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(54) **CHARGE FOR PRODUCING IRON-ORE PELLETS (VARIANTS)**

(57) The invention relates to the field of producing iron-ore pellets for blast-furnace smelting. In a first variant, a charge contains iron-ore concentrate and manganiferous limestone as a binding agent and flux, the ratio of charge components in wt% being as follows: 1.0-5.0 manganiferous limestone; and the balance iron-ore concentrate. In a second variant, the charge contains iron-ore concentrate, bauxite as a modifying agent,

and manganiferous limestone as a binding agent and flux, the ratio of charge components in wt% being as follows: 1.0-3.5 manganiferous limestone; 1.2-1.5 modifying additive; and the balance iron-ore concentrate. The invention raises the strength of green and sintered pellets while preserving a high iron content, reduces the softening-melting interval of the pellets in a blast furnace, and simplifies the production of iron-ore pellets.

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Description

[0001] The invention relates to the field of producing iron-ore pellets for blast-furnace smelting.

[0002] There are various compositions of the charge of pellets for blast-furnace smelting. In the production of fluxed pellets, the charge consists of iron-ore concentrate, bentonite and fluxing additives - limestone, chalk or dolomite.

[0003] For example, from the USSR Author's Certificate No. 692879, a method is known for producing pellets from concentrates containing **4-10%** silica in barren rock, and fluxing the charge to a CaO/SiO_2 ratio of 0.5-1.3 is produced with the introduction of magnesium oxide in the amount of providing a ratio of $\text{CaO:MgO} = 1.5-3.9$. After sintering, cooling to a temperature of 700-900 °C is conducted at a speed of 120-240 °C/min.

[0004] The disadvantage of this composition of the charge is high basicity, accompanied by a decrease in the iron content in the pellets, and the formation of glass in the structure of the pellets, reducing their strength.

[0005] The closest technical solution to the technical essence and the achieved result (the closest analogue is the prototype in the first variant) with respect to the claimed charge in the first variant is the charge for producing pellets according to the USSR Inventor's Certificate No. 800200 containing iron-ore concentrate and a binder in the form of lime-containing material. In order to reduce the cost of metallurgical processing, the charge contains chalky marl with a particle content of 2-0 microns 20-80% as a lime-containing material with the following ratio of ingredients, %: chalky marl 3-7, iron-ore concentrate - the rest.

[0006] The disadvantage of this solution is the high SiO_2 content in marl, which reduces the iron content in the pellets, the low strength of the raw pellets and the wide temperature range of softening-melting of the pellets in the blast furnace.

[0007] The closest technical solution to the technical essence and the achieved result (the closest analogue is the prototype in the second variant) with respect to the claimed charge in the second variant is the charge for producing pellets for metallization in the shaft units followed by hot briquetting according to the patent of the Russian Federation No. 2202632 for the invention containing iron-ore material, bentonite, limestone and bauxite in the following ratio of components, wt.%: the sum of bentonite and limestone is 0.5-1.0; bauxite - 0.4-1.1; iron-ore material - the rest.

[0008] The disadvantage of this charge composition is the low value of the basicity of the pellets, which determines the wide softening-melting interval in the blast furnace.

[0009] The objective of the invention is to develop a charge for the production of iron-ore pellets, which eliminated the disadvantages of the known charges.

[0010] The technical result achieved by the invention increase the strength of green and sintered pellets while maintaining a high iron content, reducing the softening-melting interval of the pellets in the blast furnace, and simplifies the production of iron-ore pellets.

[0011] The technical result is achieved due to the fact that in the charge to obtain iron-ore pellets in the first variant, containing iron-ore concentrate, flux and binder, according to the invention, the charge contains manganese limestone, intended for use as a binder, and flux, while the ratio of the components of the charge is, wt%:

- manganese limestone - (1.0-5.0);
- iron-ore concentrate - the rest.

[0012] The manganese content in manganese limestone is at least 6%.

[0013] In the charge for producing iron-ore pellets in the second variant, containing iron-ore concentrate, flux and binder, according to the invention, the charge contains bauxite, intended for use as a modifying additive, and manganese limestone, intended for use both as a binder and flux, while the ratio of the components of the charge is, wt%:

- manganese limestone - (1.0-3.5);
- modifying additive - (1,2 - 1,5);
- iron-ore concentrate - the rest.

[0014] The manganese content in manganese limestone is at least 6%.

[0015] While using charge in both variants, the preservation of a high iron content in the pellets is achieved due to a lower SiO_2 content in manganese limestone.

[0016] The increase in the strength of raw pellets in the charge in both variants is due to the increased water-physical properties of manganese limestone.

[0017] Increasing the strength of the sintered pellets in the charge in the first variant (when the content of manganese limestone is within the limits stated in the first embodiment) is achieved by increasing the content of manganese oxide.

[0018] The lower limit of the content of manganese limestone in the charge in the first variant, that is, 1.0%, is due to its minimum amount capable of providing high strength of green and sintered pellets. With less than 1.0% content of manganese limestone in the charge, the strength of green and sintered pellets decreases below the level that provides strength when using chalky marl. When the content of manganese limestone in the charge is less than 1%, the effect

of manganese oxide on the softening and melting temperatures is weak.

[0019] The upper limit of the content of manganese limestone in the charge in the first variant, that is, 5%, is due to a decrease in the iron content in the pellets and the strength of the sintered pellets. With a greater than 5.0% content of manganese limestone in the charge, the strength of the sintered pellets is reduced due to the formation of glass in their structure. Glass formation also leads to a decrease in the softening temperature and an increase in the softening-melting range.

[0020] In the charge according to the first variant, the decrease in the temperature range of softening-melting of the pellets is achieved due to the influence of manganese oxide (when the manganous limestone content is within the stated limits in the charge according to the first variant) on the softening and melting temperatures of the pellets in the blast furnace.

[0021] The reduction in the softening-melting range of pellets in the blast furnace in the charge according to the second variant is achieved due to the higher content of Al_2O_3 in the pellets and the influence of manganese oxide on the softening temperatures and melting of the pellets in the blast furnace.

[0022] An additional decrease in the softening-melting range of pellets in the blast furnace is achieved by modifying Al_2O_3 with bauxite.

[0023] The increase in the strength of green pellets in the charge according to the second variant is due to the increased water-physical properties of manganese limestone, and the strength increase of the sintered pellets (when the content of manganese limestone is within the limit stated according to the second variant) is simultaneously due to an increase in the content of manganese oxide, and also due to the formation of the structure of the brownmillerite mineral in the interaction of manganese limestone with aluminum oxide Al_2O_3 .

[0024] The lower limit of the content of manganese limestone in the charge in the second variant, that is, 1.0%, is due to its minimum amount capable of providing high strength of green and sintered pellets. With less than 1.0% content of manganese limestone in the charge, the strength of green and sintered pellets decreases below the level that provides strength when using bentonite.

[0025] The upper limit of the content of manganese limestone in the charge in the second variant, that is, 3.5%, is due to a decrease in the iron content in the pellets and the strength of the sintered pellets.

[0026] With a greater than 3.5% content of manganese limestone in the charge, the strength of the sintered pellets is reduced due to the formation of glass in their structure.

[0027] The lower limit of the bauxite content in the charge according to the second variant, that is 1.2%, is due to its minimum amount, at which the modifying effect on the softening and melting temperatures in the blast furnace occurs. With less than 1.2% bauxite content in the mixture, the effect of Al_2O_3 on the decrease in softening and melting temperatures is weak.

[0028] The upper limit of the bauxite content in the charge in the second variant, that is, 1.5%, is due to a decrease in the iron content in the pellets. With a greater than 1.5% bauxite content in the charge, the iron content in the pellets decreases.

The embodiment.

[0029] The test charge for iron-ore pellets was performed in laboratory conditions. The iron-ore concentrate was used as the iron-ore material, the chemical composition of which is given in table. 1. There are also compositions of fluxes and bauxite given there. Bentonite, fluxes and bauxite were ground in a ball mill to a particle size of less than 0.072 mm, injected into the concentrate in a predetermined amount, mixed, moistened, and then the pellets were produced in a drum granulator with a particle size of 10-15 mm. Raw pellets were tested for strength by dropping from a height of 30 cm. The sintering was performed in a muffle furnace with a programmable heat treatment mode at a maximum temperature of 1300 °C. After firing and cooling, the pellets were tested for crushing strength according to GOST 24765-81, the chemical composition and softening-melting temperatures were determined according to GOST 26517-85.

[0030] For comparison, the tests were conducted on the charge of the prototypes, respectively, according to the first and second variant. The test results are presented in Table 2.

[0031] Analysis of the obtained results shows that the claimed charge for producing iron-ore pellets in both variants ensures the achievement of the stated goal of increasing the strength of raw and sintered pellets while maintaining a high iron content and reducing the softening-melting interval in the blast furnace.

[0032] The charge in both variants for obtaining iron-ore pellets compared to the corresponding prototypes increases the strength of raw pellets from 2.2 to 3.5-5.0 drops, the strength of sintered pellets from 250 to 313-510 kg/pellet, reduces the softening-melting temperature range from 320 to 240-290 °C, retains a high iron content in the pellets.

[0033] The claimed technique can be implemented in industry with the achievement of the stated technical result.

[0034] Simplification of the charge is due to the fact that manganese limestone is intended for use as a flux and binder (i.e., such a component of the charge as a binder is not required separately).

[0035] As manganese limestone use natural raw materials (manganese ore), characterized by a manganese content

of at least 6%.

Table 1. The chemical composition of the charge components, %

Components	Fe	FeO	Fe ₂ O ₃	CaO	MgO	SiO ₂	Al ₂ O ₃	MnO	LOI
Iron-ore concentrate	67.49	28.70	64.52	0.22	0.51	5.50	0.19	0.03	0.27
Bentonite	-	-	1.50	1.00	0.50	60.00	36.90	-	-
Manganese limestone	0.84	-	1.20	40.50	0.77	8.70	3.10	9.91	35.75
Bauxite	14.04	-	20.06	0.79	0.75	8.70	40.87	-	24.90
Chalky marl	1.12	-	1.60	44.40	0.70	14.50	3.50	-	35.40
Limestone	0.18	-	0.26	54.2	0.71	1.28	0.34	0.01	42.50
LOI - loss on ignition									

Table 2. Test Results

Experiment #	The content in the charge, %				The strength of raw pellets - the number of drops, times	The iron content in the pellets, %	Crush strength of sintered pellets, kg/pellet	Softening-melting temperature range, °C
	Concentrate	Bentonite	Manganese limestone	Bauxite				
1 - according to the USSR IC No. 800200	95.0	.	Chalky marl 5.0	.	2.2	64.95	250	320
2	99.2	.	0.8	.	2.7	66.69	265	310
3	99.0	.	1.0	.	3.5	66.60	313	275
4	97.0	.	3.0	.	4.0	65.78	402	260
5	95.0	.	5.0	.	5.0	64.95	366	240
6	94.5	.	5.5	.	6.5	64.75	350	255
7 - according to patent No. 2202632	97.9	0.6	Limestone 0.4	1,1	3.0	66.12	260	390
8	98.1	.	0.8	1.1	2.8	66.33	275	340
9	97.8	.	1.0	1.2	3.9	66.21	360	290
10	96.7	.	2.0	1.3	4.2	65.77	450	270
11	95.0	.	3.5	1.5	4.5	65.08	510	265
12	94.4	.	4.0	1.6	4.9	65.84	335	280

Claims

1. The charge to obtain iron-ore pellets containing iron-ore concentrate, flux and a binder, **characterized in that** it contains manganese limestone intended for use as a binder and a flux, at that, the ratio of the components of the mixture is as follows, wt%:

- manganese limestone - (1.0-5.0);
- iron-ore concentrate - the rest.

2. The charge of claim 1, **characterized in that** the manganese content in manganese limestone is at least 6%.

3. The charge for producing iron-ore pellets containing iron ore concentrate, flux and binder, **characterized in that** the charge contains bauxite, intended for use as a modifying additive, and manganese limestone, intended for use both as a binder and flux, while the ratio of the components of the charge is, wt%:

- manganese limestone - (1.0-3.5);
- modifying additive - (1,2 - 1,5);
- iron-ore concentrate - the rest.

4. The charge of claim 3, **characterized in that** the manganese content in manganese limestone is at least 6%.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2017/000855

5	A. CLASSIFICATION OF SUBJECT MATTER	
	C22B 1/243 (2006.01)	
	According to International Patent Classification (IPC) or to both national classification and IPC	
	B. FIELDS SEARCHED	
10	Minimum documentation searched (classification system followed by classification symbols)	
	C22B 1/00-1/248	
	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched	
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)	
	PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPI, EAPATIS, PATENTSCOPE	
	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
20	Category*	Citation of document, with indication, where appropriate, of the relevant passages
		Relevant to claim No.
	A	RU 2245930 C1 (NAUCHNO-PROIZVODSTVENNOE VNEDRENCHESKOE PREDPRIATIE "TOREKS") 10.02.2005
25	A	SU 800200 A1 (SALYKIN A.A. et al.) 30.01.1981
	A	RU 2202632 C1 (OTKRYTOE AKTSIONERNOE OBSHCHESTVO "LEBEDINSKII GORNO-OBOGATITELNYI KOMBINAT") 20.04.2003
30	A	US 8333823 B2 (NU-IRON TTCHNOLOGY, LLC) 18.12.2012
35		
40	☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.	
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45	Date of the actual completion of the international search	Date of mailing of the international search report
	08 February 2018 (08.02.2018)	14 February 2018 (14.02.2018)
	Name and mailing address of the ISA/ RU	Authorized officer
50	Facsimile No.	Telephone No.
55		

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 692879 A [0003]
- US 800200 A [0005]
- RU 2202632 [0007]