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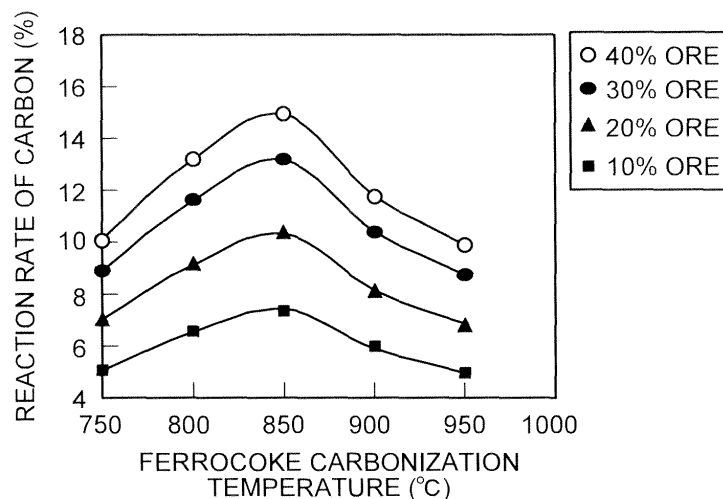
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(54) **PROCESS FOR PRODUCING FERRO COKE FOR METALLURGY**

(57) An object of the present invention is to provide a method of manufacturing ferrocoke by which CO₂ reactivity of coke in ferrocoke in a blast furnace is increased thereby decreasing a thermal reserve zone temperature and decreasing a reducing agent ratio when a briquette including a carbonaceous material and iron ore is car-

bonized to manufacture ferrocoke. The present invention is a metallurgical ferrocoke manufacturing method of manufacturing ferrocoke by carbonizing a mixture of a carbonaceous material and iron ore and is characterized in that a maximum temperature of ferrocoke during the carbonization is in a range of 800°C or higher and 900°C or lower.

FIG.8



Description

Field

5 **[0001]** The present invention relates to a metallurgical ferrocoke manufacturing method of manufacturing ferrocoke by briquetting a carbonaceous material and iron ore and carbonizing the briquette.

Background

10 **[0002]** To decrease a reducing agent ratio in a blast furnace, it is effective to decrease a thermal reserve zone temperature generated in the blast furnace (for example, see Non-Patent Literature 1). An example of a method of decreasing the thermal reserve zone temperature is a method of decreasing a starting temperature of a gasification reaction (endothermic reaction) of coke expressed by equation (1) below.

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$$\text{C} + \text{CO}_2 \rightarrow 2\text{CO} \quad (1)$$

[0003] Ferrocoke manufactured by carbonization of a briquette obtained by mixing and briquetting a carbonaceous material (coal) and iron ore is able to increase CO_2 reactivity of coke in ferrocoke due to a catalytic effect of reduced iron ore, and to decrease a reducing agent ratio due to a decrease in a thermal reserve zone temperature following the increase in the CO_2 reactivity (for example, refer to Patent Literature 1).

20 **[0004]** As a technique of manufacturing such ferrocoke, a method of mixing fine iron ore into coal and carbonizing, in an ordinary chamber coke oven, a mixture obtained by the mixing has been studied. For example, (a) a method of charging a fine mixture of coal and fine iron ore into a chamber coke oven, (b) a method of briquetting coal and iron ore in a cold environment, that is, at room temperature, and charging the briquette into a chamber coke oven (see Non-Patent Literature 2), (c) a method of carbonizing a briquette of coal and iron ore in a vertical carbonization furnace instead of a chamber coke oven (see Non-Patent Literature 3), and the like have been proposed. Because even an iron oxide is able to exhibit an effect of increasing CO_2 reactivity of coke, an effect of increasing CO_2 reactivity is presumed to be exhibited even if iron ore is not fully reduced to metallic iron (see Non-Patent Literature 4).

25 **[0005]** For ordinary coke charged into a blast furnace, CO_2 reactivity is considered to improve as carbonization temperature is decreased (for example, see Non-Patent Literature 5).

Citation List

Patent Literature

35 **[0006]** Patent Literature 1: Japanese Laid-open Patent Publication No. 2006-28594

Non-Patent Literature

40 **[0007]**

Non-Patent Literature 1: "Iron and Steel," The Iron and Steel Institute of Japan, 87, 2001, p. 357

Non-Patent Literature 2: "Coke Technology Annual Report," Japan Charcoal and Fuel Association, 1958, p. 38

Non-Patent Literature 3: "JFE Annual Report" 22, 2008, p. 20

45 Non-Patent Literature 4: "Fuel" 65, 1986, p. 1476

Non-Patent Literature 5: "Iron and Steel," The Iron and Steel Institute of Japan, 68, 1982, S-744

Non-Patent Literature 6: Kawasaki Steel Technical Report, 6 (1974), p. 16

Summary

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Technical Problem

[0008] In order to further decrease a reducing agent ratio in a blast furnace, it is necessary to use ferrocoke in the blast furnace as described above, increase CO_2 reactivity of coke in ferrocoke due to a catalyst effect of reduced iron ore, and decrease a thermal reserve zone temperature. However, conditions for manufacturing optimal ferrocoke which increase CO_2 reactivity of coke in ferrocoke have not been disclosed. Further, CO_2 reactivity of coke is desirably evaluated under conditions that have taken blast furnace conditions into consideration.

55 **[0009]** The invention has been made in view of the above problems, and its object is to provide a metallurgical ferrocoke

manufacturing method by which, when manufacturing ferrocoke by carbonizing a mixture of a carbonaceous material and iron ore, CO₂ reactivity of coke in ferrocoke inside a blast furnace is increased, thereby enabling a decrease in a thermal reserve zone temperature and a decrease in a reducing agent ratio.

5 Solution to Problem

[0010] In order to solve the above problems and achieve the object, the present invention is a metallurgical ferrocoke manufacturing method of manufacturing ferrocoke by briquetting a mixture of a carbonaceous material and iron ore to form a briquette and carbonizing the briquette, and is characterized in that a maximum temperature of ferrocoke during the carbonization is in a range of 800°C or higher and 900°C or lower. The maximum temperature of the ferrocoke during the carbonization is preferably in a range of 800°C or higher and 850°C or lower. A particle diameter of the ferrocoke is preferably in a range of 15 mm or greater and 35 mm or less, and more preferably in a range of 15 mm or greater and 28 mm or less. The ferrocoke preferably has an iron content in a range of 5 mass% or greater and 40 mass% or less and more preferably in a range of 10 mass% or greater and 40 mass% or less. Desirably, the carbonization of the briquette is performed in a vertical furnace and a furnace top gas of the vertical furnace is used as a gas that heats up the briquette. The furnace top gas includes carbon monoxide, carbon dioxide, hydrogen, methane, and nitrogen. The gas that heats up the briquette desirably includes at least two components selected from a group consisting of carbon monoxide, carbon dioxide, hydrogen, methane, and nitrogen.

20 Advantageous Effects of Invention

[0011] According to the present invention, ferrocoke having high CO₂ reactivity in a blast furnace is able to be manufactured, and a reducing agent ratio in the blast furnace is able to be decreased due to a decrease in a thermal reserve zone temperature. Further, according to the present invention, a carbonization temperature is not increased by what is more than necessary when ferrocoke is manufactured, and thus contribution to adjustment of a necessary amount of heat is achievable.

Brief Description of Drawings

30 [0012]

FIG. 1 is a schematic diagram of a shape of ferrocoke.

FIG. 2 is a graph illustrating a relation between ferrocoke carbonization temperature and reduction rate of iron in ferrocoke.

35 FIG. 3 is a graph illustrating time difference between a particle surface layer and a center to reach a same temperature during temperature increase.

FIG. 4 is a graph illustrating descending speed necessary for the particle surface layer and the center to reach the same temperature.

FIG. 5 is a graph illustrating an ore particle size distribution.

40 FIG. 6 is a graph illustrating a relation between particle diameter of ferrocoke and ventilation resistance of a mixed layer of ore and ferrocoke.

FIG. 7 is a graph illustrating ferrocoke reaction testing conditions.

FIG. 8 is a graph illustrating a relation between ferrocoke carbonization temperature and CO₂ reaction rate of carbon.

FIG. 9 is a graph illustrating a relation between iron content in ferrocoke and reaction starting temperature.

45 FIG. 10 is a graph illustrating a relation between ferrocoke carbonization temperature and reducing agent ratio in a blast furnace upon using ferrocoke.

Description of Embodiments

50 **[0013]** For ferrocoke used in blast furnace operations which is manufactured by carbonizing a briquette obtained by briquetting a mixture of a carbonaceous material and iron ore, a method of manufacturing ferrocoke was studied in order to increase CO₂ reactivity of coke in ferrocoke, and the following considerations were made.

[0014]

55 (1) Since the higher the temperature of ferrocoke upon carbonization is, the further the reduction of mixed iron ore proceeds and thus the more enhanced the catalytic effect is.

(2) Since generally the lower the temperature of coke upon carbonization is, the more improved the CO₂ reactivity of coke is, focus is also given on a coke portion obtained by carbonization of a carbonaceous material, which is a

portion other than iron in ferrocoke, and the lower the carbonization temperature is, for the coke portion in the ferrocoke too, the more improved the reactivity of the coke portion in the ferrocoke is.

[0015] That is, when the temperature of ferrocoke becomes higher upon the carbonization in manufacturing ferrocoke, there is a possibility that the CO₂ reactivity of coke increases from the viewpoint of the catalytic effect of the reduced iron but also a possibility that the CO₂ reactivity of coke decreases from the viewpoint of the properties of coke. Therefore, an optimal temperature range is considered to exist in ferrocoke manufacturing conditions for increasing the CO₂ reactivity of coke.

[0016] Therefore, the inventors, by carrying out experiments on ferrocoke that had been carbonized under varying temperature conditions to evaluate the CO₂ reactivity of coke under conditions reproducing the blast furnace gas and temperature, derived carbonization conditions of ferrocoke that increase the CO₂ reactivity of coke. The process thereof will be described hereinafter.

[0017] Ferrocoke was manufactured by carbonizing, in a batch-type pressurized carbonization furnace, a briquette (briquette) obtained by briquetting a mixture of coal and iron ore (70 mass% of coal; and 10, 20, 30, and 40 mass% of iron ore) using a briquette machine. A shape of the briquette is illustrated in FIG. 1. L is 30 mm, B is 25 mm, and T is 18 mm. L represents the length, B represents the breadth, T represents the thickness, and a representative particle diameter of ferrocoke is represented by $(\text{length} \times \text{breadth} \times \text{thickness})^{1/3}$, that is, $(L \times B \times T)^{1/3}$.

[0018] Temperatures of ferrocoke during the carbonization (ferrocoke carbonization temperatures) were 750°C, 800°C, 850°C, 900°C, and 950°C. A ferrocoke carbonization temperature is the maximum temperature during the carbonization, and is obtained by measuring a temperature at a central portion of the briquette. Temperature was increased up to this maximum temperature at 5°C/min, and maintained at the maximum temperature for 90 minutes. An atmosphere was a mixed gas of 30% of hydrogen, 11% of carbon monoxide, 17% of carbon dioxide, 21% of nitrogen, 5% of water vapor, and 16% of methane (each in vol%). These are based on a premise of continuous manufacturing by a gas-solid countercurrent moving bed using a vertical furnace, and an assumption of a process using furnace top gas as gas, in actual manufacturing of ferrocoke. Reduction rates of iron ore in ferrocoke at each ferrocoke carbonization temperature are illustrated in FIG. 2. The reduction rate increases as the ferrocoke carbonization temperature increases.

[0019] Next, influence of size of ferrocoke on productivity was studied. During carbonization, in particular, with respect to the maximum temperature that largely influences properties of a product, the temperature within the briquette is desirably maintained homogeneously. When a vertical carbonization furnace, which is a gas and solid temperature countercurrent moving bed, is used, it is necessary to set operating conditions so as to secure a time for the temperature within the briquette to become homogeneous.

[0020] FIG. 3 illustrates results of measurement of time difference between a time at which a surface layer reaches 850°C and a time at which the center reaches 850°C when the temperature was increased from 25°C to 850°C at 5°C/min as the volume of the briquette was varied. A briquette volume of 6 cc was used as a reference condition, and sorting was done with relative values with respect to a case of the briquette volume of 6 cc. The atmosphere was a mixed gas of 30% of hydrogen, 11% of carbon monoxide, 17% of carbon dioxide, 21% of nitrogen, 5% of water vapor, and 16% of methane (each in vol%), and the temperatures of the surface layer and the center of the briquette were measured. The time for the entire briquette to reach a homogeneous temperature increases as the volume of the briquette increases.

[0021] Next, operating conditions of the carbonization furnace which were necessary to make the temperature of the entire briquette homogeneous were studied. When the condition of the briquette volume of 6 cc is used as a reference, for a briquette having a volume larger than 6 cc, in order to make the time to hold all of its particles at a homogeneous temperature the same, that is, the time to hold all the particles at 850°C after the center of the briquette reaches 850°C the same, the time illustrated in FIG. 3 is required additionally with respect to the condition of 6 cc. Means for adjusting the time for the center of the briquette to reach 850°C may be a change in a descending speed of the briquette. A relation between the briquette volume and the briquette descending speed necessary for the inside of the briquette to reach a homogeneous temperature when a zone length at 850°C is 1.5 m and the briquette descending speed of 1 m/hour for the briquette volume of 6 cc is used as a reference is illustrated in FIG. 4. It is necessary to decrease the descending speed as the briquette volume is increased. This means a decrease in the production speed, and, when the volume of 6 cc is set as a reference, the production speed decreases by 5% or more when the volume becomes 14 cc or greater. When the representative particle diameter of ferrocoke is expressed by $(\text{length} \times \text{breadth} \times \text{thickness})^{1/3}$ as described above, the representative diameter of the volume of 6 cc is equivalent to 23.8 mm, the representative diameter of the volume of 14 cc is equivalent to 28.3 mm, and the representative diameter of the volume of 18 cc is equivalent to 30.6 mm. As described above, a briquette of a smaller size is more advantageous in terms of productivity, but when use in a blast furnace is assumed, a lower limit of size from the viewpoint of gas permeability is desirably specified.

[0022] Ferrocoke is desirably used by being mixed with an iron material including sintered steel, a pellet, lump ore, or the like. Hereinafter, the iron material including the sintered steel, the pellet, the lump ore, or the like will be referred to as ore. Since it is important in terms of operation to maintain the gas permeability of a mixed layer of ore and ferrocoke, the influence of ferrocoke particle diameter on ventilation resistance of the mixed layer of ore and ferrocoke was inves-

5 tigated. The ratio of ferrocoke in ore was 21 vol% (equivalent to a ferrocoke ratio of 35 mass%), and a particle size distribution of ore is illustrated in FIG. 5. A change in the ventilation resistance according to the size of ferrocoke mixed in ore was calculated using equation (2) below. Here, Φ represents a shape coefficient (assumed to be 0.7), d_p represents an average particle diameter of the ore/ferrocoke mixed layer, and ϵ represents a porosity of the ore/ferrocoke mixed layer.

$$\text{Permeability index} = (1 / \Phi d_p)^{1.3} \cdot (1 - \epsilon)^{1.3} / \epsilon^3 \quad (2)$$

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[0023] The average diameter of the mixed layer was calculated by correcting the particle size distribution illustrated in FIG. 5 according to an assumed ferrocoke size, and the porosity was assumed from the corrected particle size distribution (see Non-Patent Document 3). The results are illustrated in FIG. 6. It was found that a change in the ventilation resistance is small in a ferrocoke size range of 15 mm to 35 mm. When the size of ferrocoke is below 15 mm, the average diameter of the mixed layer decreases and thus the ventilation resistance increases. The ventilation resistance also increases under a condition in which the size of ferrocoke is large, but this is caused by a decrease in the porosity due to widening of the particle size distribution. From the above, it became clear that, in order to avoid an increase in the ventilation resistance, the ferrocoke particle diameter is preferably in a range of 15 mm to 35 mm. For ferrocoke which is manufactured using a briquetting machine and has a shape like that illustrated in FIG. 1, the previously defined representative particle diameter of ferrocoke ($= (L \times B \times T)^{1/3}$) is desirably in a range of 15 mm to 35 mm. More desirably, the representative particle diameter of ferrocoke is in a range of 20 mm to 35 mm.

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[0024] From the above, the particle diameter of ferrocoke is desirably 28.3 mm or less from the viewpoint of securing the productivity and in a range of 15 mm to 35 mm from the viewpoint of the gas permeability upon use in a blast furnace. The particle diameter of ferrocoke is desirably in a range of 15 mm to 28 mm in consideration of both ensuring the productivity and the gas permeability. Briquettes have common names such as a Masec type, a pillbox type, an egg type, an ellipse type, and the like according to shapes of molds of the briquette machine. Since any briquette has three intersecting symmetric axes (the above L, B, and T), characteristics thereof are specified by the above-expressed representative particle diameter ($= (L \times B \times T)^{1/3}$).

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[0025] Next, tests of reacting ferrocoke manufactured at ferrocoke carbonization temperatures of 750°C, 800°C, 850°C, 900°C, and 950°C under conditions simulating conditions in a blast furnace were carried out. The briquette shape was set such that L = 30 mm, B = 25 mm, and T = 18 mm in FIG. 1. Reaction conditions are illustrated in FIG. 7. In FIG. 7, the portion indicated by a bold line corresponds to surrounding conditions of a material charged from a furnace top of a blast furnace and descending down through the furnace to a temperature zone of 1200°C.

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[0026] A relation between ferrocoke carbonization temperature and reaction rate of carbon in ferrocoke for ferrocoke that has been reacted up to 1200°C under the conditions of FIG. 7 is illustrated in FIG. 8. Results were obtained, which indicated that the reaction rates at the ferrocoke carbonization temperatures of 750°C and 950°C were at a lower level, and the maximum value was obtained at 850°C. When the ferrocoke carbonization temperature was 750°C, the reduction rate of iron ore in ferrocoke was as low as 20% as illustrated in FIG. 2, and it is thus assumed that the reactivity became low because the catalytic effect of reduced iron was small. It is assumed that although the reduction rate of iron ore in ferrocoke increased as the ferrocoke carbonization temperature increased as illustrated in FIG. 2, the reactivity decreased at 950°C due to influence by a decrease in the reactivity of the coke portion.

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[0027] Reaction starting temperatures in the above tests of ferrocoke manufactured at a carbonization temperature of 850°C with its iron content varied from 0 mass% to 40 mass% are illustrated in FIG. 9. A temperature at which the reaction rate of carbon in ferrocoke reaches 0.8% was defined as the reaction starting temperature. According to FIG. 9, as the content of iron in ferrocoke increases, the effects of reactivity being improved and a decrease in the reaction starting temperature are exhibited. A large effect is exhibited from the iron content of 5 mass%, and the effect is saturated at 40 mass% or greater. As a result, it can be said that the iron content is desirably in a range of 5 mass% to 40 mass%. Therefore, the iron content in the ferrocoke is preferably in a range of 5 mass% to 40 mass%, and more preferably in a range of 10 mass% to 40 mass%.

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[0028] From the above, it became clear that, when a mixture of a carbonaceous material and iron ore is carbonized to manufacture ferrocoke, ferrocoke having a high CO₂ reactivity was able to be manufactured by setting the temperature of ferrocoke upon the carbonization in a range of 800°C to 900°C, desirably in a range of 800°C to 850°C, and particularly desirably around 850°C. The iron content in ferrocoke is preferably in a range of 5 mass% to 40 mass%, and more preferably in a range of 10 mass% to 40 mass%. Coal is preferably used as the carbonaceous material. Other than coal, biomass or the like may be used.

Example 1

[0029] Use in a blast furnace was tested for ferrocoke manufactured under respective carbonization temperature conditions.

[0030] For ferrocoke, a briquette obtained by briquetting a mixture of coal and iron ore (70 mass% of coal and 30 mass% of iron ore) using a briquette machine was continuously carbonized in a gas heating type vertical carbonization furnace. Some of furnace top gas of the carbonization furnace (30 vol% of hydrogen, 11 vol% of carbon monoxide, 17 vol% of carbon dioxide, 21 vol% of nitrogen, 5 vol% of water vapor, and 16 vol% of (methane + ethane)), which has been heated, was used as gas, and the briquette was heated up by forming a countercurrent moving bed with gas elevating in the carbonization furnace and the briquette continuously descending in the furnace. As dimensions of the briquette, the shape illustrated in FIG. 1 (L = 30 mm, B = 25 mm, and T = 18 mm) was used. In the vertical carbonization furnace, the briquette charged from the furnace top was heated up to around 600°C in approximately one hour, heated to the maximum temperature from 600°C at 2°C/min to 5°C/min, and maintained at that maximum temperature for 1.5 hours. The maximum temperature was regarded as the ferrocoke carbonization temperature. Here, for example, as described in Non-Patent Literature 6, there is a difference between the gas temperature and the solid temperature in the vertical carbonization furnace. Taking this difference into consideration, a heat transfer simulation in the countercurrent moving bed was carried out, and gas conditions were adjusted so that the solid temperature met a desired condition.

[0031] The ferrocoke manufacturing conditions (ferrocoke carbonization temperatures), the reduction rates of iron in the ferrocoke, the operating conditions (the amounts of ferrocoke used, the chamber oven coke ratios, and pulverized coal ratios), and the blast furnace operation results (reducing agent ratios) are illustrated in Table 1, and a relation between the ferrocoke carbonization temperature and the blast furnace reducing agent ratio is illustrated in FIG. 10. In Table 1, the base is a case of an ordinary blast furnace operation of not using ferrocoke, and cases 1 to 5 are cases in which an operation of uniformly mixing ferrocoke in an ore layer and charging it from the blast furnace top was carried out.

[0032]

Table 1

		Base	Case 1	Case 2	Case 3	Case 4	Case 5
Ferrocoke carbonization temperature	°C		750	800	850	900	950
Reduction rate of iron in ferrocoke	%		20	45	69	84	87
Amount of ferrocoke used	kg/t	0	100	100	100	100	100
Chamber oven coke ratio	kg/t	352	262	250	244	251	257
Pulverized coal ratio	kg/t	130	130	130	130	130	130
Reducing agent ratio	kg/t	482	463	450	444	451	457

[0033] According to Table 1, the reducing agent ratio is able to be decreased by using ferrocoke as compared to the condition (base) under which ferrocoke is not used. Particularly, the reducing agent ratio was able to be decreased by 30 kg/t or more when the temperature of ferrocoke in the carbonization (the ferrocoke carbonization temperature) was in a range of 800°C to 900°C. This is assumed to be due to interaction between an effect of a function as a catalyst increasing because of the reduction rate of iron in ferrocoke increasing by an increase in the carbonization temperature and an effect of the reactivity of the coke portion decreasing by an increase in the carbonization temperature.

[0034] An embodiment to which the invention made by the inventors is applied has been described, but the present invention is not limited by the description and drawings constituting a part of disclosure of the present invention through the present embodiment. For example, other embodiments, examples, operation techniques, and the like made by any person skilled in the art or the like based on the present embodiment are all included in the scope of the present invention.

Industrial Applicability

[0035] The present invention is applicable to a method of manufacturing ferrocoke by briquetting a mixture of a carbonaceous material and iron ore and carbonizing the briquette formed.

Claims

1. A metallurgical ferrocoke manufacturing method of manufacturing ferrocoke by briquetting a mixture of a carbonaceous material and iron ore to form a briquette and carbonizing the briquette, wherein a maximum temperature of ferrocoke during the carbonization is in a range of 800°C or higher and 900°C or lower.
2. The metallurgical ferrocoke manufacturing method according to claim 1, wherein the maximum temperature of the ferrocoke during the carbonization is in a range of 800°C or higher and 850°C or lower.
3. The metallurgical ferrocoke manufacturing method according to claim 1, wherein a particle diameter of the ferrocoke is in a range of 15 mm or greater and 35 mm or less.
4. The metallurgical ferrocoke manufacturing method according to claim 3, wherein the particle diameter of the ferrocoke is in a range of 15 mm or greater and 28 mm or less.
5. The metallurgical ferrocoke manufacturing method according to claim 1, wherein the ferrocoke has an iron content in a range of 5 mass% or greater and 40 mass% or less.
6. The metallurgical ferrocoke manufacturing method according to claim 1, wherein the carbonization of the briquette is performed in a vertical furnace and a furnace top gas of the vertical furnace is used as a gas that heats up the briquette.

FIG.1

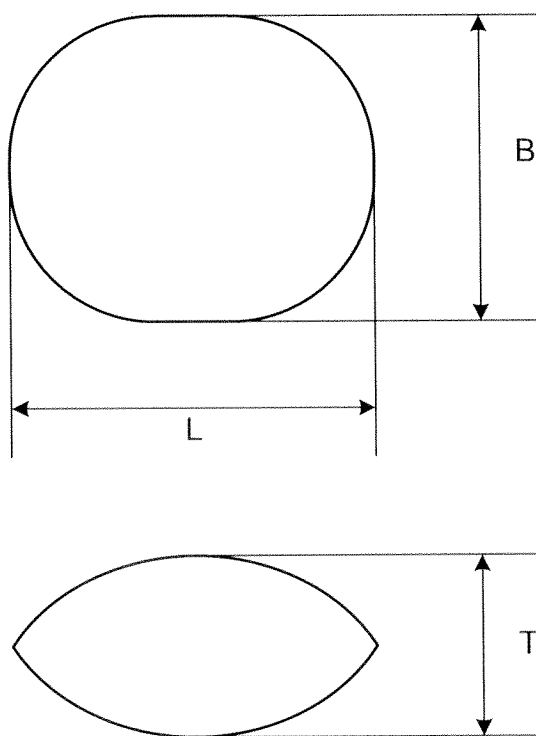


FIG.2

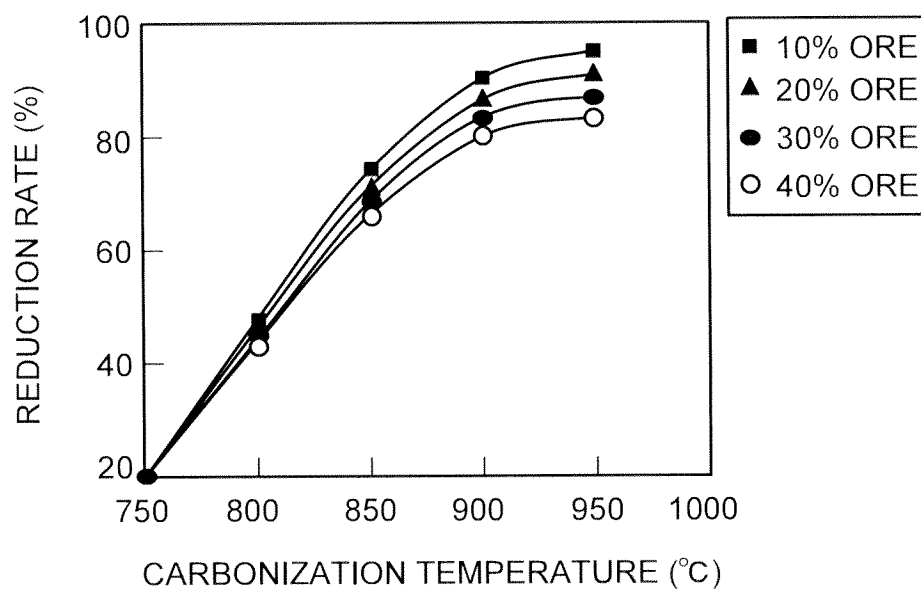


FIG.3

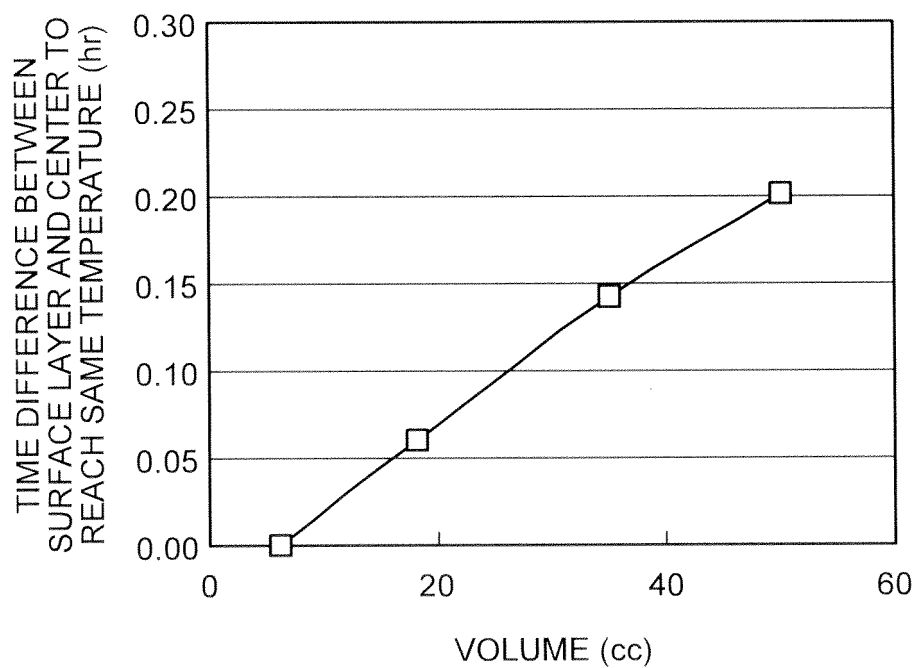


FIG.4

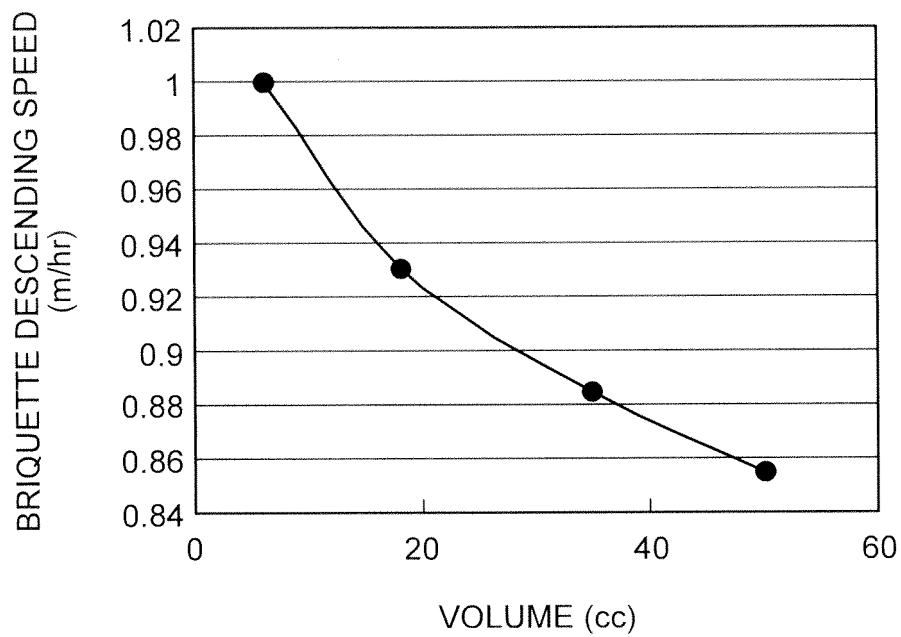


FIG.5

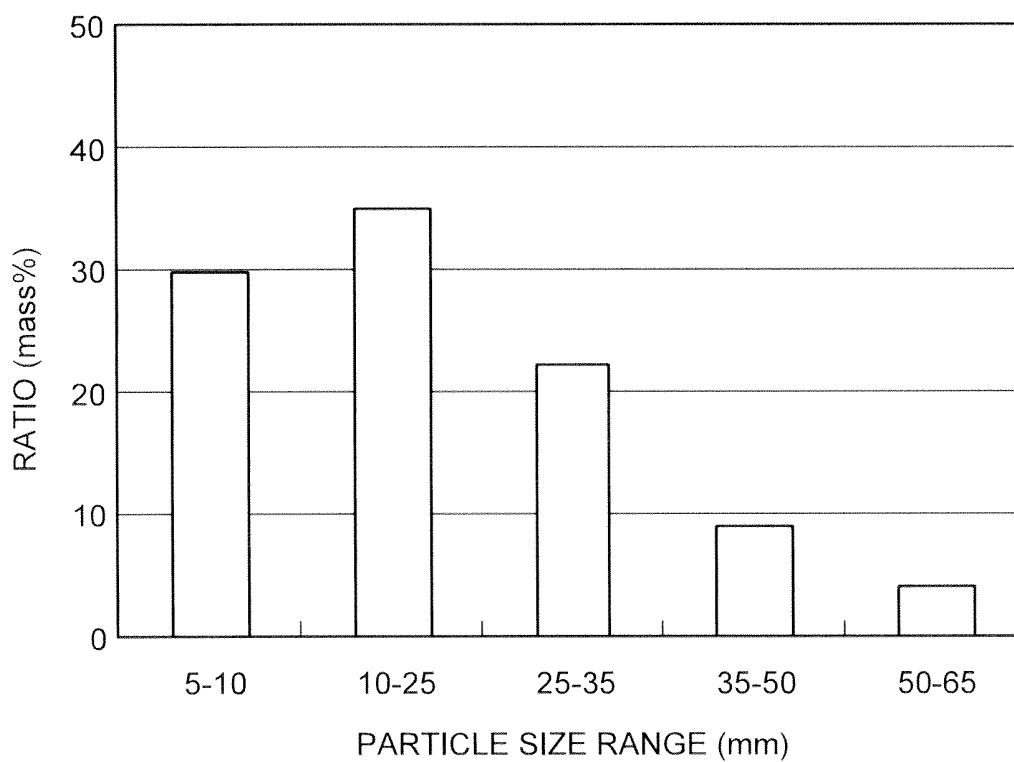


FIG.6

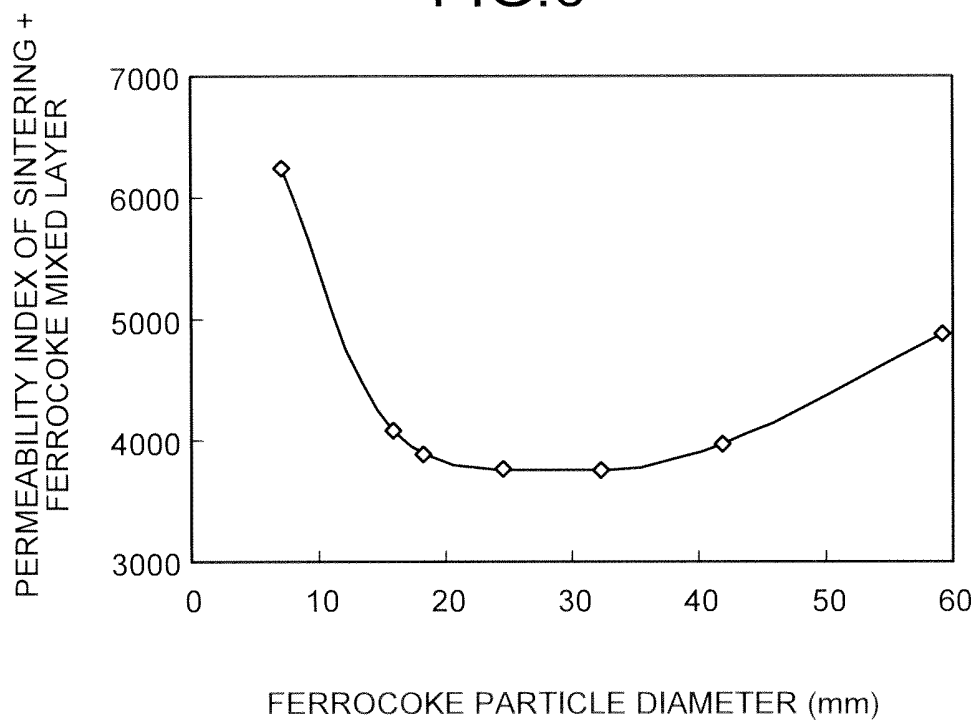


FIG.7

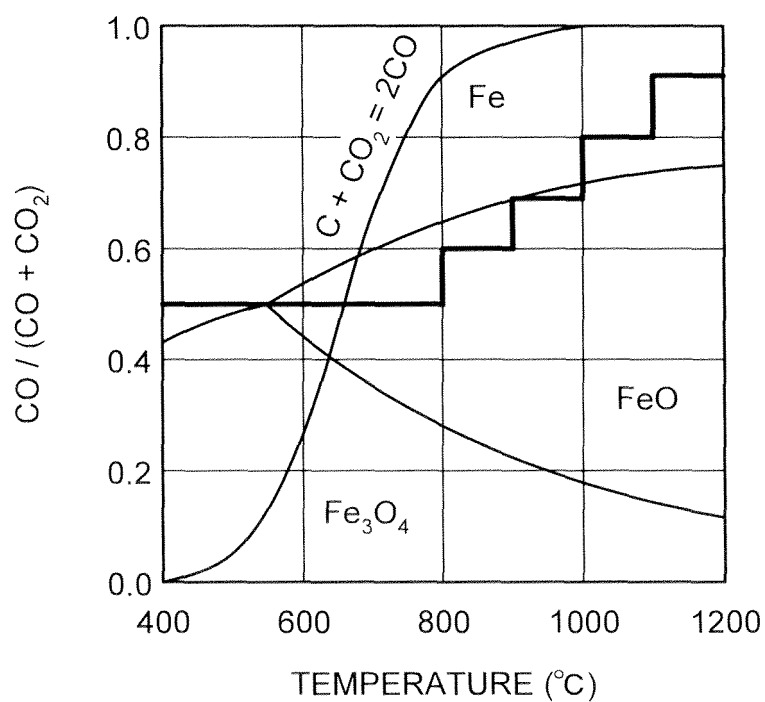


FIG.8

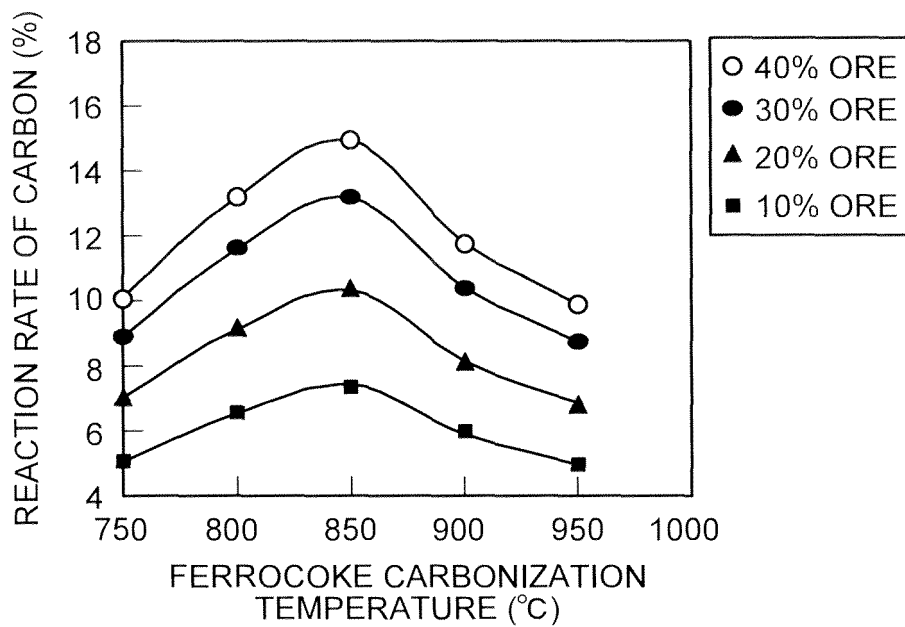


FIG.9

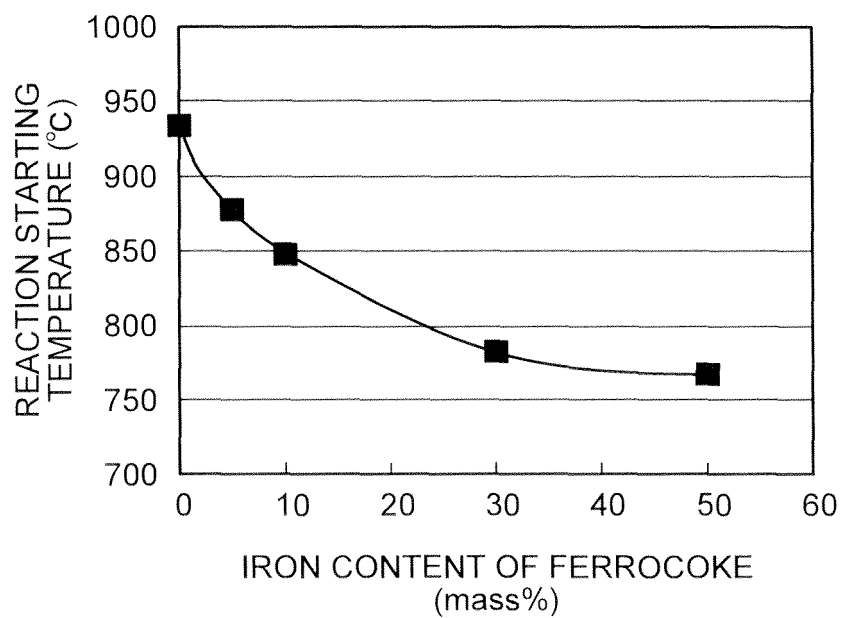
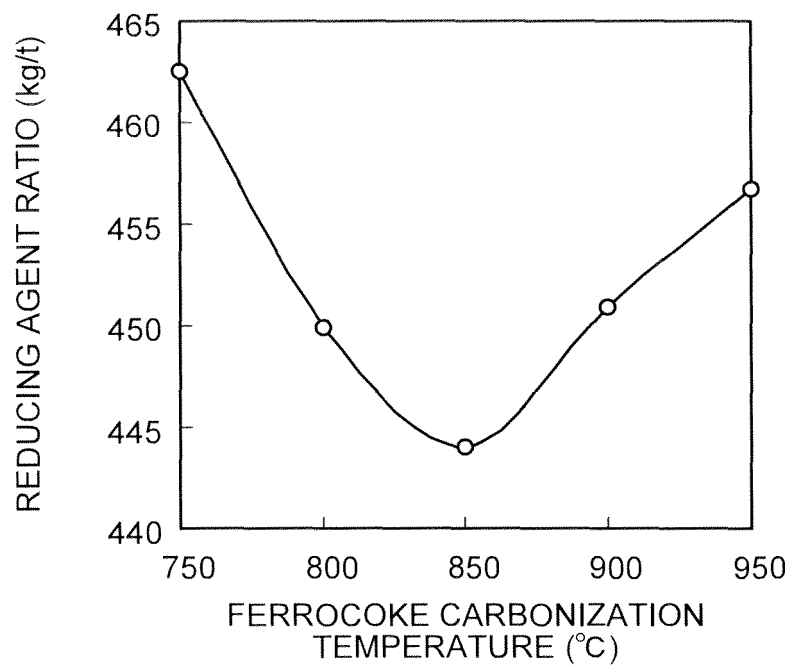


FIG.10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/054367

A. CLASSIFICATION OF SUBJECT MATTER

C10B53/08(2006.01)i, C10B57/04(2006.01)i, C21B5/00(2006.01)i, C22B1/245(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C10B53/08, C10B57/04, C21B5/00, C22B1/245

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011

Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2009-227781 A (JFE Steel Corp.), 08 October 2009 (08.10.2009), paragraphs [0015] to [0018]; fig. 1 (Family: none)	1-5 6
X Y	JP 2008-13637 A (JFE Steel Corp.), 24 January 2008 (24.01.2008), example 1 (Family: none)	1, 3-5 6
X Y	WO 2009/081506 A1 (JFE Steel Corp.), 02 July 2009 (02.07.2009), example 1 & EP 2233548 A1 & AU 2007363032 A	1, 3-5 6

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search
16 March, 2011 (16.03.11)Date of mailing of the international search report
29 March, 2011 (29.03.11)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/054367

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2009-235221 A (JFE Steel Corp.), 15 October 2009 (15.10.2009), example 1 (Family: none)	1, 3-5 6
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REFERENCES CITED IN THE DESCRIPTION

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