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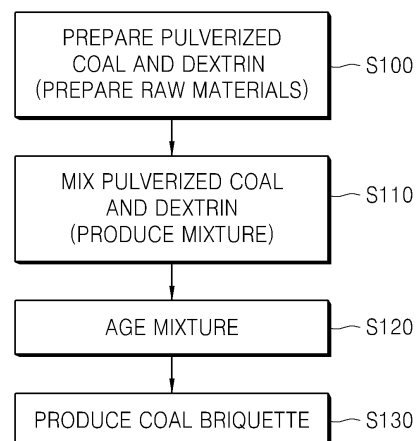
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(54) **METHOD FOR PRODUCING COAL BRIQUETTE, AND COAL BRIQUETTE PRODUCED BY SAME**

(57) The present invention relates to a method of producing a coal briquette and a coal briquette produced by using the same, and the method includes: preparing raw materials including pulverized coal and dextrin; producing a mixture by mixing the raw materials; aging the mixture; and producing a coal briquette by molding the aged mixture, and the present invention may suppress the generation of a low melting point compound when molten iron is produced, such that damage to facilities caused by a deposit may be prevented.

[FIG. 3]



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Description

[Technical Field]

[0001] The present invention relates to a method of producing a coal briquette and a coal briquette produced by using the same, and more particularly, a method of producing a coal briquette, which is capable of preventing a pipe clogging phenomenon of a smelting gasifier when molten iron is produced, and a coal briquette produced by using the same.

[Background Art]

[0002] In many steel mills around the world, a smelting reduction iron making method has been developed in which molten iron is produced by directly using coal for general use as fuel and a reducing agent and directly using iron ore fine, which accounts for 80% or more of the world's ore production as an iron source.

[0003] In the smelting reduction iron making method, molten iron is produced by charging the smelting gasifier with reduced iron obtained by reducing iron ore and a coal briquette, blowing oxygen-containing gas into the smelting gasifier to combust the coal briquette, and smelting the reduced iron by using heat generated during the combustion of the coal briquette.

[0004] In the meantime, a coal briquette may be produced by mixing pulverized coal and a binder and pressing and molding the mixture of the pulverized coal and the binder in a molding machine. The coal briquette is used as a fuel material when molten iron is produced, and in order to be stably charged in the internal side of the smelting gasifier, the coal briquette needs to have cold strength and hot strength. Accordingly, molasses and the like having excellent viscosity are used as the binder.

[0005] However, the components of the molasses differ depending on the origin of the molasses, and it is difficult to control the components of the molasses depending on the sugar production process, so that when the coal briquette is produced by using the molasses as the binder, it is impossible to constantly control a quality of the coal briquette.

[0006] Further, since molasses contains a large amount of alkali components, when a coal briquette produced by using molasses is used in the smelting gasifier, a large amount of low melting point compound, such as KCl, is generated. The generated low melting point compound is contained in reducing gas to clog a pipe from which the reducing gas is discharged and is attached inside a fluidized bed reduction furnace which produces reduced iron by using the reducing gas to clog a dispersion plate, thereby degrading process efficiency.

(Prior Art Literature 1) KR0627469 B

(Prior Art Literature 2) KR10-2017-0018275 A

[Disclosure]

[Technical Problem]

[0007] The present invention provides a method of producing a coal briquette, which is capable of suppressing the generation of a low melting point compound, and a coal briquette produced by using the same.

[0008] The present invention provides a method of producing a coal briquette, which is capable of suppressing damage to facilities to improve operation efficiency and productivity, and a coal briquette produced by using the same.

[Technical Solution]

[0009] A method of producing a coal briquette according to an exemplary embodiment of the present invention may include: preparing raw materials including pulverized coal and dextrin; producing a mixture by mixing the raw materials; aging the mixture; and producing a coal briquette by molding the aged mixture.

[0010] The preparing of the raw materials may include preparing the dextrin of which Dextrose Equivalent (DE) is more than 0 and 10 or less.

[0011] The preparing of the raw materials may include preparing the dextrin of which a particular size is 10 to 20 μm .

[0012] The producing of the mixture may include mixing 92 to 97 wt% of the pulverized coal and 3 to 9 wt% of the dextrin based on 100wt% of the total weight of the pulverized coal and the dextrin.

[0013] The aging may include heating the mixture by using steam so that the mixture maintains at 50 to 100°C.

[0014] The aging may include making an adjustment so that the mixture has a moisture content of 3 to 10 wt% based on 100 wt% of the entire mixture.

[0015] The aging may include adjusting a ratio of the amount of moisture to the amount of dextrin to 1 to 3.

[0016] The aging may include agitating the mixture.

[0017] The aging may be performed for 7 to 20 minutes.

[0018] A coal briquette according to an exemplary embodiment of the present invention includes pulverized coal and dextrin, in which the dextrin exists in a gelatinized state.

5 [Advantageous Effects]

[0019] According to the exemplary embodiments of the present invention, it is possible to produce coal briquette having excellent strength by using a binder that does not contain calcium (K) that is an alkali component. Accordingly, it is possible to secure strength of the coal briquette, and when molten iron is produced by using the coal briquette, it is possible to suppress or prevent the generation of a low melting point compound by an alkali component. Accordingly, it is possible to suppress the clogging of a pipe or the generation of a deposit to facilities caused by a low melting point compound. For example, it is possible to suppress the clogging of a pipe within a smelting gasifier and the clogging of a dispersion plate and the like of a fluidized bed reduction furnace. Further, it is possible to stably operate facilities, thereby easily maintaining and repairing the facilities and improving operation efficiency and productivity.

15 [Description of Drawings]

[0020]

FIG. 1 is a diagram schematically illustrating a configuration of a molten iron producing device according to an exemplary embodiment of the present invention.

FIG. 2 is a diagram schematically illustrating a configuration of a coal briquette producing device according to an exemplary embodiment of the present invention.

FIG. 3 is a flowchart sequentially illustrating a method of producing a coal briquette according to an exemplary embodiment of the present invention.

[Mode for Carrying Out the Invention]

[0021] Hereinafter, an exemplary embodiment of the present invention will be described in detail with reference to the accompanying drawings. However, the present disclosure is not limited to exemplary embodiments disclosed herein but will be implemented in various forms, and the exemplary embodiments are provided so that the present disclosure is completely disclosed, and a person of ordinary skill in the art can fully understand the scope of the present disclosure. A size and a relative size of a constituent element illustrated in the drawing may be exaggerated or enlarged for clearness of the description, and the same reference numeral indicates the same constituent element in the drawings.

[0022] Before describing the present invention, a configuration of a molten iron producing device will be described.

[0023] FIG. 1 is a diagram schematically illustrating a configuration of a molten iron producing device according to an exemplary embodiment of the present invention, and FIG. 2 is a diagram schematically illustrating a configuration of a coal briquette producing device according to an exemplary embodiment of the present invention. A solid line in FIG. 1 represents a movement path of a raw material, and a dotted line represents a movement path of gas.

[0024] Referring to FIG. 1, a molten iron producing device may include a fluidized bed reduction furnace 200 which reduces iron ore and produces reduced iron, a coal briquette supply device 300, and a smelting gasifier 100 which produces molten iron by using the reduced iron and the coal briquette. Further, the molten iron producing device may include a molding machine 400 for molding reduced iron into agglomerated iron in a hot state.

[0025] The fluidized bed reduction furnace 200 is a means for reducing iron ore and producing reduced iron, and the iron ore may be iron ore fine, and subsidiary materials may be added as needed. That is, the fluidized bed reduction furnace 200 may be formed with a space for reducing iron ore therein, and a dispersion plate, which is capable of uniformly dispersing gas, for example, reducing gas, supplied into the fluidized bed reduction furnace 200, may be installed inside the space. Accordingly, the fluidized bed reduction furnace 200 may reduce iron ore while making the iron ore flow by the reducing gas therein. The plurality of fluidized bed reduction furnaces 200 may be provided, and the iron ore may be produced into reduced iron while sequentially moving the plurality of fluidized bed reduction furnaces 200. For example, as the fluidized bed reduction furnace, three fluidized bed reduction furnaces (hereinafter, a first fluidized bed reduction furnace 201, a second fluidized bed reduction furnace 202, and a third fluidized bed reduction furnace 203) may be provided. In this case, the first fluidized bed reduction furnace 201 is a place which is initially charged with iron ore, and may dry and preheat the iron ore by using exhaust gas and reducing gas discharged from the second fluidized bed reduction furnace 202. The iron ore dried and preheated in the first fluidized bed reduction furnace 201 is reduced or preliminarily reduced while passing through the second fluidized bed reduction furnace 202, and the second fluidized bed reduction furnace 202 may reduce exhaust gas and reducing gas discharged from the third fluidized bed reduction furnace 203 into iron ore. Further, the third fluidized bed reduction furnace 203 may finally reduce

the iron ore by the reducing gas discharged from the smelting gasifier 100. The number of fluidized bed reduction furnaces 200 is not limited thereto, and may be reduced and increased as needed.

[0026] The molding machine 400 may agglomerate the reduced iron produced in the fluidized bed reduction furnace 200, that is, the reduced iron in a fine particle state, in a hot state. The molding machine 400 may include a first reservoir 410 for storing the reduced iron discharged from the fluidized bed reduction furnace 200, a first molding machine 420 for receiving the reduced iron from the first reservoir 410 and producing agglomerated reduced iron, such as briquette, and a second reservoir (not illustrated) for temporarily storing a molded article produced in the first molding machine 420 and supplying the stored molded article to the smelting gasifier 100. In this case, the first molding machine 420 may be a twin-roll molding machine including a pair of rolls installed to face each other. Accordingly, when a space between the pair of rolls is charged with the reduced iron in a powder state, agglomerated reduced iron may be produced by squeezing by a rotation of the pair of rolls.

[0027] The coal briquette producing device 300 may press a mixture of pulverized coal and a binder to produce a coal briquette and charge the smelting gasifier 100 with the produced coal briquette. The coal briquette producing device 300 may include a mixer 310 for mixing the pulverized coal and the binder, an aging device 320 for aging the mixture of the pulverized coal and the binder mixed in the mixer 310, a second molding machine 330 for pressing the aged mixture and producing a coal briquette, and a third reservoir 340 for storing the coal briquette and charging the smelting gasifier 100 with the coal briquette. Herein, the mixer 310 may be a drum mixer which is formed with a space capable of accommodating the pulverized coal and the binder therein and formed to be rotatable. Then, the aging device 320 may include a body 322 formed with a space capable of accommodating the pulverized coal and the binder therein, an agitator 324 for agitating the mixture, and a steam supply means 326 for supplying steam into the body 322.

[0028] The configuration and the structure of the coal briquette supply device 300 are not limited thereto, and may be modified into various forms.

[0029] The smelting gasifier 100 may be formed with an internal space in which molten iron may be produced by dissolving the reduced iron agglomerated in the molding machine and reducing gas to be supplied to the fluidized bed reduction furnace 200 may be produced. The smelting gasifier 100 may include a lower space, in which reduced iron and a carbonaceous material, such as a coal briquette and lump coal, are accommodated and molten iron is produced, in a lower portion, and an upper space for producing exhaust gas generated during a process of producing molten iron to reducing gas to be supplied to the fluidized bed reduction furnace 200. In this case, the upper space may be formed in a dome shape wider than the lower space, and the smelting gasifier 100 may be charged with the reduced iron and the carbonaceous materials (coal briquette) through the upper space. The smelting gasifier 100 may be provided with an injection lance (not illustrated) for blowing oxygen-containing gas. The oxygen-containing gas may combust carbonaceous materials, and thus it is possible to secure a heat source for smelting the reduced iron.

[0030] Further, the smelting gasifier 100 may be provided with a blowing nozzle (not illustrated) for supplying oxygen-containing gas for removing volatile substances, such as tar, generated in the process of dissolving the reduced iron. When the smelting gasifier 100 is charged with the carbonaceous material, such as a coal briquette and lump coal, volatile substances, such as tar, are generated in a process of increasing a temperature, and when the volatile substances are discharged to the outside of the smelting gasifier 100, a problem, such as a pipe clogging phenomenon, is generated. Accordingly, carbon monoxide, carbon dust, and the like may be combusted by blowing the oxygen-containing gas into the upper space of the smelting gasifier 100 into which the volatile substances flow. In this case, the volatile substance may be converted into carbon monoxide (CO) and hydrogen gas (H₂) by high-temperature chemically cracking the volatile substance by increasing a temperature of the upper space to about 900 to 1,100°C by using the generated combustion heat, and then the converted gas may be discharged from the smelting gasifier 100.

[0031] Hereinafter, a method of producing a coal briquette according to an exemplary embodiment of the present invention will be described.

[0032] FIG. 3 is a flowchart sequentially illustrating a method of producing a coal briquette according to an exemplary embodiment of the present invention.

[0033] Referring to FIG. 3, a method of producing a coal briquette according to an exemplary embodiment of the present invention may include preparing raw materials including pulverized coal and a binder (S100), mixing the raw materials and producing a mixture (S110), aging the mixture (S120), and producing a coal briquette by using the aged mixture (S130). In this case, the binder may include dextrin. Further, the method of producing a coal briquette according to the exemplary embodiment of the present invention may also further include an additional process, other than the presented processes as needed.

[0034] In the process of preparing the raw materials, as the pulverized coal, a carbon-contained raw material, such as bituminous coal, subbituminous coal, anthracite, and coke, may be used. In order to reduce the deviation of a quality of the coal briquette, the pulverized coal having the uniform particle size distribution is preferable, and a particular size of 5 mm or less is 90 wt% or more and a particular size of 3 mm or less is 80 wt% or more based on 100 wt% of the whole pulverized coal, and the pulverized coal may have an average particle size of about 1 to 2 mm. Accordingly, the pulverized coal may be used after the raw coal is crushed so as to have the particle size in the indicated range and is

selected according to the particular size. The pulverized coal may contain about 3 to 10 wt% of moisture based on 100 wt% of the whole pulverized coal. In this case, in order to adjust the content of moisture within the pulverized coal, the method may also further include a process of drying the raw coal or the pulverized coal in the process of preparing the pulverized coal.

[0035] Further, the binder may include dextrin. Dextrin is prepared by hydrolyzing starch with acid, heat, enzymes, and the like, and may be prepared by hydrolyzing various starch, such as corn, wheat, tapioca, potato, and rice. Dextrin may be prepared in a wide range from high molecular weights in which starch is slightly degraded to low molecular weights which do not exhibit iodine-starch reactions. Depending on the degree of hydrolysis of starch, three types of dextrin, such as white dextrin, pale yellow dextrin, and yellow dextrin, are produced, and white dextrin is high-molecular weight dextrin and yellow dextrin is low molecular weight dextrin.

[0036] Dextrose Equivalent (DE) of dextrin may be about 1 to 10, and preferably, may be about 0 to 5. DE of the dextrin represents a measure of how much starch made of binding of glucose is decomposed to produce glucose. As the DE is higher, the starch is more decomposed, and when the starch is completely decomposed to be glucose, DE is indicated with 100. When the DE of the dextrin exceeds 10, the starch is excessively decomposed to decrease binding force to pulverized coal, so that there may be a problem in that strength of the coal briquette is degraded. Accordingly, strength of the coal briquette may be secured by using the dextrin having the DE of the presented range.

[0037] The dextrin does not include an alkali component, such as potassium (K). Accordingly, when the coal briquette produced by using the dextrin is used as a fuel material when molten iron is produced, it is possible to suppress the generation of a low melting point compound, such as KCl, generated by the alkali component in the exhaust gas. Thus, it is possible to suppress the phenomenon that the pipe of the smelting gasifier is clogged or the dispersion plate and the like of the fluidized bed furnace is clogged by the low melting point compound.

[0038] The dextrin may be provided in a powder state, and may have a particular size of about 10 to 20 μm . In this case, when the particular size of the dextrin is larger than the presented range, the dextrin is not uniformly distributed in the pulverized coal when is mixed with the pulverized coal, so that bonding force to the pulverized coal may be degraded. Further, when the particular size of the dextrin is included in the presented range, the dextrin is uniformly dispersed in the pulverized coal to sufficiently secure a contact area with the pulverized coal, and the particular size of the dextrin needs not to be smaller than the presented range.

[0039] In the meantime, when the binder in a liquid state is used, flowability of the mixture of the binder and the pulverized coal is degraded due to a high moisture content, so that an attachment phenomenon occurs in the process of producing the coal briquette, and a phenomenon that the molding machine is uniformly charged with the mixture occurs and thus strength and the shape of the coal briquette are not uniform. Further, since the coal briquette produced as described above has the high moisture content, a drying process needs to be additionally performed before the smelting gasifier is charged with the coal briquette in order to secure strength of the coal briquette, and thus a total process time and costs increase and process efficiency is degraded. Further, the binder in the liquid state is difficult to maintain the binder component due to a layer separation, and transportation costs are high due to the need for a special transportation vehicle, such as a tank lorry, for transportation, and the binder in the liquid state is frozen in winter, so that it is not easy to store the binder.

[0040] In contrast to this, when the binder in the powder state is used, flowability of the mixture of the pulverized coal and the binder is improved, so that it is possible to produce the uniform coal briquette. Further, when the binder in the powder state is used when the coal briquette is produced, strength of the coal briquette may be sufficiently secured even without an additional drying process before the coal briquette is used in an operation. Further, the binder in the powder state has a minimized volume, so that it is easy to store and transport the binder, and there is no need to worry about freezing during winter.

[0041] When the raw materials, such as the pulverized coal and the dextrin that is the binder, are prepared, the pulverized coal and the dextrin are uniformly mixed in the mixer 310 to produce a mixture. In this case, based on the 100 wt% of the total mixture, the pulverized coal may be included by 91 to 97 wt% and the dextrin may be included by 3 to 9 wt%. Preferably, based on the 100 wt% of the total mixture, the pulverized coal may be included by 93 to 97 wt% and the dextrin may be included by 3 to 7 wt%. When the content of the binder is smaller than the presented range, it is impossible to sufficiently secure strength of the coal briquette produced, and when the content of the binder is larger than the presented range, there is a problem in that costs for producing the coal briquette increase.

[0042] The mixture produced as described above may contain about 3 to 10 wt% of moisture based on 100 wt% of the mixture. In this case, when the amount of moisture contained in the mixture is smaller than the presented range, the inside of the aging device 320 is made into a supersaturated vapor state in the subsequent aging process, so that moisture may be additionally supplied to the mixture. A ratio of the amount of moisture to the amount of dextrin may be about 1 to 3. This is for the purpose of securing viscosity by smoothly gelatinizing the dextrin in the aging process, and when the content of the moisture is smaller than the presented range, the gelatinization reaction of the dextrin does not smoothly occur, so that strength of the coal briquette produced may not be sufficiently secured. Further, when the content of the moisture is larger than the presented range, the content of moisture of the coal briquette is increased, so that

there is a problem in that a drying process needs to be additionally performed for securing strength. However, when the amount of moisture in the mixture is smaller than the presented range in the process of producing the mixture, the amount of moisture may be adjusted to the presented range by adjusting steam pressure inside the body 322 in the process of aging the mixture.

[0043] When the mixture is produced, the inside of the body 322 of the aging device 320 is charged with the mixture, and the mixture is aged while steam is supplied into the body 322 through the steam supply means 326.

[0044] The aging process may be performed under the conditions that the internal pressure of the body 322 is about 5 to 10 bars, and an internal temperature of the body 322 is 110°C or higher. An internal environment of the body 322 may be controlled so that the mixture maintains a temperature of 50 to 100°C, preferably, 50 to 100°C, during the aging of the mixture. When the temperature of the mixture is higher than the presented range, energy is much consumed for increasing the temperature of the mixture, so that the high temperature is not preferable in an aspect of process efficiency, and when the temperature of the mixture is lower than the presented range, the gelatination reaction of the dextrin does not sufficiently occur, so that it is difficult to produce the coal briquette having desired strength.

[0045] The mixture may be agitated by using the agitator 324 in the aging process. When the mixture is agitated by using the agitator 324, the temperature of the mixture may be entirely uniformly adjusted. Further, the dextrin causes the gelatination reaction to have viscosity in the process of aging the mixture, and when the mixture is agitated by using the agitator 324, the mixture is in contact with the agitator 324 to generate frictional heat. The generated frictional heat causes the gelatination reaction of the dextrin together with the steam supplied into the body 322 to be used as a heat source.

[0046] When the mixture is aged by the foregoing method, the dextrin which is uniformly dispersed in the pulverized coal meets moisture, and when the internal temperature of the body 322 of the aging device 320 is increased, the gelatination reaction of the dextrin occurs that the dextrin is expanded to a state of high viscosity. As a result, the gelatinized dextrin exhibits bonding force to the pulverized coal, thereby considerably improving strength of the coal briquette produced in the subsequent process.

[0047] An aging time of the mixture may be about 7 to 20 minutes. In this case, the aging time may be longer than a raw material mixing time, and this is for the purpose of uniformly and sufficiently gelatinizing the dextrin in the pulverized coal. Further, since the raw materials, that is, the pulverized coal and the dextrin, are provided in the powder state, it does not take much time for uniformly mixing the pulverized coal and the dextrin, but the dextrin has viscosity while being gelatinized in the aging process, so that it takes a long time to uniformly agitate the mixture. Accordingly, the aging time may be longer than the time for producing the mixture of the pulverized coal and the dextrin by about 2 to 5 times.

[0048] When the aging process is completed, the coal briquette is produced by taking out the mixture from the body 322 of the aging device 320 and charging the second molding machine 330 with the mixture. The coal briquette may be produced by charging the space between the pair of rollers with the aged mixture and then pressing the mixture, and may be formed in various forms, such as briquette or a strip shape. When the coal briquette is produced, molding pressure may be adjusted so that the produced coal briquette has apparent density of about 1.25 to 1.35 kg/m³. Accordingly, it is possible to produce the coal briquette having strength usable in the smelting gasifier.

[0049] The produced coal briquette may be temporarily stored in the third reservoir 340 and then the smelting gasifier 100 may be charged with the produced coal briquette for producing molten iron.

[0050] Hereinafter, experimental examples for verifying a physical characteristic of the coal briquette produced by the exemplary embodiment of the present invention and an effect obtained when the coal briquette is applied to an actual operation will be described.

Measurement experiment of hot strength and cold strength of coal briquette

[0051] Pulverized coal and dextrin powder having a particular size of 90% or more of 3.4 mm or less were uniformly mixed for 2 to 3 minutes, the mixture was inserted into the aging device again, and then the mixture was aged and mixed for a predetermined time by supplying steam into the aging device and increasing an internal temperature of the aging device. In this case, as the pulverized coal, hard coking coal, semi-soft coking coal, and powdered coke were mixed and used, and as the dextrin, a WSCR Wheat Dextrin product of MANILDRA was used. The mixture of the pulverized coal and the dextrin was agitated by using the agitator during the aging.

[0052] Then, a coal briquette was produced by charging the space between the pair of rolls of the second molding machine with the aged mixture. When the coal briquette was produced, the rolls of the second molding machine pressed the mixture with pressure of 20 kN/cm to produce the coal briquette having a pillow shape having a size of 64.5 mm × 25.4 mm × 19.1 mm.

Experimental Example 1

[0053] 95.5 wt% of pulverized coal having moisture content of 7.6 wt% and 4.5 wt% of powder-type dextrin were mixed

for 3 minutes, and the mixture was inserted into the aging device again and was aging-processed for 10 minutes. In this case, the dextrin, of which DE is 2, was used, and the moisture content of the aged mixture discharged from the aging device was 7.4 wt% and a temperature thereof was 62°C. Then, a coal briquette was produced by charging a space between the pair of rolls with the mixture. When the coal briquette was produced, the coal briquette was left at a room temperature for about 1 hour and then drop strength and compressive load were measured. Drop strength of the coal briquette was calculated from a ratio of a coal briquette having a particular size of 20 mm or more after 2 kg of the coal briquette produced by each experimental example were dropped freely 8 times at a height of 5 M. Further, compressive load of the coal briquette was measured by a maximum load when the coal briquette was compressed at the top of the coal briquette at a predetermined speed in a state where a lower portion of the coal briquette was fixed, and was measured with an average value of 20 coal briquette specimens.

Experimental Example 2

[0054] 95.5 wt% of pulverized coal having moisture content of 8.0 wt% and 4.5 wt% of powder-type dextrin were mixed for 3 minutes, and the mixture was inserted into the aging device again and was aging-processed for 15 minutes. In this case, the dextrin, of which DE is 2, was used, and the moisture content of the aged mixture discharged from the aging device was 6.9 wt% and a temperature thereof was 68°C. Then, a space between the pair of rolls was charged with the mixture to produce a coal briquette. When the coal briquette was produced, drop strength and compressive load were measured by the same method as that of Experimental Example 1.

Experimental Example 3

[0055] 95.5 wt% of pulverized coal having moisture content of 6.2 wt% and 4.5 wt% of powder-type dextrin were mixed for 3 minutes, and the mixture was inserted into the aging device again and was aging-processed for 10 minutes. In this case, the dextrin, of which DE is 2, was used, and the moisture content of the aged mixture discharged from the aging device was 5.4 wt% and a temperature thereof was 63°C. Then, a space between the pair of rolls was charged with the mixture to produce a coal briquette. When the coal briquette was produced, drop strength and compressive load were measured by the same method as that of Experimental Example 1.

Experimental Example 4

[0056] 95.0 wt% of pulverized coal having moisture content of 9.8 wt% and 5.0 wt% of powder-type dextrin were mixed for 3 minutes, and the mixture was inserted into the aging device again and was aging-processed for 10 minutes. In this case, the dextrin, of which DE is 2, was used, and the moisture content of the aged mixture discharged from the aging device was 8.5 wt% and a temperature thereof was 66°C. Then, a space between the pair of rolls was charged with the mixture to produce a coal briquette. When the coal briquette was produced, drop strength and compressive load were measured by the same method as that of Experimental Example 1.

Experimental Example 5

[0057] 97.5 wt% of pulverized coal having moisture content of 7.6 wt% and 2.5 wt% of powder-type dextrin were mixed for 3 minutes, and the mixture was inserted into the aging device again and was aging-processed for 10 minutes. In this case, the dextrin, of which DE is 2, was used, and the moisture content of the aged mixture discharged from the aging device was 7.2 wt% and a temperature thereof was 63°C. Then, a space between the pair of rolls was charged with the mixture to produce a coal briquette. When the coal briquette was produced, drop strength and compressive load were measured by the same method as that of Experimental Example 1.

Experimental Example 6

[0058] 95.5 wt% of pulverized coal having moisture content of 6.0 wt% and 4.5 wt% of powder-type dextrin were mixed for 3 minutes, and the mixture was inserted into the aging device again and was aging-processed for 5 minutes. In this case, the dextrin, of which DE is 2, was used, and the moisture content of the aged mixture discharged from the aging device was 5.8 wt% and a temperature thereof was 63°C. Then, a space between the pair of rolls was charged with the mixture to produce a coal briquette. When the coal briquette was produced, drop strength and compressive load were measured by the same method as that of Experimental Example 1.

Experimental Example 7

[0059] 95.5 wt% of pulverized coal having moisture content of 7.5 wt% and 4.5 wt% of powder-type dextrin were mixed for 3 minutes, and a process of aging the mixture in the aging device was omitted. In this case, the dextrin, of which DE is 2, was used. Then, a space between the pair of rolls was charged with the aged mixture to produce a coal briquette. When the coal briquette was produced, drop strength and compressive load were measured by the same method as that of Experimental Example 1.

Experimental Example 8

[0060] 95.5 wt% of pulverized coal having moisture content of 7.5 wt% and 4.5 wt% of powder-type dextrin were mixed for 3 minutes, and the mixture was inserted into the aging device again and was processed for 10 minutes. The dextrin, of which DE is 42, was used, and the moisture content of the aged mixture aged in the aging device was 7.1 wt% and a temperature thereof was 62°C. Then, a space between the pair of rolls was charged with the mixture to produce a coal briquette. When the coal briquette was produced, drop strength and compressive load were measured by the same method as that of Experimental Example 1.

[0061] The results of Experimental Examples 1 to 8 are represented in Table 1 below.

[Table 1]

Experimental Example	Mixing ratio (wt%)		Aged mixture			Quality of coal briquette	
	Pulverized coal	Dextrin	Aging time (minute)	Moisture (wt(%))	Temperature (°C)	Drop strength (%)	Compressive load (kgf)
Experimental Example 1	95.5	4.5	10	7.4	62	90	62
Experimental Example 2	95.5	4.5	15	6.9	68	88	78
Experimental Example 3	95.5	4.5	10	5.4	63	78	69
Experimental Example 4	95.0	5.0	10	8.5	66	97	74
Experimental Example 5	97.5	2.5	10	7.2	63	49	37
Experimental Example 6	95.5	4.5	5	5.8	63	62	49
Experimental Example 7	95.5	4.5	0	7.5	25	24	14
Experimental Example 8	95.5	4.5	10	7.1	62	57	44

[0062] Referring to Table 1, in the case of Experimental Examples 1 to 4 produced by the method of producing the coal briquette according to the present invention, it can be seen that drop strength and compressive load of the coal briquette are very excellent. That is, in the case of the coal briquette produced under the condition presented in the method of producing the coal briquette of to the present invention, drop strength was highly measured as 70% or more and compressive load was highly measured as 60 kgf.

[0063] However, in the case of Experimental Example 5 in which the content of dextrin used was smaller than the range presented in the present invention, drop strength and compressive load of the coal briquette were measured to be lower than those of Experimental Examples 1 to 4.

[0064] Further, even in the case of Experimental Example 6 in which the aging was performed shorter than the range presented in the present invention and Experimental Example 7 in which the aging process was not performed, drop strength and compressive load of the coal briquette were measured to be lower than those of Experimental Examples 1 to 4.

[0065] Further, even in the case of Experimental Example 8 in which the contents of raw materials, the aging time,

and the like were included in the ranges presented in the present invention, but the dextrin, of which DE was 42, was used, drop strength and compressive load of the coal briquette were measured to be lower than those of Experimental Examples 1 to 4.

[0066] Accordingly, it can be seen that when the contents of the raw materials and the process condition presented in the present invention are satisfied when a coal briquette is produced, it is possible to sufficiently secure strength of the coal briquette.

[0067] Experiments for recognizing the degree of generation of a low melting point compound and the like when the coal briquette produced by the present invention is used in an actual operation will be described.

Experimental Example 9

[0068] The coal briquette produced by Experimental Example 4 was made into a fine particle state by crushing the coal briquette. Further, a 30 ml porcelain crucible was charged with about 7 g of the crushed coal briquette, for example, specimen 1. Then, the porcelain crucible was inserted into and then was heated for 10 hours to combust specimen 1. Then, the components of combusted specimen 1 were analyzed.

Experimental Example 10

[0069] 2.7 parts by weight of quicklime and 11 parts by weight of molasses were uniformly mixed in 100 parts by weight of pulverized coal having 90% or more of a grain size of 3.4 mm or less. Then, a space between the pair of rolls was charged with the mixture to produce a coal briquette. In this case, when the coal briquette was produced, the coal briquette having the same size as that of Experimental Example 4 was produced by using the same molding pressure as that of Experimental Example 4. The coal briquette produced as described above was made into a fine particle state by crushing the coal briquette. Then, a 30 ml porcelain crucible was charged with about 7 g of the crushed coal briquette, for example, specimen 2. Then, the porcelain crucible was inserted into a heating furnace of 850°C and then was heated for 10 hours to combust specimen 2. Then, the components of combusted specimen 2 were analyzed.

[0070] Table 2 below represents the result of the analysis of the components of specimens 1 and 2.

[Table 2]

Category	Ash component of coal briquette (wt%)							
	SiO ₂	CaO	Al ₂ O ₃	MgO	TiO ₂	Fe ₂ O ₃	K ₂ O	Na ₂ O
Experimental Example 9	50.9	8.2	24.3	2.2	1.3	8.2	1.9	0.8
Experimental Example 10	38.8	27.3	20.2	2.2	1.0	4.6	3.3	0.3

[0071] Referring to Table 2, in the case of the coal briquette produced by using the dextrin, it can be seen that the amount of alkali component, that is, K₂O, which generates a deposit to a pipe, a facility, and the like, is considerably decreased compared to the coal briquette produced by using molasses. Herein, since the dextrin used as a binder does not contain a K component, it is preferable that K₂O is not detected after specimen 1 is combusted, but the K component is partially contained in the pulverized coal, so that it is determined that the K₂O component is detected.

[0072] As described above, when the coal briquette produced by using the dextrin is used in the smelting gasifier, it is possible to suppress the generation of a low melting point compound (melting point 770°C), such as KCl, generated by the alkali component. Accordingly, it is possible to suppress the clogging of the pipe of the smelting gasifier when molten iron is produced and the generation of a deposit by a low melting point compound within the fluidized bed reduction furnace, in which iron ore is reduced by using reducing gas generated in the smelting gasifier, thereby stably operating facilities.

[0073] The technical spirit of the present invention have been described according to the exemplary embodiment in detail, but the exemplary embodiment has described herein for purposes of illustration and does not limit the present invention. Further, those skilled in the art will appreciate that various modifications may be made without departing from the scope and spirit of the present invention.

[Industrial Applicability]

[0074] According to the method of producing a coal briquette and a coal briquette produced by using the same according to the exemplary embodiment of the present invention, it is possible to suppress the clogging of a pipe within a facility by suppressing the clogging of the pipe and the generation of a deposit within the facility by a low melting point compound,

and to stably operate a facility by suppressing a clogging phenomenon of a dispersion plate of the fluidized bed reduction furnace and the like, thereby improving operation efficiency and productivity.

5 **Claims**

1. A method of producing a coal briquette, comprising:

10 preparing raw materials including pulverized coal and dextrin;
producing a mixture by mixing the raw materials;
aging the mixture; and
producing a coal briquette by molding the aged mixture.

15 2. The method of claim 1, wherein the preparing of the raw materials includes preparing the dextrin of which Dextrose Equivalent (DE) is more than 0 and 10 or less.

3. The method of claim 2, wherein the preparing of the raw materials includes preparing the dextrin of which a particular size is 10 to 20 μm .

20 4. The method of claim 3, wherein the producing of the mixture includes mixing 92 to 97 wt% of the pulverized coal and 3 to 9 wt% of the dextrin based on 100wt% of the total weight of the pulverized coal and the dextrin.

25 5. The method of claim 4, wherein the aging includes heating the mixture by using steam so that the mixture maintains at 50 to 100°C.

6. The method of claim 5, wherein the aging includes making an adjustment so that the mixture has a moisture content of 3 to 10 wt% based on 100 wt% of the entire mixture.

30 7. The method of claim 1, wherein the aging includes adjusting a ratio of the amount of moisture to the amount of dextrin to 1 to 3.

8. The method of claim 7, wherein the aging includes agitating the mixture.

35 9. The method of claim 8, wherein the aging is performed for 7 to 20 minutes.

10. A coal briquette including pulverized coal and dextrin, in which the dextrin exists in a gelatinized state.

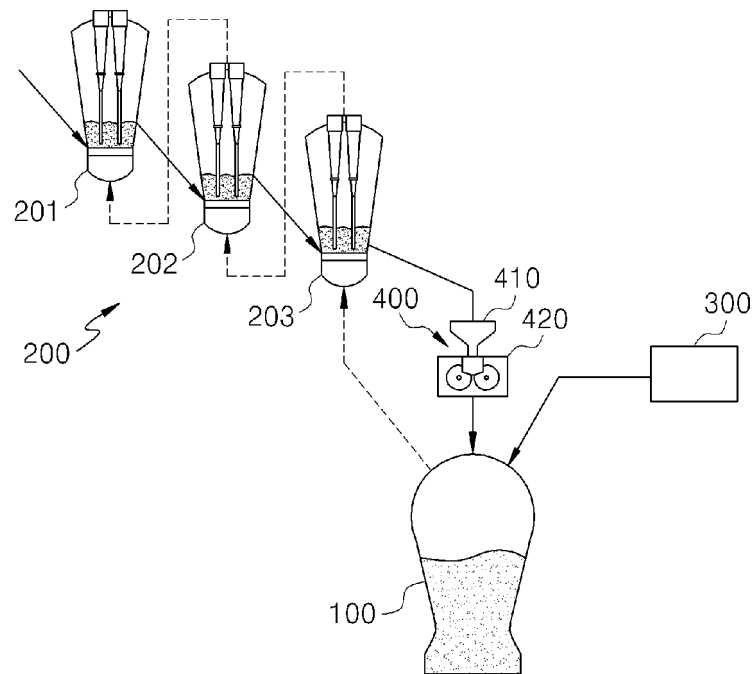
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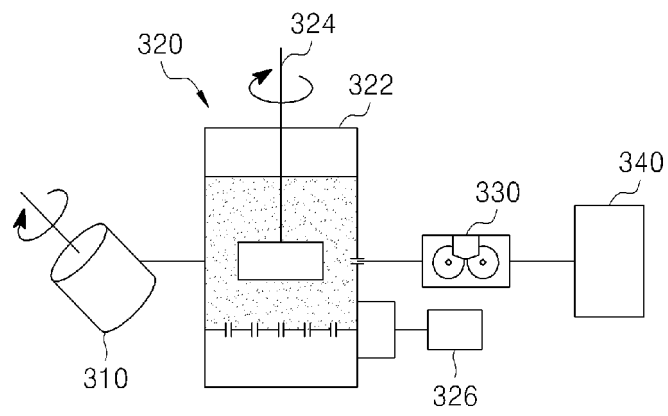
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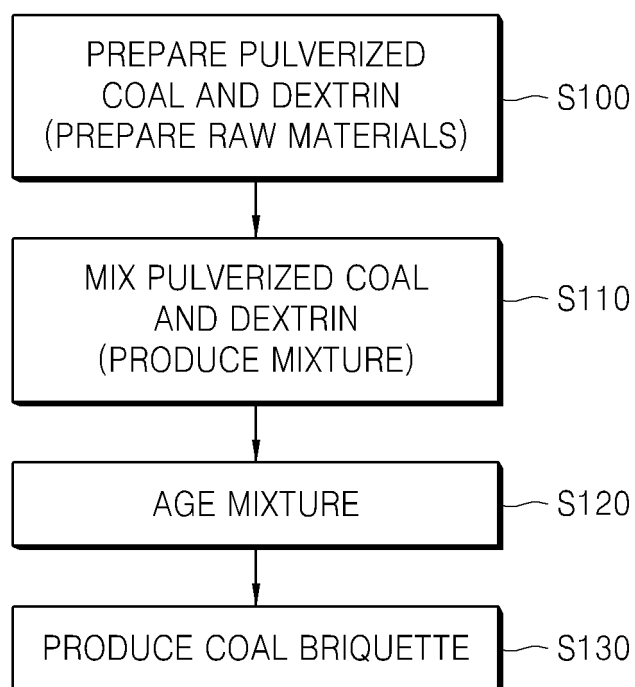
[FIG. 1]



[FIG. 2]



[FIG. 3]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2017/015329

A. CLASSIFICATION OF SUBJECT MATTER

C10L 5/14(2006.01)i, C10L 5/04(2006.01)i, C10B 53/04(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 5/00; C10L 5/44; C10B 53/02; C10L 5/10; C10L 5/34; C10L 5/04; C10B 53/04

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) & Key words: powdered coal, dextrin, aging, molding, coal briquet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2000-0020926 A (DAIHAN COAL CORP.) 15 April 2000 See example 1; claim 2; and table 1.	1-10
Y	KR 10-2017-0069544 A (KOREA INSTITUTE OF ENERGY RESEARCH) 21 June 2017 See claims 3, 8.	1-10
A	KR 10-1464917 B1 (KOREA INSTITUTE OF ENERGY RESEARCH) 26 November 2014 See claims 1-3, 8-12.	1-10
A	KR 10-2017-0068327 A (POSCO) 19 June 2017 See claims 1-13.	1-10
A	WO 2016-140428 A1 (POSCO) 09 September 2016 See claims 1-17.	1-10

☐ 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

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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REFERENCES CITED IN THE DESCRIPTION

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