

Description

Title of Invention: DESALTING PROCESS FOR CHLORINE-CONTAINING POWDER AND DESALTER FOR CHLORINE-CONTAINING POWDER

Technical Field

[0001]

The present invention relates to a desalting process for a chlorine-containing powder useful for desalting a chlorine-containing powder such as incineration ash and efficiently using the desalted powder as a cement raw material, and a desalter for a chlorine-containing powder.

Background Art

[0002]

In recycle processes of waste for preparing a cement raw material, waste containing chlorine may cause a problem due to chlorine, such as clogging of cement manufacturing facilities. Thus, when a cement raw material is prepared from chlorine containing waste, such as incineration ash, incineration ash is subjected to a desalting process for reducing the content of chlorine, and then, put in use.

[0003]

As to desalting process for, e.g., incineration ash, for example, Patent Literature 1 discloses a method of adding water to incineration ash to elute chlorine, and then, removing water. Also, Patent Literature 2, for example, discloses a desalting method of washing incineration ash multiple times by repeating addition/removal of water.

[0004]

However, the methods disclosed in, e.g., Patent Literature 1 and Patent Literature 2 require a large amount of water for desalting incineration ash. Because of this, in the regions where a large amount of industrial water (fresh water) is not available and in the case where use of industrial water (fresh water) is limited for cost reasons, it has been difficult to employ these methods.

[0005]

In connection with such a problem, for example, Patent Literature 3 discloses a method of using sea water for desalting a chlorine-containing powder such as incineration fly ash in order to obtain a cement raw material.

Citation List

Patent Literatures

[0006]

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. 2013-166135

Disclosure of Invention

Technical Problem

[0007]

However, the method of Patent Literature 3 satisfies the purpose of avoiding use of a large amount of industrial water (fresh water); however, to satisfy efficient desalting of a chlorine-containing powder, further studies were required. In addition, treatment of drainage generated from the desalting process was another concern.

[0008]

In the circumstances, an object of the present invention is to provide a desalting process and a desalter for efficiently desalting a chlorine-containing powder with e.g., sea water, without wastefully generating drainage.

Solution to Problem

[0009]

To attain the above object, according to a 1st aspect of the present invention, there is provided a desalting process for a chlorine-containing powder, comprising

a slurry formation step of forming slurry by blending a first desalting washing-solution with a chlorine-containing powder,

a chlorine elution step of eluting chlorine contained in the chlorine-containing powder into a liquid phase within the slurry,

a desalted cake formation step of separating part or whole of the liquid phase from the slurry, from which chlorine has been eluted, to obtain a first desalted cake and a first filtrate, and

a desalted cake washing step of washing the first desalted cake with a second desalting washing-solution, which is different from the first desalting washing-solution, to obtain a second desalted cake and a second filtrate, in which

while the first filtrate obtained in the desalted cake formation step and/or the second filtrate obtained in the desalted cake washing step are at least partly recycled as the first desalting washing-solution and a chlorine ion concentration of the first desalting washing-solution is controlled, the slurry step, the chlorine elution step, the desalted cake formation step and the desalted cake washing step are repeated every time a chlorine-containing powder is supplied.

[0010]

According to the desalting process for a chlorine-containing powder, a first desalting washing-solution is added to a chlorine-containing powder to prepare slurry. Then, chlorine contained in the chlorine-containing powder is eluted into the liquid phase of the slurry. From the slurry, part or whole of the liquid phase is separated to obtain a first desalted cake. The first desalted cake is washed with a second desalting washing-solution (different washing solution from the first desalting washing-solution) to successfully obtain a second desalted cake from which chlorine is sufficiently removed. Accordingly, the process is useful for preparing a cement raw material from a chlorine-containing powder such as incineration ash. Since at least part of the first filtrate (obtained in the desalted cake formation step) and/or the second filtrate (obtained in the desalted cake washing step) are recycled as a first desalting washing-solution, by repeating the aforementioned treatments every time a chlorine-containing powder is supplied, the amount of washing water used as the first desalting washing-solution per supply of the chlorine-containing powder can be reduced. Furthermore, when the first filtrate and/or second filtrate are recycled as part or whole of the first desalting washing-solution, the

chlorine ion concentration of the first desalting washing-solution tends to increase; however, even when the chlorine ion concentration (of the first desalting washing-solution) is beyond that of the sea water, the chlorine ion concentration does not significantly affect the chlorine removal efficiency from the chlorine-containing powder until it reaches a predetermined upper-limit concentration. Because of this, the merit of reducing the amount of the washing water and efficient chlorine removal can be simultaneously obtained. Moreover, since the treatment is carried out while controlling the chlorine ion concentration of the first desalting washing-solution, when the chlorine ion concentration of the first desalting washing-solution becomes unfavorable for treatment, corrective action can be taken at an appropriate timing.

[0011]

To attain the above object, according to the 2nd aspect of the present invention, there is provided the desalting process for a chlorine-containing powder as mentioned above, in which, when the chlorine ion concentration of the first desalting washing-solution exceeds a first threshold, the first desalting washing-solution is controlled so as to satisfy the first threshold, with a fresh first desalting washing-solution.

[0012]

According to the above constitution, when the first filtrate and/or second filtrate are recycled as part or whole of the first desalting washing-solution, the chlorine ion concentration of the first desalting washing-solution tends to increase. When the chlorine ion concentration finally exceeds a predetermined upper-limit concentration, chlorine removal efficiency may be affected as the case may be; however, a reduction of the chlorine removal efficiency can be prevented before happens. In this case, as the first threshold, a desired value may be appropriately set, for example, based on evaluation at the time of a trial run. More typically, for example, the chlorine ion concentration of the first desalting washing-solution constituting slurry together with a chlorine-containing powder, is 15 mass%. When the chlorine ion concentration does not exceed 15 mass%, the elution efficiency of chlorine from the chlorine-containing powder into the liquid phase of the slurry is not much affected. In other words, the chlorine removal efficiency is not much affected. In contrast, when the chlorine ion concentration of the first

desalting washing-solution exceeds 15 mass%, chlorine removal efficiency may be affected as the case may be.

[0013]

To attain the above object, according to the 3rd aspect of the present invention, there is provided the desalting process for a chlorine-containing powder as mentioned above, in which sea water is used as the first desalting washing-solution to be initially added to the chlorine-containing powder, and the chlorine ion concentration of the first desalting washing-solution is controlled not to exceed 15 mass%.

[0014]

According to the above constitution, since the chlorine ion concentration of sea water is about 3 mass%, even if the first desalting washing-solution is mainly constituted of sea water, the chlorine ion concentration is easily kept within the range of about 3 mass% to 15 mass% and a plurality of times (at least two) of treatments can be applied every time chlorine-containing powder is supplied. Accordingly, a merit of reducing the amount of, e.g., industrial water (fresh water) used herein can be obtained. Furthermore, if sea water is used as the first desalting washing-solution, an effect of suppressing elution of heavy metals (specifically, e.g., Pb and Zn) from, e.g., incineration fly ash, is observed, which to be an effect of sea water serves as a buffer solution. Accordingly, the cost for treating drainage containing heavy metals can be reduced. Moreover, when the chlorine ion concentration of the first desalting washing-solution exceeds 15 mass%, chlorine removal efficiency may be affected, as the case may be; however, a reduction of the chlorine removal efficiency can be prevented before happens.

[0015]

To attain the above object, according to the 4th aspect of the present invention, there is provided the desalting process for a chlorine-containing powder as mentioned above, in which, while the second filtrate obtained in the desalted cake washing step is at least partly recycled as the second desalting washing-solution and a chlorine ion concentration of the second desalting washing-solution is controlled, the slurry step, the chlorine elution step, the desalted cake formation step and the desalted cake washing step are repeated every time a chlorine-containing powder is supplied.

[0016]

According to the above constitution, since the second filtrate (obtained in the desalted cake washing step) is at least partly recycled as the second desalting washing-solution and aforementioned treatments are repeated every time a chlorine-containing powder is supplied, the amount of washing water used as the second desalting washing-solution per supply of the chlorine-containing powder can be reduced. Furthermore, when the second filtrate is recycled as part or whole of the second desalting washing-solution, the chlorine ion concentration of the second desalting washing-solution tends to increase, with the result that the concentration of chlorine ion remaining in the second desalted cake tends to increase and it tends to be difficult to use the cake, for example, as it is, as a cement raw material; however, since treatment is carried out while controlling the chlorine ion concentration of the second desalting washing-solution, even when the chlorine ion concentration (of the second desalting washing-solution) becomes unfavorable for treatment, corrective action can be taken at an appropriate timing.

[0017]

To attain the above object, according to the 5th aspect of the present invention, there is provided a desalting process for a chlorine-containing powder according to the fourth aspect, in which, when the chlorine ion concentration of the second desalting washing-solution exceeds a second threshold, which is different from the first threshold, the second desalting washing-solution is controlled so as to satisfy the second threshold, with a fresh second desalting washing-solution.

[0018]

According to the above constitution, if the second filtrate is recycled as part or whole of the second desalting washing-solution, the chlorine ion concentration of the second desalting washing-solution tends to increase, with the result that the concentration of chlorine ion remaining in the second desalted cake tends to increase. Accordingly, it tends to be difficult to use the cake, for example, as it is, as a cement raw material; however, it is possible to prevent the chlorine ion concentration from exceeding a predetermined upper-limit concentration before happens. In this case, as the second threshold, a desired value may be appropriately set, for example, based on evaluation at

the time of a trial run. More typically, for example, the chlorine ion concentration of the second desalting washing-solution for washing the first desalted cake is 3.5 mass%. When the chlorine ion concentration is 3.5 mass% or less, the concentration of chlorine ion remaining in the second desalted cake obtained is acceptable as the chlorine ion concentration of the desalted cake, for example, to be directly used as a cement raw material. In contrast, when the chlorine ion concentration of the second desalting washing-solution exceeds 3.5 mass%, additional washing with a washing solution having a lower chlorine ion concentration, for example, industrial water (fresh water), is required, as the case may be, in order to obtain the cake that can be used as a cement raw material.

[0019]

To attain the above object, according to the 6th aspect of the present invention, there is provided the desalting process for a chlorine-containing powder according to the 4th or 5th aspect, in which the chlorine ion concentration of the second desalting washing-solution is controlled so as not to exceed 3.5 mass%.

[0020]

According to the above constitution, since the chlorine ion concentration of the second desalting washing-solution for washing the first desalted cake is controlled so as not to exceed 3.5 mass%, the chlorine ion concentration of the liquid phase remaining in the second desalted cake obtained does not exceed (about) 3.5 mass%. Accordingly, the cake can be used, for example, as it is as a cement raw material.

[0021]

To attain the above object, according to the 7th aspect of the present invention, there is provided the desalting process for a chlorine-containing powder as mentioned above, further comprising the following steps (1) to (3).

(1) a drainage collection step of collecting one or two or more of washing solutions selected from the group consisting of the first filtrate, the second filtrate, the first desalting washing-solution recycled as the first desalting washing-solution and the second desalting washing-solution recycled as the second desalting washing-solution and not be subjected to recycling as the first desalting washing-solution or the second desalting washing-solution, as drainage;

(2) a heavy metal insolubilization step of insolubilizing heavy metals contained in the drainage as a flocculate like floc by adding a heavy metal scavenger to the drainage collected in the step (1);

(3) a heavy metal flocculation cake formation step of separating part or whole of a liquid phase from a flocculation (floc)-containing solution containing heavy metals insolubilized in the step (2) to obtain a first flocculation cake and a third filtrate.

[0022]

According to the above constitution, the drainage from a process of desalting, e.g., incineration fly ash, usually contains heavy metals. The drainage is collected and a heavy metal scavenger is added therein to allow the heavy metals to flocculate like floc, and then, the heavy metal flocculation cake is removed. In this manner, it is possible to prevent the drainage containing heavy metals from being discharged out of the system. The obtained heavy metal flocculation cake can be effectively used as a cement raw material.

[0023]

To attain the above object, according to the 8th aspect of the present invention, there is provided the desalting process for a chlorine-containing powder according to the 7th aspect, further comprising the following step (4).

(4) a heavy-metal flocculation cake washing step of washing the first flocculation cake with a third desalting washing-solution, which is different from the first desalting washing-solution and the second desalting washing-solution, to obtain a second flocculation cake and a fourth filtrate.

[0024]

According to the above constitution, the first flocculation cake obtained in the heavy metal flocculation cake formation step is washed with the third desalting washing-solution to successfully obtain a second flocculation cake from which chlorine is sufficiently removed. The obtained heavy metal flocculation cake is easily and suitably used as a cement raw material.

[0025]

To attain the above object, according to the 9th aspect of the present invention, there is provided the desalting process for a chlorine-containing powder according to the 7th or 8th aspect, in which, in the heavy metal insolubilization step, a pH of the drainage is made to be 7 to 11.

[0026]

According to the above constitution, heavy metals can be effectively insolubilized.

[0027]

To attain the above object, the present invention according to the 10th aspect provides the desalting process for a chlorine-containing powder according to the 8th aspect, in which the fourth filtrate obtained in the heavy metal flocculation cake washing step is at least partly recycled as the first desalting washing-solution.

[0028]

According to the above constitution, since the fourth filtrate obtained in the heavy metal flocculation cake washing step is at least partly recycled as the first desalting washing-solution, the amount of washing water used as the first desalting washing-solution can be reduced.

[0029]

To attain the above object, according to the 11th aspect of the present invention, there is provided the desalting process for a chlorine-containing powder according to the 10th aspect, in which while the second filtrate obtained in the desalted cake washing step is at least partly used as the third desalting washing-solution and/or the fourth filtrate obtained in the heavy metal flocculation cake washing step is at least partly recycled as the third desalting washing-solution and a chlorine ion concentration of the third desalting washing-solution is controlled, the washing treatment in the heavy metal flocculation cake washing step is carried out.

[0030]

According to the above constitution, since the second filtrate obtained in the desalted cake washing step is at least partly used as the third desalting washing-solution and/or the fourth filtrate obtained in the heavy metal flocculation cake washing step is at least partly recycled as the third desalting washing-solution, the amount of washing water

used as the third desalting washing-solution can be reduced. Furthermore, when the second filtrate is used as part or whole of the third desalting washing-solution and/or the fourth filtrate is recycled as part or whole of the third desalting washing-solution, the chlorine ion concentration of the third desalting washing-solution tends to increase, with the result that the concentration of chlorine ion remaining in the second flocculation cake tends to increase. Accordingly, it tends to be difficult to use the cake, for example, as it is, as a cement raw material; however, since a treatment is carried out while controlling the chlorine ion concentration of the third desalting washing-solution, when the chlorine ion concentration of the third desalting washing-solution reaches an unfavorable value, corrective action can be taken at an appropriate timing.

[0031]

To attain the above object, according to the 12th aspect of the present invention, there is provided the desalting process for a chlorine-containing powder according to the 11th aspect, in which when the chlorine ion concentration of the third desalting washing-solution exceeds a third threshold, which is different from the first threshold and the second threshold, the third desalting washing-solution is controlled so as to satisfy the third threshold with a fresh third desalting washing-solution.

[0032]

According to the above constitution, when the second filtrate is used as part or whole of the third desalting washing-solution and/or the fourth filtrate is recycled as part or whole of the third desalting washing-solution, the chlorine ion concentration of the third desalting washing-solution tends to increase, with the result that, the concentration of chlorine ion remaining in the second flocculation cake tends to increase. Accordingly, it tends to be difficult to use the cake, for example, as it is, as a cement raw material; however, it is possible to prevent chlorine ion concentration from exceeding a predetermined upper-limit concentration before happens. In this case, as the third threshold, a desired value may be appropriately set, for example, based on evaluation at the time of a trial run. More typically, for example, the chlorine ion concentration of the third desalting washing-solution for washing the first flocculation cake is 3.5 mass%. When the chlorine ion concentration is 3.5 mass% or less, the concentration of chlorine

ion remaining in the second flocculation cake obtained is acceptable as the chlorine ion concentration of the desalted cake, for example, to be directly used as a cement raw material. In contrast, when the chlorine ion concentration (of third desalting washing-solution) exceeds 3.5 mass%, additional washing with a washing solution having a lower chlorine ion concentration, for example, industrial water (fresh water), is required, as the case may be, in order to obtain the cake that can be used as a cement raw material.

[0033]

To attain the above object, according to the 13th aspect of the present invention, there is provided the desalting process for a chlorine-containing powder according to the 11th aspect, in which the chlorine ion concentration of the third desalting washing-solution is controlled so as not to exceed 3.5 mass%.

[0034]

According to the above constitution, since the third desalting washing-solution for washing the first flocculation cake is controlled to have a chlorine ion concentration so as not to exceed 3.5 mass%, the chlorine ion concentration of the liquid phase remaining in the second flocculation cake obtained does not exceed (about) 3.5 mass%. Accordingly, the cake can be used, for example, as it is, as a cement raw material.

[0035]

To attain the above object, according to the 14th aspect of the present invention, there is provided the desalting process for a chlorine-containing powder as mentioned above, in which the chlorine-containing powder includes one or two or more powders selected from incineration fly ash, flue ash and chlorine bypass dust.

[0036]

According to the above constitution, the process is useful for obtaining a cement raw material from waste containing chlorine such as incineration fly ash, flue ash and chlorine bypass dust.

[0037]

To attain the above object, according to the 15th aspect of the present invention, there is provided a desalter for a chlorine-containing powder comprising

a first desalting washing-solution supply apparatus for supplying a first desalting washing-solution,

an elution vessel for forming slurry by blending a chlorine-containing powder with the first desalting washing-solution from the first desalting washing-solution supply apparatus; at the same time, eluting chlorine contained in the chlorine-containing powder into a liquid phase within the slurry,

a first solid-liquid separation apparatus for separating part or whole of the liquid phase from the slurry from which chlorine is removed by elution to obtain a first desalted cake and a first filtrate,

a slurry carrier device, which transports the slurry treated in the elution vessel to the first solid-liquid separation apparatus,

a second desalting washing-solution supply apparatus for supplying a second desalting washing-solution, which is different from the first desalting washing-solution, for washing the first desalted cake in the first solid-liquid separation apparatus to obtain a second desalted cake and a second filtrate,

a first solution-sending apparatus for sending the first filtrate obtained in the first desalted cake formation treatment performed in the first solid-liquid separation apparatus and/or the second filtrate obtained in the first desalted cake washing treatment performed in the first solid-liquid separation apparatus to the first desalting washing-solution supply apparatus in order to recycle at least parts of the first filtrate and/or the second filtrate as the first desalting washing-solution, and

a first chlorine ion concentration monitoring apparatus for monitoring the chlorine ion concentration of the first desalting washing-solution.

[0038]

According to the desalter for a chlorine-containing powder, the aforementioned desalting process for a chlorine-containing powder can be effectively carried out. Particularly, owing to the presence of the first solution-sending apparatus, since the first filtrate (obtained in the first desalted cake washing treatment performed in the first solid-liquid separation apparatus) and/or the second filtrate (obtained in the first desalted cake formation treatment performed in the first solid-liquid separation apparatus) are at least

partly recycled as the first desalting washing-solution and the treatment is repeated every time a chlorine-containing powder is supplied, the amount of washing water to be used as the first desalting washing-solution per supply of a chlorine-containing powder can be reduced. When the first filtrate and/or second filtrate are recycled as part or whole of the first desalting washing-solution, the chlorine ion concentration of the first desalting washing-solution tends to increase. When the chlorine ion concentration of the first desalting washing-solution exceeds a predetermined upper-limit concentration, chlorine removal efficiency may be affected, as the case may be; however, owing to the presence of the first chlorine ion concentration monitoring apparatus for monitoring the chlorine ion concentration of the first desalting washing-solution, even when the chlorine ion concentration (of the first desalting washing-solution) reaches an unfavorable value for treatment, corrective action can be taken at an appropriate timing.

[0039]

To attain the above object, according to the 16th aspect of the present invention, there is provided the desalter for a chlorine-containing powder, further comprising

a fresh first desalting washing-solution supply apparatus for supplying a fresh first desalting washing-solution as the first desalting washing-solution to the first desalting washing-solution supply apparatus, in which

the first desalting washing-solution supply apparatus comprises a first supply regulation valve, which can change the amount of the first desalting washing-solution to be supplied from the first desalting washing-solution supply apparatus to the elution vessel; at the same time, which enables discharge from the first desalting washing-solution supply apparatus,

the fresh first desalting washing-solution supply apparatus comprises a second supply regulation valve, which can change the amount of the first desalting washing-solution to be supplied to the first desalting washing-solution supply apparatus, and

when the chlorine ion concentration of the first desalting washing-solution exceeds a first threshold, the first supply regulation valve is controlled to stop or reduce supply of the first desalting washing-solution from the first desalting washing-solution supply apparatus to the elution vessel, and to discharge part or whole of the first desalting

washing-solution from the first desalting washing-solution supply apparatus, and then, the second supply regulation valve of the fresh first desalting washing-solution supply apparatus is controlled to supply the fresh first desalting washing-solution to the first desalting washing-solution supply apparatus as the first desalting washing-solution so as to satisfy the first threshold.

[0040]

According to the above constitution, the aforementioned desalting process for a chlorine-containing powder can be effectively carried out. Particularly, owing to the presence of the fresh first desalting washing-solution supply apparatus, if a chlorine ion concentration monitored by the first chlorine ion concentration monitoring apparatus exceeds a first threshold, a fresh first desalting washing-solution can be supplied to the first desalting washing-solution supply apparatus so as to satisfy the first threshold.

Accordingly, when the chlorine ion concentration of the first desalting washing-solution exceeds a predetermined upper-limit concentration, chlorine removal efficiency may be affected, as the case may be; however, it is possible to prevent a reduction of chlorine removal efficiency before happens. In this case, as the first threshold, a desired value may be appropriately set, for example, based on evaluation at the time of a trial run. More typically, for example, the chlorine ion concentration of the first desalting washing-solution constituting slurry together with a chlorine-containing powder is 15 mass%. When the chlorine ion concentration does not exceed 15 mass%, the elution efficiency of chlorine from the chlorine-containing powder into the liquid phase of the slurry is not much affected. In other words, chlorine removal efficiency is not much affected. In contrast, when the chlorine ion concentration of the first desalting washing-solution exceeds 15 mass%, the chlorine removal efficiency may be affected in some cases.

[0041]

To attain the above object, according to the 17th aspect of the present invention, there is provided the desalter for a chlorine-containing powder, further comprising
a second solution-sending apparatus for sending the second filtrate obtained in the first desalted cake washing treatment performed in the first solid-liquid separation

apparatus to the second desalting washing-solution supply apparatus in order to recycle at least part of the second filtrate as the second desalting washing-solution; and

a second chlorine ion concentration monitoring apparatus for monitoring the chlorine ion concentration of the second desalting washing-solution.

[0042]

According to the above constitution, the aforementioned desalting process for a chlorine-containing powder can be effectively carried out. Particularly, owing to the presence of the second solution-sending apparatus, since the second filtrate (obtained in the first desalted cake washing treatment performed in the first solid-liquid separation apparatus) is at least partly recycled as the second desalting washing-solution and the treatment is repeated every time a chlorine-containing powder is supplied, the amount of washing water to be used as the second desalting washing-solution per supply of a chlorine-containing powder can be reduced. When the second filtrate is recycled as part or whole of the second desalting washing-solution, the chlorine ion concentration of the second desalting washing-solution tends to increase, with the result that, the concentration of the chlorine ion remaining in the second desalted cake tends to increase. Accordingly, it tends to be difficult to use the cake, for example, as it is, as a cement raw material; however, owing to the presence of the second chlorine ion concentration monitoring apparatus for monitoring the chlorine ion concentration of the second desalting washing-solution, even when the chlorine ion concentration of the second desalting washing-solution reaches an unfavorable value for treatment, corrective action can be taken at an appropriate timing.

[0043]

To attain the above object, according to the 18th aspect of the present invention, there is provided the desalter for a chlorine-containing powder according to the 17th aspect, further comprising

a fresh second desalting washing-solution supply apparatus for supplying a fresh second desalting washing-solution as the second desalting washing-solution to the second desalting washing-solution supply apparatus, in which

the second desalting washing-solution supply apparatus comprises a third supply regulation valve, which can change the amount of the second desalting washing-solution to be supplied from the second desalting washing-solution supply apparatus to the first desalted cake; at the same time, which enables discharge from the second desalting washing-solution supply apparatus;

the fresh second desalting washing-solution supply apparatus comprises a fourth supply regulation valve, which can change the amount of the washing solution to the second desalting washing-solution supply apparatus; and

when the chlorine ion concentration of the second desalting washing-solution exceeds a second threshold, which is different from the first threshold, the third supply regulation valve is controlled to stop or reduce supply of the second desalting washing-solution from the second desalting washing-solution supply apparatus to the first desalted cake, and to discharge part or whole of the second desalting washing-solution from the second desalting washing-solution supply apparatus, and then,

the fourth supply regulation valve of the fresh second desalting washing-solution supply apparatus is controlled to supply the fresh second desalting washing-solution to the second desalting washing-solution supply apparatus, as the second desalting washing-solution so as to satisfy the second threshold.

[0044]

According to the above constitution, the aforementioned desalting process for a chlorine-containing powder can be effectively carried out. Particularly, owing to the presence of the fresh second desalting washing-solution supply apparatus, if a chlorine ion concentration monitored by the second chlorine ion concentration monitoring apparatus exceeds a second threshold, a fresh second desalting washing-solution can be supplied to the second desalting washing-solution supply apparatus so as to satisfy the second threshold. Accordingly, when the chlorine ion concentration of the second desalting washing-solution exceeds a predetermined upper-limit concentration, it is difficult to use the desalted cake to be obtained directly as a cement raw material; however, it is possible to prevent the chlorine ion concentration from exceeding the predetermined upper-limit concentration before happens. In this case, as the second threshold, a desired value may

be appropriately set, for example, based on evaluation at the time of a trial run. More typically, for example, the chlorine ion concentration of the second desalting washing-solution for washing the first desalted cake is 3.5 mass%. When the chlorine ion concentration is 3.5 mass% or less, the concentration of chlorine ion remaining in the second desalted cake to be obtained is acceptable as the chlorine ion concentration of the desalted cake, for example, to be directly used as a cement raw material. In contrast, when the chlorine ion concentration of the second desalting washing-solution exceeds 3.5 mass%, additional washing with a washing solution having a lower chlorine ion concentration, for example, industrial water (fresh water), is required, as the case may be, in order to obtain the cake that can be used as a cement raw material.

[0045]

To attain the above object, according to the 19th aspect of the present invention, there is provided the desalter for a chlorine-containing powder according to the 15th or 17th aspect, further comprising

a heavy metal insolubilization reaction vessel for collecting and storing one or two or more solutions selected from the group consisting of the first filtrate and the second filtrate that are not to be recycled as the first desalting washing-solution or the second desalting washing-solution, the first desalting washing-solution sent as drainage from the first desalting washing-solution supply apparatus, and the second desalting washing-solution sent as drainage from the second desalting washing-solution supply apparatus, and insolubilizing heavy metals contained in the drainage as a flocculate like floc by adding a heavy metal scavenger thereto;

a second solid-liquid separation apparatus, which separates part or whole of the liquid phase from the flocculation (floc)-containing solution containing the insolubilized heavy metals to obtain a first flocculation cake and a third filtrate; and

a flocculation (floc)-containing solution carrier device for transporting the flocculation (floc)-containing solution treated in the heavy metal insolubilization reaction vessel to the second solid-liquid separation apparatus.

[0046]

According to the above constitution, the aforementioned desalting process for a chlorine-containing powder can be effectively carried out. Particularly, owing to the presence of the heavy metal insolubilization reaction vessel, the drainage from a desalting process of, e.g., incineration fly ash, can be collected and the heavy metals usually contained in the drainage can be insolubilized as a flocculate like floc by adding a heavy metal scavenger. Furthermore, owing to the presence of the second solid-liquid separation apparatus, since insolubilized heavy metals are removed as heavy metal flocculation cake, it is possible to prevent the drainage containing heavy metals from being discharged out of the system. Moreover, the obtained heavy metal flocculation cake can be effectively used as a cement raw material.

[0047]

To attain the above object, according to the 20th aspect of the present invention, there is provided the desalter for a chlorine-containing powder according to the 19th aspect, further comprising

a third desalting washing-solution supply apparatus for supplying a third desalting washing-solution, which is different from the first desalting washing-solution and the second desalting washing-solution, for washing in the second solid-liquid separation apparatus to obtain a second flocculation cake and a fourth filtrate.

[0048]

According to the above constitution, the aforementioned desalting process for a chlorine-containing powder can be effectively carried out. Particularly, owing to the presence of the third desalting washing-solution supply apparatus for supplying a third desalting washing-solution, since the first flocculation cake (obtained in the heavy metal flocculation cake formation step) is washed with the third desalting washing-solution, a second flocculation cake from which chlorine is sufficiently removed can be obtained. Accordingly, the obtained heavy metal flocculation cake is more suitably used as a cement raw material.

[0049]

To attain the above object, according to the 21st aspect of the present invention, there is provided the desalter for a chlorine-containing powder according to the 19th aspect, further comprising,

a third solution-sending apparatus for sending the fourth filtrate obtained in washing treatment of the first flocculation cake performed in the second solid-liquid separation apparatus, to the first desalting washing-solution supply apparatus in order to recycle at least part of the fourth filtrate as the first desalting washing-solution.

[0050]

According to the above constitution, the aforementioned desalting process for a chlorine-containing powder can be effectively carried out. Particularly, owing to the presence of the third solution-sending apparatus, since a fourth filtrate (obtained in the first desalted cake washing treatment performed in the second solid-liquid separation apparatus) is at least partly recycled as the first desalting washing-solution, the amount of washing water to be used as the first desalting washing-solution can be reduced.

[0051]

To attain the above object, according to the 22nd aspect of the present invention, there is provided the desalter for a chlorine-containing powder according to 19th aspect, further comprising

a fourth solution-sending apparatus for sending the second filtrate obtained in the first desalted cake washing treatment performed in the first solid-liquid separation apparatus, to the third desalting washing-solution supply apparatus in order to use at least part of the second filtrate as the third desalting washing-solution, and/or,

a fifth solution-sending apparatus for sending the fourth filtrate obtained in the first desalted cake washing treatment performed in the second solid-liquid separation apparatus, to the third desalting washing-solution supply apparatus in order to recycle at least part of the fourth filtrate as the third desalting washing-solution, and

a third chlorine ion concentration monitoring apparatus for monitoring a chlorine ion concentration of the third desalting washing-solution.

[0052]

According to the above constitution, the aforementioned desalting process for a chlorine-containing powder can be effectively carried out. Particularly, owing to the presence of the fourth solution-sending apparatus, the second filtrate (obtained in the desalted cake washing step) is at least partly used as the third desalting washing-solution; and/or owing to the presence of the fifth solution-sending apparatus, the fourth filtrate (obtained in the heavy metal flocculation cake washing step) is at least partly recycled as the third desalting washing-solution. Accordingly, the amount of washing water to be used as the third desalting washing-solution can be reduced. If the second filtrate is used as part or whole of the third salting washing-solution, and/or the fourth filtrate is recycled as part or whole of the third salting washing-solution, the chlorine ion concentration of the third desalting washing-solution tends to increase, with the result that the concentration of the chlorine ion remaining in the second flocculation cake tends to increase. Accordingly, it tends to be difficult to use the cake, for example, as it is, as a cement raw material; however, owing to the presence of the third chlorine ion concentration monitoring apparatus for monitoring the chlorine ion concentration of the third desalting washing-solution, even when the chlorine ion concentration of the third desalting washing-solution reaches an unfavorable value for treatment, corrective action can be taken at an appropriate timing.

[0053]

To attain the above object, according to the 23rd aspect of the present invention, there is provided the desalter for a chlorine-containing powder according to the 22nd aspect, further comprising a fresh third desalting washing-solution supply apparatus for supplying a fresh third desalting washing-solution as the third desalting washing-solution to the third desalting washing-solution supply apparatus, in which

the third desalting washing-solution supply apparatus comprises a fifth supply regulation valve, which can change the amount of the third desalting washing-solution to be supplied from the third desalting washing-solution supply apparatus to the first desalted cake; at the same time, which enables discharge from the third desalting washing-solution supply apparatus;

the fresh third desalting washing-solution supply apparatus comprises a sixth supply regulation valve, which can change the amount of the washing solution to be supplied to the third desalting washing-solution supply apparatus; and

when the chlorine ion concentration of the third desalting washing-solution exceeds a third threshold (which is different from the first threshold and the second threshold), the fifth supply regulation valve is controlled to stop or reduce supply of the third desalting washing-solution from the third desalting washing-solution supply apparatus to the first flocculation cake, and to discharge part or whole of the third desalting washing-solution from the third desalting washing-solution supply apparatus, and then,

the sixth supply regulation valve of the fresh third desalting washing-solution supply apparatus is controlled to supply the fresh third desalting washing-solution to the third desalting washing-solution supply apparatus, as the third desalting washing-solution so as to satisfy the third threshold.

[0054]

According to the above constitution, the aforementioned desalting process for a chlorine-containing powder can be effectively carried out. Particularly, owing to the presence of the new third desalting washing-solution supply apparatus, even if a chlorine ion concentration monitored by the third chlorine ion concentration monitoring apparatus exceeds a third threshold, a fresh third desalting washing-solution can be supplied to the third desalting washing-solution supply apparatus so as to satisfy the third threshold.

Accordingly, when the chlorine ion concentration of the third desalting washing-solution exceeds a predetermined upper-limit concentration, it is difficult to use the heavy metal flocculation cake to be obtained directly as a cement raw material, as the case may be; however, it is possible to prevent chlorine ion concentration from exceeding the predetermined upper-limit concentration before happens. In this case, as the third threshold, a desired value may be appropriately set, for example, based on evaluation at the time of a trial run. More typically, for example, the chlorine ion concentration of the third desalting washing-solution for washing the first flocculation cake is 3.5 mass%. When the chlorine ion concentration is 3.5 mass% or less, the concentration of chlorine ion remaining in the second flocculation cake to be obtained is acceptable as the chlorine

ion concentration of the desalted cake, for example, to be directly used as a cement raw material. In contrast, when the chlorine ion concentration of the third desalting washing-solution exceeds 3.5 mass%, additional washing with a washing solution having a lower chlorine ion concentration, for example, industrial water (fresh water), is required, as the case may be, in order to obtain the cake that can be used as a cement raw material.

[0055]

To attain the above object, according to the 24th aspect of the present invention, there is provided the desalter for a chlorine-containing powder according to the 19th aspect, in which a same apparatus is used as the first solid-liquid separation apparatus and the second solid-liquid separation apparatus but respective treatments by the apparatuses are carried out.

[0056]

According to the above constitution, the same structure is employed in common as those of the solid-liquid separation apparatuses to be used. In this way, the constitutions of the apparatuses can be simplified.

Advantageous Effects of Invention

[0057]

As mentioned above, according to the present invention, in desalting a chlorine-containing powder with, e.g., sea water, the treatment can be efficiently carried out without generating unnecessary drainage. Accordingly, waste such as incineration ash is subjected to desalting treatment and then can be efficiently used as a cement raw material.

Brief Description of Drawings

[0058]

[Figure 1] Figure 1 is a flowchart showing the first embodiment of the desalting process for a chlorine-containing powder according to the present invention.

[Figure 2] Figure 2 is a flowchart showing the second embodiment of the desalting process for a chlorine-containing powder according to the present invention.

[Figure 3] Figure 3 is a diagram showing the first embodiment of the whole constitution of the desalter for a chlorine-containing powder according to the present invention.

[Figure 4] Figure 4 is a diagram showing the second embodiment of the whole constitution of the desalter for a chlorine-containing powder according to the present invention.

[Figure 5] Figure 5 is a flowchart showing the third embodiment the desalting process for a chlorine-containing powder according to of the present invention.

[Figure 6] Figure 6 is a flowchart showing the fourth embodiment of the desalting process for a chlorine-containing powder according to the present invention.

[Figure 7] Figure 7 is a flowchart showing the fifth embodiment of the desalting process for a chlorine-containing powder according to the present invention.

[Figure 8] Figure 8 is a flowchart showing the sixth embodiment of the desalting process for a chlorine-containing powder according to the present invention.

[Figure 9] Figure 9 is a flowchart showing the seventh embodiment the desalting process for a chlorine-containing powder according to of the present invention.

[Figure 10] Figure 10 is a diagram showing the third embodiment of the whole constitution of the desalter for a chlorine-containing powder according to the present invention.

[Figure 11] Figure 11 is a diagram showing the fourth embodiment of the whole constitution of the desalter for a chlorine-containing powder according to the present invention.

[Figure 12] Figure 12 is a diagram showing the fifth embodiment of the whole constitution of the desalter for a chlorine-containing powder according to the present invention.

[Figure 13] Figure 13 further specifically shows a flowchart showing the desalting process for a chlorine-containing powder according to the present invention, simultaneously with a diagram showing the whole constitution of the desalter for a chlorine-containing powder according to the present invention.

[Figure 14] Figure 14 is a diagram showing the whole constitution of the desalter for a chlorine-containing powder according to the present invention, in the case the same apparatus is employed as the first solid-liquid separation apparatus and second solid-liquid separation apparatus.

[Figure 15] Figure 15 further specifically shows a flowchart showing the desalting process for a chlorine-containing powder according to the present invention, simultaneously with a diagram showing the whole constitution of the desalter for a chlorine-containing powder according to the present invention, in the case the same apparatus is employed as the first solid-liquid separation apparatus and second solid-liquid separation apparatus.

Description of Embodiments

[0059]

As the target to be subjected to desalting process of the present invention, any powder may be used as long as it is a chlorine-containing powder containing and the powder is not particularly limited. Examples of the powder include incineration fly ash, flue ash and chlorine bypass dust. These are waste materials, which are, up to present, subjected to a desalting process and then effectively used as a cement raw material. Typical incineration fly ash, which is obtained when urban waste is incinerated, more specifically, fly ash obtained when household waste (in the specification, simply referred to as "incineration fly ash") is incinerated, generally contains chlorine (Cl) in a concentration of about 10 mass% to 30 mass%. Fly ash (in the specification, simply referred to as "flue ash") generated from a gasification melting furnace contains chlorine generally in a concentration of about 10 mass% to 40 mass%. In contrast, dust contained in cement kiln bleed extraction gas, i.e., chlorine bypass dust, contains chlorine generally in a concentration of about 10 mass% to 40 mass%.

[0060]

According to the present invention, it is possible to reduce the chlorine concentration of the chlorine-containing powder as mentioned above up to about 3 mass% or less and more typically about 2 mass% or less, and effectively use the resultant powder as, for example, a cement raw material. The chlorine concentration of the chlorine-containing powder can be determined by a method known in the art; for example, ISO 29581-2 Cement-Test methods-Part2: Chemical analysis by X-ray fluorescence or X-ray fluorescence analysis according to the standard testing method of the Japan Cement

Association, JCAS I-05, i.e., "Quantitative method of chlorine in cement by X-ray fluorescence analysis" is preferably mentioned.

[0061]

Now, the present invention will be more specifically described with reference to the accompanying drawings; however, the present invention is not limited to the embodiments described based on the drawings.

[0062]

Figure 1 is a flowchart showing the first embodiment of the desalting process for a chlorine-containing powder according to the present invention.

[0063]

As shown in this embodiment, the desalting process according to the present invention comprises a slurry formation step of forming slurry by blending a first desalting washing-solution with a chlorine-containing powder, a chlorine elution step of eluting chlorine contained in the chlorine-containing powder into a liquid phase within the slurry, a desalted cake formation step of separating part or whole of the liquid phase from the slurry, from which chlorine has been eluted, to obtain a first desalted cake and a first filtrate, and a desalted cake washing step of washing the first desalted cake with a second desalting washing-solution (which is different from the first desalting washing-solution) to obtain a second desalted cake and a second filtrate.

[0064]

The first filtrate obtained in the desalted cake formation step, and/or the second filtrate obtained in the desalted cake washing step are at least partly recycled as the first desalting washing-solution. The slurry step, the chlorine elution step, the desalted cake formation step and the desalted cake washing step are repeated every time a chlorine-containing powder is supplied. In this way, since the first desalting washing-solution and/or the second desalting washing-solution once used are at least partly recycled, washing water can be saved.

[0065]

Since the chlorine ion concentration of the first desalting washing-solution repeatedly used increases as the number of repeat uses increases, the concentration is

monitored and controlled. The "monitoring" herein includes constant monitoring of the chlorine ion concentration of the first desalting washing-solution or intermittent monitoring by taking samples at predetermined time intervals or arbitrary time intervals. The "control" includes, for example, feedback control of the chlorine ion concentration of the first desalting washing-solution so as not to exceed a predetermined threshold, or control of the chlorine ion concentration of the first desalting washing-solution so as not to exceed a predetermined threshold by adding, e.g., a fresh first desalting washing-solution and the second desalting washing-solution, sea water and/or industrial water (fresh water) at a predetermined timing and amount. The target of the "first desalting washing-solution" to be "monitored" or "controlled", is not only the state of the washing solution forming slurry together with a chlorine-containing powder, which can be directly monitored or controlled, but also the chlorine ion concentration of the first desalting washing-solution before the solution is added to the chlorine-containing powder (supplied). When the first desalting washing-solution is blended with, e.g., a fresh washing solution, at a predetermined blending ratio and recycled, the chlorine ion concentration of the first desalting washing-solution before the solution is added may be a target. In short, the chlorine ion concentration of the first desalting washing-solution constituting the slurry together with a chlorine-containing powder (supplied) may be substantially monitored or controlled.

[0066]

As mentioned above, it is possible to prevent the chlorine removal efficiency from a chlorine-containing powder from decreasing due to an extreme increase of the chlorine ion concentration of the first desalting washing-solution circulated within the system. More specifically, when the chlorine ion concentration of the first desalting washing-solution constituting slurry exceeds a predetermined threshold, the chlorine ion concentration of the first desalting washing-solution circulated within the system is arbitrarily controlled or a fresh first desalting washing-solution is used for treatment every time a chlorine-containing powder is supplied. Although the number of recycle uses of the first desalting washing-solution within the system varies depending on the object to be desalted, the number of recycle uses are roughly as follows. If the target to be desalted is

incineration fly ash, flue ash or chlorine bypass dust and sea water (sea water occupies 100%) is used as initial supply of the first desalting washing-solution for repeat treatment and repeatedly used without supply of the second desalting washing-solution to be recycled as the first desalting washing-solution, the treatment of the chlorine-containing powder to be supplied can be repeated about 2 to 4 times, more typically, about 2 or 3 times, without newly preparing the first desalting washing-solution.

[0067]

Figure 2 is a flowchart showing the second embodiment of the desalting process for a chlorine-containing powder according to the present invention.

[0068]

In this embodiment, in addition to the embodiment shown in Figure 1, the second filtrate from the desalted cake washing step mentioned above is at least partly recycled as a second desalting washing-solution. Owing to the recycle use, since at least part of the second desalting washing-solution once used can be recycled, the washing water can be saved.

[0069]

Since the chlorine ion concentration of the second desalting washing-solution repeatedly used increases as the number of repeat uses increases, the concentration is monitored and controlled. The "monitoring" and "control" are the same as defined in the case of the first desalting washing-solution. The target of the "second desalting washing-solution" to be "monitored" or "controlled" is not only the state of the washing solution washing the first desalted cake directly monitored or controlled. If the second desalting washing-solution is blended with a fresh washing solution at a predetermined blending ratio and recycled, the chlorine ion concentration of the second desalting washing-solution before blending may be targeted. In short, the chlorine ion concentration of the second desalting washing-solution constituting the washing solution for washing the first desalted cake may be substantially monitored or controlled.

[0070]

As mentioned above, it is possible to prevent an extreme increase of the chlorine ion concentration of the second desalting washing-solution circulating within the system,

thereby preventing a high residual concentration of chlorine ions in the second desalted cake obtained after washing of the first desalted cake, with the result that it becomes difficult to use the second desalted cake as it is as a cement raw material. For example, when the chlorine ion concentration of the second desalting washing-solution for washing the first desalted cake exceeds a predetermined threshold, the chlorine ion concentration of the second desalting washing-solution circulating within the system may be arbitrarily controlled or a fresh second desalting washing-solution may be employed and treatment is carried out every time a chlorine-containing powder is supplied. Although the number of recycle uses of the second desalting washing-solution within the system varies depending on the object to be desalted, the number of recycle uses are roughly as follows. If the target to be desalted is incineration fly ash, flue ash or chlorine bypass dust and industrial water (fresh water) is used as the second desalting washing-solution, the treatment of the chlorine-containing powder to be supplied can be repeated about 2 to 4 times, more typically, about 2 or 3 times, without newly preparing the second desalting washing-solution.

[0071]

As the first desalting washing-solution to be used in the present invention, water except sea water such as industrial water (fresh water) and a chlorine-containing water controlled in chlorine ion concentration by adding an adjuster for chlorine ion concentration, such as NaCl and KCl, may be used. However, in the region where a large amount of industrial water (fresh water) cannot be used or in the case where use of industrial water (fresh water) is limited in view of cost, it is convenient to use sea water. When sea water is used, the first desalting washing-solution may be completely (100 mass%) occupied by sea water or may be a mixture solution of sea water and water except sea water. If the mixture solution is used, sea water occupies preferably 50 mass% or more, and more preferably, 75 mass% or more, of the first desalting washing-solution. If sea water is basically used, since sea water has a buffer function, when a chlorine-containing powder such as incineration fly ash, which is waste containing heavy metals, is treated, heavy metals such as Pb and Zn are rarely eluted into a liquid phase of slurry having the first desalting washing-solution as a component, resulting in reduction in

treatment cost of drainage containing heavy metals. More specifically, the use amount of, for example, a redox potential regulator, an inorganic flocculant and a polymer flocculant required for insolubilization treatment for heavy metals (described later) can be reduced.

[0072]

The chlorine ion concentration of the first desalting washing-solution to be added at the initial time of the repetitive treatment is preferably 2 mass% to 5 mass%, more preferably, 2 mass% to 4 mass% and most preferably 2 mass% to 3 mass%. Particularly, as the first desalting washing-solution to be added at the initial time of the repetitive treatment, sea water itself (sea water occupied 100% of the washing solution) may be used. In this case, the chlorine ion concentration is about 3 mass%. When the chlorine ion concentration of the first desalting washing-solution to be added at the initial time of the repetitive treatment is less than the aforementioned range, it is difficult to directly use sea water as the first desalting washing-solution. In contrast, when the chlorine ion concentration of the first desalting washing-solution to be added at the initial time of the repetitive treatment exceeds the above range, the first desalting washing-solution cannot be repeatedly used for a number of times and the amount of washing water is not much saved.

[0073]

In contrast, the chlorine ion concentration of the first desalting washing-solution constituting slurry together with a chlorine-containing powder after a plurality of repetitive treatments, is preferably 3 mass% to 15 mass%, more preferably, 3 mass% to 10 mass% and particularly preferably 3 mass% to 5 mass%. If the chlorine ion concentration exceeds the range, the elution efficiency of chlorine into a liquid phase of slurry having the first desalting washing-solution as a component is low, with the result that chlorine removal efficiency becomes low.

[0074]

The second desalting washing-solution to be used in the present invention is similar to the first desalting washing-solution, in terms of availability of sea water and the like. When the second desalting washing-solution is recycled, the chlorine ion concentration of the second desalting washing-solution for washing a desalted cake at the

initial time of the repetitive treatment is preferably 3.5 mass% or less, more preferably 3 mass% or less and most preferably 2.5 mass% or less. The same applies to the chlorine ion concentration of the second desalting washing-solution for washing a desalted cake after a plurality of repetitive treatments. When the chlorine ion concentration exceeds the aforementioned range, chlorine ion remains in a high concentration in the desalted cake obtained after the desalted cake washing step, with the result that the cake cannot be used as it is as a cement raw material.

[0075]

Figure 3 is a diagram showing the first embodiment of the whole constitution of the desalter for a chlorine-containing powder according to the present invention. Desalter 1 according to this embodiment comprises elution vessel 2 for storing chlorine-containing powder P1 supplied from chlorine-containing powder supply apparatus 21 and first desalting washing-solution W1 supplied from first desalting washing-solution supply apparatus 22. In elution vessel 2, first desalting washing-solution W1 is blended with chlorine-containing powder P1 to make a slurry. The slurry is mixed/stirred for a predetermined time, with the result that chlorine contained in chlorine-containing powder P1 becomes to be dissolved into a liquid phase and eluted. In this embodiment, elution vessel 2 is equipped with a stirring device 24. The slurry is mixed/stirred for the predetermined time by rotating stirring blade 24a. Also, first solid-liquid separation apparatus 3 is present for separating slurry S1, which is discharged from elution vessel 2 and transported by slurry carrier device 4, into a solid and a liquid. In first solid-liquid separation apparatus 3, part or whole of the liquid phase is separately from slurry S1 to obtain first desalted cake C1 and first filtrate W3. Note that, in this embodiment, as first solid-liquid separation apparatus 3, a filter press is used.

[0076]

Also, first solid-liquid separation apparatus 3 is configured to wash first desalted cake C1 with second desalting washing-solution W2 supplied from the second desalting washing-solution supply apparatus 31. To describe more specifically, valve mechanism Va is provided in the middle of the route for transporting slurry S1 treated in elution vessel 2 into first solid-liquid separation apparatus 3, and another valve mechanism Vb is

provided in the middle of the route for delivering second desalting washing-solution W2 from second desalting washing-solution supply apparatus 31 to first solid-liquid separation apparatus 3. The valves direct to the flows of slurry S1 and second desalting washing-solution W2 selectively to first solid-liquid separation apparatus 3. First, slurry S1 is directed to go to first solid-liquid separation apparatus 3 and treated in first solid-liquid separation apparatus 3 to obtain first desalted cake C1. Then, second desalting washing-solution W2 is directed to go to first solid-liquid separation apparatus 3. Using solution W2, first desalted cake C1 is washed to obtain second desalted cake C2 and second filtrate W4. Also, first solid-liquid separation apparatus 3 is configured to send first filtrate W3 (generated in the aforementioned desalted cake formation step S) and second filtrate W4 (generated in the aforementioned desalted cake washing step) to the reservoir unit of first desalting washing-solution supply apparatus 22 by first solution-sending apparatus 5 composed of a predetermined solution-sending pump mechanism, via predetermined valve mechanism Vc and can be recycled as first desalting washing-solution W1. Note that, if desired, for example, when the chlorine ion concentration of first filtrate W3 is excessively high, part or whole of first filtrate W3 may be directed to go out of the system via predetermined valve mechanism Vd as drainage W5.

[0077]

The reservoir unit of first desalting washing-solution supply apparatus 22 is equipped with first chlorine ion concentration monitoring apparatus 7, which is configured to monitor the chlorine ion concentration of first desalting washing-solution W1 stored in the reservoir unit (of first desalting washing-solution supply apparatus 22). In this embodiment, a chlorine ion meter is employed as first chlorine ion concentration monitoring apparatus 7. Other than this, an analysis means generally used in the art, such as ion chromatography, may be used, which is applied to appropriately diluted water. First chlorine ion concentration monitoring apparatus 7 may be arranged at a position, as shown in this embodiment, at which the chlorine ion concentration of the content in the reservoir unit of first desalting washing-solution supply apparatus 22 can be directly measured or at a position just before the washing solution enters the reservoir unit (of first desalting washing-solution supply apparatus 22). In short, any position is acceptable as

long as the chlorine ion concentration of first desalting washing-solution W1 can be estimated.

[0078]

First desalting washing-solution supply apparatus 22 is equipped with first supply regulation valve 22a consisting of a predetermined regulation valve mechanism.

Whether the content of the reservoir unit of first desalting washing-solution supply apparatus 22 is directed to go to elution vessel 2 as first desalting washing-solution W1 or directed to go out of the system as drainage W5 can be controlled by first supply regulation valve 22a as well as the amounts of the solutions directed to these can be controlled.

[0079]

Desalter 1 according to this embodiment further comprises a fresh first desalting washing-solution supply apparatus 23 for supplying fresh first desalting washing-solution W1a to first desalting washing-solution supply apparatus 22. Supply apparatus 23 is configured to successfully add solution W1a as a part of the first desalting washing-solution of the system, if desired, via second supply regulation valve 23a consisting of a predetermined regulation valve mechanism or successfully replace part or whole of the first desalting washing-solution recycled multiple times. In this case, the content of the reservoir unit of first desalting washing-solution supply apparatus 22 may be appropriately directed to go out of the system as drainage W5 in the amount corresponding to the supply amount of the fresh first desalting washing-solution W1a.

[0080]

Second desalting washing-solution supply apparatus 31 is equipped with third supply regulation valve 31a consisting of a predetermined regulation valve mechanism.

Whether the content of the reservoir unit of second desalting washing-solution supply apparatus 31 is directed to go to first solid-liquid separation apparatus 3 as second desalting washing-solution W2 or directed to go out of the system as drainage W5 can be controlled by third supply regulation valve 31a as well as the amounts of the solutions directed to these can be controlled.

[0081]

Desalter 1 according to this embodiment comprises fresh second desalting washing-solution supply apparatus 32 for supplying fresh second desalting washing-solution W2a to second desalting washing-solution supply apparatus 31. The supply apparatus 32 is configured to successfully add solution W2a as a part of the second desalting washing-solution of the system, if desired, via fourth supply regulation valve 32a consisting of a predetermined regulation valve mechanism or replace part or whole of the second desalting washing-solution recycled multiple times. In this case, the content of the reservoir unit of second desalting washing-solution supply apparatus 31 may be appropriately directed to go out of the system as drainage W5 in the amount corresponding to the supply amount of the fresh second desalting washing-solution W2a.

[0082]

Note that, the contents of the reservoir units of first desalting washing-solution supply apparatus 22 and/or second desalting washing-solution supply apparatus 31 may be discharged out of the system by directing the contents to go to the route to elution vessel 2 and/or first solid-liquid separation apparatus 3 at a desired timing such as a time point when slurry S1 is not treated and through the drainage channel provided to first solid-liquid separation apparatus 3 via a predetermined valve mechanism Vd. Drainage W5 may be subjected to a treatment for removing heavy metals, as described later, and thereafter, discharged out of the system.

[0083]

In elution vessel 2, chlorine-containing powder P1 and first desalting washing-solution W1 are mixed and stirred to obtain slurry S1. The mass ratio (W1/P1) of chlorine-containing powder P1 and first desalting washing-solution W1 in this mixture is preferably 4 to 10, more preferably 4 to 7 and particularly preferably 4 to 5. If the mass ratio (W1/P1) is smaller than 4, elution of chlorine from chlorine-containing powder P1 becomes insufficient as the case may be. In contrast, if the mass ratio (W1/P1) is larger than 10, the amount of drainage generated from first solid-liquid separation apparatus 3 in the following step increases.

[0084]

As described above, the chlorine ion concentration of first desalting washing-solution W1 of slurry S1 constituted by mixing W1 with chlorine-containing powder P1 in elution vessel 2 is preferably 3 mass% to 15 mass%, more preferably 3 mass% to 10 mass% and particularly preferably 3 mass% to 5 mass%. More specifically, since water having a higher chlorine concentration than sea water can be used as first desalting washing-solution W1, when the chlorine concentration of the liquid phase of slurry S1, which is to be discharged by solid-liquid separation in a later step, is 15 mass% or less, the liquid phase can be used as first desalting washing-solution W1. In this case, the amount of drainage generated from the desalting process for a chlorine-containing powder can be effectively reduced. In contrast, when the chlorine ion concentration of first desalting washing-solution W1 exceeds the above range, the amount of chlorine eluted from chlorine-containing powder P1 is reduced, with the result that chlorine removal efficiency becomes low.

[0085]

As described above, a lower limit, 3 mass%, of the chlorine concentration of first desalting washing-solution W1 is the value determined when sea water is used as first desalting washing-solution W1. If sea water is basically used as first desalting washing-solution W1 for use in desalting chlorine-containing powder P1, pH of slurry S1 is stably kept within the range of weak alkali, i.e., pH 11 to 12, by the sea water effectively serving as a pH buffering solution of carbonate base. Since the pH of slurry S1 is stabilized, elution of amphoteric metal components such as Pb and Zn contained in chlorine-containing powder P1 into the liquid phase is conceivably suppressed.

[0086]

The stirring time of slurry S1 by stirring blade 24a in elution vessel 2 is preferably 10 minutes to 3 hours, more preferably 10 minutes to 2 hours and further preferably 15 minutes to 1 hour. If the stirring time for slurry S1 is shorter than 10 minutes, elution of chlorine from chlorine-containing powder P1 becomes insufficient, as the case may be. In contrast, if the stirring time of slurry S1 is longer than 3 hours, the amount of the chlorine-containing powder P1 to be desalted per unit time reduces.

[0087]

As for the temperature condition for treating slurry S1 in elution vessel 2, as the temperature increases, the amount of chlorine eluted from chlorine-containing powder P1 increases. In view of cost involved in the treatment, the temperature is preferably fallen within the normal temperature range of 5°C to 30°C and more preferably 15°C to 30°C. Elution vessel 2 may be equipped with a predetermined temperature control apparatus such as a heater.

[0088]

As slurry carrier device 4 for transporting slurry S1 from elution vessel 2 to first solid-liquid separation apparatus 3, a slurry pump generally used in the art such as a screw pump and a mohno pump, may be used.

[0089]

In first solid-liquid separation apparatus 3, slurry S1 is separated into first desalted cake C1 and first filtrate W3. The salt content (C_{Cl} (mass%)) of first desalted cake C1 separated can be approximated by using moisture content (C_W (mass%)) of first desalted cake C1, the salt content (W_{Cl} (mass%)) of separated first filtrate W3, and water insoluble salt amount (C_{Cl-NS} (mass%)) of first desalted cake C1 in accordance with the following expression (1):

$$C_{Cl} \approx C_W \times W_{Cl} + C_{Cl-NS} \dots (1)$$

Note that the water insoluble salt content (C_{Cl-NS}) of chlorine-containing powder P1 is generally 0.8 mass% to 1.2 mass%.

[0090]

Since most of chlorine in chlorine-containing powder P1 is dissolved in first filtrate W3 in elution vessel 2, first desalted cake C1 obtained by solid-liquid separation of slurry S1 is constituted of a solid phase substantially containing no chlorine and a liquid phase having chlorine dissolved therein. Since the liquid phase contained in first desalted cake C1 is the same as first filtrate W3 obtained by solid-liquid separation, the above approximate expression (1) is established. From this, in order to reduce the salt content (C_{Cl}) of first desalted cake C1, the moisture content (C_W) of first desalted cake C1 may be reduced.

[0091]

For the reason mentioned above, as first solid-liquid separation apparatus 3, an apparatus which can reduce the moisture content of first desalted cake C1 to be obtained, is used; in particular, a filter press is preferably used, as is in this embodiment. The moisture content of first desalted cake C1 obtained by solid-liquid separation of slurry S1 containing chlorine-containing powder P1 by the filter press is usually 50 mass% or less. [0092]

In first solid-liquid separation apparatus 3, first desalted cake C1 obtained once by solid-liquid separation and having a moisture content of about 50 mass% is washed with second desalting washing-solution W2. In this manner, the liquid phase contained in first desalted cake C1 is almost all replaced with second desalting washing-solution W2. [0093]

More specifically, to first desalted cake C1 present in a filter chamber of first solid-liquid separation apparatus 3 (filter press) and having a moisture content of about 50 mass%, second desalting washing-solution W2, which is supplied from second desalting washing-solution supply apparatus 31, is supplied from the filter plate on the side surface of the desalted cake constituting the filter room is supplied under pressure to allow second desalting washing-solution W2 to permeate in first desalted cake C1 and discharge through the filter plate on the other side surface constituting the filter room. In this manner, the liquid phase contained in first desalted cake C1 is replaced with second desalting washing-solution W2. This constitutes second desalted cake C2. Note that, the desalted cake having a moisture content of about 50 mass% is washed above. [0094]

As described above, as second desalting washing-solution W2, sea water, fresh water and second filtrate W4 (if second filtrate W4 is recycled), are used alone or in combination. If second desalting washing-solution W2 having a chlorine ion concentration of 3.5 mass% or less is used herein, chlorine content of the second desalted cake C2 to be obtained can be controlled to be at least 2 mass% or less of the whole wet mass of the cake. Note that, even if fresh water is used as second desalting washing-solution W2, the time required for second desalting washing-solution W2 to pass through first desalted cake C1 in the above washing step is relatively very short. Because of this,

unlike the elution step from the above slurry, amphoteric metal components immobilized in the solid phase of first desalted cake C1 rarely elute into a liquid phase.

[0095]

The amount of second desalting washing-solution W2 used in the above desalted cake washing step is preferably equal or greater than the amount of chlorine-containing powder P1 of first desalted cake C1, more preferably, double or more, and particularly preferably 4 times or more. If the amount of second desalting washing-solution W2 used herein is less than that of chlorine-containing powder P1, it is sometimes impossible to sufficiently replace the liquid phase of first desalted cake C1 having a moisture content of about 50 mass% with second desalting washing-solution W2. In contrast, if the use amount of second desalting washing-solution W2 exceeds 4 times of that of chlorine-containing powder P1, the amount of drainage discharged from the desalted cake washing step, increases.

[0096]

Replacement of the liquid phase of first desalted cake C1 with second desalting washing-solution W2 may be checked by monitoring the chlorine ion concentration of second filtrate W4 discharged in the desalted cake washing step and confirming that the chlorine concentration monitored is equal to or close to the chlorine ion concentration of second desalting washing-solution W2. More specifically, second filtrate W4 is directly subjected to analysis generally used in the art such as ion chromatography and measurement by a chlorine ion meter, or after second filtrate W4 is appropriately diluted with water and the subjected to the analysis.

[0097]

In the embodiment shown in Figure 3, it is designed that first filtrate W3 and/or second filtrate W4 are sent from first solid-liquid separation apparatus 3 by first solution-sending apparatus 5 to the reservoir unit of first desalting washing-solution supply apparatus 22 and recycled as first desalting washing-solution W1. More specifically, in this embodiment, first desalting washing-solution W1 is basically recycled, thereby reducing the amount of drainage discharged in this step. Note that, in the embodiment shown in Figure 3, first filtrate W3, and/or second filtrate W4 from first solid-liquid

separation apparatus 3 are sent by first solution-sending apparatus 5 to the reservoir unit of first desalting washing-solution supply apparatus 22; however, filtrate W3, and/or filtrate W4 may be directly sent to elution vessel 2. First desalting washing-solution W1 is basically recycled; however, part of solution W1 may be diluted with fresh first desalting washing-solution W1a (which is supplied from the aforementioned fresh first desalting washing-solution supply apparatus 23 to first desalting washing-solution supply apparatus 22 via second supply regulation valve 23a) to reduce chlorine ion concentration, and recycled. In this case, as the timing of adding fresh first desalting washing-solution W1a to a single circulation and blending ratio thereof, a desired timing and blending ratio may be appropriately determined, for example, based on the evaluation in a trial run.

[0098]

As described in the above, first desalting washing-solution supply apparatus 22 is equipped with first supply regulation valve 22a consisting of a predetermined regulation valve, by which the content of the reservoir unit can be discharged toward the outside the system, as drainage W5. Note that, as to first filtrate W3 and second filtrate W4 from first solid-liquid separation apparatus 3, a route of discharging W3 and W4 toward the outside the system via a predetermined valve mechanism Vd as drainage W5 is provided. Accordingly, since drainage W5 is discharged toward outside the system in an amount equivalent to the amount of fresh first desalting washing-solution W1a added, or in some cases, the amount of fresh second desalting washing-solution W2a added, the range of the total amount of the first desalting washing-solution W1 recycled within the system can be appropriately controlled.

[0099]

In the embodiment shown in Figure 3, the desalter comprises control apparatus 201. Control apparatus 201 is configured to receive measurement signals from first chlorine ion concentration monitoring apparatus 7 and send predetermined instruction signals based on the signals to first supply regulation valve 22a provided to first desalting washing-solution supply apparatus 22, second supply regulation valve 23a provided to new first desalting washing-solution supply apparatus 23 and first solution-sending apparatus 5. According to the configuration, for example, if the value measured by first chlorine ion concentration

monitoring apparatus 7 exceeds a predetermined threshold, control apparatus 201 sends instruction signals to first solution-sending apparatus 5 based on the measurement results. Based on the instruction signals, first solution-sending apparatus 5 is operated to stop solution sending of first filtrate W3 and second filtrate W4. Based on the instruction signals to first supply regulation valve 22a and second supply regulation valve 23a sent by control apparatus 201, these regulation valve mechanisms are operated as described above to supply fresh first desalting washing-solution W1a to first desalting washing-solution W1 circulating within the system to reduce chlorine ion concentration. In this way, control can be made in a feedback manner. The supply amount of fresh first desalting washing-solution W1a may be designed to be automatically determined in accordance with a measurement value by first chlorine ion concentration monitoring apparatus 7. The operation for supply can be designed to be automatically and continuously carried out.

[0100]

In the embodiment shown in Figure 3, control apparatus 201 may control a predetermined valve mechanism (not shown in the figure) to control the amount of solution (or amount of slurry) to be sent via the valve mechanism. For example, valve mechanism Vc may be controlled by control apparatus 201 to control the solution-sending of first filtrate W3 and second filtrate W4 at the time of the aforementioned feedback control.

[0101]

In the embodiment shown in Figure 3, second desalted cake C2 discharged from first solid-liquid separation apparatus 3 is designed to be transported by desalted cake carrier device 9 to a cement manufacturing apparatus. In this case, as desalted cake carrier device 9, any device can be used without particular limitation as long as a cake having a moisture content of about 50 mass% can be transported; for example, a device generally used in the art such as a belt conveyor can be used. If the distance between a site at which a treatment is carried out by a desalter and a site at which production is carried out by a cement manufacturing apparatus is considerably long, a delivery vehicle such as a truck and a ship can be employed other than a carrier device such as a belt conveyor.

[0102]

Figure 4 shows the whole constitution of the desalter for a chlorine-containing powder according to the second embodiment of the present invention. In desalter 10 according to this embodiment, a route for circulating second filtrate W4 discharged in the desalted cake washing step carried out in first solid-liquid separation apparatus 3 as second desalting washing-solution is provided in addition to the constitution of the desalter shown in Figure 3. To be more specific, while first filtrate W3 and/or second filtrate W4 (generated in a desalted cake formation step and/or desalted cake washing step carried out in first solid-liquid separation apparatus 3) are designed to be sent by first solution-sending apparatus 5 (consisting of a predetermined liquid feed pump mechanism) via a predetermined valve mechanism Ve to the reservoir unit of first desalting washing-solution supply apparatus 22 and can be recycled as first desalting washing-solution W1; second filtrate W4 (discharged in the desalted cake washing step carried out in first solid-liquid separation apparatus 3) is designed to be sent by second solution-sending apparatus 6 (consisting of a predetermined liquid feed pump mechanism) via predetermined valve mechanism Vf to the reservoir unit of second desalting washing-solution supply apparatus 31 and can be recycled also as second desalting washing-solution W2. Note that, if desired, for example, when the chlorine ion concentration of second filtrate W4 becomes excessively high, part or whole of second filtrate W4 may be directed to go out of the system as drainage W5 via predetermined valve mechanism Vc.

[0103]

The reservoir unit of second desalting washing-solution supply apparatus 31 is equipped with second chlorine ion concentration monitoring apparatus 8 for monitoring chlorine ion concentration of second desalting washing-solution W2 stored in the reservoir unit (of second desalting washing-solution supply apparatus 31). As second chlorine ion concentration monitoring apparatus 8, the same apparatus as used in first chlorine ion concentration monitoring apparatus 7 (described above) may be used. In measuring the concentration of chlorine ion, a target solution may be appropriately diluted with water and measured. For example, analysis means generally used in the art such as a chlorine ion meter and ion chromatography may be used. In this embodiment, a chlorine ion

meter is used. Second chlorine ion concentration monitoring apparatus 8 may be arranged at a position at which the chlorine ion concentration of the content in the reservoir unit of second desalting washing-solution supply apparatus 31 can be directly measured or at a position just before a solution enters the reservoir unit (of second desalting washing-solution supply apparatus 31). In short, any position is acceptable as long as the chlorine ion concentration of second desalting washing-solution W2 can be estimated.

[0104]

In the embodiment shown in Figure 4, second filtrate W4 from first solid-liquid separation apparatus 3 is sent by second solution-sending apparatus 6 to the reservoir unit of second desalting washing-solution supply apparatus 31 and recycled as second desalting washing-solution W2. More specifically, in this embodiment, second desalting washing-solution W2 is basically recycled, thereby reducing the amount of drainage discharged in this step. Note that, although second desalting washing-solution W2 is basically recycled, part of solution W2 may be diluted with fresh second desalting washing-solution W2a (which is supplied from the aforementioned fresh second desalting washing-solution supply apparatus 32 to second desalting washing-solution supply apparatus 31 via fourth supply regulation valve 32a) to reduce chlorine ion concentration, and recycled. In this case, as the timing of adding fresh second desalting washing-solution W2a to a single circulation and blending ratio thereof, a desired timing and blending ratio may be appropriately determined, for example, based on the evaluation in a trial run.

[0105]

As described in the above, second desalting washing-solution supply apparatus 31 is equipped with third supply regulation valve 31a consisting of a predetermined regulation valve mechanism, by which the content of the reservoir unit can be discharged toward the outside the system, as drainage W5. Note that as to first filtrate W3 and/or second filtrate W4 from first solid-liquid separation apparatus 3, a route of discharging W3 and W4 toward the outside the system via predetermined valve mechanism Vc as drainage W5 is provided. Accordingly, since drainage W5 is discharged toward outside the system in an amount equivalent to the amount of fresh second desalting washing-solution

W2a added, or in some cases, the amount of fresh first desalting washing-solution W1a added, the range of the total amount of the second desalting washing-solution W2 recycled within the system can be appropriately controlled.

[0106]

In the embodiment shown in Figure 4, as is the same as the embodiment shown in Figure 3, the desalter comprises control apparatus 201, which enables feedback control by first chlorine ion concentration monitoring apparatus 7 described above and feedback control by second chlorine ion concentration monitoring apparatus 8 simultaneously or independently. More specifically, control apparatus 201 is configured to receive measurement signals from second chlorine ion concentration monitoring apparatus 8 and send predetermined instruction signals based on the signals to third supply regulation valve 31a provided to second desalting washing-solution supply apparatus 31, and fourth supply regulation valve 32a provided to fresh second desalting washing-solution supply apparatus 32, and second solution-sending apparatus 6. Accordingly, for example, if the value measured by second chlorine ion concentration monitoring apparatus 8 exceeds a predetermined threshold, control apparatus 201 sends instruction signals to second solution-sending apparatus 6 based on the measurement results. Based on the instruction signals, second solution-sending apparatus 6 is operated to stop feeding of second filtrate W4. Based on the instruction signals to third supply regulation valve 31a and fourth supply regulation valve 32a sent by control apparatus 201, these regulation valve mechanisms are operated to supply fresh second desalting washing-solution W2a to second desalting washing-solution W2 circulating within the system to reduce chlorine ion concentration in a feedback manner. The supply amount of fresh second desalting washing-solution W2a may be designed to be automatically determined in accordance with a measurement value by second chlorine ion concentration monitoring apparatus 8. The operation for supply can be designed to be automatically and continuously carried out.

[0107]

In the embodiment shown in Figure 4, control apparatus 201 may control a predetermined valve mechanism (not shown in the figure) to control the amount of solution (or amount of slurry) to be sent via the valve mechanism. For example, valve

mechanism Ve may be controlled by control apparatus 201 to control the solution-sending of first filtrate W3 and second filtrate W4 at the time of the aforementioned feedback control. For example, valve mechanism Vf may be controlled by control apparatus 201 to control the solution-sending of second filtrate W4 at the time of the aforementioned feedback control.

[0108]

Generally, the drainage generated by a desalting process of e.g., incineration ash, contains heavy metals such as Cr, Pb and Zn together with chlorine eluted therein. It is difficult to discharge the drainage at it is out of the system as a drainage satisfying environmental standard. Figure 5 to Figure 9 show flowcharts of the desalting process for a chlorine-containing powder according to other embodiments of the present invention. In these embodiments, a process for removing heavy metals contained in the drainage generated in the desalting process according to the present invention is applied.

[0109]

Figure 5 shows a flowchart of the desalting process for a chlorine-containing powder according to the third embodiment of the present invention. In this embodiment, the process comprises a drainage collection step of collecting one or two or more of washing solutions selected from the group consisting of the first filtrate and the second filtrate generated by the aforementioned desalting treatment, the first desalting washing-solution recycled as the first desalting washing-solution and the second desalting washing-solution recycled as the second desalting washing-solution, and not be subjected to recycling as the first desalting washing-solution or the second desalting washing-solution, as drainage; a heavy metal insolubilization step of insolubilizing heavy metals contained in the drainage as a flocculate like floc by adding a heavy metal scavenger to the drainage collected; and a heavy metal flocculation cake formation step of obtaining a flocculation cake (also referred to as a "first flocculation cake") and a third filtrate by separating part or whole of a liquid phase from a flocculation (floc)-containing solution containing heavy metals insolubilized. Owing the process, it is possible to separate and remove heavy metals contained in the drainage generated by the desalting process of the present

invention as a heavy metal flocculation cake from the liquid phase of the drainage. The obtained heavy metal flocculation cake can be effectively used as a cement raw material. [0110]

More specifically, first, washing solutions which are not to be recycled as the first desalting washing-solution or the second desalting washing-solution in the desalting process are collected as drainage. To the drainage collected, a heavy metal scavenger is added to insolubilize the heavy metals contained therein as a flocculate like floc. As the heavy metal scavenger, a combination of a pH adjuster and/or a redox potential regulator and at least one flocculant such as an inorganic flocculant and a polymer flocculant is mentioned.

[0111]

In the heavy metal insolubilization step, the redox potential (ORP) of the drainage collected in the above is preferably -200 mV or less and more preferably, -450 mV to -200 mV. If the redox potential (of the collected drainage) is -200 mV or less, even if chlorine is contained in a high concentration, the heavy metals dissolved in the drainage can be efficiently insolubilized. As the redox potential regulator, a redox potential regulator generally used in the art may be used; for example, sodium hydrogen sulfide (sodium hydro sulfide) is preferable. The inorganic flocculant and organic flocculant are used for forming a large flocculate like floc from small-size heavy metal particles insolubilized by controlling redox potential, thereby facilitating separation of the heavy metals from the liquid phase. Examples of the inorganic flocculant include iron chloride (FeCl_3) and polyaluminum chloride (PAC). These may be used in combination (two or more types). If iron chloride and poly aluminum chloride are used as an inorganic flocculant, even if chlorine is contained in a high concentration, small-size heavy metal particles insolubilized can be efficiently flocculated like floc. At this time, as the amount of an inorganic flocculant to be added to the liquid phase, an optimal amount thereof is desirably determined based on previous evaluation using a target solution; however, if it is difficult to perform previous evaluation and the like, it is satisfactory that the amount of an inorganic flocculant corresponds to the amount of a redox potential regulator to be added, in the term of molar equivalent. The organic flocculant is used for producing a large

flocculent-like flocculate from a small flocculent-like flocculate containing heavy metals and formed with the help of an inorganic flocculant. As a polymer flocculant, a flocculant for use solid-liquid separation in an alkaline region, such as an anionic flocculant containing a polyacrylamide as a main component. As the amount of the polymer flocculant to be added to the liquid phase, an optimal amount thereof is desirably determined based on previous evaluation using a target liquid, similarly to the case of determining the addition amount of the inorganic flocculant; however, if it is difficult to perform previous evaluation and the like, it is sufficient that the polymer flocculant may be added in the amount corresponding to 20 ppm to 30 ppm of the drainage collected.

[0112]

In the heavy metal insolubilization step, pH of the drainage (collected in the above) is preferably 7 to 11, more preferably 7.5 to 10.5 and most preferably 8 to 10.5. If the pH of the drainage (collected in the above) is 7 to 11, insolubilization of heavy metals can be effectively carried out. More specifically, for example, if the same amounts of inorganic flocculant and polymer flocculant are used at the same redox potential, pH of the drainage collected and the removal rate of Pb have the following relationship: the removal rate of Pb at pH 6 is 84.2%; 98.9% at pH 12; and 99.8% at pH 10.5. Note that, as the pH adjuster for use in adjusting pH of the drainage collected, a pH adjustment generally used in the art, such as sulfuric acid and sodium hydroxide, may be used.

[0113]

In a typical embodiment of the heavy metal insolubilization step, the drainage collected in the above is, if necessary, adjusted in pH by a pH adjuster, and then, a redox potential regulator is added. The solution is stirred/mixed for 5 minutes to 20 minutes to insolubilize heavy metals contained in the drainage as a small insoluble matter. Thereafter, an inorganic flocculant is added and the solution is stirred/mixed for 5 minutes to 20 minutes. Further, a polymer flocculant is added and the solution is stirred/mixed for 5 minutes to 20 minutes. In this manner, insolubilized heavy metals are formed into a larger flocculate like floc. In contrast, into a liquid phase, chlorine is dissolved in a high concentration. A heavy metal-containing flocculation (floc) is suspended in the liquid

phase. The flocculation (floc)-containing solution thus constituted is usually in the state of slurry.

[0114]

In contrast, in the heavy metal flocculation cake formation step, part or whole of a liquid phase is separated from the solution containing an insolubilized heavy-metal flocculation (floc) by using the same solid-liquid separation means as used in the chlorine-containing powder desalting process, such as a filter press to obtain heavy metal flocculation cake (first flocculation cake) and a third filtrate.

[0115]

Figure 6 shows a flowchart of the desalting process for a chlorine-containing powder according to the fourth embodiment of the present invention. In the embodiment, in addition to the embodiment shown in Figure 5, a heavy metal flocculation cake washing step is provided. The first flocculation cake is washed with the third desalting washing-solution to obtain the heavy metal flocculation cake washed (hereinafter referred to also as "second flocculation cake") and a fourth filtrate. In this way, the second flocculation cake from which chlorine is sufficiently removed can be obtained and more suitably used as a cement raw material.

[0116]

Figure 7 shows a flowchart of the desalting process for a chlorine-containing powder according to the fifth embodiment of the present invention. In this embodiment, in addition to the embodiment shown in Figure 6, the fourth filtrate obtained in the heavy metal flocculation cake washing step is at least partly recycled as the first desalting washing-solution for use in the aforementioned desalting process. In this way, the amount of washing water to be used as the first desalting washing-solution can be reduced.

[0117]

Figure 8 shows a flowchart of the desalting process for a chlorine-containing powder according to the sixth embodiment of the present invention. In this embodiment, in addition to the embodiment shown in Figure 6, the second filtrate obtained in the desalted cake washing step in the aforementioned desalting process is at least partly used as the third desalting washing-solution for washing heavy metal flocculation cake. In this

manner, washing treatment in the heavy metal flocculation cake washing step is carried out while controlling the chlorine ion concentration of the third desalting washing-solution. In this way, the amount of washing water to be used as the third desalting washing-solution can be reduced. In addition, if the second filtrate is used as part or whole of the third desalting washing-solution, the chlorine ion concentration of the third desalting washing-solution tends to increase, with the result that, the concentration of chlorine ion remaining in the second flocculation cake tends to increase. Accordingly, it tends to be difficult to use the cake, for example, as it is, as a cement raw material; however, since a treatment is carried out while controlling the chlorine ion concentration of the third desalting washing-solution, when the chlorine ion concentration of the third desalting washing-solution becomes unsuitable for treatment, corrective action can be taken at an appropriate timing.

[0118]

Figure 9 shows a flowchart of the desalting process for a chlorine-containing powder according to the seventh embodiment of the present invention. In this embodiment, in addition to the embodiment shown in Figure 6, the fourth filtrate obtained in the heavy metal flocculation cake washing step is at least partly recycled as the third desalting washing-solution. In this manner, washing treatment in the heavy metal flocculation cake washing step is carried out while controlling the chlorine ion concentration of the third desalting washing-solution. In this way, the amount of washing water to be used as the third desalting washing-solution can be reduced. In addition, if the fourth filtrate is recycled as part or whole of the third desalting washing-solution, the chlorine ion concentration of the third desalting washing-solution tends to increase, with the result that the concentration of chlorine ion remaining in the second flocculation cake tends to increase. Accordingly, it tends to be difficult to use the cake, for example, as it is, as a cement raw material; however, since a treatment is carried out while controlling the chlorine ion concentration of the third desalting washing-solution, when the chlorine ion concentration of the third desalting washing-solution becomes unsuitable for treatment, corrective action can be taken at an appropriate timing.

[0119]

As the third desalting washing-solution to be used in the present invention, e.g., sea water may be used as is the same as in the first desalting washing-solution and second desalting washing-solution to be used in the aforementioned desalting process. However, if the third desalting washing-solution is recycled, the chlorine ion concentration of the third desalting washing-solution for washing a desalted cake at the initial time of the repetitive treatment is preferably 3.5 mass% or less, more preferably 3 mass% or less and most preferably 2.5 mass% or less. The same applies to the chlorine ion concentration of the third desalting washing-solution for washing a desalted cake after a plurality of repetitive treatments. When the chlorine ion concentration exceeds the aforementioned range, chlorine ion remains in a high concentration in the desalted cake obtained after the heavy metal flocculation cake washing step, with the result that the cake cannot be used as a cement raw material.

[0120]

As shown in the embodiment described in Figure 8, when the second filtrate obtained in the desalted cake washing step of the desalting process is used as the third desalting washing-solution, as the chlorine ion concentration of the third desalting washing-solution increases as the number of repeat uses of second filtrate (of the desalting process) increases. Thus, the chlorine ion concentration is monitored and controlled. As shown in the embodiment described in Figure 9, as the chlorine ion concentration of the third desalting washing-solution repeatedly used increases as the number of repeats increases. Thus, the chlorine ion concentration is monitored and controlled. The "monitor" and "control" are the same as defined in the first desalting washing-solution and the second desalting washing-solution of the desalting process. The target of the "third desalting washing-solution" to be "monitored" or "controlled" is not only the state of the washing solution washing the first flocculation cake directly monitored or controlled. If the third desalting washing-solution is blended with a fresh washing solution at a predetermined blending ratio and recycled, the chlorine ion concentration of the third desalting washing-solution before blending may be targeted. In short, the chlorine ion concentration of the third desalting washing-solution constituting the washing solution for washing the first flocculation cake may be substantially monitored and controlled.

[0121]

As mentioned above, it is possible to prevent occurrence of the event where the chlorine ion concentration of the third desalting washing-solution circulating within the system excessively increases and chlorine ion remains in a high concentration in the second flocculation cake obtained after washing first flocculation cake, with the result that it is difficult to use the cake as it is as a cement raw material. For example, when the chlorine ion concentration of the third desalting washing-solution for washing the first flocculation cake exceeds a predetermined threshold, the chlorine ion concentration of the third desalting washing-solution circulating the system is arbitrarily adjusted or a fresh third desalting washing-solution is used and treatment is carried out every time a chlorine-containing powder is supplied.

[0122]

Referring to Figure 10 to Figure 12, the desalting process for a chlorine-containing powder and a desalter for a chlorine-containing powder according to the present invention will be more specifically described.

[0123]

Figure 10 shows a diagram showing the whole constitution of the desalter for a chlorine-containing powder according to the third embodiment of the present invention. Desalter 20 (according to this embodiment) comprises a heavy metal insolubilization reaction vessel 11, which is configured to collect and store one or two or more of washing solutions, which are selected from the group consisting of the first filtrate and the second filtrate described above, a first desalting washing-solution recycled as the first desalting washing-solution and a second desalting washing-solution recycled as the second desalting washing-solution, and which are not to be reused as the first desalting washing-solution or second desalting washing-solution as drainage.

[0124]

More specifically, in the embodiment shown in Figure 10, when first filtrate W3 and/or second filtrate W4 are directed to go from solid-liquid separation apparatus 3 (mentioned above) out of the system via predetermined valve mechanism Vd as drainage W5, the filtrate W3 and/or W4 can be collected and stored in heavy metal insolubilization

reaction vessel 11. When the first desalting washing-solution not to be reused is directed to go from the reservoir unit of first desalting washing-solution supply apparatus 22 (in the aforementioned desalting process) out of the system via first supply regulation valve 22a and further via predetermined valve mechanisms Vg and Vh, as drainage W5, the first desalting washing-solution can be collected and stored in heavy metal insolubilization reaction vessel 11. Also when the second desalting washing-solution not to be reused is directed to go from the reservoir unit of second desalting washing-solution supply apparatus 31 (in the aforementioned desalting process) out of the system via first supply regulation valve 31a and further via predetermined valve mechanisms Vi and Vh, as drainage W5, the second desalting washing-solution can be collected and stored in heavy metal insolubilization reaction vessel 11. Further, as described above, the contents of the reservoir vessels of first desalting washing-solution supply apparatus 22 and/or second desalting washing-solution supply apparatus 31 (in the aforementioned desalting process) may be discharged out of the system by directing the contents to go to the route to elution vessel 2 and solid-liquid separation apparatus 3 at a desired timing such as a desired time point within the period during which slurry S1 is not treated, and through the drainage channel provided to solid-liquid separation apparatus 3 via predetermined valve mechanism Vd. Such drainage W5 can be collected and stored in heavy metal insolubilization reaction vessel 11.

[0125]

In this embodiment, heavy metal insolubilization reaction vessel 11 comprises ORP modifier supply apparatus 111, by which redox potential regulator A1 can be appropriately supplied to heavy metal insolubilization reaction vessel 11. The heavy metal insolubilization reaction vessel 11 also comprises inorganic flocculant supply apparatus 112, by which inorganic flocculant A2 can be appropriately supplied to heavy metal insolubilization reaction vessel 11. Heavy metal insolubilization reaction vessel 11 also comprises polymer flocculant supply apparatus 113, by which polymer flocculant A3 can be appropriately supplied to heavy metal insolubilization reaction vessel 11. Heavy metal insolubilization reaction vessel 11 also comprises pH adjuster supply apparatus 114, by which pH adjuster A4 can be appropriately supplied to heavy metal insolubilization

reaction vessel 11. Heavy metal insolubilization reaction vessel 11 also comprises stirring device 115. By rotating stirring blade 115a of the device, the content of the vessel can be mixed and stirred for a predetermined time.

[0126]

In heavy metal insolubilization reaction vessel 11, a redox potential regulator, an inorganic flocculant and a heavy metal scavenger such as an inorganic flocculant and a polymer flocculant are added to the drainage collected above, preferably in the order of a redox potential regulator, an inorganic flocculant and a polymer flocculant, as described above to insolubilize heavy metals in the drainage as a flocculate like flocc. In this manner, a flocculate (floc)-containing solution like slurry (hereinafter referred to as "slurry S2") is formed. More specifically, in heavy metal insolubilization reaction vessel 11, drainage W5, which consists of first filtrate W3 or second filtrate W4, and redox potential regulator A1, inorganic flocculant A2, polymer flocculant A3 and pH adjuster A4 are mixed and stirred for a predetermined time by rotating stirring blade 115a of stirring device 115 to successfully form slurry S2. In this case, stirring time by stirring blade 115a for forming slurry S2 is preferably 5 minutes to 20 minutes, more preferably 10 minutes to 20 minutes, and further preferably 15 minutes to 20 minutes per addition (supply) of each of a redox potential regulator, an inorganic flocculant and a polymer flocculant. If the stirring time of slurry S2 is shorter than 5 minutes, insolubilization and flocculation of heavy metals in the drainage collected above become insufficient, as the case may be. If the stirring time of slurry S2 is longer than 20 minutes, the amount of treatment per unit time becomes low.

[0127]

In heavy metal insolubilization reaction vessel 11, the temperature of treating slurry S2 is not particularly limited. In view of cost involved in treatment, temperature within the normal temperature such as 5°C to 30°C is preferable and 15°C to 30°C is more preferable.

[0128]

Note that, in the embodiment shown in Figure 10, heavy metal insolubilization reaction vessel 11 is equipped with a redox potential monitoring apparatus 161, which

monitors the redox potential of the drainage collected and stored in heavy metal insolubilization reaction vessel 11. As redox potential monitoring apparatus 161, a measuring apparatus known in the art may be used. When the concentration of the slurry in heavy metal insolubilization reaction vessel 11 is high, a measuring apparatus for a high concentration suspension may be used.

[0129]

In the embodiment shown in Figure 10, heavy metal insolubilization reaction vessel 11 is equipped with pH monitoring apparatus 164, which monitors pH of the drainage collected and stored in heavy metal insolubilization reaction vessel 11. As pH monitoring apparatus 164, a measuring apparatus known in the art may be used. The same measuring apparatus as the above redox potential monitoring apparatus 161 may be used as long as the apparatus can measure redox potential.

[0130]

In the embodiment shown in Figure 10, ORP modifier supply apparatus 111 is equipped with ORP regulator supply regulator valve 111a consists of a predetermined regulation valve mechanism, which can control the amount of redox potential regulator A1 supplied from ORP modifier supply apparatus 111 to heavy metal insolubilization reaction vessel 11. Inorganic flocculant supply apparatus 112 is equipped with inorganic flocculant supply control valve 112a consisting of a predetermined regulation valve mechanism, which can control the amount of inorganic flocculant A2 to be supplied from inorganic flocculant supply apparatus 112 to heavy metal insolubilization reaction vessel 11. Polymer flocculant supply apparatus 113 is equipped with polymer flocculant supply control valve 113a consisting of a predetermined regulation valve mechanism, which can control the amount of polymer flocculant A3 to be supplied from polymer flocculant supply apparatus 113 to heavy metal insolubilization reaction vessel 11. The pH adjuster supply apparatus 114 is equipped with pH regulator supply regulator valve 114a consisting of a predetermined regulation valve mechanism, which can control the amount of pH adjuster A4 to be supplied from pH adjuster supply apparatus 114 to heavy metal insolubilization reaction vessel 11.

[0131]

In the embodiment shown in Figure 10, control apparatus 201 is provided, which is responsible also for feedback control of chlorine ion concentration in the desalting process. To control apparatus 201, measurement results by redox potential monitoring apparatus 161 and measurement results by pH monitoring apparatus 164 are to be always sent. Upon receiving the results, if the value measured by redox potential monitoring apparatus 161 is outside a predetermined management range, control apparatus 201 sends instruction signals (based on the results) to ORP regulator supply regulator valve 111a, which supplies redox potential regulator A1 based on the signal to the reaction vessel 11 to reduce redox potential in a feedback control manner. Similarly, if the value measured by pH monitoring apparatus 164 is outside a predetermined management range, control apparatus 201 sends instruction signals (based on the results) to pH regulator supply regulator valve 114a, which supplies pH adjuster A4 based on the signals to reaction vessel 11 to control pH in a feedback manner.

[0132]

In the embodiment shown in Figure 10, second solid-liquid separation apparatus 13 is provided for solid-liquid separation of slurry S2, which is discharged from heavy metal insolubilization reaction vessel 11 and transported by slurry carrier device 12. In second solid-liquid separation apparatus 13, part or whole of the liquid phase is separated from slurry S2 to obtain heavy metal flocculation cake (hereinafter referred to as "first flocculation cake C3") and third filtrate W6. Note that, as second solid-liquid separation apparatus 13, e.g., a filter press, which is used as first solid-liquid separation apparatus 3 in the above desalting process, can be used. As slurry carrier device 12, a slurry pump generally used in the art, such as a screw pump and a mohno pump, may be used.

[0133]

In this embodiment, first flocculation cake C3 discharged from second solid-liquid separation apparatus 13 is transported by heavy metal flocculation cake carrier 15 to a cement manufacturing apparatus. In this case, as heavy metal flocculation cake carrier 15, which is not particularly limited as long as a cake having a moisture content of about 50 mass% can be transported, a carrier generally used in the art, such as a belt conveyor, can be used, similarly to the case of desalted cake carrier device 9 used in the desalting

process mentioned above. If the distance between a site at which a treatment is carried out by a desalter and a site at which production is carried out by a cement manufacturing apparatus is considerably long, a delivery vehicle such as a truck and a ship can be employed other than a carrier device such as a belt conveyor.

[0134]

Figure 11 is a diagram showing the whole constitution of the desalter for a chlorine-containing powder according to the fourth embodiment of the present invention. Desalter 30 according to this embodiment, in addition to the constitution of the desalter shown in Figure 10, has a constitution, in which first flocculation cake C3 can be washed with the third desalting washing-solution W7 to be supplied from third desalting washing-solution supply apparatus 141 in second solid-liquid separation apparatus 13. More specifically, valve mechanism Vj is provided in the middle of the route for transporting slurry S2 (treated in heavy metal insolubilization reaction vessel 11) to second solid-liquid separation apparatus 13; whereas, another valve mechanism Vk is provided in the middle of the route for distributing third desalting washing-solution W3 from third desalting washing-solution supply apparatus 141 to second solid-liquid separation apparatus 13. By the presence of the valves, slurry S2 and third desalting washing-solution W7 can be separately directed to go to second solid-liquid separation apparatus 13. More specifically, slurry S2 is first directed to go to second solid-liquid separation apparatus 13 and treated in second solid-liquid separation apparatus 13 to obtain first flocculation cake C3. Then, third desalting washing-solution W3 is directed to go to second solid-liquid separation apparatus 13 and washes first flocculation cake C3 to obtain second flocculation cake C4 and fourth filtrate W8. In second solid-liquid separation apparatus 13, third filtrate W6 generated in the heavy metal flocculation cake formation step and fourth filtrate W8 generated in the heavy metal flocculation cake washing step are designed to be successfully discharged as drainage W9 out of the system via predetermined valve mechanism Vl. In contrast, if desired, fourth filtrate W8 (obtained in the heavy metal flocculation cake washing step) is sent to the reservoir unit of first desalting washing-solution supply apparatus 22 by third solution-sending apparatus 16

(consisting of a predetermined liquid feed pump mechanism), via a predetermined valve mechanism Vm, to successfully recycle W8 as first desalting washing-solution W1.

[0135]

In the embodiment shown in Figure 11, third desalting washing-solution supply apparatus 141 is equipped with fifth supply regulation valve 141a consisting of a predetermined regulation valve mechanism. Whether the content of the reservoir unit provided to third desalting washing-solution supply apparatus 141 is directed to go to second solid-liquid separation apparatus 13 as the third desalting washing-solution W7 or directed to go out of the system as drainage W9 can be assigned by fifth supply regulation valve 141a and the amounts of respective solutions to be directed can be controlled by valve 141a. Further, third desalting washing-solution supply apparatus 141 is equipped with fresh third desalting washing-solution supply apparatus 142 for supplying fresh third desalting washing-solution W7a. If desired, solution W7a can be added as a part of the third desalting washing-solution within the system via sixth supply regulation valve 142a (constituted of a predetermined regulation valve mechanism) and part or whole of the third desalting washing-solution repeatedly used multiple times can be replaced. In this case, the content of the reservoir unit of third desalting washing-solution supply apparatus 141 may be appropriately directed to go out of the system as drainage W9 in the amount corresponding to the supply amount of the fresh third desalting washing-solution W7a.

[0136]

Note that, the content of the reservoir unit of third desalting washing-solution supply apparatus 141 may be discharged out of the system by directing the contents to go to the route to second solid-liquid separation apparatus 13 at a desired timing such as a desired time point within the period during which slurry S2 is not treated and through the drainage channel provided to second solid-liquid separation apparatus 13 via predetermined valve mechanism V1.

[0137]

In the embodiment shown in Figure 11, control apparatus 201 is provided which can be commonly involved in both feedback control of chlorine ion concentration of the desalting process and feedback control in the embodiment described in Figure 10.

Control apparatus 201 can receive measurement signals from first chlorine ion concentration monitoring apparatus 7 and sent signals, based on the measurement signals, to third solution-sending apparatus 16. According to the constitution, for example, if the measurement value by first chlorine ion concentration monitoring apparatus 7 exceeds a predetermined threshold, control apparatus 201 sends instruction signals based on the measurement result to third solution-sending apparatus 16. Based on the instruction signals, third solution-sending apparatus 16 is operated to stop solution-sending of fourth filtrate W8. Based on the instruction signals to first supply regulation valve 22a and second supply regulation valve 23a, these regulation valve mechanisms can be operated as mentioned above to supply fresh first desalting washing-solution W1a to first desalting washing-solution W1 circulating within the system to lower chlorine ion concentration in a feedback control manner. The supply amount of fresh first desalting washing-solution W1a may be automatically determined in accordance with a measurement value by first chlorine ion concentration monitoring apparatus 7. The operation for supply can be automatically and continuously carried out.

[0138]

Note that, in the embodiment shown in Figure 11, control apparatus 201 may control a valve mechanism (not shown in the figure) to control the amount of solution (or amount of slurry) to be sent via the valve mechanism. For example, valve mechanism Vm may be controlled by control apparatus 201 to control the amount of fourth filtrate W8 to be sent at the time of the aforementioned feedback control.

[0139]

Figure 12 is a diagram showing the whole constitution of the desalter for a chlorine-containing powder according to the fifth embodiment of the present invention. Desalter 40 according to this embodiment, in addition to the constitution of the desalter shown in Figure 11, has a constitution in which second filtrate W4 (generated in the desalted cake washing step of the desalting process) is sent to the reservoir unit of third desalting washing-solution supply apparatus 141 via predetermined valve mechanism Vn by fourth solution-sending apparatus 17 (consisting of a predetermined liquid feed pump mechanism) and can be used also as third desalting washing-solution W7. Further, a

route is provided for delivering a solution to the reservoir unit of third desalting washing-solution supply apparatus 141 via predetermined valve mechanism Vo by fifth solution-sending apparatus 18 (consisting of a predetermined liquid feed pump mechanism). Owing to the constitution, fourth filtrate W8 (generated in heavy metal flocculation cake washing step) can be recycled also as third desalting washing-solution W7.

[0140]

In the embodiment shown in Figure 12, the reservoir unit of third desalting washing-solution supply apparatus 141 is equipped with third chlorine ion concentration monitoring apparatus 19 for monitoring the chlorine ion concentration of third desalting washing-solution W7 stored in the reservoir unit (of third desalting washing-solution supply apparatus 141). As third chlorine ion concentration monitoring apparatus 19, the same apparatus as used in first chlorine ion concentration monitoring apparatus 7 (described above) and second chlorine ion concentration monitoring apparatus 8 may be used. In measuring the concentration of chlorine ion, a target solution appropriately diluted with water, may be measured, for example, by analysis means generally used in the art, such as a chlorine ion meter and ion chromatography. In this embodiment, a chlorine ion meter is used. Third chlorine ion concentration monitoring apparatus 19 may be arranged at a position at which the chlorine ion concentration of the content in the reservoir unit of third desalting washing-solution supply apparatus 141 can be directly measured or at a position just before a solution enters the reservoir unit (of third desalting washing-solution supply apparatus 141). In short, any position is acceptable as long as the chlorine ion concentration of third desalting washing-solution W7 is estimated.

[0141]

In the embodiment shown in Figure 12, control apparatus 201 is provided, which can be commonly involved in both feedback control of chlorine ion concentration in the desalting process and in feedback control in the embodiments shown in Figure 10 and Figure 11. Control apparatus 201 can receive measurement signals from third chlorine ion concentration monitoring apparatus 19 and sent signals, based on the measurement signals, to fourth solution-sending apparatus 17 and fifth solution-sending apparatus 18. According to the constitution, for example, if the measurement value by third chlorine ion

concentration monitoring apparatus 19 exceeds a predetermined threshold, control apparatus 201 sends instruction signals based on the measurement result to fourth solution-sending apparatus 17 and/or fifth solution-sending apparatus 18. Based on the instruction signals, fourth solution-sending apparatus 17 is operated to stop delivery of second filtrate W4. Based on the instruction signals, fifth solution-sending apparatus 18 is operated to stop delivery of fourth filtrate W8. Based on the instruction signals to fifth supply regulation valve 141a and sixth supply regulation valve 142a, these regulation valve mechanisms can be operated as mentioned above to supply fresh third desalting washing-solution W7a to third desalting washing-solution W7 circulating within the system to lower chlorine ion concentration in a feedback control manner. The supply amount of fresh third desalting washing-solution W7a may be automatically determined in accordance with the measurement value by third chlorine ion concentration monitoring apparatus 19. The operation for supply can be automatically and continuously carried out.

[0142]

Note that, in the embodiment shown in Figure 12, control apparatus 201 may control a predetermined valve mechanism (not shown in the figure) to control the amount of solution (or amount of slurry) to be sent via the valve mechanism. For example, valve mechanism Vn may be controlled by control apparatus 201 to control the amount of second filtrate W4 to be sent at the time of the aforementioned feedback control. Also, valve mechanism Vo may be controlled to control the amount of fourth filtrate W8 to be sent at the time of the aforementioned feedback control.

[0143]

As is described in the foregoing, it can be said that a cement raw material supply system for providing a cement raw material, for example, from incineration fly ash, flue ash and chlorine bypass dust is constructed by the techniques provided by the present invention. Figure 13 herein shows a flowchart showing the desalting process for a chlorine-containing powder according to the present invention, simultaneously with a diagram showing the whole constitution of the desalter for a chlorine-containing powder according to the present invention, along with the constitution of the desalter for a

chlorine-containing powder shown in Figure 12. Note that, needless to say, part of the constitutions shown in Figure 13 can be appropriately omitted within the range described above in constituting the present invention. The same apparatus may be used as the first solid-liquid separation apparatus as well as the second solid-liquid separation apparatus and respective treatments by the apparatuses may be carried out by use of the same apparatus. Figure 14 shows desalter 50 employing the same apparatus as the first solid-liquid separation apparatus and the second solid-liquid separation apparatus. Figure 15 shows the flowchart of the whole system according to the embodiment. The notes and structures/functions represented by reference symbols shown in Figure 14 and Figure 15 are the same as defined in Figure 10 to Figure 13. According to this embodiment, the same structure is employed in common as those of the solid-liquid separation apparatuses to be used. In this way, the constitutions of the apparatuses can be simplified.

Examples

[0144]

Now, Experimental Examples will be described for more specifically describing the present invention; however, the present invention is not limited by the contents of these experimental examples.

[0145]

As chlorine-containing powder P1, flue ash generated from a gasification melting furnace was used. Table 1 shows the chemical composition of the ash.

[0146]

[Table 1]

Level	Cl (mass%)	Pb (ppm)	Zn (ppm)
A	12.8	2600	15600
B	22.3	1500	3700

[0147]

As first desalting washing-solution W1, which is to be blended with flue ash P1 to prepare slurry, aqueous solutions different in salt content shown in Table 2 (represented by levels) were prepared.

[0148]

[Table 2]

Level	Cl ⁻ (mass%)	Remarks
1	0	Tap water was boiled and allowed to cool
2	3	Sea water
3	5	Prepared by dissolving NaCl in sea water of level 2
4	10	Prepared by dissolving NaCl in sea water of level 2
5	15	Prepared by dissolving NaCl in sea water of level 2
6	18	Prepared by dissolving NaCl in sea water of level 2

[0149]

As second desalting washing-solution W2 for washing first desalted cake, aqueous solutions different in salt content shown in Table 3 (represented by levels) were prepared.

[0150]

[Table 3]

Level	Cl ⁻ (mass%)	Remarks
a	0	Tap water was boiled and allowed to cool
b	3	Sea water (the same as level 2 in Table 2)

[0151]

In treating flue ash P1 by desalter 1 for a chlorine-containing powder having the constitution shown in Figure 3, how the salt concentration of each washing solution affects treatment for flue ash P1 was checked. More specifically, using the flue ash of level A shown in Table 1 and first desalting washing-solutions W1 different in salt content shown in Table 2 and second desalting washing-solutions W2 different in salt content shown in Table 3 (represented by levels) in accordance with combinations shown in Table 4, flue

ash P1 was treated and evaluated. Note that, in all combinations, the solid-liquid ratio (mass ratio of "first desalting washing-solution W1/ flue ash P1") of slurry S1 was 4; slurry S1 was stirred by stirring blade 24a of stirring device 24 at a rotation number of 400 rpm for 30 minutes; the water contents of first desalted cake C1 and second desalted cake C2 obtained by treatment in first solid-liquid separation apparatus 3 were both 50 mass%; and the solid-liquid ratio (mass ratio of "second desalting washing-solution W2/ flue ash P1") of second desalted cake C2 in washing with second desalting washing-solution W2 was 1. In these conditions, flue ash P1 was treated. As first solid-liquid separation apparatus 3, a filter press was used.

[0152]

[Table 4]

Level		Level of first desalting washing-solution W1	Level of second desalting washing-solution W2
Experimental Example 1-1	2-a	2	a
Experimental Example 1-2	2-b		b
Experimental Example 1-3	3-a	3	a
Experimental Example 1-4	3-b		b
Experimental Example 1-5	4-a	4	a
Experimental Example 1-6	4-b		b
Experimental Example 1-7	5-a	5	a
Experimental Example 1-8	5-b		b
Experimental Example 1-9	1-a	1	a
Experimental Example 1-10	1-b		b
Experimental Example 1-11	6-a	6	a
Experimental Example 1-12	6-b		b

[0153]

Slurry S1 was stirred for 30 minutes and a liquid phase derived from first desalting washing-solution W1 was subjected to solid-liquid separation to obtain first filtrate W3. The Cl concentration, Pb concentration and Zn concentration of filtrate W3 were

determined in accordance with JIS K 0102, "Factory drainage test method". More specifically, Cl concentration was determined by potentiometric titration; and Pb concentration and Zn concentration were determined by ICP mass spectrometry (apparatus: Agilent 7900 ICP-MS (trade name) manufactured by Agilent Technologies). The chlorine content of second desalted cake C2 washed with second desalting washing-solution W2 was determined by potentiometric titration after the sample was decomposed with nitric acid and hydrogen peroxide.

The results are shown in Table 5.

[0154]

[Table 5]

Level		first filtrate W3 from slurry S1			second desalted cake C2
		Cl ⁻ (mass%)	Pb (ppm)	Zn (ppm)	Cl (mass%)
Experimental Example 1-1	2-a	6.0	0.4	0.2	0.4
Experimental Example 1-2	2-b				1.6
Experimental Example 1-3	3-a	8.1	0.9	0.2	0.4
Experimental Example 1-4	3-b				1.5
Experimental Example 1-5	4-a	14.0	2.8	0.1	0.4
Experimental Example 1-6	4-b				1.5
Experimental Example 1-7	5-a	19.5	12.0	0.3	0.4
Experimental Example 1-8	5-b				1.4
Experimental Example 1-9	1-a	3.1	32.0	3.3	0.4
Experimental Example 1-10	1-b				1.2
Experimental Example 1-11	6-a	19.0	18.0	0.3	10.6
Experimental Example 1-12	6-b				11.8

[0155]

As is apparent from Table 5, Experimental Examples 1-1 to 8, the Cl concentration of second desalted cake C2 washed with second desalting washing-solution W2 was 2.0 mass% or less. In Experimental Examples 1-1 to 4 in which slurry prepared by blending flue ash P1 with first desalting washing-solution W1 having a chlorine concentration of 3 mass% or 5 mass% was treated, the Pb concentration and Zn concentration of the first filtrate W3, which was obtained by stirring Slurry S1 for 30 minutes and subjecting a liquid phase derived from first desalting washing-solution W1 to solid-liquid separation, was a low value of 1 ppm or less. In contrast, in Experimental Example 1-9 and Experimental Example 1-10, in which slurry prepared by blending flue ash P1 with fresh water as first desalting washing-solution W1 was treated, the Pb concentration and Zn concentration of the first filtrate W3, which was obtained by stirring Slurry S1 for 30 minutes and subjecting a liquid phase derived from first desalting washing-solution to solid-liquid separation, was a relatively high value. In Experimental Example 1-11 and Experimental Example 1-12, in which slurry prepared by blending flue ash P1 with a high chlorine concentration water having a chlorine concentration of 18 mass% as first desalting washing-solution W1 was treated, elution of chlorine from flue ash P1 into the high chlorine concentration water was not sufficient and the Cl concentration of second desalted cake C2 was not sufficiently reduced.

[0156]

In treatment of drainage W5 to be discharged out of the system according to the constitution of the desalter 20 for a chlorine-containing powder shown in Figure 10, the effect of the pH of drainage W5 on the treatment was evaluated. More specifically, five samples of drainage W5 different pH to be discharged out of the system were prepared by using flue ash of level B shown in Table 1 and adding a pH adjuster to a mixture of first filtrate W3 and second filtrate W4 obtained in the same process (first desalting washing-solution W1: sea water, second desalting washing-solution W2: sea water) as level 2-b shown in Table 4. To each of the five samples, an ORP modifier (NaSH) was added so as to obtain a redox potential of -200 mV. After the mixture was stirred for 15 minutes, an inorganic flocculant (FeCl_3) was added to the mixture in the amount corresponding to the amount of the ORP modifier in terms of molar equivalent. The mixture was stirred

for 15 minutes. Then, a polymer flocculant (Diamond lock, Manufactured by Mitsubishi Chemical Corporation) (30 ppm) was added to the mixture. The drainage samples thus obtained were subjected to solid-liquid separation by suction filtration to obtain drainages W9 (corresponding to third filtrate W6) different in pH to be discharged out of the system. Table 6 shows heavy metal contents of drainage W5 (Reference Example) before pH adjustment to be discharged out of the system and drainages W9 (corresponding to third filtrate W6) different in pH and to be discharged out of the system. Table 6 also shows the Japanese uniform effluent standard as reference.

[0157]

[Table 6]

Level	pH	Cl (mass%)	Heavy metal (ppm)			
			Pb	Zn	Cr	Hg
Experimental Example 2-1	9	-	0.05	<0.05	<0.01	<0.0005
Experimental Example 2-2	10.5	-	0.10	0.3	0.5	0.0010
Experimental Example 2-3	3	-	35	0.7	0.5	0.0055
Experimental Example 2-4	6	-	7.5	0.2	<0.01	0.0010
Experimental Example 2-5	12	-	0.5	<0.05	0.4	0.0010
Reference Example	13	6	45	0.6	0.6	0.0120
Japanese uniform effluent standard			0.1	2.0	0.5	0.005

[0158]

As is apparent from Table 6, in Experimental Example 2-1 using a sample of pH 9 and Experimental Example 2-2 using a sample of pH 10.5, all heavy metals evaluated satisfied the values specified in the Japanese uniform effluent standard. In contrast, Experimental Examples 2-3 and 4 using a sample of pH in the acidic range, Experimental Example 2-5 using a sample of pH in the alkaline range, similarly to Reference Example, the amount of heavy metal, particularly, Pb was outside the range of the Japanese uniform effluent standard. As described above, it was clearly demonstrated that elution of heavy metals in the drainage can be more sufficiently suppressed by controlling pH when heavy

metal flocculation cake is formed when heavy metals are removed from a drainage in accordance within the desalting process for a chlorine-containing powder and by a desalter for a chlorine-containing powder of the present invention.

Reference Signs List

[0159]

- 1, 10, 20, 30, 40, 50 Desalter for a chlorine-containing powder
- 2 Elution vessel
- 3 First solid-liquid separation apparatus
- 4, 12 Slurry carrier device
- 5 First solution-sending apparatus (pump mechanism)
- 6 Second solution-sending apparatus (pump mechanism)
- 7 First chlorine ion concentration monitoring apparatus
- 8 Second chlorine ion concentration monitoring apparatus
- 9 Desalted cake carrier
- 11 Heavy metal insolubilization reaction vessel
- 15 Heavy metal flocculation cake carrier
- 16 Third solution-sending apparatus (pump mechanism)
- 17 Fourth solution-sending apparatus (pump mechanism)
- 18 Fifth solution-sending apparatus (pump mechanism)
- 19 Third chlorine ion concentration monitoring apparatus
- 21 Chlorine-containing powder supply apparatus
- 22 First desalting washing-solution supply apparatus
- 22a First supply regulation valve (regulation valve mechanism)
- 23 Fresh first desalting washing-solution supply apparatus
- 23a Second supply regulation valve (regulation valve mechanism)
- 24, 115 Stirring device
- 24a, 115a Stirring blade
- 31 Second desalting washing-solution supply apparatus
- 31a Third supply regulation valve (regulation valve mechanism)

- 32 Fresh second desalting washing-solution supply apparatus
- 32a Fourth supply regulation valve (regulation valve mechanism)
- 111 ORP modifier supply apparatus
- 111a ORP regulator supply regulator valve
- 112 Inorganic flocculant supply apparatus
- 112a Inorganic flocculant supply control valve
- 113 Polymer flocculant supply apparatus
- 113a Polymer flocculant supply control valve
- 114 pH Adjuster supply apparatus
- 114a pH Regulator supply regulator valve
- 141 Third desalting washing-solution supply apparatus
- 141a Fifth supply regulation valve (regulation valve mechanism)
- 142 Fresh first desalting washing-solution supply apparatus
- 142a Sixth supply regulation valve (regulation valve mechanism)
- 201 Control apparatus
- Va to Vo Valve mechanism
- P1 Chlorine-containing powder
- S1, S2 Slurry
- C1 First desalted cake
- C2 Second desalted cake
- C3 First flocculation cake
- C4 Second flocculation cake
- W1 First desalting washing-solution
- W1a Fresh first desalting washing-solution
- W2 Second desalting washing-solution
- W2a Fresh second desalting washing-solution
- W3 First filtrate
- W4 Second filtrate
- W5 Drainage to be discharged out of system
- W6 Third filtrate

- W7 Third desalting washing-solution
- W7a Fresh third desalting washing-solution
- W8 Fourth filtrate
- W9 Drainage out of system

Claims

[Claim 1]

A desalting process for a chlorine-containing powder, comprising

- a slurry formation step of forming slurry by blending a first desalting washing-solution with a chlorine-containing powder,
- a chlorine elution step of eluting chlorine contained in the chlorine-containing powder into a liquid phase within the slurry,
- a desalted cake formation step of separating part or whole of the liquid phase from the slurry, from which chlorine has been eluted, to obtain a first desalted cake and a first filtrate, and
- a desalted cake washing step of washing the first desalted cake with a second desalting washing-solution, which is different from the first desalting washing-solution, to obtain a second desalted cake and a second filtrate, wherein

while the first filtrate obtained in the desalted cake formation step and/or the second filtrate obtained in the desalted cake washing step are at least partly recycled as the first desalting washing-solution and a chlorine ion concentration of the first desalting washing-solution is controlled, the slurry formation step, the chlorine elution step, the desalted cake formation step and the desalted cake washing step are repeated every time a chlorine-containing powder is supplied.

[Claim 2]

The desalting process for a chlorine-containing powder according to Claim 1, wherein, in a case where the chlorine ion concentration of the first desalting washing-solution exceeds a first threshold, the first desalting washing-solution is controlled so as to satisfy the first threshold, with a fresh first desalting washing-solution.

[Claim 3]

The desalting process for a chlorine-containing powder according to Claim 1, wherein sea water is used as the first desalting washing-solution to be initially added to the chlorine-containing powder, and the chlorine ion concentration of the first desalting washing-solution is controlled not to exceed 15 mass%.

[Claim 4]

The desalting process for a chlorine-containing powder according to Claim 1, wherein, while the second filtrate obtained in the desalted cake washing step is at least partly recycled as the second desalting washing-solution and a chlorine ion concentration of the second desalting washing-solution is controlled, the slurry formation step, the chlorine elution step, the desalted cake formation step and the desalted cake washing step are repeated every time a chlorine-containing powder is supplied.

[Claim 5]

The desalting process for a chlorine-containing powder according to Claim 4, wherein, in a case where the chlorine ion concentration of the second desalting washing-solution exceeds a second threshold, which is different from the first threshold, the second desalting washing-solution is controlled so as to satisfy the second threshold, with a fresh second desalting washing-solution.

[Claim 6]

The desalting process for a chlorine-containing powder according to Claim 4 or 5, wherein the chlorine ion concentration of the second desalting washing-solution is controlled so as not to exceed 3.5 mass%.

[Claim 7]

The desalting process for a chlorine-containing powder according to Claim 1, further comprising the following steps (1) to (3):

(1) a drainage collection step of collecting one or two or more of washing solutions selected from the group consisting of the first filtrate, the second filtrate, the first desalting washing-solution recycled as the first desalting washing-solution and the second desalting washing-solution recycled as the second desalting washing-solution and not be subjected to recycling as the first desalting washing-solution or the second desalting washing-solution, as drainage;

(2) a heavy metal insolubilization step of insolubilizing heavy metals contained in the drainage as a flocculate like floc by adding a heavy metal scavenger to the drainage collected in the step (1);

(3) a heavy metal flocculation cake formation step of separating part or whole of a liquid phase from a flocculation (floc)-containing solution containing heavy metals insolubilized in the step (2) to obtain a first flocculation cake and a third filtrate.

[Claim 8]

The desalting process for a chlorine-containing powder according to Claim 7, further comprising the following step (4):

(4) a heavy-metal flocculation cake washing step of washing the first flocculation cake with a third desalting washing-solution, which is different from the first desalting washing-solution and the second desalting washing-solution, to obtain a second flocculation cake and a fourth filtrate.

[Claim 9]

The desalting process for a chlorine-containing powder according to Claim 7 or 8, wherein, in the heavy metal insolubilization step, a pH of the drainage is set to 7 to 11.

[Claim 10]

The desalting process for a chlorine-containing powder according to Claim 8, wherein the fourth filtrate obtained in the heavy metal flocculation cake washing step is at least partly recycled as the first desalting washing-solution.

[Claim 11]

The desalting process for a chlorine-containing powder according to Claim 10, wherein, while the second filtrate obtained in the desalted cake washing step is at least partly used as the third desalting washing-solution and/or the fourth filtrate obtained in the heavy metal flocculation cake washing step is at least partly recycled as the third desalting washing-solution, and a chlorine ion concentration of the third desalting washing-solution is controlled, the washing treatment in the heavy metal flocculation cake washing step is carried out.

[Claim 12]

The desalting process for a chlorine-containing powder according to Claim 11, wherein in a case where the chlorine ion concentration of the third desalting washing-solution exceeds a third threshold, which is different from the first threshold and the

second threshold, the third desalting washing-solution is controlled so as to satisfy the third threshold with a fresh third desalting washing-solution.

[Claim 13]

The desalting process for a chlorine-containing powder according to Claim 11, wherein the chlorine ion concentration of the third desalting washing-solution is controlled so as not to exceed 3.5 mass%.

[Claim 14]

The desalting process for a chlorine-containing powder according to Claim 1 or 7, wherein the chlorine-containing powder includes one or two or more powders selected from incineration fly ash, flue ash and chlorine bypass dust.

[Claim 15]

A desalter for a chlorine-containing powder comprising

- a first desalting washing-solution supply apparatus for supplying a first desalting washing-solution,
- an elution vessel for forming slurry by blending a chlorine-containing powder with the first desalting washing-solution from the first desalting washing-solution supply apparatus; and at the same time, eluting chlorine contained in the chlorine-containing powder into a liquid phase within the slurry,
- a first solid-liquid separation apparatus for separating part or whole of the liquid phase from the slurry from which the chlorine is removed by elution to obtain a first desalted cake and a first filtrate,
- a slurry carrier device, which transports the slurry treated in the elution vessel to the first solid-liquid separation apparatus,
- a second desalting washing-solution supply apparatus for supplying a second desalting washing-solution, which is different from the first desalting washing-solution, for washing the first desalted cake in the first solid-liquid separation apparatus to obtain a second desalted cake and a second filtrate,
- a first solution-sending apparatus for sending the first filtrate obtained in the first desalted cake formation treatment performed in the first solid-liquid separation apparatus and/or the second filtrate obtained in the first desalted cake washing treatment performed

in the first solid-liquid separation apparatus to the first desalting washing-solution supply apparatus in order to recycle at least parts of the first filtrate and/or the second filtrate as the first desalting washing-solution, and

a first chlorine ion concentration monitoring apparatus for monitoring the chlorine ion concentration of the first desalting washing-solution.

[Claim 16]

The desalter for a chlorine-containing powder according to Claim 15, further comprising

a fresh first desalting washing-solution supply apparatus for supplying a fresh first desalting washing-solution as the first desalting washing-solution to the first desalting washing-solution supply apparatus, wherein

the first desalting washing-solution supply apparatus comprises a first supply regulation valve, which can change the amount of the first desalting washing-solution to be supplied from the first desalting washing-solution supply apparatus to the elution vessel; and at the same time, which enables discharge from the first desalting washing-solution supply apparatus,

the fresh first desalting washing-solution supply apparatus comprises a second supply regulation valve, which can change the amount of the washing solution to be supplied to the first desalting washing-solution supply apparatus, and

in a case where the chlorine ion concentration of the first desalting washing-solution exceeds a first threshold, the first supply regulation valve is controlled to stop or reduce supply of the first desalting washing-solution from the first desalting washing-solution supply apparatus to the elution vessel, and to discharge part or whole of the first desalting washing-solution from the first desalting washing-solution supply apparatus, and then, the second supply regulation valve of the fresh first desalting washing-solution supply apparatus is controlled to supply the fresh first desalting washing-solution to the first desalting washing-solution supply apparatus as the first desalting washing-solution so as to satisfy the first threshold.

[Claim 17]

The desalter for a chlorine-containing powder according to Claim 15, further comprising

a second solution-sending apparatus for sending the second filtrate obtained in the first desalted cake washing treatment performed in the first solid-liquid separation apparatus to the second desalting washing-solution supply apparatus in order to recycle at least part of the second filtrate as the second desalting washing-solution; and

a second chlorine ion concentration monitoring apparatus for monitoring the chlorine ion concentration of the second desalting washing-solution.

[Claim 18]

The desalter for a chlorine-containing powder according to Claim 17, further comprising

a fresh second desalting washing-solution supply apparatus for supplying a fresh second desalting washing-solution as the second desalting washing-solution to the second desalting washing-solution supply apparatus, wherein

the second desalting washing-solution supply apparatus comprises a third supply regulation valve, which can change the amount of the second desalting washing-solution to be supplied from the second desalting washing-solution supply apparatus to the first desalted cake; and at the same time, which enables discharge from the second desalting washing-solution supply apparatus;

the fresh second desalting washing-solution supply apparatus comprises a fourth supply regulation valve, which can change the amount of the washing solution to be supplied to the second desalting washing-solution supply apparatus; and

in a case where the chlorine ion concentration of the second desalting washing-solution exceeds a second threshold, which is different from the first threshold, the third supply regulation valve is controlled to stop or reduce supply of the second desalting washing-solution from the second desalting washing-solution supply apparatus to the first desalted cake, and to discharge part or whole of the second desalting washing-solution from the second desalting washing-solution supply apparatus, and then, the fourth supply regulation valve of the fresh second desalting washing-solution supply apparatus is controlled to supply the fresh second desalting washing-solution to the second desalting

washing-solution supply apparatus, as the second desalting washing-solution so as to satisfy the second threshold.

[Claim 19]

The desalter for a chlorine-containing powder according to Claim 15 or 17, further comprising

a heavy metal insolubilization reaction vessel for collecting and storing one or two or more solutions selected from the group consisting of the first filtrate and the second filtrate that are not to be recycled as the first desalting washing-solution or the second desalting washing-solution, the first desalting washing-solution sent as drainage from the first desalting washing-solution supply apparatus, and the second desalting washing-solution sent as drainage from the second desalting washing-solution supply apparatus, and insolubilizing heavy metals contained in the drainage as a flocculate like floc by adding a heavy metal scavenger thereto;

a second solid-liquid separation apparatus, which separates part or whole of the liquid phase from the flocculation (floc)-containing solution containing the insolubilized heavy metals to obtain a first flocculation cake and a third filtrate; and

a flocculation (floc)-containing solution carrier device for transporting the flocculation (floc)-containing solution treated in the heavy metal insolubilization reaction vessel to the second solid-liquid separation apparatus.

[Claim 20]

The desalter for a chlorine-containing powder according to Claim 19, further comprising

a third desalting washing-solution supply apparatus for supplying a third desalting washing-solution, which is different from the first desalting washing-solution and the second desalting washing-solution, for washing in the second solid-liquid separation apparatus to obtain a second flocculation cake and a fourth filtrate.

[Claim 21]

The desalter for a chlorine-containing powder according to Claim 19, further comprising

a third solution-sending apparatus for sending the fourth filtrate obtained in washing treatment of the first flocculation cake performed in the second solid-liquid separation apparatus, to the first desalting washing-solution supply apparatus in order to recycle at least part of the fourth filtrate as the first desalting washing-solution.

[Claim 22]

The desalter for a chlorine-containing powder according to Claim 19, further comprising

a fourth solution-sending apparatus for sending the second filtrate obtained in the first desalted cake washing treatment performed in the first solid-liquid separation apparatus, to the third desalting washing-solution supply apparatus in order to use at least part of the second filtrate as the third desalting washing-solution, and/or,

a fifth solution-sending apparatus for sending the fourth filtrate obtained in the first flocculation cake washing treatment performed in the second solid-liquid separation apparatus, to the third desalting washing-solution supply apparatus in order to recycle at least part of the fourth filtrate as the third desalting washing-solution, and

a third chlorine ion concentration monitoring apparatus for monitoring a chlorine ion concentration of the third desalting washing-solution.

[Claim 23]

The desalter for a chlorine-containing powder according to Claim 22, further comprising

a fresh third desalting washing-solution supply apparatus for supplying a fresh third desalting washing-solution as the third desalting washing-solution to the third desalting washing-solution supply apparatus, wherein

the third desalting washing-solution supply apparatus comprises a fifth supply regulation valve, which can change the amount of the third desalting washing-solution to be supplied from the third desalting washing-solution supply apparatus to the first flocculation cake; and at the same time, which enables discharge from the third desalting washing-solution supply apparatus;

the fresh third desalting washing-solution supply apparatus comprises a sixth supply regulation valve, which can change the amount of the washing solution to be supplied to the third desalting washing-solution supply apparatus; and

in a case where the chlorine ion concentration of the third desalting washing-solution exceeds a third threshold, which is different from the first threshold and the second threshold, the fifth supply regulation valve is controlled to stop or reduce supply of the third desalting washing-solution from the third desalting washing-solution supply apparatus to the first flocculation cake, and to discharge part or whole of the third desalting washing-solution from the third desalting washing-solution supply apparatus, and then,

the sixth supply regulation valve of the fresh third desalting washing-solution supply apparatus is controlled to supply the fresh third desalting washing-solution to the third desalting washing-solution supply apparatus, as the third desalting washing-solution so as to satisfy the third threshold.

[Claim 24]

The desalter for a chlorine-containing powder according to Claim 19, wherein a same apparatus is used as the first solid-liquid separation apparatus and the second solid-liquid separation apparatus and respective treatments by the apparatuses are carried out.