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(54) **SOLID FUEL PRODUCTION METHOD**

(57) An object of the present invention is to provide a production method of a solid fuel that enables a solid fuel having a relatively high strength to be produced from a powder fuel. A production method of a solid fuel according to the present invention includes: blending a coal-derived powder fuel with a pulverized fuel having a greater mean particle diameter than the coal-derived powder fuel; compression-molding a mixture obtained by the blending; and pulverizing a part of a solid fuel obtained by the compression-molding, in which the part of the solid fuel pulverized in the pulverizing is used as the pulverized fuel in the blending. A blending proportion of the pulverized fuel with respect to the mixture obtained by the blending is preferably greater than or equal to 5% by mass and less than or equal to 50% by mass. A cohesive fine coal having a superior cohesive property to the coal-derived powder fuel is preferably further blended in the blending. A blending proportion of the cohesive fine coal with respect to the mixture obtained by the blending is preferably greater than or equal to 5% by mass and less than or equal to 30% by mass.

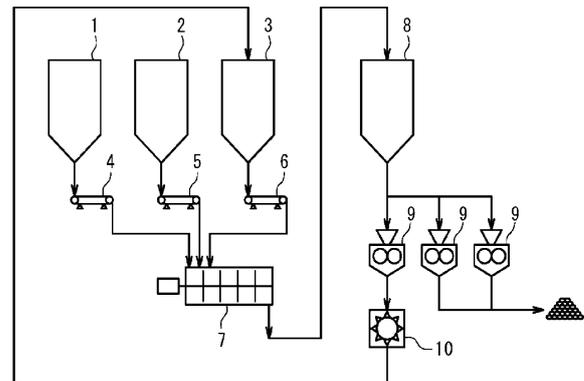


FIG. 1

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Description

[TECHNICAL FIELD]

5 **[0001]** The present invention relates to a production method of a solid fuel.

[BACKGROUND ART]

10 **[0002]** Since a powder fuel has a relatively small bulk density and is likely to be lost through scattering, the handling cost is likely to increase and dust pollution may be caused. Accordingly, compression molding of the powder fuel into a granular form (briquette) has been practiced for handleability.

[0003] For example, a modified coal obtained by thermally dehydrating a low-rank coal, e.g., a brown coal, in oil is typically in a powder form and is desired to be compression-molded into a granular form. However, since molding of the modified coal obtained from a low-rank coal having a low degree of coalification requires compression molding at an extremely high pressure, the production cost increases, and in addition, problematic powderization may occur during transport due to the compression that can be insufficient.

15 **[0004]** In this respect, a technique has been proposed of increasing strength of an obtained solid fuel through compression molding of a humidified modified coal (see Japanese Unexamined Patent Application, Publication No. 2010-116544). However, even with the technique disclosed in the above-cited publication, powderization may occur depending on a mode of use and a mode of handling of the solid fuel.

[PRIOR ART DOCUMENTS]

[PATENT DOCUMENTS]

25 **[0005]** Patent Document 1: Japanese Unexamined Patent Application, Publication No. 2010-116544

[SUMMARY OF THE INVENTION]

30 [PROBLEMS TO BE SOLVED BY THE INVENTION]

[0006] In view of the aforementioned disadvantages, an object of the present invention is to provide a production method of a solid fuel that enables a solid fuel having a relatively high strength to be produced from a powder fuel.

35 [MEANS FOR SOLVING THE PROBLEMS]

[0007] According to an aspect of the invention made for solving the aforementioned problems, a production method of a solid fuel comprises: blending a coal-derived powder fuel with a pulverized fuel having a greater mean particle diameter than the coal-derived powder fuel; compression-molding a mixture obtained by the blending; and pulverizing a part of a solid fuel obtained by the compression-molding, in which the part of the solid fuel pulverized in the pulverizing is used as the pulverized fuel in the blending.

[0008] Due to blending the coal-derived powder fuel with the pulverized fuel, the production method of a solid fuel according to the aspect of the present invention enables relatively reliable compression of the fuel upon compression molding, whereby an insufficient strength of the solid fuel due to poor compression can be prevented. Therefore, the production method of a solid fuel enables a solid fuel having a relatively great strength to be produced.

45 **[0009]** A blending proportion of the pulverized fuel with respect to the mixture obtained by the blending is preferably greater than or equal to 5% by mass and less than or equal to 50% by mass. When the blending proportion of the pulverized fuel with respect to the mixture obtained by the blending falls within the above range, a more reliable increase of the strength of the solid fuel obtained is enabled, while suppression of a rise in the production cost is enabled.

50 **[0010]** A cohesive fine coal having a superior cohesive property to the coal-derived powder fuel is preferably further blended in the blending. When the cohesive fine coal is thus blended with the coal-derived powder fuel, a solid fuel having a greater strength is enabled to be produced.

[0011] A blending proportion of the cohesive fine coal with respect to the mixture obtained by the blending is preferably greater than or equal to 5% by mass and less than or equal to 30% by mass. When the blending proportion of the cohesive fine coal with respect to the mixture obtained by the blending falls within the above range, a more reliable increase of the strength of the solid fuel obtained is enabled, while suppression of a deterioration in quality is enabled.

55 **[0012]** It is preferred that the production method further comprises: measuring a strength of the solid fuel obtained by the compression molding; and on basis of a measured value thus obtained, adjusting a blending proportion of the

cohesive fine coal in the blending, wherein in the adjusting, provided that the strength of the solid fuel is less than a predetermined lower limit, the blending proportion of the cohesive fine coal is increased, while provided that the strength of the solid fuel is greater than a predetermined upper limit, the blending proportion of the cohesive fine coal is decreased. By thus adjusting the blending proportion of the cohesive fine coal in accordance with the strength of the solid fuel, the quality of the solid fuel is enabled to be stabilized.

[0013] It is preferred that the production method further comprises: measuring a production amount of the solid fuel obtained by the compression molding; and on basis of a measured value thus obtained, adjusting a blending proportion of the pulverized fuel in the blending. In the case in which the production method further comprises: measuring a production amount of the solid fuel obtained by the compression molding; and on basis of a measured value thus obtained, adjusting a blending proportion of the pulverized fuel in the blending as described above, a speed of the compression molding is enabled to be appropriately maintained, whereby the quality of the solid fuel obtained can be stabilized.

[0014] It is preferred that, in the blending, the coal-derived powder fuel and the pulverized fuel are fed to a mixer using a conveyor scale. In the case in which, in the blending, the coal-derived powder fuel and the pulverized fuel are fed to a mixer using a conveyor scale as described above, the coal-derived powder fuel, the pulverized fuel, and optionally the cohesive fine coal, are enabled to be relatively accurately weighed and fed in a continuous manner.

[0015] A modified coal obtained by thermally dehydrating a low-rank coal in oil is preferably used as the coal-derived powder fuel, and a powdered low-rank coal is preferably used as the cohesive fine coal. When the modified coal obtained by thermally dehydrating a low-rank coal in oil is used as the coal-derived powder fuel, and the powdered low-rank coal is preferably used as the cohesive fine coal, a relatively inexpensive and high-quality solid fuel is enabled to be provided.

[0016] It is to be noted that "mean particle diameter" as referred to means a mesh opening size of a sieve at 50% cumulative mass in a particle size distribution as measured by the test sieving pursuant to JIS-Z8815 (1994). In addition, "superior cohesive property" as referred to means a greater crushing strength as measured pursuant to JIS-Z8841 (1993), in the case of conducting compression molding under the same condition.

[EFFECTS OF THE INVENTION]

[0017] As described above, the production method of a solid fuel enables a solid fuel having a relatively great strength to be produced from a powder fuel.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0018] Fig. 1 is a schematic view showing a configuration of a production device used in the production method of a solid fuel according to an embodiment of the present invention.

[DESCRIPTION OF EMBODIMENTS]

[0019] Embodiments of the present invention will be explained in detail below with appropriate reference to the drawings.

Solid Fuel Production Device

[0020] A schematic configuration of a solid fuel production device used in the production method of a solid fuel according to an embodiment of the present invention is shown in Fig. 1.

[0021] The solid fuel production device shown in Fig. 1 is a device for producing a granular solid fuel through compression molding of the coal-derived powder fuel.

[0022] The solid fuel production device shown in Fig. 1 includes: a first silo 1 for pooling the coal-derived powder fuel; a second silo 2 for pooling the cohesive fine coal having a superior cohesive property to the coal-derived powder fuel; and a third silo 3 for pooling the pulverized fuel having a greater mean particle diameter than the coal-derived powder fuel.

[0023] The solid fuel production device shown in Fig. 1 further includes: a first conveyor scale 4 for discharging the coal-derived powder fuel from the first silo 1 at an arbitrary rate (mass per unit time); a second conveyor scale 5 for discharging the cohesive fine coal from the second silo 2 at an arbitrary rate; and a third conveyor scale 6 for discharging the pulverized fuel from the third silo 3 at an arbitrary rate.

[0024] The solid fuel production device shown in Fig. 1 further includes: a mixer 7 to which the coal-derived powder fuel, the cohesive fine coal and the pulverized fuel are fed from the first conveyor scale 4, the second conveyor scale 5 and the third conveyor scale 6 respectively, and that blends these three types of materials; and a material mixture silo 8 for pooling a mixture of the coal-derived powder fuel, the cohesive fine coal and the pulverized fuel discharged from the mixer 7.

[0025] The solid fuel production device shown in Fig. 1 further includes: a molding machine 9 for compression-molding

the mixture fed from the material mixture silo 8 to form an intended solid fuel; and a pulverizing machine 10 for pulverizing a part of the solid fuel formed by the molding machine 9. The solid fuel pulverized by the pulverizing machine 10 is fed as the pulverized fuel to the third silo 3. Transport of the powder and particulates (the coal-derived powder fuel, the cohesive fine coal, the pulverized fuel and the solid fuel) between the configuration members may be carried out by well known techniques with a chute, a belt conveyor, a bucket conveyor, a pneumatic conveyor and the like.

Coal-derived powder fuel

[0026] As the coal-derived powder fuel that is the principal component of the solid fuel, a fine coal which is a small-diameter coal, a modified coal (e.g., upgraded brown coal) obtained by thermally dehydrating a low-rank coal (e.g., subbituminous coal, brown coal, etc.) in oil, and the like may be used. In particular, the production method of a solid fuel according to the embodiment of the invention enables production of a granular solid fuel containing, of the above candidates of the principal component, the modified coal which conventionally could not be easily formed into a granular form.

Cohesive fine coal

[0027] As the cohesive fine coal, any fine coal having a superior cohesive property to the coal-derived powder fuel may be used. In light of suppression of a rise in cost, it is preferred to use a pulverized coal formed from a relatively inexpensive low-rank coal (preferably a cohesive coal).

[0028] The cohesive property of the coal-derived powder fuel upon compression molding is greatly affected by the moisture content of the source material. The lower limit of the moisture content of the cohesive fine coal is preferably 20% by mass and more preferably 25% by mass. Meanwhile, the upper limit of the moisture content of the cohesive fine coal is preferably 60% by mass and more preferably 55% by mass. When the moisture content of the cohesive fine coal is less than the lower limit, the strength of the solid fuel obtained may not be sufficiently increased. To the contrary, when the moisture content of the cohesive fine coal is greater than the upper limit, adjustment of the amount of the cohesive fine coal blended may be less easy.

[0029] The lower limit of a 20% particle diameter D20 of the cohesive fine coal is preferably 0.005 mm and more preferably 0.010 mm. When the 20% particle diameter D20 of the cohesive fine coal is less than the lower limit, the cohesive fine coal may be difficult to handle due to generation of dust and the like. Meanwhile, the upper limit of the 90% particle diameter D90 of the cohesive fine coal is preferably 3 mm and more preferably 1 mm. When the 90% particle diameter D90 of the cohesive fine coal is greater than the upper limit, a blending property with respect to the coal-derived powder fuel may be insufficient and consequently the strength of the solid fuel obtained may vary. It is to be noted that "20% particle diameter D20" and "90% particle diameter D90" as referred to mean a sieve mesh size that results in a cumulative mass of particles which have passed through the sieve accounting for 20% of the mass of all particles, and a sieve mesh size that results in a cumulative mass of particles which have passed through the sieve accounting for 90% of the mass of all particles, respectively, in the test sieving pursuant to JIS-Z 8815 (1994).

Pulverized fuel

[0030] The pulverized fuel is obtained by pulverizing using the pulverizing machine 10 the solid fuel finally obtained by the production method of a solid fuel according to the embodiment of the invention.

[0031] The lower limit of the 20% particle diameter D20 of the pulverized fuel is preferably 0.5 mm and more preferably 1 mm. When the 20% particle diameter D20 of the pulverized fuel is less than the lower limit, compression moldability of the mixture thereof with the coal-derived powder fuel may not be sufficiently improved. Meanwhile, the upper limit of the 90% particle diameter D90 of the pulverized fuel is preferably 10 mm and more preferably 7 mm. When the 90% particle diameter D90 of the pulverized fuel is greater than the upper limit, a blending property with respect to the coal-derived powder fuel may be insufficient and consequently the strength of the solid fuel obtained may vary.

Silos

[0032] The silos 1, 2, 3 and 8 may be arbitrary silos capable of pooling and discharging as needed the coal-derived powder fuel, the cohesive fine coal, the pulverized fuel and the material mixture, respectively.

[0033] Of these, the first silo 1 for pooling the coal-derived powder fuel, the third silo 3 for pooling the pulverized fuel, and the material mixture silo 8 for pooling the material mixture are each preferably configured such that a nitrogen atmosphere can be provided inside. More specifically, the first silo 1, the third silo 3 and the material mixture silo 8 are each preferably equipped with a measurement mechanism for measuring carbon dioxide (CO₂) concentration inside, and a gas feeding mechanism for introducing a nitrogen gas (N₂) inside when the CO₂ concentration measured by the

measuring mechanism increases.

Conveyor scale

5 **[0034]** The conveyor scales 4, 5 and 6 are as defined by JIS-B7606 (1997) and each configured with a combination of a belt conveyor and a measuring apparatus (e.g., load cell). The conveyor scales 4, 5 and 6 are each configured such that the coal-derived powder fuel, the cohesive fine coal or the pulverized fuel being present on the belt conveyor is weighed in a real-time manner and the conveying speed of the belt conveyor is adjusted accordingly, whereby a discharge amount of the coal-derived powder fuel, the cohesive fine coal or the pulverized fuel per hour may be arbitrary set.

10

Mixer

15 **[0035]** The mixer 7 may be any batch-type or continuous type mixer that enables homogeneous blending of the coal-derived powder fuel, the cohesive fine coal and the pulverized fuel, and, for example, a mixer equipped with a rotating container, a mixer equipped with an agitating blade, and the like may be used. The mixer equipped with a rotating container is exemplified by a V-shaped mixer, a double-cone mixer, and the like. The mixer equipped with an agitating blade is exemplified by a paddle mixer, a ribbon mixer, and the like. Alternatively, a static mixer with no motor which blends the powder and the particulates falling by gravity by way of, for example, a fixed agitating blade may also be used as the mixer 7.

20

Molding machine

25 **[0036]** The molding machine 9 is exemplified by a double-roll molding machine, a tablet making machine, and the like. Of these, the double-roll molding machine which has relatively great processing ability is suitably used. The double-roll molding machine has a structure in which two cylindrical rolls are horizontally adjacent to each other, each of the rolls rotating in a direction from an upper side toward the adjacent site. A large number of cavities are provided on a peripheral surface of each of the rolls such that the cavities on the two rolls are opposite to each other and rotate synchronously. Thus, the double-roll molding machine enables molding of the powder and the particulates into a granular form through compression of the powder and the particulates between the opposed cavities.

30 **[0037]** The molding machine 9 is preferably provided with a feeding hopper equipped with a feeding screw, for stable feeding of the mixture of the coal-derived powder fuel, the cohesive fine coal and the pulverized fuel into the cavities.

35 **[0038]** In addition, particularly in the case of using the double-roll molding machine as the molding machine 9, in addition to a granular matter formed by compression molding, the material mixture may be discharged through a gap between the two rolls without being molded. Furthermore, feeding of the material mixture to the cavities may be insufficient for some reason, leading to insufficient compression and in turn powderization. In this regard, a sieve may be provided following the molding machine 9, for separating the material mixture discharged without being molded. The material mixture thus separated from the molded solid fuel may be refed to the material mixture silo 8.

Pulverizing machine

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[0039] The pulverizing machine 10 is not particularly limited, and a rotating cutter, a hammer mill and the like which are well-known may be used.

45 **[0040]** Depending on the type of the pulverizing machine 10, in the case in which the pulverized fuel having a diameter not sufficiently reduced may be discharged from the pulverizing machine 10, a sieve may be provided for separating large-diameter particles in the pulverized fuel discharged from the pulverizing machine 10 for preventing troubles in the molding machine 9, and the large-diameter particles thus separated may be refed to the pulverizing machine 10.

50 **[0041]** The production method of a solid fuel that can be practiced by using the aforementioned solid fuel production device includes: blending the coal-derived powder fuel with the cohesive fine coal and the pulverized fuel (blending step); compression-molding the mixture obtained by the blending (compression molding step); pulverizing a part of the solid fuel obtained by the compression molding (pulverizing step); measuring a strength of the solid fuel obtained by the compression molding, and on the basis of a measured value thus obtained, adjusting a blending proportion of the cohesive fine coal in the blending (strength adjusting step); and measuring a production amount of the solid fuel obtained by the compression molding, and on the basis of a measured value thus obtained, adjusting a blending proportion of the pulverized fuel in the blending (production amount adjusting step).

55

Blending Step

[0042] In the blending step, by using the conveyor scales 4, 5 and 6, the coal-derived powder fuel, the cohesive fine

coal and the pulverized fuel are fed from the silos 1, 2 and 3, respectively, to the mixer 7, which then blends the coal-derived powder fuel, the cohesive fine coal and the pulverized fuel to give a mixture.

[0043] The lower limit of the blending proportion of the cohesive fine coal with respect to the mixture (with respect to the total amount of the coal-derived powder fuel, the cohesive fine coal and the pulverized fuel) is preferably 5% by mass and more preferably 8% by mass. Meanwhile, the upper limit of the blending proportion of the cohesive fine coal with respect to the mixture is preferably 30% by mass and more preferably 25% by mass. When the blending proportion of the cohesive fine coal with respect to the mixture is less than the lower limit, the strength of the solid fuel obtained may not be sufficiently increased. To the contrary, when the blending proportion of the cohesive fine coal with respect to the mixture is greater than the upper limit, the solid fuel may be unduly expensive.

[0044] The lower limit of the blending proportion of the pulverized fuel with respect to the mixture (with respect to the total amount of the coal-derived powder fuel, the cohesive fine coal and the pulverized fuel) is preferably 5% by mass and more preferably 8% by mass. Meanwhile, the upper limit of the blending proportion of the pulverized fuel with respect to the mixture is preferably 50% by mass and more preferably 40% by mass. When the blending proportion of the pulverized fuel with respect to the mixture is less than the lower limit, the production amount of the solid fuel may not be sufficiently increased. To the contrary, when the blending proportion of the pulverized fuel with respect to the mixture is greater than the upper limit, the production efficiency of the solid fuel as a final product except for the part used as the pulverized fuel may be unduly low, and a part of the solid fuel obtained may have insufficient strength (i.e., variation of strength may be great), due to formation of gaps between particles of the pulverized fuel.

[0045] For example in the case in which the mixer 7 is a paddle mixer, a blending time period (residence time) of the materials in the mixer 7 of typically less than or equal to 30 min is desired. However, the present invention is not limited thereto and homogeneous blending of the materials is required. A degree of blending of the materials can be evaluated by, for example, collecting small amounts of samples after the blending, and observing variation of moisture therein. A great variation of moisture indicates that the blending was insufficient, and that the blending time period in the mixer 7 needs to be longer.

Compression Molding Step

[0046] In the compression molding step, the intended granular solid fuel is obtained through compression molding by the molding machine 9 of the mixture of the coal-derived powder fuel, the cohesive fine coal and the pulverized fuel.

Pulverizing Step

[0047] In the pulverizing step, a part of the solid fuel obtained by the compression molding step is pulverized by the pulverizing machine 10 to obtain the pulverized fuel described above.

[0048] By blending the pulverized fuel obtained by the pulverizing step with the coal-derived powder fuel, apparent specific gravity of the mixture to be subjected to the compression molding may be greater than that of the coal-derived powder fuel. As a result, in the compression molding step, the cavities of the molding machine are enabled to be sufficiently filled with the powder and the particulates of the materials, thereby enabling the strength of the solid fuel obtained to be increased through an increase in pressure for molding.

Strength Adjusting Step

[0049] In the strength adjusting step, the strength of the solid fuel obtained by the compression molding step is first measured. For the measurement of the strength of the solid fuel, for example, a compression breaking test, a tensile test, an impact test, a drop test, or the like may be carried out.

[0050] In the strength adjusting step, provided that the measured strength of the solid fuel is less than a predetermined lower limit, the blending proportion of the cohesive fine coal is increased, while provided that the strength of the solid fuel is greater than a predetermined upper limit, the blending proportion of the cohesive fine coal is decreased. By thus adjusting the strength of the solid fuel depending on the blending proportion of the cohesive fine coal, the solid fuel obtained is enabled to have stable quality.

Production Amount Adjusting Step

[0051] In the production amount adjusting step, the production amount of the solid fuel obtained by the compression molding step is measured. Provided that the measured production amount of the solid fuel is less than a desired lower limit, the blending proportion of the pulverized fuel is increased, while provided that the production amount of the solid fuel is greater than a predetermined upper limit, the blending proportion of the pulverized fuel is decreased.

[0052] As described above, the production amount may be adjusted to a desired value depending on the blending

proportion of the pulverized fuel. By optimizing the operating speed of the molding machine 9, further stabilization of the quality is enabled through inhibiting variation of the strength of the solid fuel obtained.

Advantages

[0053] The production method of a solid fuel according to the present embodiment enables the bulk density of the material mixture to be relatively great, due to blending with the coal-derived powder fuel the pulverized fuel formed through pulverization of a part of the solid fuel obtained by the compression molding step. As a result, the production method of a solid fuel enables the molding pressure to be great in the compression molding step, whereby the strength of the solid fuel obtained can be increased.

[0054] In addition, the production method of a solid fuel enables the cohesive property of the material mixture to be improved due to blending the cohesive fine coal with the coal-derived powder fuel, whereby the strength of the solid fuel obtained can be further increased. Accordingly, the production method of a solid fuel enables a solid fuel having a relatively great strength to be produced from a powder fuel.

Other Embodiments

[0055] The above-described embodiment does not limit the configuration of the present invention. Therefore, configuration members of each part of the above-described embodiment may be omitted, replaced, or added based on the descriptions of the present specification and the common technical knowledge, and such omission, replacement, and addition should be construed as falling within the scope of the present invention.

[0056] In the production method of a solid fuel, in the case in which the coal-derived powder fuel has a sufficient cohesive property, the blending of the cohesive fine coal may be omitted.

[0057] In addition, in the production method of a solid fuel, in the case in which conditions such as characteristics of the materials are stable, the adjusting step may be omitted. Furthermore, in the adjusting step, the blending proportion of the cohesive fine coal may be adjusted in accordance with not the strength of the solid fuel but an amount of the powder discharged from the compression molding machine together with the solid fuel and then separated by the sieve or separated during transfer between conveyors. Moreover, in the adjusting step, the strength of the solid fuel obtained may be adjusted through adjustment of the operation speed of the molding machine, instead of adjustment of the blending proportion of the cohesive fine coal.

EXAMPLES

[0058] Hereinafter, the present invention will be described in detail by way of Examples; however, the Examples are not construed as limiting the present invention.

Example 1

[0059] First, a granular solid fuel was obtained by subjecting a mixture of a coal-derived powder fuel and a cohesive fine coal at a blending mass ratio of 85:10 to compression molding in a double-roll molding machine, the coal-derived powder fuel being powder of a modified coal obtained by thermally dehydrating a brown coal in oil, whereas the cohesive fine coal being a brown coal pulverized and then filtered through a sieve having a mesh opening size of 3 mm. The rotation frequency of the double-roll molding machine was adjusted such that a crushing strength of the solid fuel obtained was 0.7 MPa, which is a value required for a typical coal-based fuel briquette. It is to be noted that the bulk density of the coal-derived powder fuel was measured to be 0.52 g/cc. As the double-roll molding machine, "K205" available from Furukawa Industrial Machinery Systems Co., Ltd. was used, equipped with rolls provided with cavities each having a longitudinal diameter of 38 mm, a shortest diameter of 38 mm, and a volume of 22 cc.

[0060] The solid fuel thus obtained was pulverized and then filtered through a sieve having a mesh opening size of 10 mm to give a pulverized fuel, and a material mixture was obtained by blending the coal-derived powder fuel, the cohesive fine coal, and the pulverized fuel at a mass ratio of 85:10:5. The material mixture was subjected to compression molding in the double-roll molding machine, with the rotation frequency of the double-roll molding machine being adjusted such that a crushing strength of the solid fuel obtained was 0.7 MPa.

[0061] The solid fuel obtained by compression molding of the material mixture containing the pulverized fuel was further pulverized and then filtered through a sieve having a mesh opening size of 10 mm to give a new pulverized fuel. Then, a material mixture obtained by blending the coal-derived powder fuel, the cohesive fine coal and the new pulverized fuel at a mass ratio of 85:10:5 was subjected to compression molding in the double-roll molding machine. The aforementioned cycle was repeated.

[0062] When the operation reached a stable state through repeating the cycle, the bulk density of the material mixture

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was measured to be 0.56 g/cc. The bulk density was measured as an aerated bulk density by using Powder Tester, Model PT-S available from HOSOKAWA MICRON CORPORATION. When the operation reached the stable state, the rotation frequency of the double-roll molding machine was 0.83 times the standard rotation frequency for production of a coal-derived fuel briquette through compression molding of fine bituminous coal.

5 **[0063]** As an index for an effective production amount of the solid fuel except for a part to be pulverized to give the pulverized fuel, an effective production amount ratio was calculated to be 0.79 by multiplying the aforementioned ratio of the rotation frequency by a total mass proportion of the coal-derived powder fuel and the cohesive fine coal in the material mixture.

10 Example 2

[0064] First, a mixture of the coal-derived powder fuel and the cohesive fine coal similar to those of Example 1 at a mass ratio of 70:10 was subjected to compression molding in the double-roll molding machine, with the rotation frequency of the double-roll molding machine being adjusted such that a crushing strength of the solid fuel obtained was 0.7 MPa.

15 **[0065]** The solid fuel thus obtained was pulverized and then filtered through a sieve having a mesh opening size of 10 mm to give a pulverized fuel, and a material mixture was obtained by blending the coal-derived powder fuel, the cohesive fine coal, and the pulverized fuel at a mass ratio of 70:10:20. The material mixture was subjected to compression molding in the double-roll molding machine, with the rotation frequency of the double-roll molding machine being adjusted such that a crushing strength of the solid fuel obtained was 0.7 MPa.

20 **[0066]** The solid fuel obtained by compression molding of the material mixture containing the pulverized fuel was further pulverized and then filtered through a sieve having a mesh opening size of 10 mm to give a new pulverized fuel. A material mixture obtained by blending the coal-derived powder fuel, the cohesive fine coal and the new pulverized fuel at a mass ratio of 70:10:20 was subjected to compression molding in the double-roll molding machine. When the operation reached a stable state through repeating the aforementioned cycle, the bulk density of the material mixture
25 was measured to be 0.58 g/cc, the rotation frequency of the double-roll molding machine was 0.97 times the standard rotation frequency, and the effective production amount ratio was 0.77.

Example 3

30 **[0067]** First, a mixture of the coal-derived powder fuel and the cohesive fine coal similar to those of Example 1 at a mass ratio of 60:20 was subjected to compression molding in the double-roll molding machine, with the rotation frequency of the double-roll molding machine being adjusted such that a crushing strength of the solid fuel obtained was 0.7 MPa.

35 **[0068]** The solid fuel thus obtained was pulverized and then filtered through a sieve having a mesh opening size of 10 mm to give a pulverized fuel, and a material mixture was obtained by blending the coal-derived powder fuel, the cohesive fine coal, and the pulverized fuel at a mass ratio of 60:20:20. The material mixture was subjected to compression molding in the double-roll molding machine, with the rotation frequency of the double-roll molding machine being adjusted such that a crushing strength of the solid fuel obtained was 0.7 MPa.

40 **[0069]** The solid fuel obtained by compression molding of the material mixture containing the pulverized fuel was further pulverized and then filtered through a sieve having a mesh opening size of 10 mm to give a new pulverized fuel. A material mixture obtained by blending the coal-derived powder fuel, the cohesive fine coal and the new pulverized fuel at a mass ratio of 60:20:20 was subjected to compression molding in the double-roll molding machine. When the operation reached a stable state through repeating the aforementioned cycle, the bulk density of the material mixture was measured to be 0.59 g/cc, the rotation frequency of the double-roll molding machine was 1.07 times the standard rotation frequency, and the effective production amount ratio was 0.86.

45 Example 4

[0070] First, a mixture of the coal-derived powder fuel and the cohesive fine coal similar to those of Example 1 at a mass ratio of 40:20 was subjected to compression molding in the double-roll molding machine, with the rotation frequency of the double-roll molding machine being adjusted such that a crushing strength of the solid fuel obtained was 0.7 MPa.

50 **[0071]** The solid fuel thus obtained was pulverized and then filtered through a sieve having a mesh opening size of 10 mm to give a pulverized fuel, and a material mixture was obtained by blending the coal-derived powder fuel, the cohesive fine coal, and the pulverized fuel at a mass ratio of 40:20:40. The material mixture was subjected to compression molding in the double-roll molding machine, with the rotation frequency of the double-roll molding machine being adjusted such that a crushing strength of the solid fuel obtained was 0.7 MPa.

55 **[0072]** The solid fuel obtained by compression molding of the material mixture containing the pulverized fuel was further pulverized and then filtered through a sieve having a mesh opening size of 10 mm to give a new pulverized fuel. A material mixture obtained by blending the coal-derived powder fuel, the cohesive fine coal and the new pulverized

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fuel at a mass ratio of 40:20:40 was subjected to compression molding in the double-roll molding machine. When the operation reached a stable state through repeating the aforementioned cycle, the bulk density of the material mixture was measured to be 0.64 g/cc, the rotation frequency of the double-roll molding machine was 1.25 times the standard rotation frequency, and the effective production amount ratio was 0.75.

Comparative Example 1

[0073] First, only the coal-derived powder fuel similar to that of Example 1 was subjected to compression molding in the double-roll molding machine, with the rotation frequency of the double-roll molding machine being adjusted such that a crushing strength of the solid fuel obtained was 0.7 MPa. The rotation frequency of the double-roll molding machine thus adjusted was 0.34 times the standard rotation frequency.

Comparative Example 2

[0074] First, a mixture of the coal-derived powder fuel and the cohesive fine coal similar to those of Example 1 at a mass ratio of 85:15 was subjected to compression molding in the double-roll molding machine, with the rotation frequency of the double-roll molding machine being adjusted such that a crushing strength of the solid fuel obtained was 0.7 MPa. The rotation frequency of the double-roll molding machine thus adjusted was 0.41 times the standard rotation frequency.

[0075] Results obtained from Examples 1 to 4 and Comparative Examples 1 and 2 are shown in Table 1 below.

Table 1

	Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2
Coal-derived powder fuel (mass%)	85	70	60	40	100	85
Cohesive fine coal (mass%)	10	10	20	20	0	15
Pulverized fuel (mass%)	5	20	20	40	0	0
Bulk density of mixture (g/cc)	0.56	0.58	0.59	0.64	0.52	0.54
Molding speed ratio	0.83	0.97	1.07	1.25	0.34	0.41
Effective production amount ratio	0.79	0.77	0.86	0.75	0.34	0.41

[0076] As is clear from Table 1, due to blending with other materials the pulverized fuel formed by pulverizing the solid fuel, the rotation frequency of the double-roll molding machine was enabled to be relatively increased. In other words, it was proven that, provided that the rotation frequency of the double-roll molding machine is constant, blending the pulverized fuel with other materials enables production of a solid fuel having a relatively high strength.

[INDUSTRIAL APPLICABILITY]

[0077] The production method of a solid fuel according to the present invention can be suitably used for producing a granular solid fuel by using a coal-derived powder fuel that is inferior in compression moldability.

[Explanation of the Reference Symbols]

[0078]

- 1, 2, 3, 8 Silo
- 4, 5, 6 Conveyor scale
- 7 Mixer
- 9 Molding machine
- 10 Pulverizing machine

Claims

1. A production method of a solid fuel comprising:

5 blending a coal-derived powder fuel with a pulverized fuel having a greater mean particle diameter than the coal-derived powder fuel;
 compression-molding a mixture obtained by the blending; and
 pulverizing a part of a solid fuel obtained by the compression-molding,
10 wherein the part of the solid fuel pulverized in the pulverizing is used as the pulverized fuel in the blending.

2. The production method according to claim 1, wherein a blending proportion of the pulverized fuel with respect to the mixture obtained by the blending is greater than or equal to 5% by mass and less than or equal to 50% by mass.

3. The production method according to claim 1, wherein a cohesive fine coal having a superior cohesive property to the coal-derived powder fuel is further blended in the blending.

4. The production method according to claim 3, wherein a blending proportion of the cohesive fine coal with respect to the mixture obtained by the blending is greater than or equal to 5% by mass and less than or equal to 30% by mass.

20 5. The production method according to claim 3, further comprising:

 measuring a strength of the solid fuel obtained by the compression-molding; and
 on basis of a measured value thus obtained, adjusting a blending proportion of the cohesive fine coal in the blending,
25 wherein in the adjusting, provided that the strength of the solid fuel is less than a predetermined lower limit, the blending proportion of the cohesive fine coal is increased, while provided that the strength of the solid fuel is greater than a predetermined upper limit, the blending proportion of the cohesive fine coal is decreased.

30 6. The production method according to claim 1, further comprising:

 measuring a production amount of the solid fuel obtained by the compression-molding; and
 on basis of a measured value thus obtained, adjusting a blending proportion of the pulverized fuel in the blending.

35 7. The production method according to claim 1, wherein in the blending, the coal-derived powder fuel and the pulverized fuel are fed to a mixer using a conveyor scale.

8. The production method according to any one of claims 1 to 7, wherein a modified coal obtained by thermally dehydrating a low-rank coal in oil is used as the coal-derived powder fuel, and a powdered low-rank coal is used as the cohesive fine coal.

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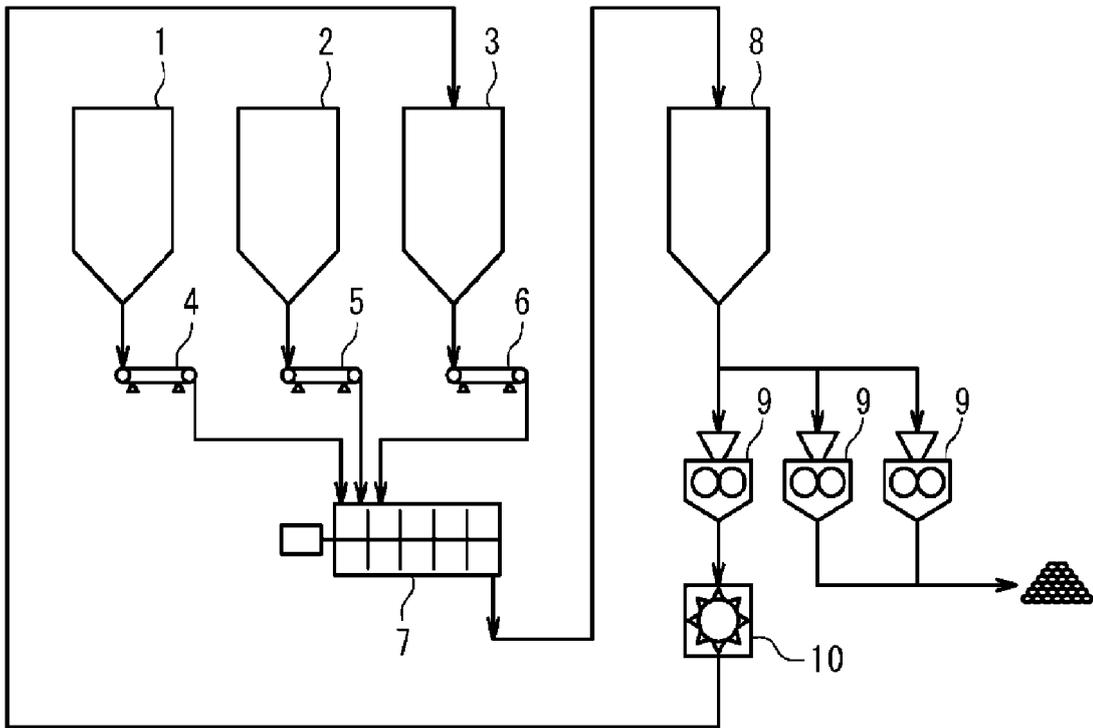


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
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5	A. CLASSIFICATION OF SUBJECT MATTER C10L5/08(2006.01)i, C10L5/04(2006.01)i	
	According to International Patent Classification (IPC) or to both national classification and IPC	
10	B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) C10L5/08, C10L5/04	
15	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 1996-2017 Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017	
	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)	
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
	Category*	Citation of document, with indication, where appropriate, of the relevant passages
25	A	WO 2015/098935 A1 (Ube Industries, Ltd.), 02 July 2015 (02.07.2015), & CN 105849239 A
	A	JP 2015-218271 A (Kobe Steel, Ltd.), 07 December 2015 (07.12.2015), (Family: none)
30	A	WO 2014/174985 A1 (Kobe Steel, Ltd.), 30 October 2014 (30.10.2014), & JP 2014-214201 A & US 2015/0376529 A1 & EP 2990467 A1 & CN 105121608 A & AU 2014258729 A & RU 2015150204 A
35	A	WO 2012/137956 A1 (Kobe Steel, Ltd.), 11 October 2012 (11.10.2012), & JP 2012-219140 A
40	<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.	
45	* 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
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	"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	
50	Date of the actual completion of the international search 03 August 2017 (03.08.17)	Date of mailing of the international search report 15 August 2017 (15.08.17)
55	Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/026675

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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REFERENCES CITED IN THE DESCRIPTION

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