

## Description

Title of Invention:

WASHING TREATMENT METHOD FOR CHLORINE-CONTAINING POWDER,  
AND WASHING TREATMENT SYSTEM FOR CHLORINE-CONTAINING  
POWDER

Technical Field

[0001]

The present invention relates to a washing treatment method for a chlorine-containing powder and a washing treatment system for the chlorine-containing powder, which can be suitably applied for converting incinerated ash or the like into a cement raw material.

Background Art

[0002]

In recycle treatment for converting a waste material into a cement raw material, the waste material containing chlorine has a possibility of causing problems such as a blockade of a cement production facility, due to the chlorine. Accordingly, when a chlorine-containing powder such as incinerated ash or cement kiln dust (CKD) is used as a waste material of an object to be treated, and is converted to the cement raw material, it is conducted to reduce the chlorine content by desalination treatment, and use the resultant powder.

[0003]

With regard to the desalination treatment for incinerated ash or the like, for example, Patent Literature 1 discloses a method in which water is added to the incinerated ash to elute chlorine and then the ash is dehydrated. In addition, Patent Literature 2 discloses a method of desalinating the incinerated ash by washing the incinerated ash a plurality of times, by repeating mixture with water and dehydration. In addition, Patent Literature 3 discloses a method of promoting elution of a chlorine ion from a sparingly-

soluble Friedel's salt which is contained in the ashes and dust, by introducing carbon dioxide into a suspension of the ashes and dust to be washed.

#### Citation List

##### Patent Literature

[0004]

Patent Literature 1: Japanese Patent Laid-Open No. 2002-338312

Patent Literature 2: Japanese Patent Laid-Open No. 2003-211129

Patent Literature 3: Japanese Patent Laid-Open No. 10-128304

#### Summary of Invention

##### Technical Problem

[0005]

When the chlorine-containing powder such as incinerated ash is subjected to continuous washing treatment, a method is usually adopted which includes: accommodating a chlorine-containing powder that has been converted into a slurry formed by at least water being added, in a treatment tank having a predetermined accommodation capacity; washing the slurried chlorine-containing powder with water, while stirring the slurry with a stirring blade and also blowing carbon-dioxide-containing gas into the slurry, which advantageously acts on elution of a chlorine ion and has been converted into air bubbles by a disk type diffuser (air diffusion disk) or the like; and filtering and separating the slurry which has overflowed from the treatment tank. However, according to the findings of the present inventors, there has been a problem that the slurry which has been stirred by such a method requires a relatively long period of time for filtration/separation by a filter press or the like.

[0006]

Then, an object of the present invention is to provide a washing treatment method for a chlorine-containing powder and a washing treatment system for the chlorine-containing powder, which reduce a time period necessary for filtering and separating a

slurry that is obtained by adding at least water to the chlorine-containing powder such as incinerated ash, and enable more efficient treatment.

#### Solution to Problem

[0007]

In order to achieve the above object, the present invention provides firstly a washing treatment method for a chlorine-containing powder, comprising:

a chlorine-containing powder introduction step of accommodating a slurry that is formed by adding at least water to the chlorine-containing powder, in a treatment tank having a predetermined accommodation capacity;

a chlorine elution step of stirring the slurry that has been accommodated in the treatment tank, and eluting chlorine contained in the chlorine-containing powder in a liquid phase; and

a filtration/separation step of filtering some or all of the liquid phase out from the slurry after the chlorine has been eluted, and obtaining a desalinated cake, wherein

in the chlorine elution step, the slurry is stirred by a mixed stirring flow of a carbon-dioxide-containing gas and the slurry, which is formed by the gas that is blown into the slurry accommodated in the treatment tank, and circulates through a lower layer and an upper layer of the accommodated slurry while the gas entrains the slurry.

[0008]

According to the above washing treatment method for the chlorine-containing powder, in the chlorine elution step, the slurry that has been formed by adding at least water to the chlorine-containing powder is stirred by a mixed stirring flow of the carbon-dioxide-containing gas and the slurry, which is formed by the gas that is blown into the slurry accommodated in the treatment tank, and circulates through a lower layer and an upper layer of the slurry accommodated in the treatment tank while the gas entrains the slurry; and accordingly, can well disperse even solid phase particles having a relatively large particle size throughout the slurry so that the solid phase particles do not stay in the bottom side in the treatment tank. Thereby, a state is formed in which the particle size distribution of the solid phase particles that are the solid phase component contained in the

slurry is widely and satisfactorily dispersed; in the filtration/separation step after the chlorine elution step, the solid phase particles having a relatively large particle size act as nuclei, and together with solid phase particles having a relatively small particle size, form a packed structure having voids among particles, which appropriately communicate with each other; and it becomes easy for a liquid phase to pass therethrough. Thus, the washing treatment method can shorten the time period necessary for filtering and separating the slurry which has passed through the chlorine elution step.

[0009]

In order to achieve the above object, the present invention provides secondly the above washing treatment method for the chlorine-containing powder, wherein the treatment tank is configured so that the slurry accommodated in the treatment tank overflows in response to the chlorine-containing powder which is additionally introduced, and is discharged toward the filtration/separation step.

[0010]

According to the above configuration, a special operation by an operator or the like is not required for carrying out the slurry from the treatment tank, which has passed the chlorine elution step, and such continuous washing treatment is possible as to respond to the chlorine-containing powder which is additionally introduced.

[0011]

In order to achieve the above object, the present invention provides thirdly the above washing treatment method for the chlorine-containing powder, wherein in the filtration/separation step, the liquid phase is separated by a filter press.

[0012]

According to the above configuration, the desalinated cake can be obtained more efficiently in the filtration/separation step.

[0013]

In order to achieve the above object, the present invention provides fourthly the above washing treatment method for the chlorine-containing powder, wherein the chlorine-containing powder includes one or more types selected from the group consisting of incinerated fly ash, molten fly ash and cement kiln dust.

[0014]

According to the above configuration, the incinerated fly ash, molten fly ash, cement kiln dust and the like, which are waste materials containing chlorine, can be desalinated and effectively used as a cement raw material, for example.

[0015]

In order to achieve the above object, the present invention provides fifthly the above washing treatment method for the chlorine-containing powder, wherein the washing treatment can be performed in response to the chlorine-containing powder which is continuously introduced.

[0016]

In order to achieve the above object, the present invention provides sixthly a washing treatment system for a chlorine-containing powder, comprising:

a treatment tank having a predetermined accommodation capacity and configured to accommodate a slurry that is formed by adding at least water to the chlorine-containing powder;

a tubular air diffusion device that is additionally provided in the treatment tank and forms a mixed stirring flow of a carbon-dioxide-containing gas and the slurry, which is formed by the gas that is blown into the slurry accommodated in the treatment tank, and circulates through a lower layer and an upper layer of the accommodated slurry while the gas entrains the slurry; and

a filtration/separation device configured to filter some or all of the liquid phase out from the slurry taken out from the treatment tank, and obtain a desalinated cake.

[0017]

According to the above washing treatment system of the chlorine-containing powder, the chlorine elution step of stirring the slurry that is formed by adding at least water to the chlorine-containing powder and eluting chlorine into the liquid phase thereof is configured to be capable of stirring the slurry by using the tubular air diffusion device additionally provided in the treatment tank, and by forming the mixed stirring flow of the carbon-dioxide-containing gas and the slurry, which is formed by the gas that is blown into the slurry accommodated in the treatment tank, and circulates through a lower layer

and an upper layer of the slurry accommodated in the treatment tank while the gas entrains the slurry; and accordingly, when the slurry is stirred, can well disperse the whole of the slurry so that even solid phase particles having a relatively large particle size do not stay in the bottom side in the treatment tank. Thereby, a state is formed in which the particle size distribution of the solid phase particles that are the solid phase component contained in the slurry is widely and satisfactorily dispersed; in the filtration/separation step after the chlorine elution step, the solid phase particles having a relatively large particle size act as nuclei, and together with solid phase particles having a relatively small particle size, form a packed structure having voids among particles, which appropriately communicate with each other; and it becomes easy for a liquid phase to pass therethrough. Thus, the washing treatment method can shorten the time period necessary for filtering and separating the slurry which has passed through the chlorine elution step.

[0018]

In order to achieve the above object, the present invention provides seventhly the above washing treatment system for the chlorine-containing powder, wherein the treatment tank is configured so that the slurry accommodated in the treatment tank overflows in response to the chlorine-containing powder which is additionally introduced, and is discharged toward the filtration/separation device.

[0019]

According to the above configuration, a special operation by an operator or the like is not required for carrying out the slurry from the treatment tank which has passed the chlorine elution step, and such a continuous washing treatment is possible as to correspond to the chlorine-containing powder which is additionally introduced.

[0020]

In order to achieve the above object, the present invention provides eighthly the above washing treatment system for the chlorine-containing powder, wherein the filtration/separation device is a filter press.

[0021]

According to the above configuration, the desalinated cake can be obtained more efficiently in the filtration/separation step by the filtration/separation device.

[0022]

In order to achieve the above object, the present invention provides ninthly the above washing treatment system for the chlorine-containing powder, further comprising a conveying device configured to convey the obtained desalinated cake to a cement production facility.

[0023]

According to the above configuration, a desalinated cake which has been obtained by desalinating a waste material containing chlorine, for example, such as incinerated fly ash, molten fly ash and cement kiln dust, can be conveyed to the cement production facility in the state, and can be effectively used as a cement raw material.

[0024]

In order to achieve the above object, the present invention provides tenthly the above washing treatment system for the chlorine-containing powder, wherein the washing treatment can be performed in response to the chlorine-containing powder which is continuously introduced.

#### Advantageous Effects of Invention

[0025]

According to the present invention, there can be provided a washing treatment method for a chlorine-containing powder and a washing treatment system for the chlorine-containing powder, which reduce a time period necessary for filtering and separating a slurry that is obtained by adding at least water to the chlorine-containing powder such as incinerated ash, and enable more efficient treatment. Therefore, it is possible to efficiently desalinate a waste material such as incinerated ash, and effectively use the desalinated cake as a cement raw material or the like.

#### Brief Description of Drawings

[0026]

FIG. 1 shows a flow chart for explaining a basic configuration of the washing treatment which is performed in the present invention.

FIG. 2 shows an explanatory diagram of a schematic configuration of one example of a washing treatment system for a chlorine-containing powder according to the present invention.

FIG. 3 shows a graph showing particle size distributions of solid phase components of desalinated cakes C1 which were obtained in Example 1 and Comparative Examples 1 and 2 in Test Example 2.

#### Description of Embodiments

[0027]

An object to be treated in the present invention may be a powder which contains chlorine, and is not particularly limited, but includes incinerated fly ash, molten fly ash and cement kiln dust. These objects are waste materials which have conventionally been effectively used as a cement raw material after having been subjected to desalination treatment, and in the incinerated fly ash of typical municipal waste, specifically, fly ash which is generated when domestic waste material is incinerated (, which shall be referred to simply as "incinerated fly ash", in this specification), chlorine (Cl) is contained generally at a concentration of about 10 mass% to 30 mass%; and in addition, in the fly ash which has been generated from the gasification melting furnace (, which shall be referred to simply as "molten fly ash", in this specification), chlorine is contained generally at a concentration of about 10 mass% to 40 mass%. On the other hand, the cement kiln dust which is a dust contained in an extracted gas from a cement kiln, chlorine is generally contained at a concentration of about 10 mass% to 40 mass%.

[0028]

According to the present invention, the chlorine content of the waste material as described above can be reduced to, for example, typically a concentration of about 0.1 mass% to 3 mass%, and more typically a concentration of about 0.1 mass% to 1.5 mass%. In addition, the desalinated cake of which the chlorine content has been thus reduced can be effectively used as the cement raw material or the like.

[0029]

The concentration of chlorine in the chlorine-containing powder can be measured by known methods, and preferable examples thereof include fluorescent X-ray analysis methods which apply correspondingly to ISO 29581-2 Cement-Test methods-Part 2: Chemical analysis by X-ray fluorescence, or "Determination of chlorine in cement by fluorescent X-ray analysis" in a standard testing method of Japan Cement Association JCAS I-05, or the like.

[0030]

The present invention will be described in more detail below with reference to the drawings, but the present invention is not limited to the embodiments described with these drawings.

[0031]

FIG. 1 shows a flow chart for explaining a basic configuration of the washing treatment which is performed in the present invention. As is shown in the flow chart, the washing treatment method according to the present invention comprises: a chlorine-containing powder introduction step (s-1) of accommodating a slurry that is formed by adding at least water to a chlorine-containing powder, in a treatment tank having a predetermined accommodation capacity; and a chlorine elution step (s-2) of stirring the slurry accommodated in the treatment tank and eluting chlorine contained in the chlorine-containing powder into a liquid phase; and a filtration/separation step (s-3) of filtering some or all of the liquid phase out from the slurry after the chlorine has been eluted, and obtaining a desalinated cake.

[0032]

Then, in the washing treatment method according to the present invention, in the above chlorine elution step, the slurry is stirred by a mixed stirring flow of the above slurry and a carbon-dioxide-containing gas, which is formed by the above gas that is blown into the slurry accommodated in the treatment tank, and circulates through a lower layer and an upper layer of the accommodated slurry in the treatment tank while the above gas entrains the above slurry. Thereby, the washing treatment method can well disperse even solid phase particles having a relatively large particle size throughout the slurry so that the solid phase particles do not stay in the bottom side in the treatment tank. In addition, a state is

formed in which the particle size distribution of the solid phase particles that are the solid phase component contained in the slurry is widely and satisfactorily dispersed; in the filtration/separation step after the chlorine elution step, the solid phase particles having a relatively large particle size act as nuclei, and together with solid phase particles having a relatively small particle size, form a packed structure having voids among particles, which appropriately communicate with each other, which exhibits a satisfactory filtration rate. Due to this excellent filtration rate, the time period required of the above filtration/separation step is remarkably shortened, and it becomes possible to efficiently perform the washing treatment for the chlorine-containing powder.

[0033]

In addition, in the washing treatment method according to the present invention, such washing treatment is possible as to respond to the chlorine-containing powder which is continuously introduced. In other words, as for the above introduction of the chlorine-containing powder, it is generally possible, for example, to continuously supply a wash liquid for desalination to the treatment tank, which contains the chlorine-containing powder and at least water, but in the subsequent filtration/separation step, a batch type of treatment is generally usual depending on the specification of the filtration/separation device to be used; but, it is possible to perform the washing treatment without interrupting the continuity of the above introduction of the chlorine-containing powder, by having a buffer tank of the slurry which is supplied from the chlorine elution step, in an upstream side of the filtration/separation device. For information, "continuity" which is used here does not necessarily mean that a washed product is produced continuously on the time axis without any interruption at all, but means that when viewed in a time range that is common knowledge in the operation, and typically when viewed in a time range of about 50 minutes to 100 minutes for example, the production of the washed product is not interrupted by the above continuity of the introduction of the chlorine-containing powder; and thereby the efficiency of the operation of the washing treatment is sufficiently improved.

[0034]

FIG. 2 shows an explanatory diagram of a schematic configuration of one example of a washing treatment system for a chlorine-containing powder according to the present invention.

[0035]

As is shown in FIG. 2, the washing treatment system 1 for the chlorine-containing powder according to this embodiment comprises a treatment tank 2; and into the treatment tank 2, a chlorine-containing powder P1 which is supplied from a chlorine-containing powder supply device 21 and the first wash liquid W1 for desalination, which is supplied from a supply device 22 for the first wash liquid for desalination, are introduced, and a pH adjustor pH1 which is supplied from the pH adjustor supply device 23 can also be introduced as needed. In the embodiment shown in FIG. 2, the supply devices 21 to 23 are configured to continuously supply the slurry materials P1, W1 and pH1 to the treatment tank 2, respectively; in the treatment tank 2, at least the chlorine-containing powder P1 and the first wash liquid W1 for desalination are mixed to form a slurry; and the slurry S1 is stirred for a predetermined time period, and thereby chlorine contained in the chlorine-containing powder P1 is dissolved and is eluted in a liquid phase. For information, in the embodiment shown in FIG. 2, at least the chlorine-containing powder P1 and the first wash liquid W1 for desalination are introduced into the treatment tank 2, and are mixed to form a slurry, but there is no problem even if a slurry is separately formed and is introduced into the treatment tank 2.

[0036]

In addition, in the washing treatment system 1 for the chlorine-containing powder according to this embodiment, the slurry S2 which has passed through the treatment in the treatment tank 2 is conveyed to a filtration/separation device 6 via a slurry conveying device 4. In the filtration/separation device 6, some or all of the liquid phase is filtered out from the slurry S2, and a desalinated cake C1 is obtained in which the chlorine content decreases. In addition, a buffer tank 5 is provided in an upstream side of the filtration/separation device 6, temporarily stores the slurry S2 which is conveyed from the treatment tank 2, and is configured to supply a predetermined amount to the filtration/separation device 6, every time when a slurry supply valve 8a having a

predetermined valve mechanism is opened in desired timing. Due to such a buffer tank 5 being provided, it is possible as is described above to perform the washing treatment without disturbing the above continuity of the introduction of the chlorine-containing powder.

[0037]

As described above, in the treatment tank 2, at least the chlorine-containing powder P1 and the first wash liquid W1 for desalination are mixed to form a slurry, and it is preferable for a mass ratio (W1/P1) between the chlorine-containing powder P1 and the first wash liquid W1 for desalination to be 4 to 10, is more preferable to be 4 to 7, and is particularly preferable to be 4 to 5. When the mass ratio (W1/P1) is smaller than 4, elution of chlorine from the chlorine-containing powder P1 becomes insufficient, in some cases. When the mass ratio (W1/P1) is larger than 10, the amount of filtrate increases which is produced in the subsequent filtration/separation step.

[0038]

It is preferable for a concentration of a chloride ion in the first wash liquid W1 for desalination, which is mixed with the chlorine-containing powder P1 in the treatment tank 2 and constitutes the slurry S1, to be 3 mass% or lower, is more preferable to be 2 mass% or lower, and is particularly preferable to be 1 mass% or lower. The lower limit is not particularly set, but the chlorine concentration of industrial water is usually about 0.005 mass%, which originates from river water, underground water or the like. When the concentration of the chloride ion in the first wash liquid W1 for desalination is higher than 3 mass%, the elution efficiency of chlorine from the chlorine-containing powder P1 decreases in the chlorine elution step depending on the chlorine content of the chlorine-containing powder P1, in some cases.

[0039]

A pH level of the above slurry S1 in the chlorine elution step is preferably 6 to 11, is more preferably 6 to 10.5, and is particularly preferably 6 to 9. Here, as for the pH level of the slurry S1, because a carbon-dioxide-containing gas is blown into the slurry S1, which will be described later, it is possible to adjust the pH level to 7 or lower by dissolution of carbon dioxide in the gas, but a pH adjustor pH1 may be added to the slurry

S1. Due to the pH adjustor pH1 being added, the pH level of the slurry S1 can be adjusted to 6 to 9, and chlorine can be effectively eluted from the sparingly soluble Friedel's salt which is contained in the ashes and dust. Diluted sulfuric acid, hydrochloric acid or the like can be used as the pH adjustor pH1.

[0040]

As is shown in FIG. 2, in the washing treatment system 1 for the chlorine-containing powder according to this embodiment, a tubular air diffusion device 3 is additionally provided in the treatment tank 2. The tubular air diffusion device 3 includes: a nozzle 31 configured to communicate with an air supply pipe 33 for supplying a carbon-dioxide-containing gas A1 and blow the gas A1 therefrom; and a cylindrical tube 32 having a cylindrical shape, configured to arrange the nozzle 31 at an inner end thereof. The tubular air diffusion device 3 is also configured so that the gas A1 blown from the nozzle 31 rises upward together with the slurry while entraining the slurry in the inside of the cylinder of the cylindrical tube 32 to form a mixed jet flow of the gas A1 and the slurry S1, and is spouted from an upper end opening portion 32a of the cylindrical tube 32. On the other hand, the tubular air diffusion device 3 is configured so that a pressure in the lower side of the inside of the cylinder of the cylindrical tube 32 becomes negative compared to that in the upper side, as the slurry inside of the cylinder rises upward, and thereby the slurry which has stayed in a bottom side of the treatment tank 2 is sucked into the inside of the cylinder of the cylindrical tube 32 from a lower end opening portion 32b of the cylindrical tube 32. Due to such a mechanism of the tubular air diffusion device 3, a mixed stirring flow of the slurry S1 and the gas A1 is formed, which circulates through the lower layer and the upper layer in the slurry accommodated in the treatment tank 2 while the above gas entrains the above slurry, and is configured to stir the whole of the slurry accommodated in the treatment tank 2.

[0041]

The above mechanism of the tubular air diffusion device 3 will be more specifically described below. Due to an air lift effect generated by the blow of the above gas A1 from the nozzle 31, a difference of specific weight is formed between the slurries in the inside and the outside of the cylindrical tube 32, and a mixed jet flow of the above

slurry and the above gas is formed in the cylindrical tube 32. The shape of the above gas in the above mixed jet flow becomes an air bubble form having an arbitrary diameter which is ascribed to a shape of the nozzle 31 for blowing the gas into the above slurry, shearing which is caused by collision with the above slurry, when the gas is blown into the slurry from the nozzle 31 or after the gas has been blown, or the like. The speed of the above mixed stirring flow which flows in the cylindrical tube 32 is preferably 1 m/sec or higher, is more preferably 2 m/sec or higher, and is particularly preferably 3 m/sec or higher. There is no upper limit of the speed of this mixed stirring flow, but from the viewpoint of preventing sudden spout of the slurry S1 from the treatment tank 2, the speed is preferably 15 m/sec or lower. When the speed of the above mixed stirring flow which flows in the cylinder of the cylindrical tube 32 is lower than 1 m/sec, the formed stirring flow becomes weak, and it becomes difficult to stir the whole of the slurry S1 accommodated in the treatment tank 2, in some cases.

[0042]

In addition, the cylindrical tube 32 in the tubular air diffusion device 3 may adopt a substantially conical structure in which the inner diameter decreases from a lower end portion side in which the nozzle 31 is arranged, toward the upper end opening portion 32a. According to the structure, it is possible to further increase the spout pressure of the above mixed jet flow from the upper end opening portion 32a.

[0043]

Furthermore, it is also acceptable to provide a structure such as a protruding portion or a spacer in the inside of the cylinder of the cylindrical tube 32 of the tubular air diffusion device 3 so as to partially block the flow of the above mixed jet flow, and to make the structure serve as a turbulence generating unit. According to this structure, it can become easy to generate air bubbles due to the cavitation effect.

[0044]

Here, the cavitation effect is such a phenomenon that a vacuum cavity is formed by a pressure difference in a micro-local region in a fluid, and the vacuum cavity becomes a fine air bubble, and it can be said that the cavitation effect is a phenomenon which occurs widely and generally in a fluid. Therefore, the cavitation air bubbles can be generated in

the above slurry due to shapes of the nozzle 31 and the cylindrical tube 32 of the tubular air diffusion device 3, shapes of the upper end opening portion 32a and the lower end opening portion 32b of the cylindrical tube 32, and the like, even if there is not a special turbulence generating unit by the above structure.

[0045]

In the present invention, the above mixed jet flow which is formed by the tubular air diffusion device 3 and the mixed stirring flow of the above slurry and the above gas, which originates in the mixed jet flow and circulates through the lower layer and the upper layer of the slurry accommodated in the treatment tank 2, may contain air bubbles due to the above cavitation effect. The air bubble due to the cavitation effect generates a high impact pressure of several GPa in a local region of several  $\mu\text{m}$  order at the time of collapse, and a temperature of several thousand  $^{\circ}\text{C}$  arises microscopically due to adiabatic compression at the time of the collapse of the air bubble. Therefore, the cavitation air bubble has an effect of breaking an aggregate of a solid phase existing in the slurry S1, due to the impactive force of its collapse. In addition, the cavitation air bubble has an effect of improving the elution efficiency of chlorine from the chlorine-containing powder P1, due to the heating at the time of its collapse

[0046]

In the treatment tank 2, a plurality of tubular air diffusion devices 3 as described above may be installed in order to form a more effective stirring flow. In this case, by unifying the spout direction of the above mixed jet flows caused by the plurality of tubular air diffusion devices 3 to a vertical direction of the treatment tank 2, it is possible to effectively stir the whole of the inside of the treatment tank 2. In addition, it is also acceptable to additionally provide the tubular air diffusion device 3 in the treatment tank 2, and further provide a general-purpose stirring blade in combination.

[0047]

As the slurry conveying device 4 configured to convey the slurry S1 from the treatment tank 2 to the buffer tank 5, a general-purpose slurry pump such as a screw pump or a Mohno pump may be used, but in the embodiment shown in FIG. 2, an inclined gutter is provided at a position at which an overflow of the treatment tank 2 occurs. In doing so,

the slurry S2 which has overflowed from the treatment tank 2 in accordance with the amount of the increase is automatically conveyed to the buffer tank 5, when the amount of the slurry S1 increases due to the chlorine-containing powder P1 and/or the first wash liquid W1 for desalination which may be continuously supplied to the treatment tank 2.

[0048]

A mechanism and material of the buffer tank 5 are not limited as long as the buffer tank 5 can store a predetermined amount of the slurry S2 and appropriately supply the slurry to the filtration/separation device 6.

[0049]

The filtration/separation device 6 may be any device as long as the device can filter out some or all of the liquid phase from the slurry S2 which has passed the treatment in the treatment tank 2; and a filter press or the like, for example, is preferably exemplified.

Also, in the embodiment shown in FIG. 2, the filter press is used as the filtration/separation device 6. In such a filtration/separation device 6 (filter press), the introduced material to be treated is subjected to solid-liquid separation through a filter cloth, and a dehydrated cake is obtained of which the water content is usually reduced to about 50 mass%. At this time, a pressure of the compression may be 0.2 MPa to 2 MPa, which is performed for adjusting the thickness and water content of the dehydrated cake (though compression at the time of introduction of the material to be treated is sometimes referred to as "primary compression"); the mesh size of the filter cloth may be any size as long as the filter cloth can collect a solid phase having a particle size of 0.1  $\mu\text{m}$  or larger, and the compression method and the type of the filter cloth are not particularly limited.

For information, in the embodiment shown in FIG. 2, when the slurry S2 is introduced into the filtration/separation device 6 (filter press), a slurry supply pump 7a having a predetermined pump mechanism is configured to be capable of introducing the slurry S2 while pressurizing the slurry S2. Specifically, the slurry supply pump 7a enables the material to be treated to be pressed into the filtration/separation device 6, and thereby can more rapidly introduce the slurry S2 into the filtration/separation device 6 (filter press). In addition, the water which is removed when the slurry S2 is introduced into the filtration/separation device 6 (filter press) is discharged as the first filtrate W3; and

accordingly, in the embodiment shown in FIG. 2, a filtrate discharge valve 8c having a predetermined valve mechanism is configured to be capable of opening itself and discharging the filtrate to the outside of the system.

[0050]

In addition, the filtration/separation device 6 (filter press) washes the dehydrated cake which has been obtained after having been subjected to the solid-liquid separation once and has a water content of about 50 mass%, with the use of a second wash liquid W2 for desalination; and replaces almost all of the liquid phase which is contained in the dehydrated cake, with the second wash liquid W2 for desalination (a case in which the wash liquid is circulated in a forward direction with respect to a direction in which the material to be treated is introduced and washes the material is also referred to as "forward washing", and a case in which the wash liquid is circulated in the reverse direction with respect to the direction in which the material to be treated is introduced and washes the material is also referred to as "reverse washing"). This makes it possible to more reliably desalinate the dehydrated cake. It is preferable that a concentration of the chloride ion in the second wash liquid W2 for desalination is lower than that in the above first wash liquid W1 for desalination; and more specifically, the concentration is preferably 0.5 mass% or lower, is more preferably 0.3 mass% or lower, and is particularly preferably 0.1 mass% or lower. The lower limit is not particularly set, but the chlorine concentration of industrial water is usually about 0.005 mass%, which originates from river water, underground water or the like.

[0051]

In the embodiment shown in FIG. 2, the second wash liquid W2 for desalination is configured to be supplied from a supply tank 61 for the second wash liquid for desalination, which has been additionally provided on the filtration/separation device 6 (filter press), when a supply valve 8b for the second wash liquid for desalination having a predetermined valve mechanism is opened at a desired timing. In addition, at this time, a supply pump 7b for the second wash liquid for desalination having a predetermined pump mechanism is configured to be capable of washing the dehydrated cake while pressurizing the second wash liquid W2 for desalination. In other words, the supply pump 7b enables

the second wash liquid W2 for desalination to be introduced while being pressurized, and thereby can more rapidly wash the dehydrated cake by the second wash liquid W2 for desalination. In addition, at the time of or after the washing with the second wash liquid W2 for desalination, it is acceptable to compress the dehydrated cake for adjusting the thickness or water content thereof, in the same manner as in the primary compression treatment at the time of introduction of the above slurry S2 (where compression at the time of or after the washing of the dehydrated cake is referred to as "secondary compression", in some cases.).

[0052]

For information, in the embodiment shown in FIG. 2, in the filtration/separation device 6, a filtrate return pump 7c having a predetermined pump mechanism is configured to send the second filtrate W4 which has been produced in washing of the dehydrated cake by the second wash liquid W2 for desalination to a storing portion in the supply device 22 for the wash liquid for desalination, and reuse the second filtrate W4 as the first wash liquid W1 for desalination. This can save the amount of water to be used for the wash liquid for desalination. In addition, when the concentration of chlorine or the like has increased due to the reuse of the filtrate, a filtrate discharge valve 8c having a predetermined valve mechanism is configured to be capable of discharging the filtrate to the outside of the system by opening its valve. For information, as described above, the concentration of chlorine and the like in the above first filtrate is relatively high which is produced when the slurry S2 has been introduced into the filtration/separation device 6 (filter press), and accordingly is configured to be basically discharged to the outside of the system by the filtrate discharge valve 8c being opened, but may be sent to the storing portion of the supply device 22 for the wash liquid for desalination and be reused as the first wash liquid W1 for desalination in the same manner as the second filtrate W4, depending on the case.

[0053]

In addition, as is shown in FIG. 2, in the washing treatment system 1 for the chlorine-containing powder according to this embodiment, the desalinated cake C1 which has been obtained in the filtration/separation device 6 is configured to be conveyed to a

cement production apparatus 9 and used as a cement raw material. For the conveyance at this time, a general-purpose device such as a belt conveyor may be used, which can convey a cake having a water content of about 50 mass%.

[0054]

Furthermore, as is shown in FIG. 2, in the washing treatment system 1 for the chlorine-containing powder according to this embodiment, the carbon-dioxide-containing gas A2 which is discharged from the cement production apparatus 9 is configured to be supplied to the above tubular air diffusion device 3 and be used as some or all of the carbon-dioxide-containing gas A1. According to this method, the gas discharged from the cement production apparatus 9 can heat the slurry in the chlorine elution step by a calorie contained in itself, and can improve the elution efficiency of chlorine from the chlorine-containing powder P1.

[0055]

As described above, according to the present invention, when the slurry is stirred which is obtained by adding at least water to the chlorine-containing powder, a specific stirring unit is adopted and accordingly can well disperse the whole of the slurry S1 accommodated in the treatment tank 2, because even though solid phase particles have a relatively large size, the solid phase particles do not stay in the bottom side in the treatment tank 2. Thereby, a state is formed in which the particle size distribution of the solid phase particles that are the solid phase component contained in the slurry is widely and satisfactorily dispersed; in the filtration/separation step by the filtration/separation device 6, the solid phase particles having a relatively large particle size act as nuclei, and together with solid phase particles having a relatively small particle size, form a packed structure having voids among particles, which appropriately communicate with each other, which exhibits a satisfactory filtration rate. Due to this excellent filtration rate, the time period required of the filtration/separation device 6 is remarkably shortened, and it becomes possible to efficiently perform the washing treatment for the chlorine-containing powder P1. Here, the solid phase particle may contain calcium carbonate produced by a chemical reaction between a calcium component dissolving in the slurry S1 and carbon dioxide in the gas A1 blown into the slurry S1.

[0056]

According to Examples which will be described later, when the filter press was used as the filtration/separation device 6, the time periods required of the steps of press-in for the slurry and reverse washing were significantly reduced among the time periods required of the steps of press-in for the slurry, forward washing (water washing), primary compression, reverse washing (water washing) and secondary compression. Therefore, it is considered that the configuration of the present invention greatly contributes to the improvement of the filtration rate, in the process of dehydration from the slurry-like composition through a filtration/separation member such as the filter cloth. In addition, the required time period can be typically shortened to 25 minutes or shorter, for example; can be more typically shortened to 22 minutes or shorter, for example; and can be further more typically shortened to 20 minutes or shorter. Thereby, it is considered that the efficiency of the operation of the washing treatment can be sufficiently improved.

## Examples

[0057]

In order to describe the present invention in more detail, specific Test Examples will be described below, but the present invention is not limited to embodiments of these Test Examples.

[0058]

### [Test Example 1]

It was evaluated what influence the equipment specification of the chlorine elution step in the treatment tank 2 gives on the required time period of the filtration/separation step, in the configuration of the washing treatment system 1 for the chlorine-containing powder shown in FIG. 2.

[0059]

As the chlorine-containing powder P1, molten fly ash (Cl: 12.8 mass%, Pb: 2600 ppm, and Zn: 15600 ppm) was used which was generated from a gasification melting furnace (hereinafter referred to as "molten fly ash P2"). In addition, tap water was used as the first wash liquid W1 for desalination for slurring the molten fly ash P2 and the

second wash liquid W2 for desalination for washing the dehydrated cake. In addition, as the treatment tank 2, a tank having an accommodation capacity of 3.5 m<sup>3</sup> was used.

[0060]

As the filtration/separation device 6, a filter press was used (air permeability of filter cloth: 1000 cm/min, thickness of filter cloth: 1.8 mm, and filter cloth: herringbone weave of polypropylene); a solid-liquid ratio of the slurry S1 (mass ratio of "first wash liquid W1 for desalination / molten fly ash P2") was set at four; a solid-liquid ratio of the desalinated cake C1 (mass ratio of "second wash liquid W2 for desalination / molten fly ash P2") was set at one at the time of washing with the second wash liquid W2 for desalination, in the filtration/separation device 6; and a water content of the desalinated cake C1 which was to be obtained by the treatment was set at 50 mass%.

[0061]

In Table 1, the equipment specifications of the chlorine elution step and pH levels of slurries in cases of the respective specifications are collectively shown for each level which was subjected to the evaluation. Specifically, in Example 1, levels were provided in which the supply of the gas A1 and the stirring of the slurry S1 were performed only by the tubular air diffusion device 3; in Comparative Example 1, levels were provided in which the gas A1 was supplied by fine air bubbles blown from a disk type air diffusion disk that was installed in the treatment tank 2 instead of the tubular air diffusion device 3, and the slurry S1 was stirred by a stirring blade arranged in the treatment tank 2; in Comparative Example 2, levels were provided in which the gas A1 was not supplied and the slurry S1 was stirred only by a stirring blade which was arranged in the treatment tank 2 instead of the tubular air diffusion device 3; and it was evaluated what influence each equipment specification gives on the time period required of the filtration/separation step. In addition, for supplying the gas A1 to the slurry S1, a tubular air diffusion device (Aquablaster AL-1500, manufactured by Aience Inc.) was used in Example 1, and an air diffusion disk (Teller C type, manufactured by Elastox Co., Ltd.) was used, in Comparative Example 1. Furthermore, as the stirring blade, a four-blade type stirring blade was used which had a diameter of 600 mm.

[0062]

[Table 1]

|                       | Chlorine elution step             |                                         |                                   |                               |                 |
|-----------------------|-----------------------------------|-----------------------------------------|-----------------------------------|-------------------------------|-----------------|
|                       | Supply method of gas A1           |                                         | Stirring method of slurry S1      |                               | pH of slurry S1 |
|                       | Specification of treatment tank 2 | Amount of supply (m <sup>3</sup> /time) | Specification of treatment tank 2 | Stirring time period (minute) |                 |
| Example 1             | Tubular air diffusion device      | 100                                     | Tubular air diffusion device      | 120                           | 10.5            |
| Comparative Example 1 | Air diffusion disk                | 100                                     | Stirring blade                    | 120                           | 10.5            |
| Comparative Example 2 | None                              | -                                       | Stirring blade                    | 120                           | 12.0            |

[0063]

Table 2 summarizes time periods required of the filtration/separation step, and the filtration rate (kg/hr) per unit area (m<sup>2</sup>) of the filter cloth which was concerned with the filtration and separation, for each of the above levels. For information, the required time periods were summarized for each of the following steps of press-in, forward washing, primary compression, reverse washing and secondary compression, which are related to operation steps of the filter press.

[0064]

(Press-in)

A step of charging a slurry into a filtration/separation chamber which is surrounded by a filter cloth of a filter press, through a pipe which is connected to an introduction port at which the surrounding of the filter cloth of the filtration/separation chamber is partially unbound, and filling the filtration/separation chamber with a certain amount of slurry under a predetermined pressure, while discharging the first filtrate W3 which was filtered by the filter cloth, from a discharge port side / in this Test Example, one filtration/separation chamber was filled with the slurry of about 20L under a pressurization condition of 0.3 MPa.

[0065]

(Forward washing)

A step of washing the slurry with a second wash liquid W2 for desalination through a pipe into which the slurry was introduced / in this Test Example,  $0.3 \text{ MPa} \times 1$  minute was set to be fixed among each level.

[0066]

(Primary compression)

A step of applying a predetermined pressure to a filter plate which was arranged so as to sandwich a cake layer through a filter cloth surrounding a filtration/separation chamber of a filter press, and adjusting the thickness and water content of the dehydrated cake / in this Test Example,  $0.3 \text{ MPa} \times 4$  minutes was set to be fixed among each level.

[0067]

(Reverse washing)

A step of introducing the second wash liquid W2 for desalination into the dehydrated cake through a pipe in the discharge port side of the filtrate from the filtration/separation chamber of the filter press, in a direction opposite to the forward washing, and washing the dehydrated cake / in this Test Example, the reverse washing was performed until an electric conductivity of the second filtrate W4 became  $900 \text{ mS/m}$  (when the electric conductivity of the filtrate of the reverse washing became the above electric conductivity, the chlorine content of the obtained desalinated cake C1 is expected to be about  $0.5 \text{ mass\%}$ ).

[0068]

(Secondary compression)

A step of applying a predetermined pressure to a filter plate which has been arranged in the outside so as to sandwich a cake layer through a filter cloth surrounding a filtration/separation chamber of a filter press after the reverse washing, and adjusting the thickness and an amount of water of the dehydrated cake / in this Test Example,  $0.7 \text{ MPa} \times 4$  minutes was set to be fixed among each level.

[0069]

[Table 2]

|                          | Filtration/separation step    |                    |                        |                    |                          |       |                                           |
|--------------------------|-------------------------------|--------------------|------------------------|--------------------|--------------------------|-------|-------------------------------------------|
|                          | Required time period (minute) |                    |                        |                    |                          |       | Filtration rate<br>(kg/m <sup>2</sup> hr) |
|                          | Press-in                      | Forward<br>washing | Primary<br>compression | Reverse<br>washing | Secondary<br>compression | Total |                                           |
| Example 1                | 3                             | 1                  | 4                      | 8                  | 4                        | 20    | 14.1                                      |
| Comparative<br>Example 1 | 5                             | 1                  | 4                      | 13                 | 4                        | 27    | 10.1                                      |
| Comparative<br>Example 2 | 7                             | 1                  | 4                      | 16                 | 4                        | 32    | 9.4                                       |

[0070]

As is shown in Table 2, in Example 1 in which the tubular air diffusion device 3 was used as the specification of the treatment tank 2 in the chlorine elution step, the time periods required of the filtration/separation step by the filter press required 3 minutes for the press-in, 8 minutes for the reverse washing, and 20 minutes in total; but on the other hand, in Comparative Example 1 in which the air diffusion disk and the stirring blade were used as the specification of the treatment tank 2 in the chlorine elution step, the time period required 5 minutes for the press-in, and required 13 minutes for the reverse washing, and required 27 minutes in total, which consumed longer time period; and in Comparative Example 2 in which only the stirring blade was used as the specification of the treatment tank 2 in the chlorine elution step, the time period required 7 minutes for the press-in, required 16 minutes for the reverse washing, and required 32 minutes in total, which consumed further longer time period. In addition, the filtration rate (kg/m<sup>2</sup>/hr) was determined as an indicator of the treatment capacity; and as a result, the filtration rate was 14.1 in Example 1, was 10.1 in Comparative Example 1, and was 9.4 in Comparative Example 2. As a result, it has become clear that when the stirring of the slurry S1 and the supply of the gas A1 are performed in the treatment tank 2 in the chlorine elution step with the use of the tubular air diffusion device 3, the washing treatment capacity of the chlorine-containing powder is significantly improved.

[0071]

[Test Example 2]

The particle size distributions of the solid phase components of the desalinated cakes C1 which were obtained in each level in Test Example 1 were examined with a laser

diffraction/scattering type particle size distribution measuring device. The results are shown in FIG. 3.

[0072]

As shown in FIG. 3, there were a lot of fine particles in the solid phase component of Comparative Example 1, and there were a lot of coarse particles in the solid phase component of Comparative Example 2: but on the other hand, the particle size distribution of the solid phase particles of the solid phase component of Example 1 was relatively positioned in the middle between those of Comparative Example 1 and Comparative Example 2. The reasons have been considered to be because in Comparative Example 1, though calcium carbonate produced by the supply of carbon-dioxide-containing gas A1 is a relatively fine particle, the whole of the treatment tank 2 is not sufficiently stirred by the combination of the air diffusion disk and the stirring blade, and the overflow from the treatment tank 2 contained a lot of calcium carbonate particles; and because in Comparative Example 2, the solid phase component containing the molten fly ash P2 which was used as the chlorine-containing powder P1 remained in an agglomerating state, due to stirring with only the stirring blade. On the other hand, in Example 1 which used the tubular air diffusion device 3, the reason has been considered to be that firstly because a mixed stirring flow of the slurry and the gas is formed which circulates through the lower layer and the upper layer of the slurry S1 accommodated in the treatment tank 2 while the gas A1 entrains the slurry S1, and the whole of the slurry S1 accommodated in the treatment tank 2 can be sufficiently stirred, and further secondly because calcium carbonate particles are produced by the supply of the carbon-dioxide-containing gas A1, a state in which the particle size distribution of the solid phase particles of the solid phase component was widely and satisfactorily dispersed was formed in the slurry S2 which overflowed from the treatment tank 2.

#### Reference Signs List

[0073]

- 1 washing treatment system for chlorine-containing powder
- 2 treatment tank

|           |                                                      |
|-----------|------------------------------------------------------|
| 3         | tubular air diffusion device                         |
| 4         | slurry conveying device                              |
| 5         | buffer tank                                          |
| 6         | filtration/separation device                         |
| 7a        | slurry supply pump                                   |
| 7b        | supply pump for second wash liquid for desalination  |
| 7c        | filtrate return pump                                 |
| 8a        | slurry supply valve                                  |
| 8b        | supply valve for second wash liquid for desalination |
| 8c        | filtrate discharge valve                             |
| 9         | cement production apparatus                          |
| 21        | chlorine-containing powder supply device             |
| 22        | supply device for first wash liquid for desalination |
| 23        | pH adjustor supply device                            |
| 31        | nozzle                                               |
| 32        | cylindrical tube                                     |
| 33        | air supply pipe                                      |
| 61        | supply tank for second wash liquid for desalination  |
| A1 and A2 | carbon-dioxide-containing gas                        |
| P1        | chlorine-containing powder                           |
| P2        | molten fly ash                                       |
| S1 and S2 | slurry                                               |
| C1        | desalinated cake                                     |
| W1        | first wash liquid for desalination                   |
| W2        | second wash liquid for desalination                  |
| W3        | first filtrate                                       |
| W4        | second filtrate                                      |
| pH1       | pH adjustor                                          |

## Claims

### [Claim 1]

A washing treatment method for a chlorine-containing powder, comprising:  
a chlorine-containing powder introduction step of accommodating a slurry that is formed by adding at least water to the chlorine-containing powder, in a treatment tank having a predetermined accommodation capacity;  
a chlorine elution step of stirring the slurry that has been accommodated in the treatment tank, and eluting chlorine contained in the chlorine-containing powder in a liquid phase; and  
a filtration/separation step of filtering some or all of the liquid phase out from the slurry after the chlorine has been eluted, and obtaining a desalinated cake, wherein  
in the chlorine elution step, the slurry is stirred by a mixed stirring flow of a carbon-dioxide-containing gas and the slurry, which is formed by the gas that is blown into the slurry accommodated in the treatment tank, and circulates through a lower layer and an upper layer of the accommodated slurry while the gas entrains the slurry.

### [Claim 2]

The washing treatment method for the chlorine-containing powder according to claim 1, wherein the treatment tank is configured so that the slurry accommodated in the treatment tank overflows in response to the chlorine-containing powder which is additionally introduced, and is discharged toward the filtration/separation step.

### [Claim 3]

The washing treatment method for the chlorine-containing powder according to claim 1 or 2, wherein in the filtration/separation step, the liquid phase is separated by a filter press.

### [Claim 4]

The washing treatment method for the chlorine-containing powder according to claim 1 or 2, wherein the chlorine-containing powder includes one or more types selected from the group consisting of incinerated fly ash, molten fly ash and cement kiln dust.

### [Claim 5]

The washing treatment method for the chlorine-containing powder according to claim 1 or 2, wherein the washing treatment can be performed in response to the chlorine-containing powder which is continuously introduced.

[Claim 6]

A washing treatment system for a chlorine-containing powder, comprising:

a treatment tank having a predetermined accommodation capacity and configured to accommodate a slurry that is formed by adding at least water to the chlorine-containing powder;

a tubular air diffusion device that is additionally provided in the treatment tank and forms a mixed stirring flow of a carbon-dioxide-containing gas and the slurry, which is formed by the gas that is blown into the slurry accommodated in the treatment tank, and circulates through a lower layer and an upper layer of the accommodated slurry while the gas entrains the slurry; and

a filtration/separation device configured to filter some or all of the liquid phase out from the slurry taken out from the treatment tank, and obtain a desalinated cake.

[Claim 7]

The washing treatment system for the chlorine-containing powder according to claim 6, wherein the treatment tank is configured so that the slurry accommodated in the treatment tank overflows in response to the chlorine-containing powder which is additionally introduced, and is discharged toward the filtration/separation device.

[Claim 8]

The washing treatment system for the chlorine-containing powder according to claim 6 or 7, wherein the filtration/separation device is a filter press.

[Claim 9]

The washing treatment system for the chlorine-containing powder according to claim 6 or 7, further comprising a conveying device configured to convey the obtained desalinated cake to a cement production facility.

[Claim 10]

The washing treatment system for the chlorine-containing powder according to claim 6 or 7, wherein the washing treatment can be performed in response to the chlorine-containing powder which is continuously introduced.