

DESCRIPTION

AERATION APPARATUS

Technical Field

[0001]

The present invention relates to treatment of effluent from an exhaust gas desulfurizer employed in an electric power plant, such as a coal-fired, crude-oil-fired, or heavy-oil-fired power plant, and particularly relates to an aeration apparatus employing aeration for decarbonating (aerating) effluent (used seawater) from an exhaust gas desulfurizer for desulfurization using a seawater method.

Background Art

[0002]

Conventionally, in an electric power plant using coal, crude oil, or the like as fuel, sulfur oxides (SO_x), such as sulfur dioxide (SO₂), are removed from combustion exhaust gas (hereinafter called "boiler exhaust gas") discharged from a boiler, and then the boiler exhaust gas is discharged into the atmosphere. Known examples of such desulfurization treatment with an exhaust gas desulfurizer include systems employing a limestone-plaster method, a spray dryer method, or a seawater method.

[0003]

An exhaust gas desulfurizer employing the seawater method (hereinafter called "seawater desulfurizer") uses seawater as an absorbent. In this system, for example, seawater and boiler exhaust gas are supplied to the inside of a desulfurization tower (absorption tower) having a substantially cylindrical shape, such as a vertically disposed cylinder, to cause gas-liquid contact in a wet system, thereby removing sulfur oxides using the seawater as an absorbing solution.

As shown in Fig. 8, for example, when the seawater (used seawater) used as an absorbent for desulfurization in the aforementioned desulfurization tower flows in the seawater oxidation treatment system (SOTS) 1 to be drained away, the used seawater is decarbonated (aerated) by aeration with micro-air-bubbles 2 discharged from an aeration device 10 disposed on a bottom face 1a of the seawater oxidation treatment system 1.

[0004]

Figs. 9 and 10 show a conventional aeration apparatus 10. Headers 12 are each connected to an air-supplying pipe 11 and are disposed on a bottom face 1a of the seawater oxidation treatment system 1. The headers 12 are provided with a large number of aeration nozzles 13 that are horizontally arranged so as to be equally spaced and approximately parallel to the

bottom face 1a. The aeration nozzles 13 are rubber hoses provided with a large number of small cuts (not shown) and covering the outer face of a base material; they are generally called "diffuser nozzles". Such aeration nozzles 13 can discharge a large number of micro-air-bubbles having approximately the same size by causing the cuts to open when the hose is expanded by the pressure of air supplied from the air-supplying pipe 11.

There is no technical literature that discloses the application of aeration nozzles to an aeration apparatus employing aeration for decarbonating (aerating) effluent (used seawater) from an exhaust gas desulfurizer for desulfurization using a seawater method.

Disclosure of Invention

[0005]

In the conventional aeration apparatus 10, for example, as shown in Fig. 9, the aeration nozzles 13 are arranged equally spaced over the entire bottom face 1a of the seawater oxidation treatment system 1. The equally spaced arrangement of the aeration nozzles 13 is intended to generate micro-air-bubbles 2 for aeration approximately uniformly per unit area of the bottom face of the seawater oxidation treatment system.

However, the properties (e.g., pH) of used seawater may be inhomogeneous in the lateral direction of the seawater

oxidation treatment system 1 in an upstream inlet port area for letting the used seawater flow into the seawater oxidation treatment system 1.

[0006]

However, since the conventional structure having the aeration nozzles 13 arranged equally spaced has a tendency to generate a local circulating flow for each of the equally spaced aeration nozzles 13, if the used seawater flowing into the seawater oxidation treatment system 1 is in an inhomogeneous state, the mixing of the used seawater in the lateral width direction of the seawater oxidation treatment system 1 is difficult. This poses a problem of insufficient mixing causing inhomogeneous seawater properties.

That is, in the case that the aeration nozzles 13 are arranged equally spaced over the entire bottom face 1a, for example, as shown in Fig. 11, upward flows f_a flowing toward the water surface are generated with micro-air-bubbles 2 for each aeration nozzle 13 or for each unit consisting of adjacent aeration nozzles 13. At the same time, downward flows f_b flowing toward the bottom face 1a from the water surface side are generated to compensate for the used seawater consumed by the upward flows from the bottom. Therefore, the used seawater, as a whole, flows to the downstream side of the seawater oxidation treatment system 1 while forming a plurality of local circulating flows due to the upward flows

fa and the downward flows fb.

[0007]

Consequently, in the lateral direction of the seawater oxidation treatment system 1, it is difficult to form a large circulating flow of the entire used seawater, which causes a difficulty in the mixing of used seawater having properties that are inhomogeneous in the lateral direction. Such insufficient mixing causes, for example, inhomogeneous properties in the used seawater to be discharged into the surrounding sea area to cause a decrease in the decarbonation performance, or results in lengthening of the seawater oxidation treatment system 1 for sufficiently mixing used seawater to avoid the occurrence of unevenness in the decarbonation performance.

The present invention has been made under the above-described circumstances, and it is an object of the present invention to provide an aeration apparatus that can perform sufficient mixing in the lateral direction of the used seawater flowing in a seawater oxidation treatment system.

[0008]

The present invention employs the following solutions for solving the above-mentioned problems.

The aeration apparatus according to the present invention is installed in a seawater oxidation treatment system for draining used seawater discharged from a desulfurization tower

of an exhaust gas desulfurizer using seawater as an absorbent and configured to conduct decarbonation by generating micro-air-bubbles in the used seawater, wherein headers communicating with an air-supplying pipe are installed on a bottom face of the seawater oxidation treatment system, and aeration units generating the micro-air-bubbles from aeration nozzles attached to the headers include nozzleless sections for partly forming bottom regions where micro-air-bubbles are not generated.

[0009]

In this aeration apparatus, the headers communicating with the air-supplying pipe are installed on the bottom face of the seawater oxidation treatment system, and aeration units generating the micro-air-bubbles from aeration nozzles attached to the headers are provided with nozzleless sections for partly forming bottom regions where micro-air-bubbles are not generated. Accordingly, upward flows are formed in regions where the micro-air-bubbles are generated, and downward flows are formed in regions where the micro-air-bubbles are not generated due to the nozzleless sections. Therefore, a large circulating flow over the width in the lateral direction of the seawater oxidation treatment system is formed in the used seawater flowing in the seawater oxidation treatment system, and this circulating flow accelerates the mixing of the entire used seawater.

The nozzleless sections may be provided sequentially or intermittently along either side wall in the lateral direction of the seawater oxidation treatment system. Furthermore, the nozzleless sections may be arranged along both side walls in an alternating manner.

[0010]

In the aeration apparatus, it is preferable that a partition member extending in the flow direction of the seawater oxidation treatment system be installed so as to separate the region where micro-air-bubbles are generated and the region where micro-air-bubbles are not generated from each other in the width direction of the seawater oxidation treatment system, and the partition member allow used seawater to flow in the width direction of the seawater oxidation treatment system at the water surface side and at the bottom face side. With this, the formation of the large circulating flow over the width of the seawater oxidation treatment system is further accelerated.

[0011]

In the aeration apparatus, it is preferable that the aeration nozzles be vertically arranged so as to extend upward in the vertical direction from the headers. Such an arrangement can increase the number of aeration nozzles that can be disposed per unit area of the bottom face of the seawater oxidation treatment system.

[0012]

According to the present invention described above, by providing the nozzleless sections, upward flows are generated in the regions where micro-air-bubbles are generated and downward flows are generated in the regions where micro-air-bubbles are not generated due to the nozzleless sections. As a result, a large circulating flow over the width in the lateral direction of the seawater oxidation treatment system is formed in the used seawater flowing in the seawater oxidation treatment system. Since such a formation of the circulating flow accelerates the mixing of the entire used seawater, insufficient mixing can be avoided even if the properties of the used seawater flowing in the seawater oxidation treatment system are different at both sides in the width direction of the seawater oxidation treatment system. Therefore, the used seawater passing through the aeration apparatus and being discharged to the surrounding sea area can have approximately homogeneous seawater properties as a whole. Thus, the provision of the nozzleless sections can significantly improve the decarbonation performance.

Furthermore, in the aeration apparatus whose decarbonation performance is improved, the length of the seawater oxidation treatment system necessary for performing a predetermined level of decarbonation can be decreased. Therefore, an advantage can be also realized in that the cost

and the space for installing the seawater oxidation treatment system can be decreased.

Brief Description of Drawings

[0013]

[FIG. 1] FIG. 1 is a cross-sectional view illustrating a first embodiment of an aeration apparatus according to the present invention.

[FIG. 2A] FIG. 2A is a partial cross-sectional view of a main portion showing a plan view of FIG. 1.

[FIG. 2B] FIG. 2B is a partial cross-sectional view illustrating the inner structure of a main portion of aeration nozzles.

[FIG. 3] FIG. 3 is a cross-sectional view illustrating a second embodiment of an aeration apparatus according to the present invention.

[FIG. 4] FIG. 4 is a plan view illustrating a third embodiment of an aeration apparatus according to the present invention.

[FIG. 5] FIG. 5 is a perspective view illustrating vertically arranged aeration nozzles in the third embodiment.

[FIG. 6] FIG. 6 is a plan view illustrating a first modification of an aeration apparatus according to the present invention.

[FIG. 7] FIG. 7 is a plan view illustrating a second

modification of an aeration apparatus according to the present invention.

[FIG. 8] FIG. 8 is a view schematically illustrating an aeration apparatus installed in a seawater oxidation treatment system.

[FIG. 9] FIG. 9 is a plan view illustrating a conventional aeration apparatus.

[FIG. 10] FIG. 10 is a perspective view illustrating the aeration apparatus shown in FIG. 9.

[FIG. 11] FIG. 11 is a cross-sectional view illustrating a conventional aeration apparatus.

[0014]

Explanation of Reference Signs:

- 1: seawater oxidation treatment system (SOTS)
- 1a: bottom face
- 2: micro-air-bubbles
- 10A to 10D: aeration apparatus
- 11: air-supplying pipe
- 12: header
- 13, 13A: aeration nozzle (diffuser nozzle)
- 14: cut
- 20, 20A, 20B: aeration unit
- 30, 30A, 30B: nozzleless section (nozzleless portion)
- 40: partition member

Best Mode for Carrying Out the Invention

[0015]

An embodiment of an aeration apparatus according to the present invention will now be described with reference to the drawings.

In a first embodiment shown in FIGS. 1 and 2A, an aeration apparatus 10A is installed, for example, in the inside of a seawater oxidation treatment system (SOTS) 1 for draining seawater used for desulfurization (hereinafter called "used seawater") discharged from a desulfurization tower (not shown) of an exhaust gas desulfurizer using seawater as an absorbent into the surrounding sea area. In this aeration apparatus 10A, the decarbonation (aeration) is conducted by generating a large number of micro-air-bubbles in the used seawater flowing in the seawater oxidation treatment system 1.

[0016]

The aeration apparatus 10A is connected to an air supply source (not shown) disposed outside the seawater oxidation treatment system 1 through an air-supplying pipe 11. The other end of the air-supplying pipe 11 is connected to headers 12 arranged along a bottom face 1a of the seawater oxidation treatment system 1.

Each header 12 is branched in the flow direction and the width direction of the bottom face 1a. The side faces of the headers 12 are provided with a large number of aeration

nozzles 13, called "diffuser nozzles", so as to extend in the horizontal direction. That is, in the aeration apparatus 10A of this embodiment, the headers 12 communicating with the air-supplying pipe 11 are installed on the bottom face 1a of the seawater oxidation treatment system 1, and the aeration nozzles 13 for generating a large amount of micro-air-bubbles from cuts 14 are attached to the side faces of each header 12 so as to extend along the bottom face 1a in the horizontal direction.

[0017]

The structure of the aeration nozzles 13 will now be briefly described.

As shown in FIG. 2B, the aeration nozzles 13 are installed on the side faces of each header 12, with flanges 15 disposed therebetween. The air-supplying pipe 11 and the headers 12, which are placed in used seawater, are resin pipes in view of corrosion resistance, for example.

The aeration nozzles 13 each have a structure composed of a base material 16 having an approximately cylindrical shape and made of a resin in view of corrosion resistance against used seawater, a rubber hose 17 provided with a large number of cuts 14 and disposed so as to cover the outer circumference of this base material 16, and joining members 18, such as wire or bands, for fixing both ends of the hose 17 to the base material 16. The cuts 14 are closed when they are in a normal

state where no pressure is applied thereto.

[0018]

One end of the base material 16 communicates with the inside of the header 12 via an air inlet 19 passing through the header 12 and the flange 15 in order to enable the introduction of air when the base material 16 is attached to the header 12. The interior of the base material 16 is divided in the horizontal direction by a partition plate 16a provided at an intermediate point in the axial direction thereof. The flow of air is inhibited by this partition plate 16a. In addition, an air outlet 16b is provided in the side face of the base material 16, at a position on the header 12 side of the partition plate 16a. This air outlet 16b allows air to flow out between the inner circumferential surface of the hose 17 and the outer circumferential surface of the base material 16, that is, to flow out into a pressurization space 21, by applying a pressure to the hose 17 to expand it. Therefore, as indicated with the arrow A in the drawing, the air flowing in the aeration nozzle 13 from the header 12 flows into the interior of the base material 16 from the air inlet 19 and then flows out into the pressurization space 21 from the air outlet 16b in the side face.

The joining members 18 fix the hose 17 to the base material 16 and prevent air that flows in through the air outlet 16b from leaking out through the two ends.

[0019]

In the thus configured aeration nozzle 13, the air flowing in from the header 12 through the air inlet 19 flows out into the pressurization space 21 through the air outlet 16b and stays in the pressurization space 21 to increase the internal pressure because of the cuts 14 being closed. As a result, the hose 17 is expanded by the increased internal pressure of the pressurization space 21 to open the cuts 14 provided in the hose 17, resulting in the outflow of micro-air-bubbles into the used seawater. Such generation of micro-air-bubbles is performed in all of the aeration nozzles 13 that are provided with air via the air-supplying pipe 11 and the headers 12.

[0020]

In the seawater oxidation treatment system 1 having a channel width W , aeration units 20 formed of the headers 12 and the aeration nozzles 13 described above are disposed so as to cover a unit installation width W_a on the bottom face 1a, while leaving a portion in the lateral direction. Thus, in the seawater oxidation treatment system 1 having a channel width W , a region having a missing portion width W_b where the aeration units 20 are not provided defines nozzleless sections 30.

That is, the headers 12 communicating with the air-supplying pipe 11 are installed on the bottom face 1a of the

seawater oxidation treatment system 1, and the aeration units 20 generating micro-air-bubbles from the aeration nozzles 13 attached to the headers 12 include the nozzleless sections 30 partly forming bottom regions not generating micro-air-bubbles. The nozzleless sections 30 in this case are provided successively along either side wall in the lateral direction of the seawater oxidation treatment system 1.

[0021]

In such an aeration apparatus 10A, since the aeration units 20 generating micro-air-bubbles from the aeration nozzles 13 attached to the headers 12 include the nozzleless sections 30 partly forming the bottom regions that do not generate micro-air-bubbles, upward flows (the arrows Fa in FIG. 1) of used seawater rising toward the water surface are generated with the micro-air-bubbles from the aeration nozzles 13 in the region having the unit installation width Wa.

Consequently, since the amount of the used seawater at the bottom face 1a side of the seawater oxidation treatment system 1 is decreased by the upward flows of the used seawater, in order to compensate for this decrease, downward flows (the arrows Fb in FIG. 1) are formed in the region not generating micro-air-bubbles due to the nozzleless sections 30. The downward flows in this case are formed in the nozzleless sections 30 provided along the side wall of the seawater oxidation treatment system 1.

[0022]

Consequently, in the seawater oxidation treatment system 1, the upward flows in the unit installation width W_a where the aeration units 20 are installed and the downward flows in the missing portion width W_b where the nozzleless sections 30 are provided are combined to form a circulating flow that widely circulates over approximately the whole cross section of the seawater oxidation treatment system 1 in the used seawater flowing in the seawater oxidation treatment system 1. Thus, in the used seawater flowing in the seawater oxidation treatment system 1, a large circulating flow over the channel width W is formed in the lateral direction of the seawater oxidation treatment system 1, thereby accelerating the mixing of the entire used seawater.

[0023]

In a second embodiment shown in FIG. 3, a partition member 40 extending in the flow direction of the seawater oxidation treatment system 1 is installed so as to separate the region having the unit installation width W_a where micro-air-bubbles are generated and the region having the missing portion width W_b where micro-air-bubbles are not generated from each other in the width direction of the seawater oxidation treatment system 1. Other components are basically identical to those described in the first embodiment, and detailed descriptions thereof are omitted below.

[0024]

The partition member 40 is, for example, a plate-like member partitioning the lateral direction of the seawater oxidation treatment system 1 and is positioned in the height (depth) direction of the seawater oxidation treatment system 1, so as to allow used seawater to flow in the width direction of the seawater oxidation treatment system 1 at the water surface side and at the bottom face side, but to block the flow in the middle portion.

As a result, the upward flows and the downward flows of circulating flows formed in the seawater oxidation treatment system 1 are reliably separated with the partition member 40 serving as a boundary. With this configuration, the formation of a large circulating flow over the channel width W of the seawater oxidation treatment system 1 can be further accelerated.

[0025]

In a third embodiment shown in FIGS. 4 and 5, the aeration nozzles 13A are vertically arranged instead of the horizontally arranged aeration nozzles 13. The same portions as those in the above-described embodiments are designated with the same reference numerals, and detailed descriptions thereof are omitted.

In this embodiment, since aeration units 20A having the vertically arranged aeration nozzles 13A are employed, the

number of nozzles disposed per unit area of the seawater oxidation treatment system 1 can be increased. Accordingly, the unit installation width W_a' for installing the aeration units 20A can be made smaller than that of a horizontal arrangement ($W_a' < W_a$), provided that the conditions such as the channel width W of the seawater oxidation treatment system 1 and the amount of air for generating micro-air-bubbles are the same. Consequently, the missing portion width W_b' of the nozzleless sections 30A can be made larger than that of the horizontal arrangement ($W_b' > W_b$).

[0026]

By employing such vertically arranged aeration nozzles 13A, the ratio of the unit installation width W_a' forming the upward flows and the missing portion width W_b' forming the downward flows can be close to 1:1. Therefore, a large circulating flow over the channel width W is readily and reliably formed in used seawater flowing in the seawater oxidation treatment system 1, thereby further accelerating the mixing of the used seawater.

[0027]

A first modification and a second modification of the above-described embodiments are shown in FIG. 6 and FIG. 7, respectively, and will be described. The same portions as those in the above-described embodiments are designated with the same reference numerals, and detailed descriptions thereof

are omitted.

In an aeration apparatus 10C of the first modification shown in FIG. 6, the nozzleless sections 30B not generating micro-air-bubbles are disposed intermittently in the flow direction of the seawater oxidation treatment system 1. That is, aeration units 20 (20A) having the unit installation width W_a (W_a') and aeration units 20B having the channel width W are arranged alternately in the flow direction of used seawater. As a result, the nozzleless sections 30B not generating micro-air-bubbles are intermittently formed with predetermined intervals along one side wall of the seawater oxidation treatment system 1. Consequently, since downward flows are also intermittently formed, the turbulence occurring in the flow of used seawater is increased, thus accelerating mixing.

[0028]

In an aeration apparatus 10D of the second modification shown in FIG. 7, the channel width W of the seawater oxidation treatment system 1 is divided into two areas, and, in each area, regions generating micro-air-bubbles due to the aeration units 20 (20A) and regions not generating micro-air-bubbles due to nozzleless sections 30B are alternately arranged. As a result, in the entire seawater oxidation treatment system 1, the nozzleless sections 30B are arranged in a checkerboard pattern. In this case, the division ratio of the channel width W is not limited to two equal parts.

[0029]

With such an arrangement in a checkerboard pattern, since the directions of circulating flows formed in the used seawater are alternately opposite to each other, the turbulence occurring in the flow is increased, thus accelerating mixing.

Thus, the arrangement of the nozzleless sections 30 (30A, 30B) may be successive along either side wall in the lateral direction of the seawater oxidation treatment system 1 or may be intermittent. Furthermore, the arrangement of the nozzleless sections 30 (30A, 30B) may be alternately intermittent along both side walls.

[0030]

According to the present invention described above, a large circulating flow over the channel width W in the lateral direction of the seawater oxidation treatment system 1 is formed in used seawater flowing in the seawater oxidation treatment system 1 by providing nozzleless sections 30 (30A, 30B) not generating micro-air-bubbles. Since such a formation of the circulating flow accelerates the mixing of the entire used seawater, insufficient mixing can be avoided even if the properties of the used seawater flowing in the seawater oxidation treatment system 1 are different at both sides in the width direction of the seawater oxidation treatment system 1. Therefore, the used seawater passing through the aeration

apparatus and being drained into the surrounding sea area can have approximately homogeneous seawater properties as a whole. Thus, the provision of the nozzleless sections 30 (30A, 30B) is effective for improving the decarbonation performance.

[0031]

Furthermore, by improving the decarbonation performance of the aeration apparatus, the length of the seawater oxidation treatment system 1 necessary for conducting a predetermined level of decarbonation can be decreased. Therefore, the cost and the space for installing the seawater oxidation treatment system 1 can also be decreased.

The present invention is not limited to the above-described embodiments and can be variously modified within the scope of the present invention.

CLAIMS

1. An aeration apparatus being installed in a seawater oxidation treatment system for draining used seawater discharged from a desulfurization tower of an exhaust gas desulfurizer using seawater as an absorbent and configured to conduct decarbonation by generating micro-air-bubbles in the used seawater, wherein

headers communicating with an air-supplying pipe are installed on a bottom face of the seawater oxidation treatment system, and aeration units generating the micro-air-bubbles from aeration nozzles attached to the headers comprise nozzleless sections for partly forming bottom regions where micro-air-bubbles are not generated.

2. The aeration apparatus according to Claim 1, wherein a partition member extending in the flow direction of the seawater oxidation treatment system is installed so as to separate the region where micro-air-bubbles are generated and the region where micro-air-bubbles are not generated from each other in the width direction of the seawater oxidation treatment system, and the partition member allows used seawater to flow in the width direction of the seawater oxidation treatment system at the water surface side and at the bottom face side.

3. The aeration apparatus according to Claim 1 or 2, wherein the aeration nozzles are vertically arranged so as to extend upward in the vertical direction from the headers.