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Refractory brick with high emissivity coating for furnace and method for making the same

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ABSTRACT

Insulating brick (1) to be built inside of an industrial furnace for high temperature heating including a blacken film layer (2) in contact with an inside of the furnace, having a blackness higher than 0.85, and method for manufacturing the same including the steps of mixing a coloring raw material with solvent such as water, alcohol, and kerosene, the coloring raw material including 2 - 100wt% of at least one kind of material selected from a group of materials, including iron oxide, chrome oxide, manganese oxide, titanium oxide, and cobalt, and balance of at least one kind of material selected from a group of materials, including aluminum oxide, silicon oxide, zirconia, magnesium oxide, calcium oxide, sodium oxide, silicon carbide, and carbon, coating above mixture on an inside part of the insulating brick in contact with an inside of the furnace, to form a blacken film layer (2), and baking the insulating brick having the blacken film layer formed thereon for 1 - 7 hours at 500 - 1700 C.

DESCRIPTION

HEAT INSULATION BRICK MADE CONSTRICTION IN FURNACE FOR INDUSTRIAL USE & METHOD FOR MANUFACTURE THE SAME

Technical Field

The present invention relates to insulating bricks for industrial furnaces that require high temperature heating, and more particularly, to an insulating brick, blackness of an inside surface, that faces an inside of a furnace, of which is made high, to enhance emissivity, for saving energy; and a method for manufacturing the same. Background Art

The insulating bricks are used for building an inside part of various industrial furnaces, such as hot blast furnaces, incinerators, and heating furnaces, that require high temperature heating. The insulating brick for the various industrial furnaces is formed of an insulating material of which principal component is a metal oxide, such as chamotte, alumina, alumina-silicate, and zircoma, which requires much energy when the brick is used for a heating furnace that uses radiant energy because the insulating materials have a low emissivity even though the insulating materials have a high insulating performance.

Most of the insulating bricks of the metal oxide have a blackness (saturation of black color) is in a range of 0.6 ~ 0.8. It is defined that a perfect black color has 100% emissivity, and a substance that has 100% emissivity has a blackness of unity.

A related art insulating brick has been manufactured of one of above materials, and used for building an inside part of the furnace as it is.

A cracking furnace of naphtha cracker, a general industrial furnace, consumes about 30Gcal/hr of energy, which corresponds to about 7 billion Korean Won (K.Won) worth of bunker C oil.

The Korea Petrochemical Industrial Co., Ltd, a Korean company, has 8 units of the cracking furnaces, which are supposed to consume about 56 billion K.Won of energy.

A size of thermal radiant energy in an industrial furnace increases sharply together with rise of a temperature, such that most of heat is transmitted by heat radiation in a high temperature. In the industrial furnace, a ratio of a near infrared ray to

a far infrared ray is approx. 1/2 at a furnace temperature in the vicinity of 800°C. At a

CLAIMS (1)

1. What is Claimed is:

1. An insulating brick to be built inside of an industrial furnace for high temperature heating comprising: a blacken film layer in contact with an inside of the furnace, the blacken film layer having a blackness higher than 0.85.

2. The insulating brick as claimed in claim 1, wherein the blacken film layer includes;

2 ~ 100wt% of at least one kind of material selected from a group of materials, including iron oxide, chrome oxide, manganese oxide, titanium oxide, and cobalt, and balance of at least one kind of material selected from a group of materials, including aluminum oxide, silicon oxide, zirconia, magnesium oxide, calcium oxide, sodium oxide, silicon carbide, and carbon.

3. A method for manufacturing an insulating brick to be built inside of industrial furnace comprising the steps of: mixing a coloring raw material with solvent such as water, alcohol, and kerosene, the coloring raw material including 2 ~ 100wt% of at least one kind of material selected from a group of materials, including iron oxide, chrome oxide, manganese oxide, titanium oxide, and cobalt, and balance of at least one kind of material selected from a group of materials, including aluminum oxide, silicon oxide, zirconia, magnesium oxide, calcium oxide, sodium oxide, silicon carbide, and carbon; coating above mixture on an inside part of the insulating brick in contact with an inside of the furnace, to form a blacken film layer; and baking the insulating brick having the blacken film layer formed thereon for 1 ~ 7

hours at 500 ~ 1700°C.

4. The method as claimed in claim 3, wherein the blacken film layer has a blackness over 0.85.

furnace temperature in the vicinity of 1000 ~ 1300°C, the ratio of a near infrared ray to

a far infrared ray is higher than 90%. Others are around 5% of visible lights. Therefore, it is hard to expect a heating effect made by emissivity if the substance is not one that absorbs the near infrared ray. Disclosure of Invention

An object of the present invention, devised for solving the related art problem, lies on providing an insulating brick, blackness of an inside part of which in contact with an inside of various furnaces is made high, to enhance emissivity, for saving energy, and a method for manufacturing the same.

The object of the present invention can be achieved by providing an insulating brick to be built inside of an industrial furnace for high temperature heating including a blacken film layer in contact with an inside of the furnace, having a blackness higher than 0.85. Moreover, the present invention provides a method for manufacturing an insulating brick including the blacken film layer.

FIG 1 illustrates an insulating brick in accordance with a preferred embodiment of the present invention, including a blacken film layer 2 with a blackness over 0.8, preferably 0.85 ~ 1.0, at an inside part of a brick 1, having a form the same with a related art brick, in contact with an inside surface of a furnace.

An energy absorption and a color have the following relation. In general, though ice is colorless and transparent since the ice transmits a light, however, the ice turns into thick gray if the ice is broken up. What a substance shines white implies that entire wavelengths of a visible light return, i.e., reflect, what a substance looks black implies that entire wavelengths of the visible light are taken, i.e., absorb. Even though snow hardly melt even in an early spring, the snow melts soon once sand is spread thereon. This is because, even though the snow reflects sunlight, the sand absorbs the sunlight, to elevate a temperature of the snow. By utilizing this principle, the blacken film layer of the present invention having a particular blackness is formed.

Thermal radiation is emission of electro-magnetic wave caused by a group of atoms loosened by heat. An intensity of the thermal radiation is dependent on kind and temperature of a substance; the higher the temperature, the higher the intensity of the thermal radiation. Therefore, if a low temperature substance is in the vicinity of a high temperature substance, the low temperature substance absorbs a portion of a radiant ray, and turns the radiant ray into heat. The heat is radiant heat or an emissive heat.

The insulating brick of the present invention may be formed of any material as far as the material is one that has been used in the field of art of the present invention, and has a blackness below 0.8 without any particular limitation in view of material, such as alumina, alumina-silicate, zirconia, and the like.

The present invention is achieved by coating coloring raw material on a related art brick such that the coating has a blackness higher than 0.80, preferably higher than 0.85. Materials that can make the blackness higher than 0.85 are inorganic materials, such as metal oxides, carbides and the like, which permit coloring at an elevated

temperature higher than 500°C. As such various inorganic materials, 2 ~ 100wt% of at least one kind (hereafter called as a principal co

mponent) of material selected from a group of materials, including FeO, Fe_2O_3, Cr_2O_3, manganese oxide, titanium oxide, and cobalt may be used. Moreover, the present invention suggests to use only the principal component, or to use the principal component mixed with at least one kind of material selected from a group of materials, including aluminum oxide, silicon oxide, zirconia, magnesium oxide, calcium oxide, sodium oxide, silicon carbide, and carbon. There is no particular limitation in a mixing ratio of the principal component and auxiliary principles as far as mixing ratio provides the blackness higher than 0.85.

The insulating brick of the present invention permits to enhance an emissivity to save energy while maintaining the present insulating performance as it is, by processing one or more than one side surfaces of a refractory insulating brick close to a black body by using an inorganic material having a heat resistance higher than 500°C.

Brief Description of Drawings The accompanying drawings, which are included to provide a further understanding of the invention, illustrate an embodiment of the invention and together with the description serve to explain the principle of the invention.

In the drawings;

FIG. 1 illustrates a structure of a refractory insulating brick in accordance with a preferred embodiment of the present invention, wherein a reference numeral 1 denotes an insulating brick, and reference numeral 2 denotes a black film coating. Best Mode for Carrying Out the Invention

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. The insulating brick of the present invention can be manufactured by mixing, forming, and drying raw materials of an insulating brick, coating a coloring raw material on the insulating brick, prepared by mixing at least one kind of principal component selected from a group of materials including FeO, Fe_2O_3, Cr_2O_3, manganese oxide, titanium oxide, and cobalt with at least one kind of auxiliary principles selected from a group of materials, including aluminum oxide, silicon oxide, zirconia, magnesium oxide, calcium oxide, sodium oxide, silicon carbide, and carbon in a ratio ranging 2 ~ 100wt%, and baking the insulating brick. Or, alternatively, the insulating brick of the present invention can be manufactured by mixing, forming, drying, and baking raw materials of an insulating brick, to manufacture the insulating brick that is a primary product, and coating the coloring raw material including the principal component the auxiliary principles on the insulating brick, and baking the insulating brick.

For manufacturing a certain form of brick, a brick is formed of a raw material used presently used widely, such as chamotte, alumina, alumina-silicate, and zirconia, and dried by using a known method.

Then, the principal component (at times, together with the auxiliary principles) of the color material is mixed with a solvent, such as kerosene, alcohol, or water, and the like, and coated on one of an inside surfaces of the dried insulating brick by spraying, brushing, dipping, rolling, and the like. Then, the coated insulating brick is baked for 1 ~ 7 hours at a temperature ranging

500 ~ 1700°C.

As the coloring raw material component that forms the blacken film layer is diffused into an inner part of, and forms a unit of, the insulating brick by the baking, the insulating brick becomes to have a portion of a black body, to enhance durability and emissivity. Moreover, the baking prevents break away of the blacken film layer that can take place during use of the insulating brick.

Though dependent on the coloring raw material component that forms the blacken film layer, it is preferable that the baking temperature is lower than a maximum

temperature of use of the insulating brick. The best temperature is in a range 200 ~ 300°C

lower than the maximum temperature of use. In the meantime, when the insulating brick is baked at a temperature 50 ~ 100°C higher than a temperature of use, the insulating brick has a higher blackness, and favorable in view of emissivity, and durability.

If the baking temperature is lower than 500°C, no sintering takes place, to fail to make the blacken film layer component to react with the insulating brick, and to fail to form a unit, resulting in poor bonding, that is liable to fall off, and resulting in poor coloring due to failure of reactions between respective components.

When the blacken film layer is formed on a refractory insulating brick by mixing 5 ~ 10wt% of the principal component with 90 ~ 95wt% alumina, it is observed that a bonding strength is manifested, and an insulating layer and the blacken film layer are

unitized, at 1650°C.

In a case the baking temperature exceeds 1700°C, a liquid phase is formed, that

drops the emissivity.

Moreover, a baking time period, having a relation with the baking temperature, is set the shorter, if the baking temperature is set the higher, and vice versa. If the baking time period is shorter than an hour, no baking takes place, resulting in a poor bonding strength, to cause, not only an easy fall off of the blacken film layer, but also a poor coloring effect as reactions between respective components fail. If the baking time period exceeds 7 hours, a liquid phase is produced, to drop the blackness, with a poor emissivity. The insulating brick manufactured according to the present invention, with a blackness higher than 0.85, permits to save 3 ~ 5% of energy, approx. 1 ~ 1.5Gcal/hr per a furnace, corresponding to approx. 0.2 ~ 0.35 bil. K.Won.

Table 1 shows an energy saving effect of the insulating brick of the present invention. Table 1 shows a result for a case of one naphtha cracker cracking furnace, in which the blacken film layer is formed of composition indicated therein on an insulating brick with a blackness in a range of 0.6, and is baked.

Table 1 Raw material: weight %

	1	2	3	4	5	6	7	8	9	10	11	12
Iron oxide	2	7	10	16	17	95	50					
Chrome oxide	2	3	10	15	19			85				50
MgO	1	2	4	3	5				90			
Titanium oxide		5		11	15						75	
Cobalt		1		2	1					60		
Silicon carbide		4	5	5	3						5	
Carbon			2	3	2							2
Alumina	60	60	50	30	30	5	40	15		35	15	40
Silicon carbide	30	13	14	10	3		10		10	5	5	8
Others	5	5	5	5	5							
Total	100	100	100	100	100	100	100	100	100	100	100	100
Blackness	0.80	0.85	0.90	0.95	0.99	0.94	0.92	0.96	0.95	0.90	0.97	0.95
Energy Consump. (Gcal/hr)	29.7	29.2	28.7	28.5	28.4	28.6	28.9	28.5			28.5	28.6
BC oil Equivalent (Bil. K.Won/Y)	6.9	6.813	6.697	6.65	6.627	6.672	6.743	6.65			6.648	6.673
Effect (% of saved money)	1.43	2.67	4.33	5.0	5.33	4.68	3.67	5.0			5.02	4.67

The bonding strengths following baking are tested for embodiments 1, 2, 3, 5, 7, 8,

10, and 12 in table 1, of which results are shown in table 2. Table 2

	*Ex. 1	Ex. 2	*Em. 1	Em. 2	Em. 3	Em. 5	Em. 7	Em. 8	Em.10	Em.12	Not tested

Baking Condition	Temp. (°C)	150	450	550	1100	1250	1300	1450	1550	1650	1680	-
	Time (h)	24	10	5	5	3	3	3	1	2	1	-
Bonding Strength (kg/cm^2)	900 (°C)	6	15	31	53	77	75	-	-	-	-	4
	1500 (°C)	5	13	27	51	65	68	72	71	74		
	1650 (°C)	6	13	25	-	-	-	69	70	73	75	5
Remark		Weak Bonding strength		Manifest a bonding strength providing durability over one year								*1

* 1 : Weak bonding strength. *Ex : Comparative Example *Em : Embodiment

As can be noted in above tables 1 and 2, though the baking temperatures vary with the raw materials of the blacken film layer, in a case of the embodiment 5 with the

blackness 0.99, an insulating brick with a 900°C maximum temperature of use has a

bonding strength higher than $32kg/cm^2$.

Table 3 shows a test result of a naphtha cracker cracking furnace of the insulating

brick with a maximum temperature 1500°C on which the blacken film layer of the raw

material of embodiment 5 is formed by coating with rolling, and baking under the baking condition of table 2. A comparative example in table 3 is tested after spraying the raw material of embodiment 5 on the insulating brick of a naphtha cracker cracking furnace. Table 3

	Embodiment 5	Comparative example
Bonding strength (kg/cm^2)	Over 30	Below 10
Durability	1 ~ 5 years	Below 20 months
Blackness	0.99	Impossible to measure
Effect (energy saving)	5.33% of energy saving lasts more than one year	Drops below 1% after 6 months

Remark More than 95 % is in position after Less than 50% is in position after one year. one year.

More than 95% of effect is Below 30% of effect is maintained maintained even after one year. after 9 - 6 years.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents. Industrial Applicability

The insulating brick in accordance with one of different embodiments of the present invention is applicable to industries because the insulating brick of the present invention provides insulating brick for energy saving type industrial furnaces by making related art insulating brick with a blackness below 0.8 to include a blacken film layer with a blackness over 0.8, more preferably, over 0.85, on a surface thereof, to enhance an emissivity.

PATENT CITATIONS

Cited Patent	Filing date	Publication date	Applicant	Title
SU1265184A1 *				*Title not available*
US5668072 *	May 9, 1996	Sep 16, 1997	Equity Enterprises	High emissivity coating

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WO2013005196A1	Jul 6, 2012	Jan 10, 2013	Saint-Gobain Centre De Recherches Et D'etudes Europeen	Regenerator
WO2013130021A1 *	Feb 29, 2012	Sep 6, 2013	Scg Chemicals Co., Ltd.	High emissivity coating compositions and manufacturing processes therefore
WO2014048586A1 *	Apr 24, 2013	Apr 3, 2014	Refractory Intellectual Property Gmbh & Co. Kg	Mix for producing a fire-resistant material, a fire-resistant material, a method for producing a fire-resistant material and use of a material as a sintering aid
EP2820364A4 *	Feb 29, 2012	Sep 9, 2015	Scg Chemicals Co Ltd	High emissivity coating compositions and manufacturing processes therefore
US9212098	Apr 24, 2013	Dec 15, 2015	Refractory Intellectual Property Gmbh & Co.	Blend for the production of a refractory material, a refractory material, a method for the manufacture of a refractory material, and use of a substance as a sintering aid

* Cited by examiner

CLASSIFICATIONS

International Classification	C04B35/105, F27D1/00, C04B35/043, C04B35/12, C04B35/66, F27D, C04B35/103, C04B41/50, C04B41/87, C04B35/478

Cooperative Classification	F27D1/0006, C04B2235/3232, C04B35/0435, C04B2235/3241, C04B35/105, C04B35/01, C04B2235/3206, C04B2235/3272, C04B2235/3275, C04B35/478, C04B41/5031, C04B35/12, C04B2235/3826, C04B2235/422, C04B41/87, C04B2235/9661, C04B35/103, C04B35/66, C04B41/009, C04B2235/3217
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LEGAL EVENTS

Date	Code	Event	Description
Jul 29, 2004	AK	Designated states	**Kind code of ref document:** A2 **Designated state(s):** AE AG AL AM AT AU AZ BA BB BG BR BW BY BZ CA CH CN CO CR CU CZ DE DK DM DZ EC EE EG ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX MZ NA NI NO NZ OM PG PH PL PT RO RU SC SD SE SG SK SL SY TJ TM TN TR TT TZ UA UG US UZ VC VN YU ZA ZM ZW
Jul 29, 2004	AL	Designated countries for regional patents	**Kind code of ref document:** A2 **Designated state(s):** BW GH GM KE LS MW MZ SD SL SZ TZ UG ZM ZW AM AZ BY KG KZ MD RU TJ TM AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LU MC NL PT RO SE SI SK TR BF BJ CF CG CI CM GA GN GQ GW ML MR NE SN TD TG
Nov 24, 2004	121	Ep: the epo has been informed by wipo that ep was designated in this application	
Jul 12, 2005	WWE	Wipo information: entry into national phase	**Ref document number:** 2006500624 **Country of ref document:** JP
Mar 22, 2006	122	Ep: pct app. not ent. europ. phase	