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(54) **COKE AND METHOD FOR PRODUCING SAME**

(57)   This coke is characterized by being obtained by mixing 2 to 8% ashless coal with coal and carbonizing the mixture thereby produced, and is further characterized in that the maximum fluidity (MF) value (log (ddpm)) of the mixture of coal and ashless coal is 1.8 to 3.0. By keeping the additive rate of the ashless coal at 8% or less while compensating for the caking property using the ashless coal, and ensuring the overall fluidity using the coal, volume break and inhibition of the growth of crystals due to the ashless coal is prevented, thereby allowing coke with large particles to be produced.

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Description

Technical Field

5 **[0001]** The present invention relates to coke used in blast furnace ironmaking and a method for producing the same and, in particular, relates to coke blended with ashless coal obtained by extraction treatment of coal with a solvent.

Background Art

10 **[0002]** Coke used in blast furnace ironmaking is required to have various properties, e.g., a certain level of mechanical strength such that coke is not easily crushed in the blast furnace, reactivity, an apparent density, and the size and distribution of lumps necessary to ensure gas permeability in the blast furnace. As the raw material for coke satisfying such requirements, usually, hard coking coal, which is referred to as "coking coal", is used, which has high quality with a caking property, fluidity, or degree of coalification in a certain range, and which is expensive coal compared with coal

15 generally used as fuel for boilers. Such hard coking coal softens and melts at about 400°C to form a viscous liquid, fuse together, and swells by including gas. Therefore, spaces between coal particles are effectively filled, and adhesion between particles is facilitated, thus producing strong coke. However, in recent years, under limited resources and rising costs, there has been an attempt to use inexpensive, low-quality coal as the raw material for coke. For example, various technological developments have been made for blending a larger amount of low-rank coal with hard coking coal.

20 **[0003]** Low-rank coal, such as non-coking or slightly coking coal, has a lower fluidity than hard coking coal and has a poor caking property, and therefore, inhibits adhesion between coal particles, resulting in an increase in defect density, thus decreasing the strength of coke. Accordingly, in order to compensate the caking property, techniques have been disclosed for coking in which asphalt pitch (ASP), i.e., a caking additive derived from petroleum, or ashless coal (Hyper-coal, HPC) composed of a soluble component obtained by extraction of coal with an organic solvent, is added. In

25 particular, regarding ashless coal, various techniques have been developed for the effective utilization of low-rank coal. For example, Patent Literature 1 discloses a technique for coking in which ashless coal is added to coal including low-rank coal and describes that when ashless coal is added in an amount of 5% to 10%, high-strength coke can be obtained.

Citation List

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Patent Literature

[0004] PTL 1: Japanese Unexamined Patent Application Publication No. 2009-221361

35 Summary of Invention

Technical Problem

[0005] Ashless coal has a higher fluidity than coking coal (unmodified coal). Therefore, coke has a very strong structure
40 when a large amount of ashless coal is added, even if a large amount of low-rank coal is blended. However, in addition to strength, coke used in a blast furnace is also required to be formed of large and uniform particles. When a large amount of ashless coal is added, small particles tend to be mixed in the resulting coke. For this reason, there is room for further improvement in Patent Literature 1.

[0006] Furthermore, it is generally believed that variations occur in quality (strength, particle size, porosity, and the
45 like) due to the structure of a coke oven. In the coke oven, since heat is transferred from the oven wall, the temperature is low at the central portion of the oven, and the effective heating time in the carbonization process is short. Furthermore, in the coke oven, since a pressure distribution occurs in the height direction, a large load is applied in the lower part of the coke oven, and coking coal or the like (coal charge) is unlikely to swell. Free swelling occurs in the upper part of the coke oven. As a result, the quality of the resulting coke varies depending on the position in the coke oven.

50 **[0007]** The present invention has been achieved in view of the problems described above. It is an object of the present invention to provide coke with uniform quality, composed of large particles and having sufficient strength, in which the blending amount of hard coking coal is reduced, and a method for producing the same.

Solution to Problem

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[0008] In order to solve the problems, the present inventors have found that the particle size of coke is decreased by volume break. As a result of verification of the mechanism of occurrence of volume break, it has been conceived that addition of a large amount of ashless coal causes volume break. Accordingly, the present inventors have decided to

optimize the amount of ashless coal added so that overall fluidity can be secured by coal.

[0009] That is, coke according to the present invention is obtained by carbonizing a coal mixture including coal and 2% to 8% of ashless coal composed of a solvent-soluble component of coal, characterized in that the coal mixture has a maximum fluidity MF value (log (ddpm)) of 1.8 to 3.0.

[0010] In such a manner, by adding ashless coal having a higher fluidity than coal (coking coal), the caking property required for coke formation is compensated to increase the strength of coke; in the carbonization process, ashless coal flows at a temperature lower than that of coal and bonds coal particles together uniformly in the coke oven; and furthermore, since spaces between coal particles are filled owing to the high swelling property, the quality of coke is made uniform. Moreover, by setting the amount of ashless coal added and the average maximum fluidity of the entire coal mixture, which serves as the coal charge, to appropriate ranges, the particle size of coke can be increased.

[0011] Furthermore, a method for producing coke according to the present invention includes a mixing step in which 2% to 8% of ashless coal is mixed with coal to obtain a coal mixture having a maximum fluidity MF value (log (ddpm)) of 1.8 to 3.0, and a carbonization step in which the coal mixture is carbonized.

[0012] By following such a procedure, in the method for producing coke, coking coal is selected on the basis of the average maximum fluidity value that can be calculated in advance and is blended and mixed with ashless coal in the mixing step, and the coal mixture is carbonized in the carbonization step. Thereby, it is possible to produce coke composed of uniform and large particles having sufficient strength.

Advantageous Effects of Invention

[0013] In the coke according to the present invention, sufficient strength and particle size can be achieved while reducing raw material costs. Furthermore, in the method for producing coke according to the present invention, ashless coal can be produced, for example, from low-rank coal, and thus, raw material costs can be reduced. Furthermore, it is possible to produce coke with sufficient strength and particle size uniformly, regardless of the position inside the coke oven, by a simple production method.

Description of Embodiments

[0014] Coke and a method for producing the same according to the present invention will be described in detail below.

[Coke]

[0015] The coke according to the present invention is fed into a blast furnace for producing pig iron, and is obtained by carbonizing a coal mixture including coal and ashless coal under the general conditions as described later. Coal and ashless coal, which are raw materials for coke, will be described below.

(Coal)

[0016] As will be described later, one type or two or more types of coal having a quality which makes it possible to set the average maximum fluidity MF value of the mixture of coal and ashless coal to be within a specific range, are used. In particular, in the case where low-rank coal classified as weakly coking coal or non-coking or slightly coking coal, which is difficult to use alone as a raw material for coke, is used, hard coking coal or semi-hard coking coal which is commonly used as a raw material for coke is combined for use. In general, the low-rank coal refers to coal having a maximum fluidity MF value (log (ddpm)) of 2.0 or less and an average maximum reflectance Ro value of 1.1 or less. The maximum fluidity MF value represents thermal fluidity, and the average maximum reflectance Ro value represents the degree of coalification. In the coke according to the present invention, although depending on the characteristics of coal, weakly coking coal and non-coking or slightly coking coal can be blended at a blending ratio (including ashless coal) of about 50% at maximum, on the dry coal basis. Although dried coal may be produced by air drying or the like, coal in the state of containing moisture may be mixed with ashless coal and subjected to carbonization.

[0017] The coal is preferably in a pulverized form, and specifically, 80% or more of particles of the coal have a diameter of 3 mm or less. In this description, the particle diameter refers to the maximum length of the particle. The expression "80% or more of particles have a diameter of 3 mm or less" means that "80% or more of the particles of coal pass through a sieve with an opening of 3 mm". Note that, the coal with a particle size of 3 mm or less means powder or particles which, when pulverized coal is screened with a sieve (metal wire sieve, standard number JIS Z 8801-1(2006)) with an opening of 3 mm or less, pass through the sieve. Such coal may be pulverized in advance or pulverized while being mixed with ashless coal, which will be described in detail when the production method is described.

(Ashless coal: 2% to 8%)

[0018] Ashless coal is a type of modified coal obtained by modifying coal for the effective utilization of resources, and has been developed for efficient use as fuel. Ashless coal is modified coal obtained by removing ash and insoluble coal components as much as possible from coal, and is produced by a method in which, by subjecting coal to extraction with a solvent having a high affinity for the coal, an extract from which insoluble components, such as ash, are separated is obtained, and the solvent is removed from the extract by distillation or evaporation. Such ashless coal can be produced by a known method (for example, refer to Japanese Patent No. 4045229). Consequently, ashless coal does not substantially contain ash, and contains large amounts of organic substances which are soluble in the solvent and which have softening and melting properties. Structurally, ashless coal has a wide molecular weight distribution ranging from a component with a relatively low molecular weight having two or three fused aromatic rings to a component with a high molecular weight having about five or six fused aromatic rings. Furthermore, ashless coal is dewatered in a state of mixture (slurry) of coal and the solvent before extraction and separation. Therefore, the moisture content is decreased to about 0.2% to 3% by mass, and ashless coal has a sufficient calorific value. Accordingly, ashless coal has a high fluidity under heating, and generally melts at 200°C to 300°C (has softening and melting properties) regardless of the grade of coal used as a raw material. In the present invention, regarding coal used as a raw material for ashless coal, quality does not matter. Furthermore, in order to increase the strength of coke, ashless coal is preferably in a pulverized form with a size as small as possible, and specifically, the diameter (maximum length) is preferably 1 mm or less.

[0019] As described above, since ashless coal has a high volatile content, excellent thermal fluidity, and a high caking property, it can compensate the caking property of low-rank coal, such as weakly coking coal or non-coking coal. Furthermore, since ashless coal starts to flow at a temperature lower than that of coking coal, by adding and dispersing ashless coal into coal, ashless coal bonds coal particles together uniformly in the coke oven, including at the central portion of the oven in which the temperature rise is slow, in the carbonization process. Furthermore, since ashless coal has a higher swelling property than coking coal, even in the lower part of the coke oven in which a large load is applied, particles of ashless coal swell and spaces between coal particles are filled. At the same time, ashless coal generates swelling pressure, thus bonding other coal particles together. As a result, occurrence of defects, such as poor adhesion between coal particles (macrocracks) and excessive swells (coarse pores), which may act as starting points for breakage of coke, can be reduced, and it is possible to suppress variations in quality in the width and height directions in the coke oven. When the content (blending ratio) of ashless coal in the mixture of ashless coal and coal (coal mixture, coal charge) is less than 2%, it is not possible to sufficiently obtain a caking property required in the case where low-rank coal is blended or the advantageous effects described above. Therefore, the content of ashless coal is set at 2% or more, preferably, 3% or more.

[0020] On the other hand, ashless coal is produced by modifying inexpensive low-rank coal in many cases. Therefore, it is believed that, in coke (carbon) formed using such coking coal having a low degree of coalification, crystal growth is small (the breadth or thickness of the carbon network structure is small) compared with carbon derived from hard coking coal or the like having a high degree of coalification. Furthermore, as the amount of ashless coal increases, the continuous phase of ashless coal in coke increases, and when the continuous phase becomes excessive, the continuous phase itself may act as a starting point for breakage. Furthermore, in addition to volume break, breakage of coke also includes surface breakage. In the drum strength (DI) mainly used as the index for strength of coke, volume break is unlikely to be indicated. When a large amount of ashless coal is added, the particle size of coke is unlikely to increase, and strength rather decreases. This tendency becomes noticeable when the content exceeds 8%. Therefore, the content of ashless coal is set at 8% or less, preferably 6% or less. In such a manner, in the coke according to the present invention, the content of ashless coal is reduced to a certain level or less, and strength is secured by the original caking property of coking coal (coal) to some extent.

(Maximum fluidity MF value (log (ddpm)): 1.8 to 3.0)

[0021] When the maximum fluidity MF value of the mixture of coal and ashless coal (coal mixture) is less than 1.8, fluidity is insufficient, and the strength of the resulting coke decreases. Specifically, when the maximum fluidity MF value is less than 1.8, the blending amount of low-rank coal having a low fluidity and a low swelling property is large, and particles of such coal are unlikely to bond with other coal particles in the carbonization process. Therefore, the maximum fluidity MF value of the mixture of coal and ashless coal is set at 1.8 or more, preferably 2.0 or more. Furthermore, when the maximum fluidity MF value is 1.8 or more, the swelling property is likely to be secured, and since coal particles swell by including gas in the carbonization process, spaces between coal particles are effectively filled, and adhesion between particles is facilitated, thus producing strong coke. On the other hand, when the maximum fluidity MF value exceeds 3.0, there is a concern that fluidity may become excessive and bubbles may occur in coke. Therefore, the maximum fluidity MF value of the mixture of coal and ashless coal is set at 3.0 or less, preferably 2.6 or less. The maximum fluidity MF value of the mixture of coal and ashless coal is defined as the value measured on the mixture, and can be measured

by the Gieseler plastometer method in accordance with JIS M8801. However, in the case where the maximum fluidity MF value for each of various types of coal and ashless coal is known, approximate calculation may be performed by multiplying the blending ratio (mass%/(100%)) and summing up.

[0022] Furthermore, when the average maximum reflectance Ro value of the mixture of coal and ashless coal is small, because of the low degree of coalification, swelling and fusing of particles of coal and ashless coal may become insufficient in the carbonization process, and because of the low strength of the coke matrix, high-strength coke is unlikely to be obtained. The average maximum reflectance Ro value of the mixture of coal and ashless coal is preferably 0.95 or more, more preferably 1.0 or more. On the other hand, even if the average maximum reflectance Ro value is large, the quality of coke is not degraded by this alone. However, the maximum reflectance Ro value increases as the amount of high-rank coal, such as hard coking coal, increases, and hard coking coal has a high swelling property. Consequently, when an excessively large amount of such coking coal is blended, in addition to an increase in raw material costs, there is a concern that the swelling pressure may become excessive, resulting in a severe damage of the coke oven. Specifically, the average maximum reflectance Ro value of the mixture of coal and ashless coal is preferably 1.3 or less, more preferably 1.2 or less.

[Method for producing coke]

[0023] The method for producing coke according to the present invention includes a mixing step in which ashless coal is mixed with coal, and a carbonization step in which the coal and the like are carbonized. The individual steps will be described below.

(Mixing step)

[0024] In the mixing step, coal and ashless coal are mixed to obtain a coal mixture. The blending ratio and the maximum fluidity MF value of the coal mixture are as described above. In this step, preferably, these coals are simultaneously pulverized. Since coal has lower pulverizability than ashless coal, as described above, when 80% or more of particles of coal are pulverized to a diameter of 3 mm or less, ashless coal is pulverized to particles with a diameter of 1 mm or less at the same time. For example, coal and ashless coal are fed through a hopper into a known mixer, and stirring is performed while pulverizing by an ordinary method. Thereby, secondary particles of ashless coal are easily pulverized and coal is also pulverized. Note that the procedure and method of mixing are not particularly specified, and for example, ashless coal and coal which are pulverized in advance may be mixed.

(Carbonization step)

[0025] In the present invention, the conditions for carbonization are not particularly limited, and usual carbonization conditions in the coke production using a coke oven can be employed. For example, the coal mixture is charged into a chamber oven, in which about 30 tons can be charged through a charging hole, and carbonization is performed. At the time of charging, by sufficiently increasing the bulk density of the coal mixture, high-strength coke can be obtained. Preferably, the bulk density is set at 730 kg/m^3 or more. In particular, in the case of a coal mixture in which the fluidity of the entire mixture is low, by increasing the bulk density, insufficient strength due to the low fluidity can be compensated to some extent. Specifically, in a coal mixture with a maximum fluidity MF of less than 2.0, the bulk density is preferably set at 750 kg/m^3 or more. The carbonization is performed under the conditions at a temperature of preferably 950°C or higher, more preferably 1,000°C or higher, and preferably 1,200°C or lower, more preferably 1,050°C or lower, for a time of preferably 8 hours or more, more preferably 10 hours or more, and preferably 24 hours or less, more preferably 20 hours or less.

EXAMPLES

[0026] The coke and the method for producing the same according to the present invention will be specifically described on the basis of examples and comparative examples.

[Coke making]

(Production of ashless coal)

[0027] First, ashless coal was produced in a Hyper-coal continuous production facility (Bench Scale Unit) by the method described below.

[0028] Using bituminous coal produced in Australia as raw coal, 5 kg of the raw coal (in terms of dried coal) and 1-

methylnaphthalene (manufactured by Nippon Steel Chemical Co., Ltd.), as a solvent, in four times (20 kg) the volume of the raw coal were mixed to prepare a slurry The slurry was subjected to extraction treatment in a batch-type autoclave with an inner volume of 30 L, at 370°C for one hour in a state in which the pressure was increased to 1.2 MPa by introducing nitrogen. The slurry was separated into a supernatant and a solid-content concentrated liquid in a gravity settling tank maintaining the same temperature and the same pressure. By separating and recovering the solvent from the supernatant by distillation, 2.7 kg of ashless coal was obtained. The ash content of the resulting ashless coal was 0.9% by mass. The maximum fluidity MF value (log (ddpm)) and the average maximum reflectance Ro value were as shown in Table 1. The ashless coal was pulverized such that 100% (all) of the ashless coal had a particle size (maximum length) of 3 mm or less.

(Mixing step)

[0029]   The ashless coal and various types of coal shown in Table 1 were each adjusted to a moisture content of 7.5% by mass, and mixed at the blending ratio shown in Table 2, on the dry coal basis. Note that the maximum fluidity MF values (log (ddpm)) of coal and ashless coal shown in Table 1 were measured by the Gieseler plastometer method in accordance with JIS M8801. The average maximum reflectance Ro value was measured in accordance with JIS M8816. Furthermore, regarding mixtures, the maximum fluidity MF values and the average maximum reflectance Ro values were calculated from the blending ratios of various types of coal and ashless coal, which are shown in Table 2. Furthermore, 100% of coal was pulverized so as to have a particle size of 3 mm or less and the pulverized coal was mixed.

(Carbonization step)

[0030]   The mixture (coal charge) was placed inside a retort made of steel, and by applying vibration to the retort, the bulk density was adjusted to the value shown in Table 2. Then, the retort was placed in an electric furnace of a both-side heating type, and the mixture was subjected to carbonization under a nitrogen stream, thereby forming a sample. The carbonization was performed under conditions in which the temperature was raised at 3°C/min, heating was performed at 1,000°C for 20 minutes, and then, the retort was taken out of the electric furnace and left to cool naturally. Furthermore, as an evaluation reference, a sample (No. 20) was produced using coal having a high maximum fluidity MF value in which non-coking coal was not blended and ashless coal was not added.

[Evaluation]

(Strength)

[0031]   As the strength of coke, the drum strength index DI^{150}_{15} is shown in Table 2. Specifically, in accordance with JISK2151, the sample was rotated in a drum for 150 revolutions, then screened using a sieve with an opening of 15 mm, and the weight ratio of the remaining portion was calculated. The acceptability criterion for strength is set to DI^{150}_{15} of 84.8% or more. Note that the coke strength was measured using samples whose particle size distribution had been measured by the method described later.

(Average particle size)

[0032]   Coke was dropped twice using shatter equipment, and was subjected to impacts of 30 revolutions using a drum tester. Regarding the coke subjected to impacts, the particle size distribution was measured using sieves with square openings of 100, 75, 50, 38, 25, and 15 mm. The average particle size was calculated from the formula (1) below. Note that no samples remained over the sieve with a square opening of 100 mm. The calculated average particle size is shown in Table 2. The acceptability criterion is set at an average particle size of 45.0 mm or more.

$$\text{Average particle size (mm)} = (87.5 \times M_{75\text{-}100} + 62.5 \times M_{50\text{-}75} + 44.0 \times M_{38\text{-}50} + 31.5 \times M_{25\text{-}38} + 20.0 \times M_{15\text{-}25} + 7.5 \times M_{15<})/M_{ALL} \cdots (1)$$

$M_{75\text{-}100}$: weight of coke over 75 mm sieve
$M_{50\text{-}75}$: weight of coke under 75 mm sieve and over 50 mm sieve
$M_{38\text{-}50}$: weight of coke under 50 mm sieve and over 38 mm sieve
$M_{25\text{-}38}$: weight of coke under 38 mm sieve and over 25 mm sieve
$M_{15\text{-}25}$: weight of coke under 25 mm sieve and over 15 mm sieve

$M_{15<}$: weight of coke under 15 mm sieve
M_{ALL}: sum of weight of sieved coke (= M_{75-100} + M_{50-75} + M_{38-50} + M_{25-38} + M_{15-25} + $M_{15<}$)

[Table 1]

Raw material coal	Maximum fluidity Log MF (logddpm)	Average maximum reflectance Ro
Low-volatile-content hard coking coal group	0.68	1.66
Hard coking coal group	2.20	1.35
Semi-hard coking coal group	3.10	0.78
Weakly coking coal 1	0.99	1.05
Weakly coking coal 2	2.58	0.75
Non-coking coal 1	0.40	0.68
Non-coking coal 2	0.02	1.22
Ashless coal	4.78	0.95

[Table 2]

Group	No.	Lowvolatile-content hard coking coal	Hard coking coal	Semi-hard coking coal	Weakly coking coal 1	Weakly coking coal 2	Non-coking coal 1	Non-coking coal 2	Ashless coal	Average log MF (logddpm)	Average Ro	Bulk density (kg/m³)	Average particle size (mm)	DI150/15 (%)
Comparative Example	1	5	25	30	15	10	0	15	0	1.92	1.070	730	42.6	84.2
Comparative Example	2	5	25	30	15	10	15	0	0	1.98	0.989	730	42.3	82.4
Comparative Example	3	5	24	30	15	10	0	15	1	1.95	1.066	730	42.8	84.2
Comparative Example	4	5	24	30	15	10	15	0	1	2.01	0.985	730	44.3	84.4
Example	5	5	23	30	15	10	0	15	2	1.98	1.062	730	45.1	84.8
Example	6	5	23	30	15	10	15	0	2	2.03	0.981	730	45.8	85.2
Example	7	5	22	30	15	10	0	15	3	2.00	1.058	730	45.9	85.1
Example	8	5	21	30	15	10	0	15	4	2.03	1.054	730	46.2	85.7
Example	9	5	21	30	15	10	15	0	4	2.08	0.973	730	49.0	86.0
Example	10	5	19	30	15	10	0	15	6	2.08	1.046	730	49.4	85.4
Example	11	5	19	30	15	10	15	0	6	2.14	0.965	730	47.2	85.3
Example	12	5	17	30	15	10	0	15	8	2.13	1.038	730	46.5	85.2
Example	13	5	17	30	15	10	15	0	8	2.19	0.957	730	45.6	85.1
Comparative Example	14	5	15	30	15	10	0	15	10	2.18	1.030	730	43.8	84.1
Comparative Example	15	5	15	30	15	10	15	0	10	2.24	0.949	730	44.5	84.6
Comparative Example	16	5	25	25	15	10	0	20	0	1.77	1.092	730	40.2	82.6

(continued)

Sample		Coke blending ratio (%)								Mixture			Coke	
Group	No.	Coal								Average log MF (logddpm)	Average Ro	Bulk density (kg/m$_3$)	Average particle size (mm)	DI$^{150}_{15}$ (%)
		Low-volatile-content hard coking coal	Hard coking coal	Semi-hard coking coal	Weakly coking coal 1	Weakly coking coal 2	Non-coking coal 1	Non-coking coal 2	Ashless coal					
Comparative Example	17	5	25	25	15	10	0	20	0	1.77	1.092	780	42.3	84.3
Example	18	5	23	25	15	10	0	20	2	1.82	1.084	780	45.3	85.4
Example	19	5	21	25	15	10	0	20	4	1.87	1.076	780	49.9	86.8
Reference Example	20	5	30	40	15	10	0	0	0	2.34	1.033	730	47.7	85.8

[0033] As shown in Table 2, in Sample Nos. 1, 2, 16, and 17 in which non-coking coal is blended, without ashless coal being added, the strength is insufficient, coke is formed of many small particles, and the average particle size is insufficient. Similarly, in Sample Nos. 3 and 4 in which the content of ashless coal is insufficient, the strength and average particle size are insufficient.

[0034] In contrast, in Sample Nos. 5 to 13, 18, and 19 in which the content of ashless coal and the maximum fluidity MF value of the mixture are within the ranges of the present invention, the resulting coke has sufficient strength and particle size although the fluidity is lower than that of Sample No. 20. In particular, in Sample Nos. 8 to 11 and 19 in which the content of ashless coal is 4% to 6%, the resulting coke has a particle size as large as that of Sample No. 20. Furthermore, in Sample Nos. 16 to 19, since the blending ratio of non-coking coal having a low fluidity is relatively large, the fluidity of the mixture is also low. However, in Sample Nos. 18 and 19 in which ashless coal is added, the bulk density of the mixture is increased, and then carbonization is performed, the resulting coke has sufficient strength and particle size. On the other hand, in Sample Nos. 14 and 15 in which the content of ashless coal is excessive, although the fluidity of the mixture is the same as or higher than that of Sample Nos. 5 to 13, the strength and the particle size are insufficient.

[0035] While the present invention has been described in detail with reference to embodiments and examples, the gist of the present invention is not limited to the above description, and the scope of rights should be construed widely on the basis of the claims. In the present invention, various modifications and changes are possible on the basis of the above description.

Claims

1. Coke obtained by carbonizing a coal mixture including coal and 2% to 8% of ashless coal composed of a solvent-soluble component of coal,
   wherein the coal mixture has a maximum fluidity MF value (log (ddpm)) of 1.8 to 3.0.

2. A method for producing coke comprising:

   a mixing step in which 2% to 8% of ashless coal is mixed with coal to obtain a coal mixture having a maximum fluidity MF value (log (ddpm)) of 1.8 to 3.0; and
   a carbonization step in which the coal mixture is carbonized.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/067936

A. CLASSIFICATION OF SUBJECT MATTER
C10B57/04(2006.01)i, *C10B57/08*(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)
C10B57/04, C10B57/08

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 | 1996-2013 |
| Kokai Jitsuyo Shinan Koho | 1971-2013 | Toroku Jitsuyo Shinan Koho | 1994-2013 |

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
JSTPlus/JST7580(JDreamIII)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2008-174592 A (Kobe Steel, Ltd.), 31 July 2008 (31.07.2008), claims; paragraphs [0037] to [0039]; examples; table 1 (Family: none)	1,2
A	JP 2009-221361 A (Kobe Steel, Ltd.), 01 October 2009 (01.10.2009), entire text (Family: none)	1,2

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

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance		
"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed	"&"	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 August, 2013 (02.08.13)	13 August, 2013 (13.08.13)

Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2009221361 A **[0004]**

- JP 4045229 B **[0018]**