

SPECIFICATION

Title of Invention

METHOD OF PREPARING COAL ASH

5

Technical Field

[0001]

The present invention relates to a method of preparing coal ash, coal ash, and a cement composition.

10

Background Art

[0002]

Cohesive soil has an extremely small particle diameter and is hardened. Therefore, it is difficult to mix and agitate
15 cohesive soil with a solidification material, in soil improvement. In order to solve the problem, for example, a method of using a special agitator, a method of increasing water content to improve uniformity with a solidification material, or a method of using a dispersant acting on soil particles in
20 combination with solidification material milk may be used.

[0003]

On the other hand, the safety of a nuclear power plant is questionable, and the operating ratio of a coal-fired power plant increases. Therefore, the efficient use of coal ash produced
25 in the operation of a coal-fired power plant becomes an issue.

Fly ash that accounts for most of coal ash is used as an admixture of concrete. However, the quality of fly ash is defined in detail by JIS, and a process such as classification is required to maintain a certain level of quality. For example,
5 coarse powder or the like removed by classification is landfilled. In this case, it is difficult to say that coal ash is efficiently used.

[0004]

In addition, it is known that unburned carbon in coal ash
10 has an adverse effect (for example, admixture adsorption) during concrete manufacturing, and various methods are disclosed regarding a method of removing unburned carbon (for example, Patent Literature Nos. 1 to 3).

15 Prior art Literature

Patent Literature

[0005]

[Patent Literature No. 1] Japanese Laid-open Patent
Publication No. H08-026740

20 [Patent Literature No. 2] Japanese Laid-open Patent
Publication No. H11-011999

[Patent Literature No. 3] Japanese Laid-open Patent
Publication No. 2007-054773

25

Summary of Invention

Problems to be solved

[0006]

However, in the methods disclosed in Patent Literature Nos.
5 1 to 3, there are problems such as necessity of a new equipment,
high running costs, or low classification efficiency.

[0007]

In addition, in a case where an additive such as coal ash
is mixed with a solidification material to realize the efficient
10 use of the coal ash, the amount of the solidification material
can be reduced. Therefore, cost reduction such as a reduction
in the amount of sludge can be expected.

However, in a case where the processing target is soil such
as cohesive soil, as described above, it is difficult to mix
15 and agitate the soil with a solidification material. Therefore,
solidification materials which are currently known have
problems such as an increase in cost or low efficiency. From
the viewpoint of efficient use of coal ash, it is preferable
to use the entire amount of coal ash. In addition, in a case
20 where a technique can improve uniformity during mixing in
improvement of cohesive soil through a simple process without
requiring a process such as removal of unburned carbon, the
technique is extremely significant but is not currently known.

[0008]

25 Therefore, an object of the present invention is to provide

coal ash, a method of preparing the same, and a cement composition containing the coal ash, in which the coal ash containing a large amount of unburned carbon can be used without performing a process of classification and in which uniformity during mixing
5 in improvement of cohesive soil can be improved.

Solution to Problems

[0009]

The present inventors performed a thorough investigation
10 in order to achieve the object and found that, even in a case where coal ash having a high ignition loss, which may have an adverse effect for concrete manufacturing, the coal ash obtained by crushing the coal ash in a predetermined range can achieve to improve uniformity during mixing in improvement of cohesive
15 soil. That is, the present invention is as follows.

[0010]

[1] A method of preparing coal ash comprising:

crushing coal ash having an ignition loss of 3.5 mass% or higher such that a ratio (L_g/L_p) of a lightness (L_g value) of
20 the coal ash after crushing to a lightness (L_p value) of the coal ash before crushing is 0.9 or lower.

[2] The method of preparing coal ash according to [1],
in which the coal ash is crushed such that the ratio (L_g/L_p) of the lightness (L_g value) after crushing to the lightness (L_p
25 value) before crushing is 0.6 or higher.

[3] The method of preparing coal ash according to [1] or [2],

in which the coal ash is crushed such that a ratio (V_g/V_p) of a content (V_g) of particles having a particle diameter of 45 μm or more in the coal ash after crushing measured by a laser diffraction particle size analysis method to a content (V_p) of the particles having a particle diameter of 45 μm or more in the coal ash before crushing measured by the analysis method is 0.85 or lower.

10 [0011]

[4] Coal ash,

in which after crushing, an ignition loss is 3.5 mass% or higher, a content of particles having a particle diameter of 45 μm or more measured by a laser diffraction particle size analysis method is 20 vol% or higher and 45 vol% or lower, a Blaine specific surface area is 3200 cm^2/g or higher and 4200 cm^2/g or lower, and a lightness (L_g value) is 25.0 or higher and 50.0 or lower, and

20 a ratio (L_g/L_p) of the lightness (L_g value) of the coal ash after crushing to a lightness (L_p value) of the coal ash before crushing is 0.9 or lower.

[5] The coal ash according to [4],

in which the ignition loss is 8.0 mass% or lower.

[0012]

25 [6] A cement composition including:

the coal ash according to [4] or [5]; and
cement.

[7] The cement composition according to [6],
in which the cement is at least one selected from the group
5 consisting of normal Portland cement, high early strength
Portland cement, moderate heat Portland cement, and low-heat
Portland cement.

[8] The cement composition according to [6] or [7],
in which a content of the coal ash is higher than 5 mass%
10 and 40 mass% or lower with respect to a total amount of the cement
composition.

Effects of Invention

[0013]

15 According to the present invention, coal ash, a method of
preparing the same, and a cement composition containing the coal
ash can be provided, in which the coal ash containing a large
amount of unburned carbon can be used without performing a
process of classification and in which uniformity during mixing
20 in improvement of cohesive soil can be improved. As a result,
the entire amount of coal ash produced from a coal-fired power
plant can be used as a raw material, and the work efficiency
in soil improvement can be improved.

25 Mode for carrying out the Invention

[0014]

[Method of Preparing Coal Ash and Coal Ash]

(1) Method of Preparing Coal Ash

A method of preparing coal ash according to an embodiment
5 of the present invention comprises: crushing coal ash having
an ignition loss of 3.5 mass% or higher such that a ratio (L_g/L_p)
of a lightness (L_g value) of the coal ash after crushing to a
lightness (L_p value) of the coal ash before crushing is 0.9 or
lower.

10 [0015]

According to the present invention, in a case where
predetermined crushing is performed on coal ash having an
ignition loss of 3.5 mass% or higher to use the crushed coal
ash in improvement of cohesive soil, coal ash (improved coal
15 ash) capable of improving mixing properties with cohesive soil
can be manufactured.

Here, the ignition loss is proportional to the amount of
unburned carbon in the coal ash, and "ignition loss being 3.5
mass% or higher" represents that the amount of so-called unburned
20 carbon is high. By performing the predetermined crushing on
coal ash having a high ignition loss, at least a part of unburned
carbon contained in particles of the coal ash is exposed to the
particle surface sides. As a result, mixing properties between
cement particles and clay particles can be improved by the coal
25 ash. The unburned carbon exposed to the particle surfaces of

the coal ash by crushing exhibits the same property as unburned carbon in powder particles present before crushing, and the property is hydrophobicity. That is, the amount of unburned carbon exposed to the particle surfaces of the coal ash by the predetermined crushing is higher than that before crushing. Therefore, hydrophobicity is further improved. For example, in a case where a mixture of cement and the coal ash is used as a solidification material, excessive water absorption is not exhibited during cement mixing due to the hydrophobic unburned carbon exposed to the particle surfaces. As a result, dispersibility between clay particles and cement particles in improvement of cohesive soil having high water content can be efficiently improved.

[0016]

The ignition loss of the coal ash relates to the content of unburned carbon, and it can be presumed that, in a case where the ignition loss of the coal ash is high, the content of unburned carbon in the coal ash is also high. Accordingly, in a case where the ignition loss of the coal ash is lower than 3.5 mass%, the absolute content of unburned carbon exhibiting hydrophobicity is low. Therefore, dispersibility of clay particles cannot be improved. The ignition loss of the coal ash is preferably 3.5 mass% or higher and 9.0 mass% or lower and more preferably 6.0 mass% or higher and 9.0 mass% or lower. The ignition loss can be measured by a method described below in Examples.

[0017]

The coal ash having an ignition loss of 3.5 mass% or higher is, for example, ash produced from a coal-fired power plant, and is produced by burning pulverized coal. Examples of the coal
5 ash are: coal ash that is collected from combustion gas of a combustion boiler by falling when the combustion gas passes through an air preheater, an economizer, or the like; fly ash that is collected by an electrical dust collector; and coal ash that falls to a furnace bottom of a combustion boiler.

10 [0018]

The coal ash having an ignition loss of 3.5 mass% or higher is crushed by, for example, a crusher such that a ratio (L_g/L_p) of a lightness (L_g value) of the coal ash after crushing to a lightness (L_p value) of the coal ash before crushing is 0.9 or
15 lower. As a result, unburned carbon contained in coal ash particles is exposed.

As the crusher, a ball mill or a vibration mill (that refines powder by applying vibration to a container and transmitting the vibration to media (balls and rods) in the
20 container) can be used.

[0019]

For crushing, first, the lightness (L_p value) of the coal ash before crushing is measured, and the ratio (L_g/L_p) of the lightness (L_g value) of the coal ash after crushing to the
25 lightness (L_p value) of the coal ash before crushing is adjusted

to be 0.9 or lower. Regarding the coal ash to be crushed, the entire amount of the coal ash may be crushed, or a part of the coal ash may be crushed. In addition, a mixture of the crushed coal ash and the non-crushed coal ash may be used as the coal ash after crushing. Even in a case where a part of the coal ash is crushed and a mixture of the crushed coal ash and the non-crushed coal ash is used as the coal ash after crushing, the coal ash has to be crushed such that a ratio (L_g/L_p) of a lightness (L_g value) of the mixed coal ash containing the crushed coal ash after crushing to a lightness (L_p value) of the coal ash before crushing is 0.9 or lower.

Here, the lightness of coal ash relates to blackness and is an index mainly indicating the abundance of unburned carbon exposed to the surface. In a case where L_g/L_p , which is the ratio before and after crushing, is higher than 0.9, unburned carbon contained in the coal ash is not sufficiently present on the surface. As a result, in a case where a mixture of the coal ash and cement is used as a solidification material, dispersibility between clay particles and cement particles cannot be efficiently improved.

L_g/L_p is preferably 0.6 or higher and 0.9 or lower, and more preferably 0.6 or higher and 0.85 or lower. In a case where L_g/L_p is 0.6 or higher, crushing of spherical particles can be suppressed as much as possible, and deterioration in fluidity can be suppressed.

The lightness of the coal ash can be measured by a method described below in Examples.

[0020]

In addition, particles having a particle diameter of 45
5 μm or more contain a large amount of non-spherical particles,
and from the viewpoints of improving fluidity by crushing and
pulverizing the particles to expose spherical particles
contained therein, it is preferable that the coal ash is crushed
such that a ratio (V_g/V_p) of the content (V_g ; vol%) of particles
10 having a particle diameter of 45 μm or more in the coal ash after
crushing measured by a laser diffraction particle size analysis
method to the content (V_p ; vol%) of the particles having a
particle diameter of 45 μm or more measured in the coal ash before
crushing by the analysis method is 0.85 or lower. It is more
15 preferable that the coal ash is crushed such that the ratio
(V_g/V_p) is 0.6 or higher and 0.80 or lower. Particles having
a particle diameter of 45 μm or more in the coal ash may be crushed,
and the crushed coal ash may be mixed with the non-crushed coal
ash to be used as the coal ash after crushing.

20 [0021]

As described above, the coal ash capable of improving
dispersibility of clay particles can be easily obtained by
performing the predetermined crushing. That is, the entire
amount of coal ash produced from a coal-fired power plant can

be used as a raw material, there are no problems such as necessity of a new equipment or high running costs, and the work efficiency in soil improvement can be improved.

[0022]

5 (2) Coal Ash:

In coal ash according to an embodiment of the present invention, after crushing, an ignition loss is 3.5 mass% or higher, the content of particles having a particle diameter of 45 μm or more measured by a laser diffraction particle size
10 analysis method is 20 vol% or higher and 45 vol% or lower, a Blaine specific surface area is 3200 cm^2/g or higher and 4200 cm^2/g or lower, and a lightness (Lg value) is 25.0 or higher and 50.0 or lower, and a ratio (Lg/Lp) of the lightness (Lg value) of the coal ash after crushing to a lightness (Lp value) of the
15 coal ash before crushing is 0.9 or lower.

[0023]

In a case where the ignition loss of the coal ash is lower than 3.5 mass%, the absolute content of unburned carbon exhibiting hydrophobicity is low. Therefore, dispersibility of
20 clay particles can be improved. The ignition loss of the coal ash is preferably 3.5 mass% or higher and 9.0 mass% or lower and more preferably 6.0 mass% or higher and 9.0 mass% or lower.

[0024]

In a case where the content of particles having a particle
25 diameter of 45 μm or more measured by a laser diffraction particle

size analysis method in the coal ash is lower than 20 vol%, the amount of non-spherical particles is low, and the effect of exposing unburned carbon particles by crushing to improve dispersibility deteriorates. In a case where the content of particles having a particle diameter of 45 μm or more is higher than 45 vol%, the amount of non-spherical particles is high, and fluidity deteriorates or hydration activity of the coal ash itself deteriorates.

The content of particles having a particle diameter of 45 μm or more is preferably 20 vol% or higher and 45 vol% or lower and more preferably 23 vol% or higher and 43 vol% or lower.

[0025]

In a case where the Blaine specific surface area of the coal ash is lower than 3200 cm^2/g , hydration activity deteriorates, and a predetermined strength may not be obtained. In a case where the Blaine specific surface area of the coal ash is higher than 4200 cm^2/g , fluidity deteriorates.

The Blaine specific surface area is preferably 3200 cm^2/g or higher and 4200 cm^2/g or lower and more preferably 3300 cm^2/g or higher and 4000 cm^2/g or lower.

[0026]

In addition, in a case where the lightness (Lg value) of the crushed coal ash is lower than 25.0, the amount of unburned carbon increases, the coal ash becomes more black, and there is a color difference between the coal ash and the surrounding

soil in soil improvement. In a case where the lightness (Lg value) of the crushed coal ash is higher than 50.0, the amount of unburned carbon exposed is low. Therefore, in a case where the crushed coal ash is mixed with cohesive soil, superior
5 fluidity cannot be obtained, and uniform mixing may not be performed.

The lightness of the coal ash is preferably 30.0 or higher and 50.0 or lower and more preferably 35.0 or higher and 45.0 or lower.

10 [0027]

In a case where the ratio (Lg/Lp) of the lightness (Lg value) of the coal ash after crushing to a lightness (Lp value) of the coal ash before crushing is higher than 0.9, unburned carbon contained in the coal ash is not sufficiently present
15 on the surface. As a result, in a case where a mixture of the coal ash and cement is used as a solidification material, dispersibility between clay particles and cement particles cannot be efficiently improved.

The ratio is preferably 0.6 or higher and 0.9 or lower and
20 more preferably 0.6 or higher and 0.85 or lower.

[0028]

The coal ash according to the embodiment of the present invention can be prepared by the method of preparing coal ash according to the embodiment of the present invention. In order
25 to prepare the coal ash of the embodiment of the present invention,

a crusher such as a ball mill or a disk mill is used, and it is preferable to measure a particle diameter distribution, a Blaine specific surface area, and a color difference after crushing to check whether or not predetermined physical property values are obtained.

[0029]

It is preferable that the coal ash of the embodiment of the present invention is used for a cement composition described below and can also be used for other various applications by utilizing the properties thereof.

[0030]

[Cement Composition]

A cement composition of an embodiment of the present invention comprises: the coal ash of the embodiment of the present invention; and cement.

The kind of the cement is not particularly limited, and is preferably at least one selected from the group consisting of normal Portland cement, high early strength Portland cement, moderate heat Portland cement, and low-heat Portland cement.

[0031]

It is preferable that the content of the coal ash is preferably higher than 5 mass% and 40 mass% or lower with respect to the total amount of the cement composition. By setting the content of the coal ash to be higher than 5 mass% and 40 mass% or lower, the cement composition can be used as a solidification

material. Preferably, the content is 25 mass% or higher and 35 mass% or lower.

[0032]

In order to obtain the cement composition, in addition to
5 the coal ash and the cement, for example, gypsum, blast furnace slag, limestone powder, or burned lime can be mixed. In order to mix the components, for example, a V-type mixer, a vibrating mixer, a pan mixer, or a planetary centrifugal mixer can be used.

[0033]

10 The cement composition of the embodiment of the present invention is used preferably as a cement-based solidification material and more preferably as a cement-based solidification material for improvement of cohesive soil.

In a case where the cement composition is used as a
15 cement-based solidification material for improvement of cohesive soil, the amount of water (mixing water) used for mixing is preferably 80 parts by mass or more and 120 parts by mass or less and more preferably 85 parts by mass or more and 110 parts by mass or less with respect to 100 parts by mass of the
20 cement composition.

Examples

[0034]

Next, the present invention will be described in more detail with Examples but is not limited to the Examples.

25 [0035]

(Preparation of Coal Ash A to F)

Each of coal ash A to F produced from a coal-fired power plant in Japan was crushed by a test ball mill (inner volume: 100 L). The degree of crushing was adjusted by checking powder
5 physical properties by a laser diffraction particle size analyzer, a Blaine specific surface area measuring device, and a color difference meter.

The coal ash properties (ignition loss, amount of carbon, MT-45 μ R, ratio between MT-45 μ R values before and after crushing,
10 Blaine specific surface area, L value, and ratio between L values before and after crushing) of the coal ash A to F before and after crushing are shown in the following Table 1.

[0036]

[Table 1]

		Before Crushing					After Crushing				
		Ignition Loss (mass%)	Amount of Carbon (mass%)	MT-45 μ R (vol%) (Vp)	Blaine specific surface area (cm ² /g)	L Value (Lp Value)	MT-45 μ R (vol%) (Vg)	Blaine specific surface area (cm ² /g)	L Value (Lg Value)	MT-45 μ R Ratio (Vg/Vp)	L Value Ratio (Lg/Lp)
Coal Ash	A	4.10	3.54	37.6	3370	48.0	24.8	3450	44.0	0.66	0.89
	B	5.26	4.51	36.3	3620	41.2	25.8	3710	36.0	0.71	0.87
	C	6.21	5.39	40.6	3410	38.0	26.6	3520	30.0	0.66	0.79
	D	6.21	5.39	40.6	3410	38.0	35.5	3460	36.2	0.87	0.95
	E	8.80	7.70	45.6	3790	35.8	36.5	4050	29.0	0.80	0.81
	F	8.80	7.70	45.6	3790	35.8	41.0	3850	34.0	0.90	0.95

[0037]

The coal ash properties were obtained as follows.

(1) Ignition Loss:

The ignition loss was measured according to JIS A 6201 "Fly
5 Ash for use in Concrete" (ignition loss at 975°C for 15 minutes).

(2) Amount of Carbon:

The amount of carbon was measured by a carbon/sulfur
analyzer for solid materials(EMIA-320V, manufactured by Horiba
Ltd.).

10 (3) MT-45 μ R (content of particles having a particle
diameter of 45 μ m or more):

MT-45 μ R was measured by a laser diffraction particle size
analyzer (MICROTRAC MT-3300EX, manufactured by Nikkiso Co.,
Ltd.). The content (Vp; vol%) of particles having a particle
15 diameter of 45 μ m or more in the coal ash before crushing was
measured by a laser diffraction particle size analysis method,
and the content (Vg; vol%) of particles having a particle
diameter of 45 μ m or more measured in the coal ash after crushing
was measured by the analysis method. Based on the measured
20 values, a ratio (Vg/Vp; MT-45 μ R ratio) of the content (Vg; vol%)
of particles having a particle diameter of 45 μ m or more measured
by a laser diffraction particle size analysis method in the coal
ash after crushing to a content (Vp; vol%) of the particles having
a particle diameter of 45 μ m or more measured by the analysis

method in the coal ash before crushing was obtained.

[0038]

(4) Blaine Specific Surface Area

The Blaine specific surface area was measured according
5 to JIS R5201 "Physical Testing Methods for Cement".

(5) Color Difference (L value):

The lightness (L value) defined by the International
Commission on Illumination (CIE) was measured by a color
difference meter (CR-300) manufactured by Konica Minolta Japan,
10 Inc. The lightness (Lp value) of the coal ash before crushing
and the lightness (Lg value) of the coal ash after crushing were
measured. Based on the measured values, the ratio (Lg/Lp; L
value ratio) of the lightness (Lg value) of the coal ash after
crushing to a lightness (Lp value) of the coal ash before crushing
15 was obtained.

[0039]

(Mixing Test for Examples and Comparative Examples)

30 g of each of the coal ash A to F after crushing, 70 g
of cement (normal Portland cement, manufactured by Sumitomo
20 Osaka Cement Co., Ltd.), and 100 g of mixing water were
sufficiently uniformly mixed by a hand mixer to prepare cement
milk. The cement milk and 1 L (wet density: 1.846 g/cm³) of
kaolin (manufactured by Kishida Chemical Co., Ltd.) as cohesive
soil were added together into a planetary centrifugal mixer and
25 were mixed with each other to prepare a specimen according to

JGS 0821-2009 "Practice for Making and Curing Stabilized Soil Specimens without Compaction".

The details of mixing (water content: 35 mass%) are shown in Table 2 below.

5 [0040]

The coal ash E and the coal ash F were formed of the same sample and were different in the degree of crushing. The same shall be applied to the coal ash G and the coal ash H.

[0041]

10 After mixing, mixing properties between the solidification material and the cohesive soil were evaluated by a vane shear test. In the vane shear test, a vane blade welded to a stainless steel plate (0.5 cm×3 cm) in a vertical direction was attached to a tip of a torque driver (manufactured by Tohnichi
15 Mfg. Co., Ltd.) and was inserted into the sample to measure a maximum torque (refer to Table 2 below). Based on the measured maximum torque, a vane shear resistance value was obtained. The results are shown in Table 2 below. In addition, evaluation indices (refer to the following description) based on the
20 resistance values are also shown.

G (good): vane shear resistance value < 10.0 kN/m²

Av (average): 10.0 kN/m² ≤ vane shear resistance value ≤ 12.0 kN/m²

P (poor)X: vane shear resistance value > 12.0 kN/m²

[0042]

[Table 2]

	Coal Ash	Crushing	L Value Ratio (Lg/Lp)	Mixing Test (g)				Vane Shear Resistance Value		
				Kaolin	Cement	Coal Ash	Mixing Water	Maximum Torque (CN·m)	Value (kN/m ²)	Evaluation
Example 1	C	Crushed	0.79	1846	70	30	100	9.3	7.5	G
Example 2	B	Crushed	0.87	1846	70	30	100	10.9	8.8	G
Example 3	A	Crushed	0.89	1846	70	30	100	11.4	9.2	G
Example 4	C	Crushed	0.79	1846	70	30	90	10.5	8.5	G
Example 5	E	Crushed	0.81	1846	70	30	100	8.0	6.5	G
Comparative Example 1	C	Not Crushed	1.00	1846	70	30	100	16.1	13.0	P
Comparative Example 2	B	Not Crushed	1.00	1846	70	30	100	16.7	13.5	P
Comparative Example 3	A	Not Crushed	1.00	1846	70	30	100	19.3	15.6	P
Comparative Example 4	D	Crushed	0.95	1846	70	30	100	15.8	12.8	P
Comparative Example 5	E	Not Crushed	1.00	1846	70	30	100	14.7	11.9	Av
Comparative Example 6	F	Crushed	0.95	1846	70	30	100	12.6	10.2	Av

[0043]

It was found from a comparison between Examples 1 to 3 and 5 and Comparative Examples 1 to 3 and 5 that, for Examples 1 to 3 and 5 containing the crushed coal ash, the vane shear resistance values were low, and mixing properties were good. As can be seen from Example 4, even in a case where the water content was lower than that of Example 1, good mixing properties were obtained. In Comparative Examples 4 and 6, the degree of crushing was lower than that of Examples 1 and 5, and mixing properties were insufficient.

Industrial Applicability

[0044]

According to the present invention, coal ash that is increasingly produced as the power generation amount increases in a coal-fired power plant can be efficiently used, and uniformity during mixing in improvement of cohesive soil can be improved.

CLAIMS

1. A method of preparing coal ash comprising:

crushing coal ash having an ignition loss of 3.5 mass% or
5 higher such that a ratio (L_g/L_p) of a lightness (L_g value) of
the coal ash after crushing to a lightness (L_p value) of the
coal ash before crushing is 0.9 or lower.

2. The method of preparing coal ash according to claim

10 1,

wherein the coal ash is crushed such that the ratio (L_g/L_p)
of the lightness (L_g value) after crushing to the lightness (L_p
value) before crushing is 0.6 or higher.

15 3. The method of preparing coal ash according to claim

1 or 2,

wherein the coal ash is crushed such that a ratio (V_g/V_p)
of a content (V_g) of particles having a particle diameter of
45 μm or more in the coal ash after crushing measured by a laser
20 diffraction particle size analysis method to a content (V_p) of
the particles having a particle diameter of 45 μm or more in
the coal ash before crushing measured by the analysis method
is 0.85 or lower.