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COMPACTING OF FLY DUSTS FROM CUPOLA AND ELECTRIC ARC FURNACE

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Preliminary Note – Prethodno priopćenje

Recycling and utilization of dust waste is important not only from the point of view of its usage as an alternative source of raw materials, but regarding the environmental problems also. Dust emissions arise from thermal and chemical or physical processes and mechanical actions. Two kinds of fly dusts from cupola furnaces (hot and cold blast cupola furnace) and fly dust from electric arc furnace were used by experiments. They were pelletized only with addition of water and briquetted with different addition of water glass, bentonite and cement. Quality of briquettes was tested by compression – strength test and by break down test in green state, after drying and after storing (1 month).

Key words: electric arc furnace, cupola furnace, fly dust, briquettes, pellets.

Kompaktiranje lebdeće prašine iz kupolne i elektrolučne peći. Recikliranje i iskorištavanje otpadne prašine važno je zbog aspekta njezine uporabe kao alternativnog izvora sirovina, ali također i s obzirom na ekološke probleme. Emisija prašina nastaje iz termičkih, kemijskih ili fizikalnih procesa te mehaničkih aktivnosti. U eksperimentalnom dijelu korištene su dvije vrste lebdeće prašine iz kupolne peći (s predgrijanim i hladnim zrakom) te elektrolučne peći. Prašina je peletizirana samo uz dodatak vode i briketirana s različitim dodatkom vodenog stakla, bentonita i cementa. Kvaliteta briketa je određena ispitivanjem tlačne čvrstoće u sirovom stanju, nakon sušenja i nakon skladištenja (1 mjesec).

Ključne riječi: elektrolučne peć, kupolna peć, lebdeća prašina, briketi, peleti

INTRODUCTION

A typical foundry process includes the following major activities: melting and metal treatment in the melting shop; preparation of molds and cores in the molding shop; casting of molten metal into the mold, cooling for solidification, and removing the casting from the mold in the casting shop; and finishing of raw casting in the finishing shop [1, 2].

Different types of melting furnaces and metal treatments are used to produce ferrous and non-ferrous materials depending on the type of metal involved.

Cast iron is typically melted in cupola furnaces, induction furnaces, electric arc furnaces, or rotary furnaces. Use of induction furnaces is preferred over cupola furnaces due to their superior environmental performance. Cast steel is typically melted in electric arc furnaces or coreless induction furnaces.

This article concerns with fly dust from cast iron production in hot and cold blast cupola furnace and with fly dust from steel production in electric arc furnace. In the article the basic properties of fly dusts are described and possibilities of their solidification with the goal of their recycling in melting aggregates are given.

Recycling and utilization of dust wastes is important not only from the point of view of their usage as an alternative source of raw materials, but regarding the environmental problems also. In a majority of cases the reach iron-containing materials present fine concentrates, so that their use in furnace metal works, requires, their solidification to ensure enough gas – penetreability [3]. Traditionally, in such processes, as charge agglomerate, pellets and briquettes are used.

Metal works use three technologies of fine ores, concentrates and wastes agglomeration, these are [4]:

- Aglomeration, technology involving the fine ores and concentrate sintering with carburant materials at a high temperature.
- Granulation, or pelletization, consisting in pellets making, basing on the ability of moisturized particles of the grind ore and concentrate to form pellets different in size and solidity, with subsequent pelleting in special equipment until acquisition of the required size and shape, and the final roasting.
- Briquetting, or pelletization of lumps (briquettes) manufacturing with or without addition of binding agents, with subsequent mixture pressing into briquettes with given shape and size. Authors [5, 6] describe briquetting of cupola dust and its recycling in cupola furnace.

REALISED EXPERIMENTS

Main goal of experiments described in this paper has been to find suitable methods for stabilization of fly

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dusts from steel and cast-iron production by using of different kinds of binders and different kinds of hardening of these binders. Fly dust from electric arc furnace (sample A) and fly dusts from two different kinds of cupola furnaces (sample B – fly dust from hot blast cupola furnace, sample C –from cold blast cupola furnace) were used by experiments.

USED EXPERIMENTAL MATERIALS AND THEIR PROPERTIES

Figures 1, 2 and 3 show the shapes of dust grains (dust from electric arc furnace, dust from cold blast cupola furnace and dust from hot blast cupola furnace), their density and moisture.

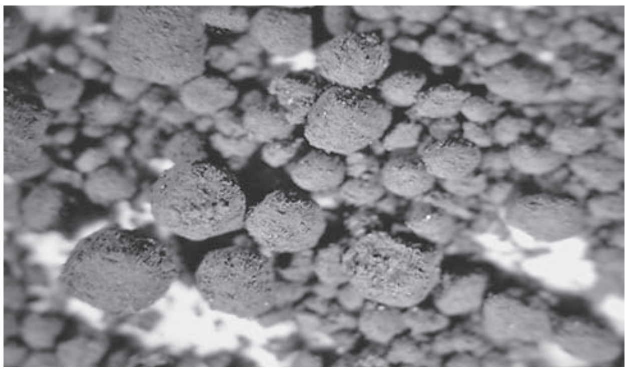
METHODS OF DUSTS COMPACTING

Next treatment and using of dusts in melting processes is possible only after their compacting. Two kinds of compacting methods are possible: pelletizing and briquetting.

The first method for dust compacting was used pelletizing with using of pelletized dish with diameter of 1 020 mm and high of walls 235 mm. Only bentonite and water were used as binders by pelletizing. Different chemical, mineralogical and granulometric analyse caused different behaviour of dusts by pelletizing.

The dust from electric arc furnace was pelletized with water addition and then with bentonite. The pellets got very small diameters, they were not suitable for the next treatment.

The dust from hot blast cupola furnace was pelletized only with addition of water. Created pellets were very small and they were crumbled very quickly. Very similar situation has been by pelletizing the dust from cold blast cupola furnace only with this difference that some of pellets had very big diameter but, after very short time they crumbled too. Figure 4 shows pellets prepared from the dust from cold blast cupola furnace.

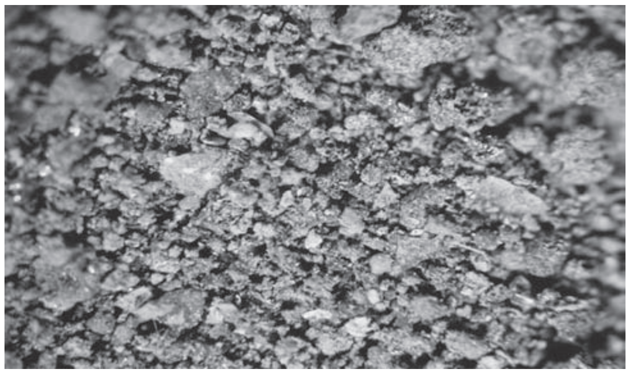


a)

Chemical composition / mas.%					
Fe	$Fe_{met}al$	FeO	Fe_2O_3	SiO_2	CaO
30,16	1,12	3,16	38,02	3,48	6,34
MgO	Al_2O_3	MnO	PbO	ZnO	C
2,07	0,89	2,41	2,41	23,3	1,09
Density / g · cm^{-3}			4,327		
Moisture /mas. %			0,17		

b)

Figure 1 Basic properties of dust from electric arc furnace a – grains shape (2,5x), b – chemical composition, density and moisture



a)

Chemical composition / mas.%					
Fe	$Fe_{met}al$	FeO	Fe_2O_3	SiO_2	CaO
15,9	0,22	15,38	4,67	23,11	5,77
MgO	Al_2O_3	MnO	PbO	ZnO	C
2,94	4,20	0,68	0,11	0,44	34,5
Density / g · cm^{-3}			1,981		
Moisture / mas. %			17,21		

b)

Figure 2 Basic properties of dust from hot blast cupola furnace a – grains shape (2,5x), b – chemical composition, density and moisture

Fine coarse materials is possible compacting by briquetting. Briquetting of fine materials with addition of binding agents is the most easy way to involve valuable wastes into recycling. The marketable briquettes must meet a number of requirements, such as [3]:

- it must be solid enough to eliminate its damaging during transportations,
- it must retain its solidity while moisturized during transportations,
- it must be solid enough at high temperatures,
- it must have a homogenous chemical composition,
- it must provide the identical geometry of pieces, its prime cost must be equal to the cost of conventional materials.

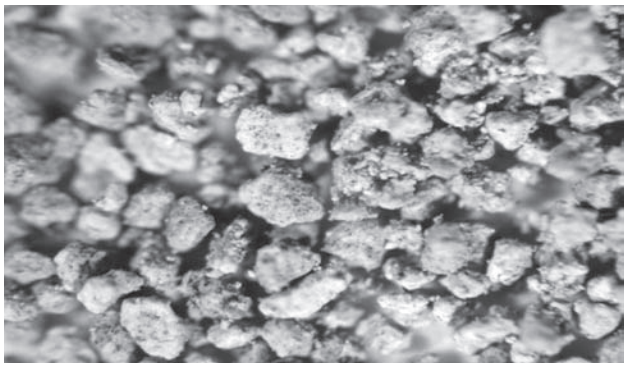
Briquetting mixtures were prepared in a sand mill from dust with addition of bentonite, water glass and cement. The briquettes were prepared with help of drop hammer for the production of specimens (for sand mixture properties testing).

Quality of briquettes was evaluated by compression strength test and by break down test.

ACHIEVED RESULTS

Dust from electric arc furnace

By briquetting of dust from electric arc furnace 2 kinds of binders were used: water glass and bentonite.



a)

Chemical composition / mas.%					
Fe	Fe_{met}al	FeO	Fe_2O_3	SiO_2	CaO
24,13	2,01	9,63	20,96	42,12	1,89
MgO	Al_2O_3	MnO	PbO	ZnO	C
0,88	2,12	2,67	0,56	3,21	3,59
Density / g · cm^{-3}			1,850		
Moisture / mas. %			0,67		

b)

Figure 3 Basic properties of dust from cold blast cupola furnace a – grains shape (5x), b – chemical composition, density and moisture

Figure 4 Pellets prepared from the dust from cold blast cupola furnace

By using of water glass the rising of water glass content caused gentle increasing of compression strength of green briquettes. The samples after drying had some times higher compression strength up to 119 N·cm^{-2} (2 % of water glass). The drying of briquettes caused increasing the compression strength from 6,52 N·cm^{-2} to 122 N·cm^{-2} by addition of 8 % of bentonite. Using of bentonite caused increasing of compression strength after drying but long lasting storage degraded it and most of samples were crushed.

Briquettes with bentonite had a very low drop impact resistance. They crushed after the first drop on the metal plate. The briquettes made with water glass addition were crushed or broken after the first drop too only the sample with 8 % of water glass was crushed after the third drop.

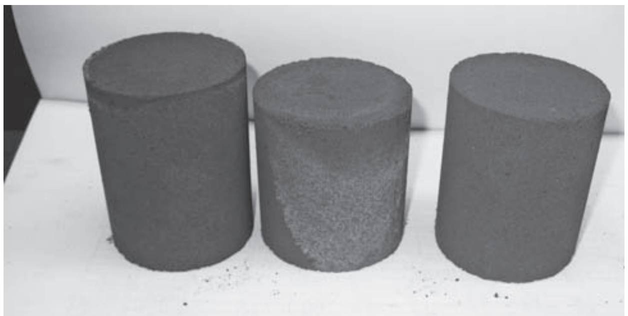


Figure 5 Samples B-4 (dust from hot blast cupola furnace + 2 % of water glass)

Dust from hot blast cupola furnace

By briquetting of dust from hot blast cupola furnace the water glass and bentonite were used. In the green state the higher compression strength was achieved by water glass use, but after drying the samples with bentonite had more higher compression strength and after 1 month another increasing of the compression strength was obtained.

Figure 5 shows briquettes prepared from the dust with addition of water glass after drying (it is seen the water glass on the surface of briquette).

All samples with bentonite could be stock more then one month with minimum brittleness of briquettes. Achieved results showed that 6% of bentonite is sufficient for good quality of briquettes.

Briquettes with water glass were broken or were disintegrated after the first drop and briquett with bentonite were not disintegrated neither after third drop from the high of 1 m.

Dust from cold blast cupola furnace

The water glass, bentonite and cement were used by briquetting of fly dust from cold blast cupola. The highest compression strength in the green state was achieved by briquettes with cement. After drying the best results were achieved with use of water glass, where by 6 % of water glass the compression strength was 126,5 N·cm^{-2}. All samples were disintegrated after 1 month.

CONCLUSIONS

Fly dusts from melting processes (melting of cast iron and steel) content some amount of FeO, Fe, SiO_2 and C and they can be recycled into the melting process. Three kinds of fly dusts were observed: fly dust from electric arc furnace (production of steel), fly dusts from cold and hot blast cupola furnace (production of cast iron).

Before charging the dust in to the furnace it is necessary its compacting. The next results follows from the realized experiments:

- Pelletizing as a method of compacting is not suitable for any of all three dusts. It is true that the best results were achieved for the dust from electric arc furnace but obtained pellets were very small. The pellets made from fly dust from cold blast cupola furnace had quite big diameter but the amount of these pellets was very low.

- Briquetting of fly dusts was realized with addition of water glass and bentonite and by briquetting of fly dust from cold blast cupola furnace the cement was used too.
- The best results by briquetting were achieved by using of dust from hot blast cupola furnace with bentonite addition. The briquettes achieved very good compression strength and their ability to resistant crushing was very high. The briquettes prepared from dust from electric arc furnace observed the best properties with use of water glass as a binder but their ability to resistant crushing was low. The similar situation was by the using of dust from cold blast cupola furnace.

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Note: The responsible for English language is official the lecturer from BERG-Faculty, TU Košice, Slovakia