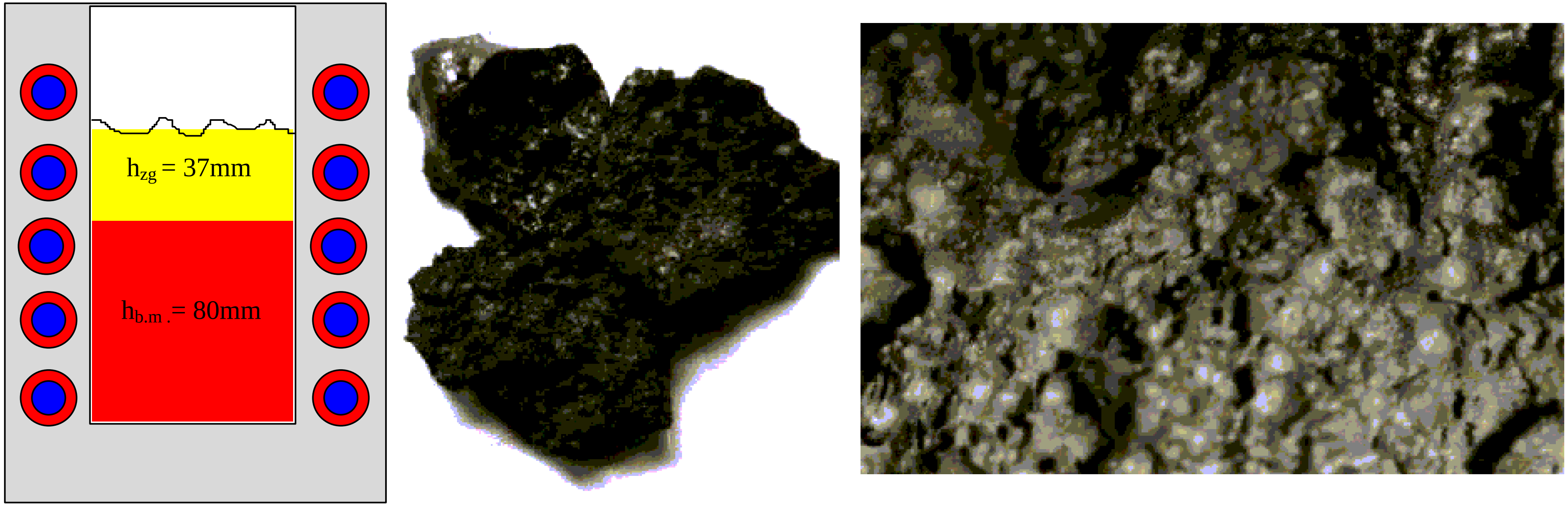
V_a = 2 cm^3; ρ_a = 1,22995 g/cm^3;

V_s = 1,2 cm^3; ρ_s = 2,0499 g/cm^3;

holes percentage = 40%;

Porous material with ununiform porosity ($\phi_{bubbles}$ = 1 ÷ 5mm), bubbles with ϕ = 5 mm represent approx. 50% of the bubbles.

Figure 2 Slag with micropellets - charge 5.



Natural size
Macroscopic slag aspect

X 10
Microscopic slag aspect

Steel: C = 0,2%;
quantity = 2 kg;

Slag: CaO = 50%;
SiO_2 = 25%;
FeO = 25%;
I_B = 2;
quantity = 0,2 kg;

Micropellets: C = 25%
Fe = 45%
Ca = 15%
quantity = 12,5g

RESULTS

m = 1,6626g

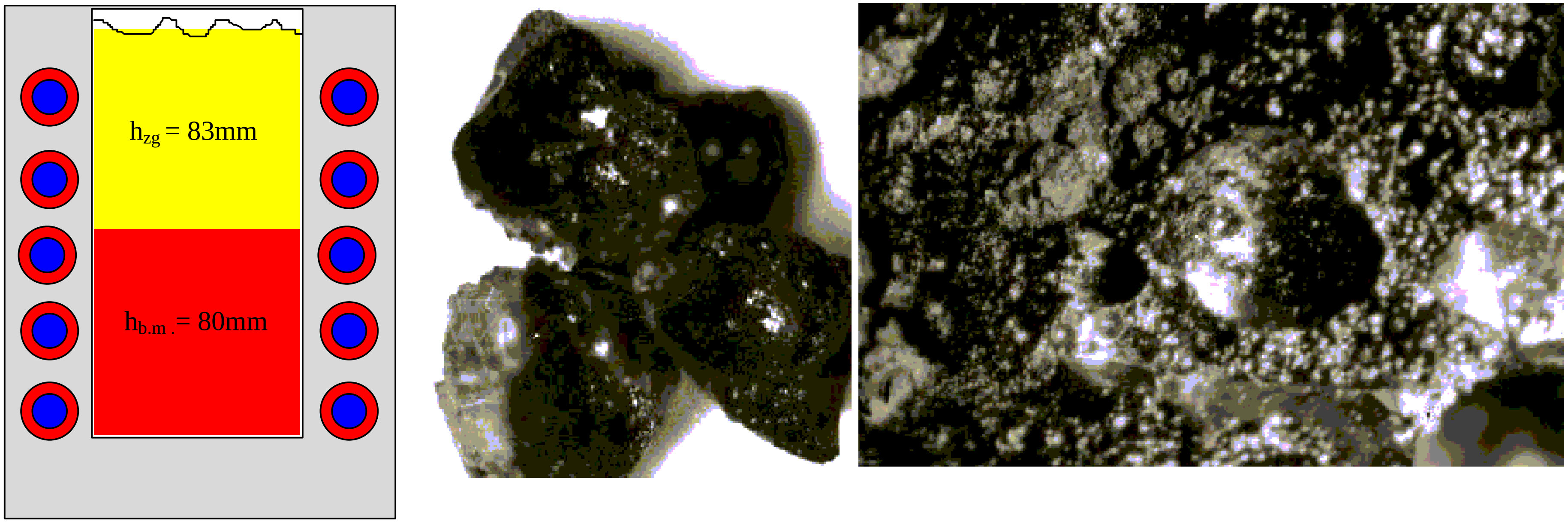
$V_a = 1{,}5\ cm^3$; $\rho_a = 1{,}1084\ g/cm^3$;

$V_s = 0{,}8\ cm^3$; $\rho_s = 2{,}0782\ g/cm^3$;

holes percentage = 46,66%;

Porous material with uniform porosity ($\phi_{bubbles} = 0{,}5 \div 2mm$),

Figure 3 Slag with micropellets - charge 8.



Natural size
Macroscopic slag aspect

X 10
Microscopic slag aspect

Steel: $C = 0{,}2\%$;
quantity = 2 kg;

Slag: $CaO = 50\%$;
$SiO_2 = 25\%$;
$FeO = 25\%$;
$I_B = 2$;
quantity = 0,2 kg;

Micropellets: $C = 25\%$
$Fe = 45\%$
$Ca = 15\%$
quantity = 50g (forced process)

RESULTS

m = 1,0053g

$V_a = 0{,}8\ cm^3$; $\rho_a = 1{,}2566\ g/cm^3$;

$V_s = 0{,}2\ cm^3$; $\rho_s = 5{,}0265\ g/cm^3$;

holes percentage = 75%;

Porous material with ununiform porosity ($\phi_{bubbles} = 1 \div 10mm$), bubbles with $\phi = 5 \div 10$ mm are more than 70% of all bubbles.

Figure 4 Slag with micropellets - charge 8 forced process.

Table1 Dust materials used in charges.

Charges	Element	Millscale, %	Blast furnace dust, %	Coke dust, %	Coal dust, %	Lime dust, %
I	Fe = 60% Ca = 15% C = 10%	64,00	3,31	5,52	2,21	24,96
			Carbon content - 11,04%			
II	Fe = 55% Ca = 15% C = 10%	61,92	3,50	5,84	2,34	26,39
			Carbon content - 11,68%			
III	Fe = 50% Ca = 15% C = 20%	52,42	6,70	11,18	4,46	25,23
			Carbon content - 22,34%			
IV	Fe = 40% Ca = 15% C = 30%	40,59	10,17	16,94	6,78	25,52
			Carbon content - 33,89%			
V	Fe = 65% Ca = 10% C = 10%	71,49	3,41	5,70	2,27	17,13
			Carbon content - 11,38%			
VI	Fe = 60% Ca = 10% C = 15%	65,61	5,15	8,58	3,43	17,23
			Carbon content - 17,16%			
VII	Fe = 60% Ca = 5% C = 20%	67,33	7,11	11,88	4,74	8,94
			Carbon content - 23,73%			
VIII	Fe = 45% Ca = 15% C = 25%	47,66	7,95	18,55	-	25,84
			Carbon content - 26,50%			
IX	Fe = 50% Ca = 10% C = 25%	54,92	8,20	19,12	-	17,75
			Carbon content - 27,32%			
X	Fe = 50% Ca = 5% C = 30%	56,58	10,24	23,92	-	9,26
			Carbon content - 34,16%			

Table2 Optimal charges.

Charges	**Charge composition** [%]			**Micro - peletising duration** [min]	**Humidity** [%]	**Density** [g/cm^3]		**Granulometric range, [mm]**				
								>5	5 ÷ 3	3 ÷ 2	2 ÷ 1	<1
	Fe	Ca	C			wet	dry	Granulometric analysis [%]				
5	65	10	10	10	2,5	1,30	1,27	6,0	25,0	18,0	50,0	1,0
6	60	10	15	11	2,9	1,26	1,22	3,0	36,0	33,0	27,0	1,0
7	60	5	20	8	1,6	1,26	1,24	3,0	18,0	26,0	49,0	4,0
8	45	15	25	14	3,1	1,10	1,07	1,0	8,0	5,5	77,0	8,5