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(54) Lumped skull lining material

(57) FIELD: The applied for invention lumped skull lining material relates to the ferrous metallurgy, in general, and to blast-furnace manufacture, in particular. It may be used while cast iron production in blast-furnaces.

ESSENCE: The applied for invention skull lining material contains a titanium containing component and a flux component. The titanium containing component includes grains of ilmenite and/or pseudobrukite, and/or perovskite. The flux component is a connecting component and generally consists of alum silicates, calcium alum silicates and calcium alum ferrites, wherein content of the structural components is:
grains of ilmenite and/or pseudobrukite, and/or perovskite
51 -60%, vol.
flux connection
15 - 35 %, vol.
pores
the rest

TECHNICAL EFFECT: The invention brings to the effective technical result which is effective guide of strong durable skull lining in blast-furnace metal receiver without any substantial disturbances into the melting process provided by the applied for invention changes in mineralogical composition and structure of the skull lining material aimed at ensuring its main properties.

EP 2 031 077 A1

Description

Technical Field

[0001] This invention relates to the ferrous metallurgy, in general, and to blast-furnace manufacture, in particular. It may be used while cast iron production in blast-furnaces.

Background of the invention

[0002] It is known that protective layer of skull lining on the walls of metal receiver is necessary for long campaign of blast furnaces and getting their high technical and economic indices. To achieve this objective while melting different skull lining materials containing titanium are introduced in the furnace by different methods. One of the most effective methods is feeding skull lining material through the blast-furnace mouth. This kind of feeding demands specific requirements to granular metric composition of lumped skull lining materials and their strength.

[0003] Conventional lumped skull lining material in accordance with the 'Method of blast-furnace melting' (SU 1401046, IPC: C21 B 5/00 from 21/08/85) is a skull lining agglomerate containing $V_2\,O_5$ 0.3 -1.00 % and TiO_2 1.00 - 3.00 % from material mass. The essence of the conventional decision is that while blast-furnace melting with the conversion pig iron fed into the furnace without $V_2\,O_5$ and TiO_2 skull lining agglomerate is fed periodically into the furnace with the ferrous part containing $V_2\,O_5$ and TiO_2

[0004] The main disadvantage of the conventional skull lining material is that titanium dioxide in the agglomerate is considered to be enough for effective formation of the protective layer of skull lining. The fact that the basis of this agglomerate as the material for cast iron melting are ferrous oxides and skull lining components are supporting additives does not taken into consideration. It is known that the conditions providing successful operating processes of cast iron melting do not coincide with the conditions of skull lining formation in metal receiver. On the contrary, they often contradict. That is why they must be separated in space and time. Moreover, it is rather problematic to combine the basic components necessary for getting cast iron and skull lining in one material which is agglomerate.

[0005] It should be kept in mind that the above mentioned agglomerate is irrational and ineffective for the use in modern methods of local building of skull lining in the places of tuyere of blast- furnace hearth. Besides, it leads to over consumption of expensive titanium and to the decrease of available hearth storage and as a result to the decline of technical and economic indices of melting.

[0006] The known lumped skull lining material is described in 'Method of protective skull lining formation in blast-furnace' (RU № 2179583 IPC: 21 B 5/00 from 28.11.2000) as a slug 70 -100 mm received in the result of smelting of titanium-magnetite-iron ore materials. The known lumped skull lining material contains (see the table below):

Metal, % from mass	CaO	SiO2	MgO	Al2O3	TiO2	FeO	TiCN
3-5	28-32	28-31	10-11	12-15	8-10	0.5-1.5	1.5-3.5

[0007] The other known lumped skull lining material described in 'Method of protective skull lining formation in blast-furnace' (RU № 2223331 IPC: C 21 B 3/00 from 29.01.2003) is a metallic concentrate containing a mixture of metallic component (35 - 50 % from mass) which forms a basis and skull component (50 - 65 %) which is a skull lining component and flux.

[0008] The skull component of the known metallic concentrate contains, in average:

Al2 O3 14 -16 %, MgO 11 -14 %, Ti02 8 -10%, MnO 0.3-0.4%, FeO 1.5-2.0%, Si02 25 - 28%, и CaO - the rest.

[0009] The main disadvantage of the conventional and the known compositions of lumped skull lining materials is that skull lining component is not the basis of the known materials described above. That is why titanium component can not work effectively. As the result, the more volume of skull lining material is necessary and, therefore, more undesirable components are included in it among which is Si02 which content achieves 31 %.

[0010] Furthermore, the periodical feeding of the known skull lining materials requires remixing since with titanium containing material not being a basis either significant amount of metal forming or skull forming materials is fed into the mixture. On the one hand, this influences slag regime of furnaces and introduces additional disturbances in the process of melting and can cause mistakes when taking optimum technical decisions. On the other hand, the low concentration of skull lining component and as a consequence high specific consumption of the materials do not allow to use them locally for the protection of the separate zones of blast furnace tuyere from burn-out.

Summary of the invention

[0011] Accordingly, the object of this invention is to provide a mineralogical composition and the structure of lumped skull lining material, the use of which will provide effective building of durable skull lining in metal receiver of blast furnace without significant disturbances in the process of blast furnace melting due to the basic properties of the material.

[0012] This objective may be accomplished with a lumped skull lining material which contains a titanium containing component and a flux component. The titanium containing component includes grains of ilmenite and/or pseudobrukite, and/or perovskite. Being a connecting component, the flux component generally includes calcium alum silicates and titanite (sphenum) or water compounds of alum silicates, calcium silicates and calcium alum ferrite, wherein content of the component is as follows:

grains of ilmenite and/or pseudobrukite, and/or perovskite	51 -60%, vol.
flux connection	15 - 35 %, vol.
pores	the rest

[0013] The lumped skull lining material in accordance with claim 1 is characterized by containing alumina additives, eg. stavrolite and/or slag/cinder got from ferrotitanium melting up to 20%.

[0014] The applied for invention mineralogical composition contains ilmenite grains (FeTi03) and/or pseudobrukite (Fe2Ti05) and/or perovskite (CaOTi02) as the basis, and the flux connecting component (15-35 %) which forms the material structure that provides strength while overloading, transporting and storing from the one hand, and from the other, formation of hard durable skull lining even when used locally due to the complex influence on the processes of Ti transition into cast iron as well as in the walls of the hearth and the blast-furnace bottom in the local zones commensurable with the sizes of the separate zones of the disturbances of carbonic lining of metal receiver.

[0015] When skull lining material with the mineralogical content described above is fed over tuyere zone, the mentioned ilmenite grains and/or pseudobrukite and/or perovskite as the basis together with the mentioned flux component provide necessary fluctuation of the compound which demonstrates an effective capability in the tuyere zone without substantial disturbances of the blast-furnace melting process.

[0016] Increase of the content of the grains of ilmenite and/or pseudobrukite and/or perovskite over 60% due to the decrease of the flux connecting component lower than 15% significantly worsens the strength characteristics of the separately taken piece of the lumped skull lining material and its granular metric composition after loading and transporting operations. In the same time the temperature of the primary slag formation and its toughness grow that cause substantial kinetic difficulties in the course of mass exchange processes which ensure the high temperature titanium-containing skull lining phases and skull lining formation.

[0017] The decrease of the content of the grains of ilmenite and/or pseudobrukite and/or perovskite lower than 51 % due to the increase of the flux connecting component over 31 % contributes much into the increase of material strength and to improvement of its granular metric composition after loading and transporting. However, lowered temperature of the material of the primary slag formation, its viscosity, toughness and high activity contribute to the dispersion of the necessary for the fluctuation of high temperature mass needed for skull lining composition formation.

[0018] Introduction into the composition of the material of the alumina-containing starts in the form of staurolite and/or slag from the smelting of ferrotitanium within the indicated limits ensures the partial replacement of titanium containing components because of the more complete transition of titanium into the metallic phase during the smelting of cast iron and shaping of sufficiently strong lining slag from the excessive carbon nitride phases.

[0019] The alumina containing materials, which decrease the viscosity of the primary slag during melting of the skull lining material in the blast furnace easify the process of reduction of titanium from the slag solution when it interacts with carbon of coke and transition of titanium into cast iron. Slag from the smelting of ferrotitanium acts analogously, and they are additional source of titanium in the form of metal or its alloy with iron, which relatively easily passes into cast iron as a result of dissolution.

[0020] Exceeding the mentioned interface of the alumina containing materials will influence significantly the process of skull lining formation. The decreased temperature of the primary slag formation, the viscosity of slag and its high activity will contribute to the dispersion of the necessary for the fluctuation of high temperature masses necessary for the formation of the skull lining composition.

[0021] Thus, the body of the essential factors of the technical solution applied for invention makes it possible to solve the stated objective aimed at the effective guidance of durable skull lining in the well of the blast furnace, including local, without the introduction of essential interferences in the course of blast furnace melting.

[0022] This is confirmed by the examples of the concrete realization of the applied invention.

[0023] To obtain lumped skull lining material under laboratory conditions ilmenite concentrate and limestone were used.

[0024] The initial stock components taken in relationship 70:30 were mixed up and briquettes made from this mixture were formed on the press on the bond from the foundry concentrate. The briquettes were fired in the air atmosphere under the conditions included drying, heating up to the temperature 13500 C, holding at this temperature and cooling together with the kiln. Briquettes with high apparent porosity 35-40% and strength for compression 6-7MPa were obtained. Their structure composed 40-45% of ilmenite and 35-40% of perovskite and alumina silicate of calcium.

[0025] After the reheating of the briquettes up to the temperature 9500 C in the atmosphere of CO_2 and the presence of carbon their strength decreased to 3-4 MPa that can indirectly testify about the sensitive decrease of their strength in the upper levels of blast furnace.

[0026] In the second series of experiments the pore-forming limestone was replaced by the grinded to 70 mkm cement clinker. The regime of kilning was not changed. The briquettes with acceptable porosity of 25-30% and strength for the compression of 12-14 MPa were obtained. Their structure was 55-58% of the ilmenite and the perovskite. The bond consisted of alum silicate of calcium predominantly and titanite (sphene) and glass (uncrystallized phase) in small volumes.

[0027] After the reheating of the briquettes to the temperature of 9500 C in the atmosphere of CO_2 and the presence of carbon their strength in effect did not decrease that testifies about their high heat resistance.

[0028] In the third series of experiments the briquettes were obtained by unfired method, with the application of the ground cement clinker. The briquettes with comparatively low porosity 10-15% and strength for the compression of 11-12 MPa were obtained. Their structure consisted of 50-55% of the ilmenite grains, cemented by the bond of hydrated alum silicates, silicates of calcium and alum ferrite of calcium.

[0029] After the reheating of the briquettes to the temperature 9500 C in the atmosphere CO_2 and with the presence of carbon the samples were covered by cracks that indicated their relatively low heat resistance and possible separation into the separate fragments in the upper levels of blast furnace. Although their strength decreased it was 5-6 MPa that is sufficient for the material not be carried out from the furnace by blowing.

[0030] The experimental melting performed at the blast-furnace with the volume 700 cubic meters aimed at the study of the influence of alumina additives on the coefficient of titanium distribution between slag/cinder and iron cast (LTi). The results of the research have demonstrated that:

$$LTi = \{ Ti \} / [Ti] = 10.33 - 0.68\, Al_2O_3$$

where {Ti } - titanium content in the slag/cinder,
[Ti] - titanium content in the cast iron,
Al_2O_3 - content of Al_2O_3 in the slag.

[0031] All the mentioned above leads to a conclusion that the more Al_2O_3 in blast-furnace slag/cinder, the more titanium transit into iron cast. The claimed effect confirms this fact.

[0032] The research of the complex influence of the lumped skull lining material on the indicators of melting in blast-furnaces was carried out at the blast-furnaces of two metallurgical plants. Durable melting proved that application of the lumped skull lining material reduces heat loads on refrigerators according to melting intensity and coefficient of hearth wear from 4% to 18% that in its turn may ensure decrease of coke on 8-20 kg/ton and increase in the productivity of blast-furnace on 5-8%.

[0033] Therefore, it is evident that applied for invention lumped skull lining material ensures effective formation of fluctuation of the compounds with high temperature viscous mass while blast-furnace melting due to the mineral composition the material applied whereby the objective to guide effectively strong durable skull lining in blast-furnace metal receiver, including local one, can be fulfilled without any substantial disturbances into the melting process.

[0034] The formation of strong lining slag according to the results of examples reduces thermal loads on the refrigerators of metal receiver depending on the intensity of melting and coefficient of wear of furnace hearth from 4 to 18% that in its turn ensures reduction in the expenditures of coke per 8-20 kg/t of cast iron and increase in the productivity of blast furnaces on 5-8%.

Claims

1. A lumped skull lining material comprising a titanium containing component and a flux component **characterized in that** said titanium containing component includes grains of ilmenite and/or pseudobrukite, and/or perovskite and said flux component is
a connecting component and generally consists of calcium alum silicates and titanite (sphenum) or water combination of alum silicates, calcium silicates and alum ferrites, wherein the proportion of the structural components is:

grains of ilmenite and/or pseudobrukite, and/or perovskite	51 -60%, vol.
flux connection	15 - 35 %, vol.
pores	the rest.

2. The lumped skull lining material in accordance with claim 1 is **characterized in that** it includes alumina containing additives up to 20%, eg. stavrolite and/or slag/cinder got from ferrotitanium melting.

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EUROPEAN SEARCH REPORT

Application Number
EP 08 10 4234

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	KURUNOV I F ET AL: "Methods of extending a blast-furnace campaign" METALLURGIST, KLUWER ACADEMIC PUBLISHERS-PLENUM PUBLISHERS, NE, vol. 50, no. 11-12, 1 November 2006 (2006-11-01), pages 605-613, XP019506205 ISSN: 1573-8892 * page 607 - page 611 * -----	1,2	INV. C21B7/04 C21B3/02 C21B5/00
A	RU 2 223 329 C1 (OTKRYTOE AKTSIONERNOE OBSHCHESTVO "SEVERSTAL") 10 February 2004 (2004-02-10) * abstract * -----	1,2	

TECHNICAL FIELDS SEARCHED (IPC)
C21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 January 2009	González Junquera, J

2

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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19-01-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
RU 2223329 C1	10-02-2004	NONE	

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