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APPLICATION OF FINE-GRAINED COKE BREEZE FRACTIONS IN THE PROCESS OF IRON ORE SINTERING

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Preliminary Note – Prethodno priopćenje

The testing cycle, described in the paper, included fine-grained coke breeze granulation tests and iron concentrate sintering tests with the use of selected granulate samples. The use of granulated coke breeze in the sintering process results in a higher process efficiency, shorter sintering duration and fuel saving.

Key words: ore sintering, coke breeze, granulation, centrifugal pelletizer

INTRODUCTION

Amounts of generated yearly waste fine-grained coal materials in coal, coke and chemical industries are relatively high, which considerably intensifies exploration of new methods of their management. These waste materials include coal slurries, flotation tailings, coal abrasive coke dusts, fine-grained fractions of coke breeze and coal soot. A shared property of these materials is their grain size, mostly below 2 mm. The most common way of the above material management is their utilisation for production of coal blends, coal concentrates and energetic fuels. They are also used by other industries – the best example is metallurgy where attempts of replacing conventional reducers (e.g. coke or coke breeze) with fine-grained coal materials have been observed for several years [1-3].

The fuel used in iron ore sintering processes is coke breeze. Its combustion yields enough amounts of heat which is delivered to the sinter mix. One of the factors that significantly affect the course of coke breeze combustion is its grain size. Many studies and industrial practices have shown that coarse-grained coke breeze causes delayed combustion, which leads to higher heat energy consumption during the process. On the other hand, fine-grained fuel reduces permeability of the sinter mix and, therefore, the efficiency of the process itself. For this reason, the use of coke breeze fraction with grains sized below 1 mm is avoided on the sinter belt. In the present paper, results of a study on coke breeze undersize grain granulation in the aspect of the produced agglomerate utilisation in the process of iron ore sintering have been discussed. Effects of the agglomerate on overall fuel consumption during the process and sinter output have been determined [4-10].

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RESEARCH METHODOLOGY

The proposed testing cycle included fine-grained coke breeze granulation tests and iron concentrate sintering tests with the use of selected granulate samples. For the granulation tests, coke breeze fractions with the grain size below 1 mm were used. The grain analysis is presented in Table 1.

Table 1 **The grain analysis of investigated coke breeze**

Grain Class /mm	Each class fraction / %					
	Test number					Average
	1	2	3	4	5	
1 - 0.5	34,0	32,9	33,8	33,8	33,8	33,7
0,50-0,25	22,0	21,1	21,0	19,5	20,4	20,8
below 0,25	44,0	46,0	45,2	46,8	45,8	45,5
Average grain / mm	0,39	0,38	0,39	0,38	0,39	0,39

The granulation tests were performed in a GS 106 centrifugal pelletizer (Figure 1). Such devices feature a mobile component (a rotating disc), while its walls remain stationary. During centrifugation of the disc, the material is frequently rotated, which leads to its granulation. For the above granulation tests, burnt lime and hydrated lime were used as binding materials. The granulation process parameters were as follows:

- granulation time – 2 min
- disc rotation speed – 300 rpm
- water content – about 14 – 15 %
- binding material addition – 10 %.

The iron concentrate sintering tests with the use of produced coke breeze undersize grain granulate were performed on a sinter pan. A schematic diagram of the entire sintering system is presented in Figure 2.

The sintering tests were performed with the use of alkaline-stable sinter mix. The alkalinity was adjusted by maintaining a proper fraction of limestone in the sintering feed. In Tables 2 and 3, compositions of the investigated sinter mixes are presented.

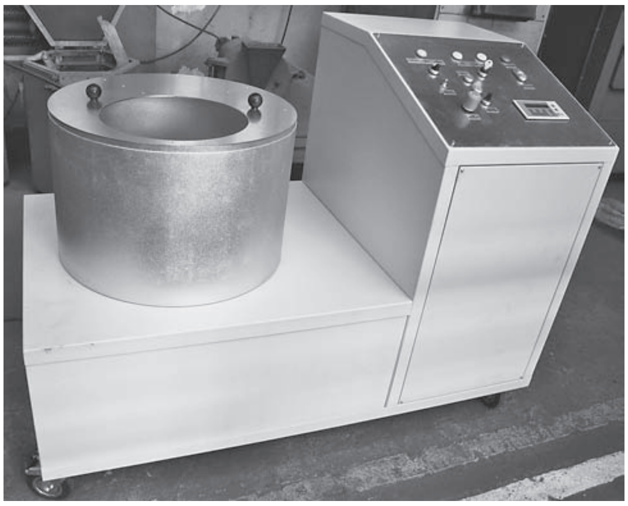

Figure 1 The centrifugal pelletizer

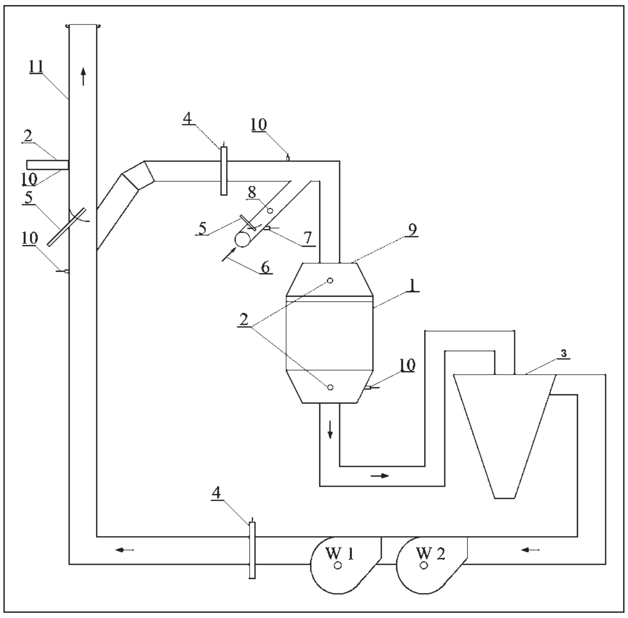

Figure 2 The schematic diagram of laboratory sintering system:
(1 - Sinter pan, 2 - Sampling points for exhaust gas analysis, 3 - Exhaust gas neutralisation system 4 - Orifice meters, 5 - Choke valves, 6 - Air delivery line, 7 - Air flow measurements, 8 - Oxygen delivery line, 9 - The cap of exhaust gas delivery line to the pan, 10 - Exhaust gas temperature measurements, 11 - Funnel - W1, W2 – exhaust gas fans)

RESULTS AND DISCUSSION

Results of the mix sintering tests are presented in Table 4 which contains basic data regarding the sintering process: its duration, sintering rate, process efficiency and post-stabilisation sintering output. Graphic interpretations of the results are shown in Figures 3 - 4.

Based on the analysis of results, improvement of the selected parameters of iron concentrate sintering with the use of fine-grained coke breeze granulate has been observed, including:

- improved process efficiency from 4 to 9 %
- reduced sintering duration from 5 to 9 %
- reduced consumption of basic coke breeze fractions.

Table 2 **Composition of the mix used for sintering tests with granulated coke breeze fraction and hydrated lime**

No.	Components	H_2O	Fe	SiO_2	CaO	MgO
			%	%	%	%
1	Concentrate I	10,10	67,94	4,48	0,10	0,31
2	Concentrate II	9,80	65,03	8,05	0,39	0,54
3	Concentrate III	10,05	65,53	5,75	0,15	0,12
4	Fine ore	4,20	60,27	11,02	0,78	0,21
5	Burnt lime	0,00	0,65	0,82	79,80	18,11
6	Slag	4,18	18,74	14,77	38,57	7,13
7	Dusts	0,00	51,21	6,61	10,85	1,45
8	Mill scale	4,10	72,02	1,80	1,24	0,71
9	Dolomite	5,62	0.88	1,24	30,90	19,20
10	Lime for granulation H	0,00	0,00	0,00	89,00	1,00
11	Limestone	0,92	0,25	1,90	53,86	0,49
12	Coke breeze (11% ash)	10,00	1,13	4,13	0,72	0,11

Table 3 **Composition of the mix used for sintering tests with granulated coke breeze and burnt lime**

No.	Components	H_2O	Fe	SiO_2	CaO	MgO
			%	%	%	%
1	Concentrate I	10,10	67,94	4,48	0,10	0,31
2	Concentrate II	9,80	65,03	8,05	0,39	0,54
3	Concentrate III	10,05	65,53	5,75	0,15	0,12
4	Agloore	4,20	60,27	11,02	0,78	0,21
5	Burnt lime	0,00	0,65	0,82	79,80	18,11
6	Slag 0–8	4,18	18.74	14,77	38,57	7,13
7	Dusts	0,00	51.21	6,61	10,85	1,45
8	Mill scale	4,10	72,02	1,80	1,24	0,71
9	Dolomite	5,62	0,88	1,24	30,90	19,20
10	Lime for granulation B	0,00	0,65	0,82	79,80	18,11
11	Limestone	0,92	0,25	1,90	53,86	0,49
12	Coke breeze (11% pop.)	10,00	1,13	4,13	0,72	0,11

Table 4 **Average results of sintering tests with the use of granulated coke breeze fraction**

Parameter	Comp. mix	Mixes with granulated coke breeze undersize grain	
		Hydrated lime	Burnt lime
I. Mix characteristics			
1. Humidity / %	7,47	7,33	7,53
2. Bulk density / kg/m^3	1895,6	1887,9	1890,4
3. Flow resistance / s	5,51	5,47	5,20
II. Process parameters			
1. Sintering duration / min	14,03	13,36	12,83
2. Negative pressure (initial and final) / mm H_2O	1150/ 910	1110/ 880	1060/ 870
3. Exhaust gas temperature (under the pan) / °C	464,7	435,0	473,9
4. Sintering vertical rate	39,33	41,20	42,86
5. Process efficiency (charge sinter) / kg/m^2·h	1221,7	1272,9	1334,6
6. Solid fuel consumption (dry) / kg/t of the sinter	54,68	54,07	54,01
7. Post-stabilisation sinter output / %	84,95	85,13	85,60

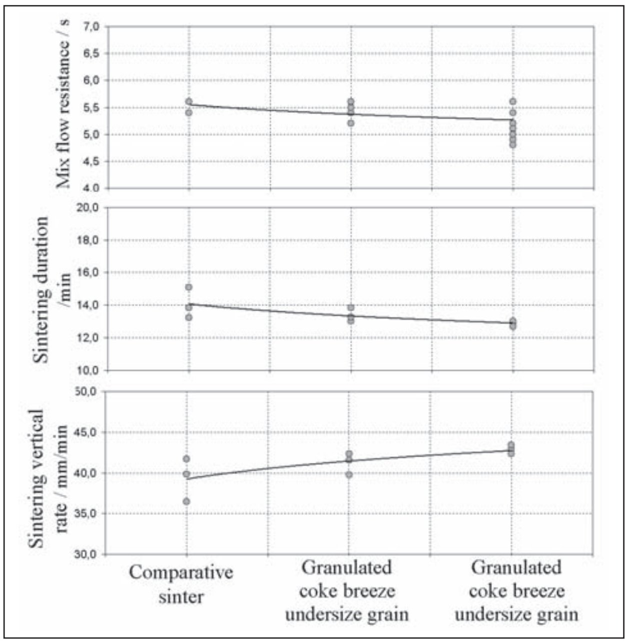

Figure 3 Effects of the binding material type of granulated coke breeze undersize grain on the mix permeability (flow resistance), sintering duration and sintering vertical rate

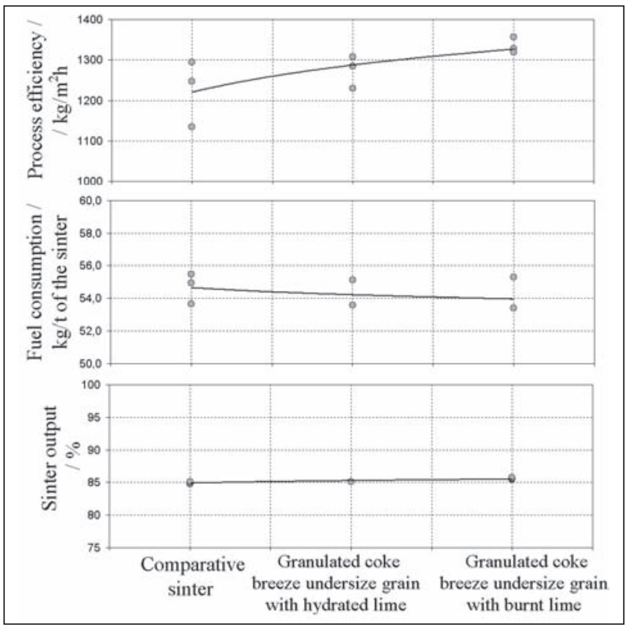

Figure 4 Effects of the binding material type of coke breeze undersize grain on the process efficiency, fuel consumption and sinter output

Moreover, the other process parameters have not been found deteriorated. The findings are highly consistent with the results of studies conducted in the Nippon Steel Corporation where for fine-grained coke breeze granulation, a centrifugal pelletizer was also applied [11], which is illustrated in Figure 5.

CONCLUSION

The investigations have proved that the fine-grained coke breeze fraction can be agglomerated by means of the granulation method using a centrifugal pelletizer.

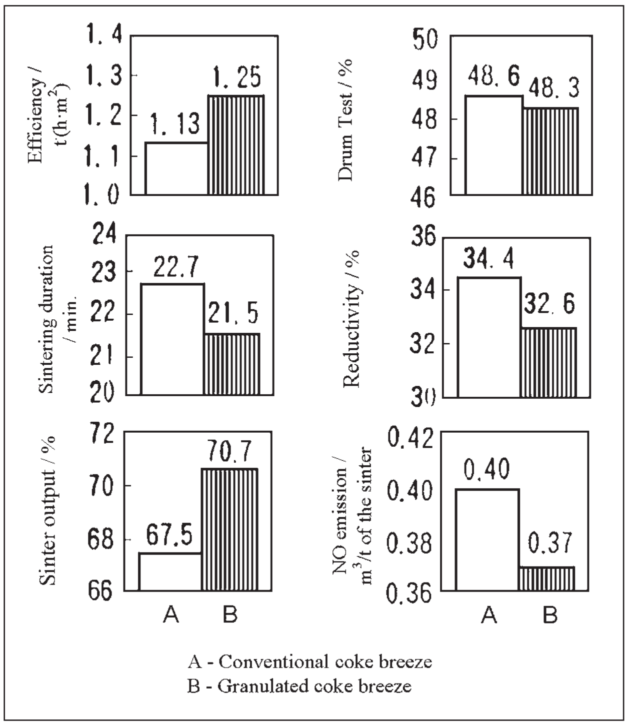

Figure 5 Comparative results of laboratory sintering tests with the use of iron concentrate mix and granulated coke breeze [11]

The method yields a coarser-grained coke breeze fraction which can be used in ferriferous material sintering processes. Moreover, this application leads to a higher process efficiency, shorter sintering duration and fuel saving.

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Note: A. Sliwakowska is Responsible for English language, Gliwice, Poland