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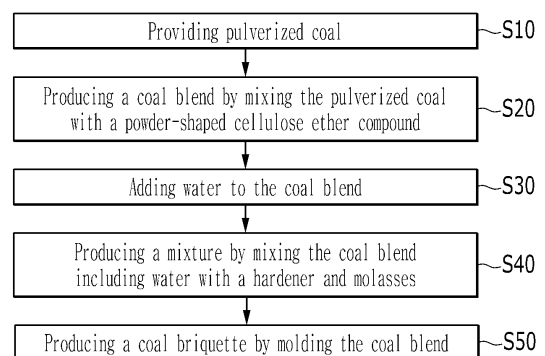
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(54) **COAL BRIQUETTE, METHOD FOR PRODUCING SAME, AND METHOD FOR PRODUCING MOLTEN IRON**

(57) Provided are a coal briquette and a method for producing the same, the coal briquette is inserted into a dome part of a melting and gasification furnace in a molten iron manufacturing apparatus and being rapidly heated, wherein the molten iron manufacturing apparatus comprises a melting and gasification furnace into which reduced iron is inserted, and a reducing furnace connected to the melting and gasification furnace and providing reduced iron. The method for producing a coal briquette comprises the steps of: providing pulverized coal; producing a binder mixture by mixing starch and an acidic aqueous solution; producing a coal blend by mixing the pulverized coal and the binder mixture; and producing a coal briquette by molding the coal blend.

FIG. 1



Description**[Technical Field]**

5 **[0001]** Coal briquettes, methods for producing the same, and methods for producing molten iron are related. More particularly, coal briquettes, producing methods thereof, and methods for producing molten iron having improved binder performance by controlling a mixing order of a cellulose ether compound, molasses, and a hardener and thus by mixing them uniformly are related.

10 **[Background Art]**

[0002] In a reduced iron smelting method, iron ore is used in a reducing furnace and a melting and gasification furnace that smelts reduced iron ore. When smelting iron ore in the melting and gasification furnace, coal briquettes as a heat source to smelt the iron ore are inserted into the melting and gasification furnace. After reduced iron is smelted in the melting and gasification furnace, the reduced iron is converted to molten iron and slag and is discharged to the outside. The coal briquettes that are inserted into the melting and gasification furnace form a coal-packed bed. Oxygen is injected through a tuyere that is installed in the melting and gasification furnace such that the coal-packed bed is burned to generate a combustion gas. The combustion gas is converted to a reducing gas of a high temperature while moving upward through the coal-packed bed. The reducing gas of a high temperature is discharged to the outside of the melting and gasification furnace to be supplied to a reducing furnace as a reducing gas.

[0003] The coal briquettes are manufactured by mixing and then compressing pulverized coal and a binder. It is necessary to manufacture coal briquette having improved cold strength and hot strength so that the coal briquette is used to manufacture molten iron. Accordingly the coal briquette is manufactured by using a binder, such as molasses, having improved viscosity.

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[DISCLOSURE]**[Technical Problem]**

30 **[0004]** Coal briquette having improved cold strength and hot strength is provided by controlling a blending order of a cellulose ether compound, molasses, and a hardener. In addition, a method of producing the coal briquette is provided. A method of producing molten iron including the method of producing the coal briquette is provided.

[Technical Solution]

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[0005] Coal briquette according to an example embodiment of the present invention is inserted into a dome part of a melting and gasification furnace and then rapidly heated therein in a molten iron manufacturing apparatus including i) the melting and gasification furnace into which reduced iron is inserted and ii) a reducing furnace connected to the melting and gasification furnace and providing the reduced iron. A method of manufacturing a coal briquette includes i) providing pulverized coal, ii) producing a coal blend by mixing the pulverized coal with a powder-shaped cellulose ether compound, iii) adding water to the coal blend, iv) producing a mixture by mixing the coal blend including water with a hardener and molasses, and v) producing a coal briquette by molding the coal blend.

[0006] In the step of producing the coal briquette, an amount of the cellulose ether compound included in the coal briquette may be 0.1 wt% to 0.7 wt%, an amount of the hardener may be 0.5 wt% to 3.0 wt%, and an amount of the molasses may be 3 wt% to 12 wt%. More preferably, an amount of the cellulose ether compound may be 0.2 wt% to 0.5 wt%, an amount of the hardener may be 1.0 wt% to 2.5 wt%, and an amount of the molasses may be 5 wt% to 10 wt%.

[0007] In the step of producing the coal briquette, an amount of moisture included in the coal briquette may be 3 wt% to 13 wt%. More preferably, an amount of moisture included in the coal briquette may be 5 wt% to 11 wt%.

[0008] A ratio of the amount of moisture included in the coal briquette relative to the amount of the cellulose ether compound included in the coal briquette may be 5 to 40. In addition, a ratio of the amount of moisture included in the coal briquette relative to the amount of the cellulose ether compound included in the coal briquette may be 7 to 20.

[0009] In the step of providing the coal blend, an average particle size of the cellulose ether compound may be 50 μm to 100 μm . More preferably, in the step of providing the mixture, a ratio of an average particle size of the pulverized coal relative to an average particle size of the cellulose ether compound may be 7 to 30. A ratio of an average particle size of the pulverized coal relative to an average particle size of the cellulose ether compound may be 10 to 20.

[0010] The cellulose ether compound may include at least one compound selected from the group consisting of methyl cellulose (MC), hydroxyethyl cellulose (HEC), hydroxypropyl cellulose (HPC), hydroxypropylmethyl cellulose (HPMC), and hydroxyethylmethyl cellulose (HEMC).

[0011] Viscosity of the cellulose ether compound may be 4,000 cps to 80,000 cps. The hardener may be quicklime, slaked lime, calcium carbonate, limestone, cement, bentonite, clay, silica, silicate, dolomite, phosphoric acid, sulfuric acid, or oxide.

[0012] A method of producing a coal briquette according to an example embodiment of the present invention may further include drying the mixture before producing the coal briquette by molding the mixture or drying the coal briquette after producing the coal briquette.

[0013] A method of producing molten iron according to an example embodiment of the present invention includes i) producing the coal briquette manufactured according to the method, ii) providing reduced iron by reducing iron ore in a reducing furnace, and iii) producing molten iron by inserting the coal briquette and the reduced iron into a melting and gasification furnace. In the step of providing reduced iron, the reducing furnace may be a fluidized-bed reducing furnace or a packed-bed reducing furnace.

[0014] Coal briquette according to an example embodiment of the present invention is inserted into a dome part of a melting and gasification furnace and then rapidly heated therein in a molten iron manufacturing apparatus including i) the melting and gasification furnace into which reduced iron is inserted and ii) a reducing furnace connected to the melting and gasification furnace and providing the reduced iron. The coal briquette includes 0.1 wt% to 0.7 wt% of a cellulose ether compound, 0.5 wt% to 3.0 wt% of a hardener, 3 wt% to 12 wt% of molasses, 3 wt% to 13 wt% of moisture, and a balance of pulverized coal. More preferably, it may include 0.2 wt% to 0.5 wt% of the cellulose ether compound, 1.0 wt% to 2.5 wt% of the hardener, 5 wt% to 10 wt% of the molasses, 5 wt% to 11 wt% of the moisture, and a balance of the pulverized coal.

[Advantageous Effects]

[0015] A hot strength and a cold strength of the coal briquette may be remarkably improved by controlling a blending order of the cellulose ether compound, molasses, and hardener. In addition, the cellulose ether compound including almost no alkali component is used to decrease an amount of the molasses including a high alkali content and thus reduce an attachment of the coal briquette to a reducing furnace due to the alkali component.

[Description of the Drawings]

[0016]

FIG. 1 is a schematic flowchart of a method for producing coal briquettes according to an example embodiment of the present invention.

FIG. 2 is a schematic view of a molten iron manufacturing apparatus using the coal briquettes of FIG. 1.

FIG. 3 is a schematic view of another molten iron manufacturing apparatus using the coal briquettes of FIG. 1.

[Mode for Invention]

[0017] Terms such as first, second, and third are used to illustrate various portions, components, regions, layers, and/or sections, but not to limit them. These terms are used to discriminate the portions, components, regions, layers, or sections from other portions, components, regions, layers, or sections. Therefore, a first portion, component, region, layer, or section as described below may be a second portion, component, region, layer, or section within the scope of the present invention.

[0018] It is to be understood that the terminology used therein is only for the purpose of describing particular embodiments and is not intended to be limiting. It must be noted that, as used in the specification and the appended claims, the singular forms include plural references unless the context clearly dictates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated properties, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other properties, regions, integers, steps, operations, elements, and/or components thereof.

[0019] Unless it is mentioned otherwise, all terms including technical terms and scientific terms used herein have the same meaning as the meaning generally understood by a person with ordinary skill in the art to which the present invention belongs. The terminologies that are defined previously are further understood to have the meanings that coincide with related technical documents and the contents that are currently disclosed, but are not to be interpreted as having ideal or very official meanings unless defined otherwise. The present invention will be described more fully hereinafter with reference to the accompanying drawings, in which example embodiments of the invention are shown. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention.

[0020] FIG. 1 schematically shows flowchart of a method for producing coal briquettes according to an example

embodiment of the present invention. The flowchart of the method for producing coal briquettes of FIG. 1 is an exemplary flowchart, and the present invention is not limited thereto. Thus, the producing method of coal briquettes may be variously modified.

[0021] As shown in FIG. 1, the method of producing a coal briquette includes providing pulverized coal (S10), producing a coal blend by mixing the pulverized coal with a powder-shaped cellulose ether compound (S20), adding water to the coal blend to mix them (S30), producing a mixture by mixing the coal blend including water with a hardener and molasses (S40), and producing a coal briquette by molding the coal blend (S50). In addition, the method of producing the coal briquette may further include other steps as needed.

[0022] First, in the step (S10), pulverized coal is provided. The pulverized coal may be a raw material including carbon such as bituminous coal, subbituminous coal, anthracite, coke, and the like. A particle size of the pulverized coal may be controlled to be 4 mm or less.

[0023] Subsequently, in the step (S20), the pulverized coal is mixed with a cellulose ether compound to provide a coal blend. In other words, the cellulose ether compound is added to the pulverized coal, and the mixture is uniformly mixed to provide a coal blend.

[0024] Herein, the cellulose ether compound is not liquid but powder-shaped. When a binder solution is used, a carboxymethyl cellulose (CMC) solution may be used to secure better flowability by using a binder itself having low viscosity. However, the binder having low viscosity may deteriorate strength of a coal briquette. In addition, a liquid-type binder may not uniformly maintain a binder component due to a layer separation and also needs a special transport vehicle such as a tank lorry and the like and thus costs high. Furthermore, the binder solution is frozen during winter season and thus may not be easily stored.

[0025] On the contrary, when the powder-shaped cellulose ether compound is used as a binder, the cellulose ether compound itself has high viscosity and thus may provide a coal briquette having excellent strength. In addition, since the cellulose ether compound is powder-shaped, the cellulose ether compound may be packed into a minimum volume and thus easily stored and also simply transported. Furthermore, it is free from being frozen during winter season. Accordingly, the powder-shaped cellulose ether compound is appropriate for use.

[0026] Viscosity of the cellulose ether compound may be in a range of 4,000 cps to 80,000 cps. The viscosity of the cellulose ether compound is obtained by measuring viscosity of a cellulose ether compound aqueous solution having a concentration of 2 wt% at 20 ± 0.1 ° C with DV-II+Pro (spindle HA) made by Brookfield Ametek. When the cellulose ether compound has too low viscosity, a solution including the cellulose ether compound, for example, an aqueous solution including the cellulose ether compound has too low viscosity, and thus a binding force of the cellulose ether compound with the pulverized coal is decreased. As a result, strength of coal briquette may be decreased. On the other hand, when the cellulose ether compound has too high viscosity, the cellulose ether compound has so large a molecular weight that its dissolubility is decreased, and thus the cellulose ether compound may have no sufficient binding force with the pulverized coal. Accordingly, viscosity of the cellulose ether compound may be adjusted within the above range.

[0027] The cellulose ether compound may include methyl cellulose (MC), hydroxyethyl cellulose (HEC), hydroxypropyl cellulose (HPC), hydroxypropylmethyl cellulose (HPMC) or hydroxyethylmethyl cellulose (HEMC), and the like.

[0028] The methyl cellulose (MC) has a degree of substitution with a methyl group in a range of 18 wt% to 32 wt%, and the hydroxyethyl cellulose (HEC) has a degree of substitution with a hydroxyethyl group in a range of 20 wt% to 80 wt%. The hydroxypropyl cellulose (HPC) has a degree of substitution with a hydroxypropyl group in a range of 20 wt% to 80 wt%, and the hydroxypropylmethyl cellulose (HPMC) has a degree of substitution with a methyl group in a range of 18 wt% to 32 wt% and with a hydroxypropyl group in a range of 2 wt% to 14 wt%. In addition, the hydroxyethylmethyl cellulose (HEMC) may have a degree of substitution with a methyl group in a range of 18 wt% to 32 wt% and with a hydroxyethyl group in a range of 2 wt% to 14 wt%. The cellulose ether compound may not include carboxymethyl cellulose (CMC).

[0029] On the other hand, an average particle size of the powder-shaped cellulose ether compound may be in a range of 50 μm to 100 μm . When the powder-shaped cellulose ether compound has too small a particle size, its producing process cost is increased. In addition, when the cellulose ether compound has too large a particle size, a specific surface area of the cellulose ether compound becomes smaller, and dissolubility of the cellulose ether compound is decreased, and accordingly, a strength of a coal briquette produced by using the cellulose ether compound may be decreased. Accordingly, a particle diameter of the powder-shaped cellulose ether compound may be adjusted within the above range. On the other hand, in further detail, an average particle size of the powder-shaped cellulose ether compound may be 78 μm . Herein, a particle diameter of the powder-shaped cellulose ether compound may be in a range of less than or equal to 0.18 mm and greater than or equal to 97 %.

[0030] A ratio of the average particle size of the pulverized coal relative to the average particle size of the cellulose ether compound may be 7 to 30. In further detail, the ratio of the average particle size of the pulverized coal relative to the average particle size of the cellulose ether compound may be 10 to 20. When the ratio of the average particle size is too large or too small, the cellulose ether compound may not show a sufficient binding force as a binder in the pulverized coal. Accordingly, the ratio of the average particle size may be maintained within the above range.

[0031] Subsequently, water is added to the coal blend and mixed therewith in the step (S30). When the water is added to the coal blend wherein the powder-shaped cellulose ether compound is uniformly distributed, the cellulose ether compound dispersed in the pulverized coal is dissolved in the water. As a result, the dissolved cellulose ether compound may exhibit a binding force with the pulverized coal and thus much improve a strength of a coal briquette produced in the subsequent process. As described above, a coal briquette having excellent strength with a minimum process cost may be produced not by directly mixing the liquid binder with the pulverized coal but by separating processes into mixing the liquid binder with the powder-shaped cellulose ether compound first and then, adding water thereto.

[0032] Subsequently, in the step (S40), a hardener and molasses are added to the coal blend to which the water is added to prepare a mixture. Specifically, the hardener is used in a range of 0.5 wt% to 3.0 wt%, and the molasses is used in a range of 3 wt% to 12 wt%. The hardener may be quicklime, slaked lime, calcium carbonate, limestone, cement, bentonite, clay, silica, silicate, dolomite, phosphoric acid, sulfuric acid, or oxide and the like. When the hardener is included in too small an amount, the binder and the hardener may have no sufficient chemical bond and secure no sufficient strength of a coal briquette. In addition, when the hardener is included in too large an amount, an ash component in a coal briquette is increased, and the coal briquette may not sufficiently play a role of a fuel in a melting-gasifying furnace. Accordingly, the hardener may be adjusted within the above range.

[0033] When the molasses is used in too small an amount, a strength of a coal briquette may be deteriorated. In addition, when the molasses is used in too large an amount, the molasses may have a problem of adherence and the like during molding the mixture. Accordingly, the molasses may be adjusted within the above range. Specifically, the hardener may be included in a range of 1.0 wt% to 2.5 wt%, and the molasses may be included in a range of 5 wt% to 10 wt%.

[0034] Herein, the mixture may include moisture in an amount of 1 wt% to 13 wt%.

[0035] On the other hand, it is important to mix the hardener and the molasses in the step (S40) after adding and mixing water with the coal blend in the step (S30). The hardener and the molasses have stronger affinity for water than that of the cellulose ether compound. Unlike an example embodiment of the present invention, when the cellulose ether compound is mixed with the hardener and the molasses first, and water is added thereto, the hardener and the molasses having affinity for water reacts moisture first, and thus the cellulose ether compound may not be completely dissolved in the water.

[0036] In other words, after adding water in a liquid state in the step (S30) to the powder-shaped cellulose ether compound uniformly dispersed in the pulverized coal in the step (S20) to contact the water with the powder-shaped cellulose ether compound mixed with the pulverized coal and thus uniformly dissolve the powder-shaped cellulose ether compound therein in the pulverized coal, a uniform mixture of the hardener and the molasses needs to be added thereto in the step (S40) to produce a coal briquette having excellent strength.

[0037] On the other hand, not shown in FIG. 1, but a step of drying the mixture after the step (S40) may be added. In other words, when moldability of the mixture of the pulverized coal, the powder-shaped cellulose ether compound, the water, the hardener, and the molasses needs to be adjusted, the mixture may be dried to remove a part of moisture. As a result, manufacture workability of a coal briquette in a subsequent process and a strength of the coal briquette may be much improved.

[0038] Lastly, the mixture is molded in the step S50 to provide a coal briquette. For example, the mixture is inserted between a pair of rollers and compressed to produce the coal briquette to have a pocket or strip shape. As a result, a coal briquette having excellent hot strength and cold strength may be provided.

[0039] Herein, an amount of the cellulose ether compound included in the coal briquette may be 0.1 wt% to 0.7 wt%. More preferably, the amount of the cellulose ether compound may be 0.2 wt% to 0.5 wt%. When the cellulose ether compound is included in too large an amount, a producing cost of a coal briquette is increased. In addition, when the cellulose ether compound is included in too small an amount, a sufficient binding force may not be exhibited, and thus a strength of a coal briquette is decreased. Accordingly, the amount of the cellulose ether compound needs to be adjusted within the above range.

[0040] Meanwhile, an amount of the hardener included in the coal briquette may be 0.5 wt% to 3.0 wt%. More preferably, the amount of the hardener may be 1.0 wt% to 2.5 wt%. When the amount of the hardener is too small, the binder and the hardener may have no sufficient chemical bond and thus fail in sufficiently securing a strength of a coal briquette. In addition, when the amount of the hardener is too large, an ash component in a coal briquette is increased, and thus the coal briquette may not play a sufficient role of a fuel in a melting-gasifying furnace. Accordingly, the amount of the hardener may be adjusted within the above range.

[0041] Meanwhile, an amount of the molasses included in the coal briquette may be 3 wt% to 12 wt%. More preferably, the amount of the molasses may be 5 wt% to 10 wt%. When the amount of the molasses is too small, a strength of coal briquette may be deteriorated. In addition, when the amount of the molasses is too large, there may be a problem of attachment and the like during molding of the mixture. Accordingly, the amount of the molasses may be adjusted within the above range.

[0042] Meanwhile, an amount of moisture included in the coal briquette may be 3 wt% to 13 wt%. More preferably,

the amount of the moisture may be 5 wt% to 11 wt%. In addition, when the amount of the moisture is too small, a cold strength of a coal briquette may be decreased. Accordingly, the amount of the moisture may be adjusted within the above range.

[0043] Accordingly, the coal briquette manufactured according to the method includes 0.1 wt% to 0.7 wt% of a cellulose ether compound, 0.5 wt% to 3.0 wt% of a hardener, 3 wt% to 12 wt% of molasses, 3 wt% to 13 wt% of moisture, and a balance of pulverized coal. More preferably, it may include 0.2 wt% to 0.5 wt% of the cellulose ether compound, 1.0 wt% to 2.5 wt% of the hardener, 5 wt% to 10 wt% of the molasses, 5 wt% to 11 wt% of the moisture, and a balance of the pulverized coal.

[0044] FIG. 2 schematically illustrates a molten iron manufacturing apparatus 100 using the coal briquettes manufactured in FIG. 1. A structure of the molten iron manufacturing apparatus 100 of FIG. 2 is exemplary, and the present invention is not limited thereto. Therefore, the structure of the molten iron manufacturing apparatus 100 of FIG. 2 may be variously modified.

[0045] The molten iron manufacturing apparatus 100 of FIG. 2 includes a melting and gasification furnace 10 and a packed-bed reducing furnace 20. In addition, it may include other devices as needed. Iron ore is inserted into the packed-bed reducing furnace 20 and then reduced. The iron ore inserted into the packed-bed reducing furnace 20 is dried in advance and then passed through the packed-bed reducing furnace 20 such that reduced iron is manufactured. The packed-bed reducing furnace 20 is a packed-bed reducing furnace and receives the reducing gas from the melting and gasification furnace 10 to form a packed bed therein.

[0046] The coal briquette manufactured by the method of FIG. 1 is inserted in to the melting and gasification furnace 10 and thus a coal-packed bed is formed in the melting and gasification furnace 10. A dome part 101 is provided in an upper portion of the melting and gasification furnace 10. That is, a space that is wider than other portions of the melting and gasification furnace 10 is formed, and high-temperature reducing gas exists in the space. Thus, the coal briquette inserted into the dome part 101 is converted into char through a thermal decomposition reaction by a high-temperature reducing gas. The char generated from the thermal decomposition reaction of the coal briquette moves to the bottom of the melting and gasification furnace 10 and then exothermically reacts with oxygen supplied through a tuyere 30. As a result, the coal briquette may be used as a heat source that maintains the melting and gasification furnace 10 at a high temperature. Meanwhile, since char provides ventilation, a large amount of gas generated from the lower portion of the melting and gasification furnace 10 and reduced iron supplied from the packed-bed reducing furnace 20 may more easily and uniformly pass through the coal-packed bed the melting and gasification furnace 10.

[0047] In addition to the coal briquette, lump carbon ash or coke may be inserted into the melting and gasification furnace 10 as needed. The tuyere 30 is provided in an exterior wall of the melting and gasification furnace 10 for injection of oxygen. Oxygen is injected into the coal-packed bed such that a combustion zone is formed. The coal briquette is combusted in the combustion zone to generate the reducing gas.

[0048] FIG. 3 schematically illustrates another molten iron manufacturing apparatus 200 using the coal briquette manufactured in FIG. 1. A structure of the molten iron manufacturing apparatus 200 of FIG. 3 is an exemplarily structure, and the present invention is not limited thereto. Therefore, the structure of the molten iron manufacturing apparatus 200 of FIG. 3 may be variously modified. The structure of the molten iron manufacturing apparatus 200 of FIG. 3 is similar to the structure of the molten iron manufacturing apparatus 100 of FIG. 2, and therefore like reference numerals designate like elements in the molten iron production apparatus 100 of FIG. 2, and a detailed description thereof will be omitted.

[0049] As shown in FIG. 3, the molten iron manufacturing apparatus 200 includes a melting and gasification furnace 10, a fluidized-bed reducing furnace 22, reduced iron compression device 40, and a compression reduced iron storage bath 50. Herein, the compression reduced iron storage bath 50 may be omitted.

[0050] The manufactured coal briquettes are inserted into the melting and gasification furnace 10. Herein, the coal briquettes generate a reducing gas in the melting and gasification furnace 10 and the reducing gas is supplied to the fluidized-bed reducing furnace 22. Fine iron ores are supplied to a plurality of reducing furnaces 22 having fluidized beds, and are fluidized by a reducing gas supplied to the fluidized-bed reducing furnace 22 from the melting and gasification furnace 10 such that reduced iron is manufactured. The reduced iron is compressed by the reduced iron compression device 40 and stored in the compression reduced iron storage bath 50. The compressed reduced iron is inserted into the melting and gasification furnace 10 from the compression reduced iron storage bath 50 together with coal briquettes and then molten in the melting and gasification furnace 10. The briquette coal is supplied to the melting and gasification furnace 10 and converted into char having ventilation, and as a result, a large amount of gas generated at the bottom of the melting and gasification furnace 10 and the compressed reduced iron more easily and uniformly pass through a coal-packed bed in the melting and gasification furnace 10, such that molten iron with high quality may be provided.

[0051] Meanwhile, since the cellulose ether compound that rarely includes alkali components is used with molasses as a mixed binder in the coal briquette, alkali components may be reduced. Therefore, it is possible to prevent a dispersing plate (not illustrated) or a cyclone (not illustrated) in the fluidized-bed reducing furnace 22 from being clogged due to the deposition of alkali components such as potassium by the molasses containing a large amount of alkali components.

[0052] Hereinafter, the present invention will be described in further detail with reference to experimental examples. The experimental examples are used only to illustrate the present invention, and are not meant to be restrictive.

Experimental Examples

[0053] Less than or equal to 3.4 mm of pulverized coal, less than or equal to 0.2 mm of cellulose ether compound powder, water, quicklime as a hardener, and molasses are mixed in order to prepare a mixture. As for the pulverized coal, a mixture of hard coking coal, semi soft coking coal, and cokes power was used, and as for the cellulose ether compound, hydroxypropylmethyl cellulose (HPMC, Mecellose®) made by Samsung Fine Chemicals Co., Ltd. was used. The obtained mixture was inserted between a pair of rolls to produce a coal briquette. Herein, the pair of rolls was used under a pressure of 20 kN/cm, and the coal briquette was produced to have a size of 64.5 mm x 25.4 mm x 19.1 mm and a pillow shape. The other detail producing process of the coal briquette may be easily understood by a person having an ordinary skill in a related art of the present invention, and thus its detailed description will be omitted.

Experimental Example 1

[0054] 100 parts by weight of pulverized coal having a moisture content of 7.6 % and an average diameter of 1.1 mm was mixed with 0.3 parts by weight of HPMC powder having an average diameter of 78 μ m and viscosity of 28,000 cps, and 3 parts by weight of water was added thereto and mixed therewith. Subsequently, 1.89 parts by weight of quicklime was added thereto, and 7 parts by weight of molasses was added thereto to prepare a mixture. The mixture was inserted between a pair of rolls to produce a coal briquette. The other experiment processes are the same as those of Experimental Example.

Experimental Example 2

[0055] 100 parts by weight of pulverized coal having an average diameter of 1.1 mm and a moisture content of 7.5 % was mixed with 0.5 parts by weight of HPMC powder having an average diameter of 78 μ m and viscosity of 28,000 cps, and 5 parts by weight of water was added thereto and mixed therewith. Subsequently, 1.35 parts by weight of quicklime was added thereto, and 5 parts by weight of molasses was added thereto to prepare a mixture. The mixture was inserted between a pair of rolls to produce a coal briquette. The other experiment processes were the same as those of Experimental Example 1.

Comparative Example 1

[0056] 100 parts by weight of pulverized coal having a moisture content of 7.6 % and an average diameter of 1.1 mm was mixed with 0.3 parts by weight of HPMC powder having an average diameter of 78 μ m and viscosity of 28,000 cps and 1.89 parts by weight of quicklime. Subsequently, 3 parts by weight of water and 7 parts by weight of molasses were added thereto and mixed therewith to prepare a mixture. The obtained mixture was inserted between a pair of rolls to produce a coal briquette. The other experiment processes were the same as those of Experimental Example 1.

Comparative Example 2

[0057] 100 parts by weight of pulverized coal having a moisture content of 7.7 % and an average diameter of 1.1 mm was mixed with 0.5 parts by weight of HPMC powder having an average diameter of 78 μ m and viscosity of 28,000cps and 1.35 parts by weight of quicklime. Subsequently, 5 parts by weight of water and 5 parts by weight of molasses were added thereto to prepare a mixture. The mixture was inserted between a pair of rolls to produce a coal briquette. The other experiment processes were the same as those of Experimental Example 1.

Comparative Example 3

[0058] 100 parts by weight of pulverized coal having a moisture content 7.5 % and an average diameter of 1.1 mm, 0.3 parts by weight of HPMC powder having an average diameter of 78 μ m and viscosity of 28,000 cps, 3 parts by weight of water, 1.89 parts by weight of quicklime, and 7 parts by weight of molasses were simultaneously mixed to prepare a mixture. The mixture was inserted between a pair of rolls to produce a coal briquette. The other experiment processes were the same as those of Experimental Example 1.

Experiment Result

[0059] A drop strength and a compression load of the coal briquettes according to Experimental Examples 1 to 2 and Comparative Examples 1 to 3 were measured. The drop strength of each coal briquette was obtained from a ratio of coal briquettes having a diameter of greater than or equal to +20 mm after freely 4 times dropping the 2 kg of the coal briquette from 5 M high. In addition, the compression load of each coal briquette was measured as a maximum load when compressed at a speed of 50 mm/min, an average compression load of 20 coal briquette specimens was obtained, and the results are shown in Table 1.

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(Table 1)

Experimental Example	Blend amount (parts by weight)						Coal briquette		
	Pulverized coal	HPMC	Moisture	Quicklime	Molasses	Moisture (%)	Drop strength (%)	Compression load (Kgf)	
Experimental Example 1	100	0.3	3	1.89	7	9.4	89	32	
Experimental Example 2	100	0.5	5	1.50	6	10.2	83	31	
Comparative Example 1	100	0.3	3	1.89	7	9.4	64	26	
Comparative Example 2	100	0.5	5	1.35	5	10.6	43	17	
Comparative Example 3	100	0.3	3	1.89	7	9.6	62	27	

[0060] As shown in Table 1, when pulverized coal was mixed with HPMC powder first, water was added thereto and mixed therewith, and quicklime and molasses were sequentially mixed therewith to produce each coal briquette in Experimental Examples 1 to 2, the coal briquettes showed excellent drop strength and compression load. On the contrary, the coal briquettes according to Comparative Examples 1 to 3 showed much smaller drop strength and compression load than those of the coal briquettes according to Experimental Examples 1 to 2. Accordingly, a coal briquette turns out excellent in terms of a drop strength and a compression load when produced by controlling an order of blending a cellulose ether compound, molasses, and a hardener to obtain a uniform mixture.

[0061] The present invention is not limited to the example embodiments and may be embodied in various modifications, and it will be understood by a person of ordinary skill in the art to which the present invention pertains that the present invention may be carried out through other specific embodiments without modifying the technical idea or essential characteristics thereof. Therefore, the aforementioned embodiments should be understood to be exemplary but not limiting the present invention in any way.

<Description of Symbols>

[0062]

- 10. melting and gasification furnace
- 20. packed-bed reducing furnace
- 22. fluidized-bed reducing furnace
- 30. tuyere
- 40. reduced iron compression device
- 50. compression reduced iron storage bath
- 100, 200. molten iron manufacturing apparatus
- 101. dome part

Claims

1. A method of producing a coal briquette being inserted into a dome part of a melting and gasification furnace and being rapidly heated in a molten iron manufacturing apparatus, wherein the molten iron manufacturing apparatus comprises a melting and gasification furnace into which reduced iron is inserted, and a reducing furnace connected to the melting and gasification furnace and providing the reduced iron wherein the method comprises providing pulverized coal, producing a coal blend by mixing the pulverized coal with a powder-shaped cellulose ether compound, adding water to the coal blend to mix the same, producing a mixture by mixing the coal blend including water with a hardener and molasses, and producing a coal briquette by molding the coal blend, wherein in the step of producing the coal briquette, the amount of the cellulose ether compound included in the coal briquette is 0.1 wt% to 0.7 wt%, an amount of the hardener is 0.5 wt% to 3.0 wt%, and an amount of the molasses is 3 wt% to 12 wt%.
2. The method of producing the coal briquette of claim 1, wherein an amount of the cellulose ether compound is 0.2 wt% to 0.5 wt%, an amount of the hardener is 1.0 wt% to 2.5 wt%, and an amount of the molasses is 5 wt% to 10 wt%.
3. The method of producing the coal briquette of claim 1, wherein in the step of producing the coal briquette, the amount of moisture included in the coal briquette is 3 wt% to 13wt%.
4. The method of producing the coal briquette of claim 3, wherein the amount of moisture included in the coal briquette is 5 wt% to 11 wt%.
5. The method of producing the coal briquette of claim 1, wherein a ratio of the amount of moisture included in the coal briquette relative to the amount of the cellulose ether compound included in the coal briquette is 5 to 40.

6. The method of producing the coal briquette of claim 1, wherein a ratio of the amount of moisture included in the coal briquette relative to the amount of the cellulose ether compound included in the coal briquette is 7 to 20.
- 5 7. The method of producing the coal briquette of claim 1, wherein in the step of providing the coal blend, an average particle size of the cellulose ether compound is 50 μm to 100 μm .
8. The method of producing the coal briquette of claim 1, wherein in the step of providing the mixture, a ratio of an average particle size of the pulverized coal relative to an average particle size of the cellulose ether compound is 7 to 30.
- 10 9. The method of producing the coal briquette of claim 1, wherein in the step of providing the coal blend, a ratio of an average particle size of the pulverized coal relative to an average particle size of the cellulose ether compound is 10 to 20.
- 15 10. The method of producing the coal briquette of claim 1, wherein the cellulose ether compound includes at least one compound selected from the group consisting of methyl cellulose (MC), hydroxyethyl cellulose (HEC), hydroxypropyl cellulose (HPC), hydroxypropylmethyl cellulose (HPMC), and hydroxyethylmethyl cellulose (HEMC).
- 20 11. The method of producing the coal briquette of claim 1, wherein viscosity of the cellulose ether compound is 4,000 cps to 80,000 cps.
- 25 12. The method of producing the coal briquette of claim 1, wherein the hardener is quicklime, slaked lime, calcium carbonate, limestone, cement, bentonite, clay, silica, silicate, dolomite, phosphoric acid, sulfuric acid, or oxide.
- 30 13. The method of producing the coal briquette of claim 1, wherein the method further includes drying the mixture before producing the coal briquette by molding the mixture.
- 35 14. The method of producing the coal briquette of claim 1, wherein the method further includes drying the mixture after producing the coal briquette by molding the mixture.
- 40 15. A method of producing molten iron, comprising producing the coal briquette manufactured according to claim 1, providing reduced iron by reducing iron ore in a reducing furnace, and producing molten iron by inserting the coal briquette and the reduced iron into a melting and gasification furnace.
- 45 16. The method of producing molten iron of claim 15, wherein in the step of providing reduced iron, the reducing furnace is a fluidized-bed reducing furnace or a packed-bed reducing furnace.
- 50 17. A coal briquette inserted into a dome part of a melting and gasification furnace and then rapidly heated therein in a molten iron producing apparatus including a melting and gasification furnace into which reduced iron is inserted, and a reducing furnace connected to the melting and gasification furnace and providing the reduced iron and wherein the coal briquette includes 0.1 wt% to 0.7 wt% of a cellulose ether compound, 0.5 wt% to 3.0 wt% of a hardener, 3 wt% to 12 wt% of molasses, 3 wt% to 13 wt% of moisture, and a balance of pulverized coal.
- 55 18. The coal briquette of claim 17, which includes 0.2 wt% to 0.5 wt% of the cellulose ether compound, 1.0 wt% to 2.5 wt% of the hardener, 5 wt% to 10 wt% of the molasses, 5 wt% to 11 wt% of the moisture, and a balance of the pulverized coal.

FIG. 1

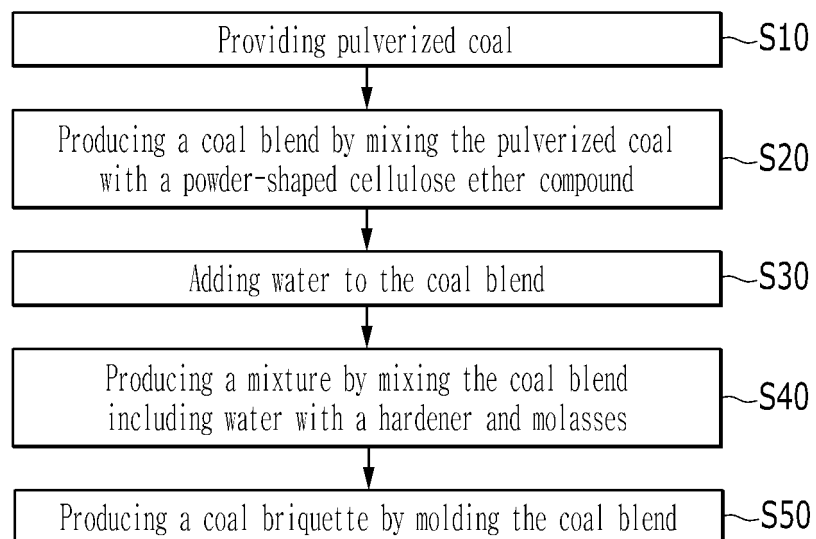


FIG. 2

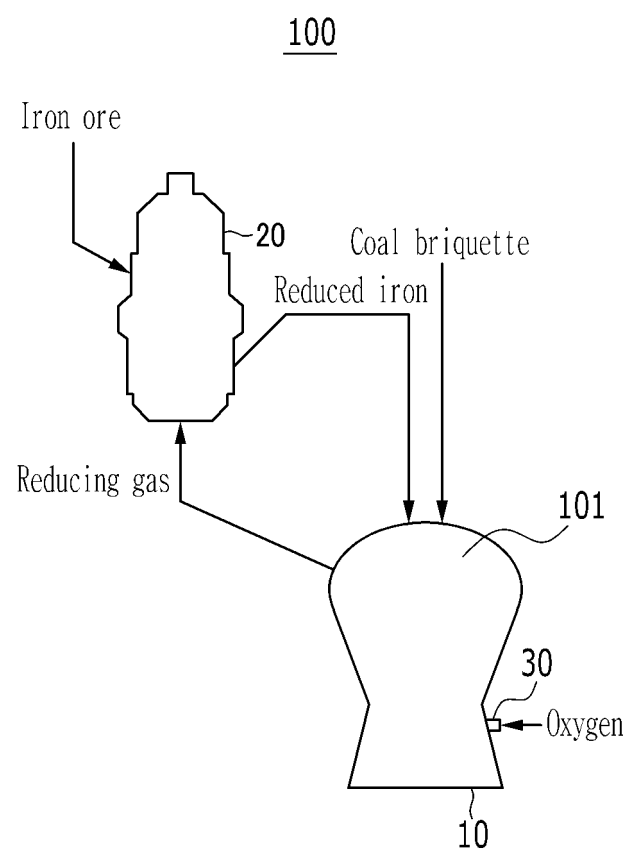
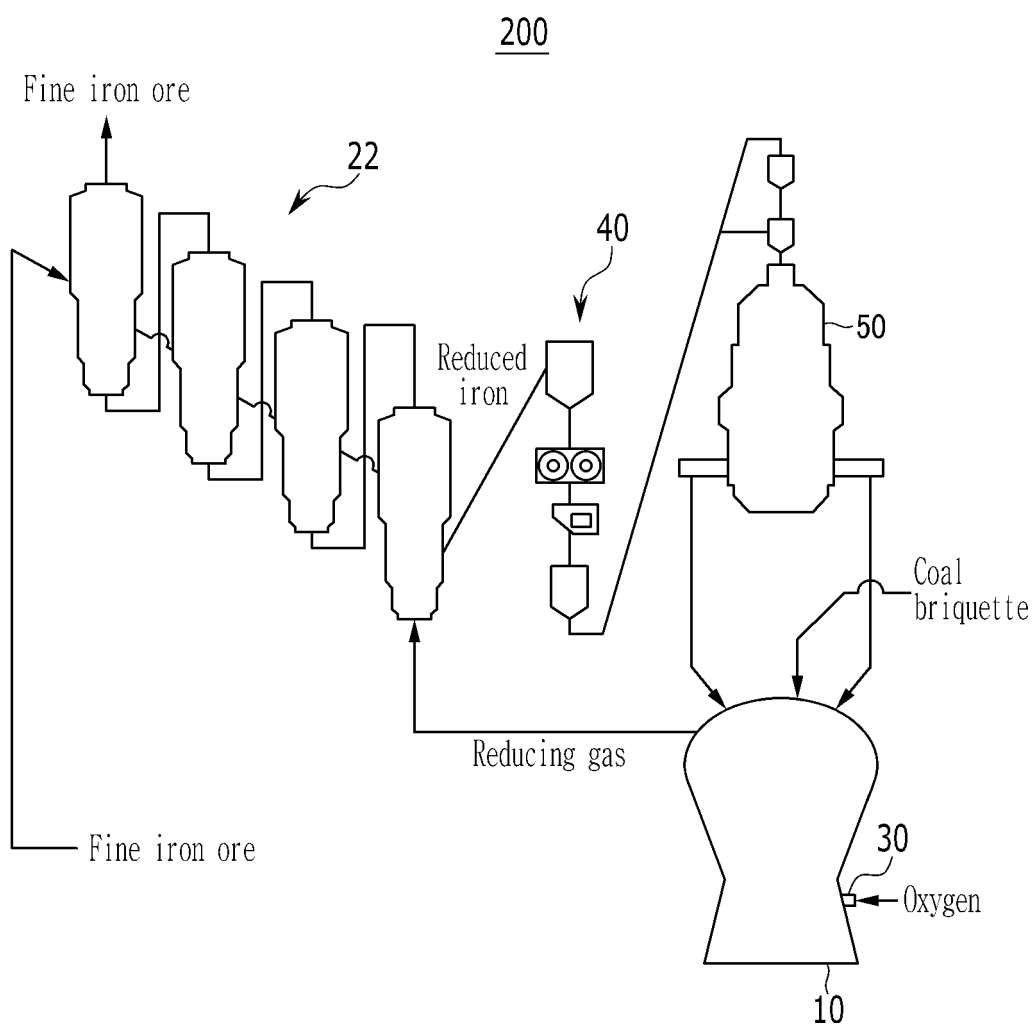


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2016/003411

A. CLASSIFICATION OF SUBJECT MATTER

C10L 5/14(2006.01)i, C10L 5/22(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)

C10L 5/14; C10L 5/16; C10L 5/32; C10L 5/44; C21B 11/02; B01J 2/28; F27B 1/20; C10L 9/10; C10L 5/02; C10L 5/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

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

eKOMPASS (KIPO internal) & Keywords: apparatus for manufacturing ingot iron, coal briquette, cellulose ether compound, hardening agent, syrup

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2015-0075973 A (POSCO) 06 July 2015 See abstract; paragraphs [0002] and [0021]-[0058]; and claims 1-18.	1-18
Y	KR 10-0178452 B1 (MOON, Dae - Kyu et al.) 01 April 1999 See pages 2 and 3; and table 1.	1-18
A	JP 2003-253280 A (YAMANAKA CO., LTD.) 10 September 2003 See paragraphs [0011]-[0036]; and claims 1-7.	1-18
A	KR 10-2015-0079281 A (SAMSUNG FINE CHEMICALS CO., LTD.) 08 July 2015 See paragraphs [0025]-[0027]; and claims 1-3.	1-18
A	JP 2011-047053 A (POSCO) 10 March 2011 See paragraphs [0011]-[0022]; and claim 1.	1-18

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

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

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"&" document member of the same patent family

Date of the actual completion of the international search

12 JULY 2016 (12.07.2016)

Date of mailing of the international search report

13 JULY 2016 (13.07.2016)

Name and mailing address of the ISA/KR


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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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