Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).
This invention relates to a gas-liquid contact apparatus for use, for example, in the desulfurization and other treatment of flue gas wherein an absorbing fluid is spouted in an absorption tower through which flue gas flows, and thereby brought into gas-liquid contact with the flue gas.

Conventionally, various types of gas-liquid contact apparatus are being used as wet flue gas desulfurizers for removing harmful substances (e.g., sulfur dioxide) from the flue gas of a coal-fired boiler or the like. As an example of such gas-liquid contact apparatus, an apparatus of the so-called liquid column type is disclosed in Japanese Utility Model Laid-Open No. 53828/84.

In this apparatus, an absorbing fluid (e.g., a lime slurry) is spouted upward in the form of liquid columns from a plurality of nozzles disposed in the absorption tower, and flue gas is made to flow through the spouted streams of the absorption fluid. Thus, sulfur dioxide and dust (e.g., fly ash) contained in the flue gas can be effectively removed.

The basic construction thereof is such that, as schematically illustrated in FIG. 5, flue gas inlet or outlet sections 52 and 53 for introducing or discharging flue gas are defined in the upper and lower parts of an absorption tower 51. At the same time, header pipes 54 are disposed in absorption tower 51 and a large number of upward facing nozzles 55 are formed on these header pipes 54.

Moreover, a fluid reservoir 56 for storing an absorbing fluid (e.g., a lime slurry) 57 is defined at the bottom of absorption tower 51. This fluid reservoir 56 communicates with the aforesaid header pipes 54 by means of a circulation pipe 58, and an injection pump 59 is installed in this circulation pipe 58.

In the gas-liquid contact apparatus having the above-described construction, pump 59 is operated to spout absorbing fluid 57 upward from upward nozzles 55. On the other hand, flue gas is introduced from one of flue gas inlet or outlet sections 52 and 53 and made to flow through the spouted streams of absorbing fluid 57, so that gas-liquid contact is effected. The treated flue gas from which sulfur dioxide and the like have been removed is discharged from the other of flue gas inlet or outlet sections 52 and 53.

According to this technique in which absorbing fluid 57 is spouted upward, gas-liquid contact is effected over a long period of time during which the absorbing fluid makes a round trip (i.e., rises and falls). Moreover, when the spouted streams reach their peaks and falls down while spreading like umbrellas, absorbing fluid 57 is divided into liquid droplets and thereby enhances the gas-liquid contact effect. When the content of sulfur dioxide and the like in the flue gas is low, an economical operation may be carried out by varying the height of liquid columns. Furthermore, as compared with an apparatus of the so-called packed tower type in which an absorbing fluid is made to flow downward through a tower packed with lattice-like grids and thereby brought into contact with a gas, the apparatus of the aforesaid type has several advantages, for example, in that the fluid passage of this apparatus is less liable to clog.

Accordingly, one object of the present invention is to provide a gas-liquid contact apparatus which can make the above described equipment more compact and reduce the equipment cost, operating cost and other costs without decreasing the efficiency of absorption of sulfur dioxide and the like.

A further prior art that is of interest is WO 96/14138 that discloses a gas-liquid contactor comprising a passage having a lower end an upper end; an inlet formed near the lower end of said passage through which gases are introduced into the passage; means for introducing fluid into the passage so as to produce liquid particles which are entrained in the gases; means located in the passage for separating the liquid particles from the gases; and means for maintaining the flow of the gases within the passage at a velocity sufficient to carry the liquid particles from the introducing means to the separating means.

Additionally, means are located adjacent the separating means for receiving the fluid from the separating means and returning the fluid to the introducing means under the force of gravity. There is an outlet associated with the passage through which gases escape from the gas-liquid contactor.

In the particular embodiment the means for introducing fluid into said passage are horizontal spray heads creating jets travelling radially across said passage.

In the above-described technique, however, injection pump 59 having a high power load is operated to spout absorbing fluid 57 within fluid reservoir 56 from nozzles 55 (only one injection pump is shown in FIG. 5 for the sake of simplicity, but a plurality of injection pumps are actually used). In order to make the apparatus more compact and reduce the equipment cost and the operating cost, it would be desirable to omit such injection pumps.

Accordingly, another object of the present invention is to provide a gas-liquid contact apparatus which can make the apparatus shown in FIG. 5 more compact and reduce the equipment cost and the operating cost, for the sake of simplicity, but a plurality of injection pumps are actually used). In order to make the apparatus more compact and reduce the equipment cost and the operating cost, it would be desirable to omit such injection pumps.

Accordingly, one object of the present invention is to provide a gas-liquid contact apparatus which can make the above described equipment more compact and reduce the equipment cost, operating cost and other costs without decreasing the efficiency of absorption of sulfur dioxide and the like.

A further prior art that is of interest is WO 96/14138 that discloses a gas-liquid contactor comprising a passage having a lower end an upper end; an inlet formed near the lower end of said passage through which gases are introduced into the passage; means for introducing fluid into the passage so as to produce liquid particles which are entrained in the gases; means located in the passage for separating the liquid particles from the gases; and means for maintaining the flow of the gases within the passage at a velocity sufficient to carry the liquid particles from the introducing means to the separating means.

Additionally, means are located adjacent the separating means for receiving the fluid from the separating means and returning the fluid to the introducing means under the force of gravity. There is an outlet associated with the passage through which gases escape from the gas-liquid contactor.

In the particular embodiment the means for introducing fluid into said passage are horizontal spray heads creating jets travelling radially across said passage.

SUMMARY OF THE INVENTION

The invention is as defined in the accompanying claims in which claim 1 has been divided into a two-part form based on the assumption that WO 96/14138 is the nearest state of the art.

In order to improve the above-described prior arts the present invention provides a gas-liquid contact apparatus for desulfurization and other treatment of a flue gas comprising an absorption tower through which flue gas flows; a fluid reservoir, and an absorbing fluid feed line in fluid communication with said fluid reservoir and with fluid spouting nozzles in said absorption tower, wherein the fluid level of said reservoir is determined so
as to be above the position of said nozzles; an inlet disposed in the lower part of said absorption tower for introducing the flue gas into said absorption tower, such that said flue gas can flow upwardly through said absorption tower; catcher means disposed in the absorption tower at a position which is above said fluid level in the fluid reservoir, said catcher means serving to catch at least a portion of the absorbing fluid spouted from said nozzles; a circulation passage in fluid communication with said catcher means and said fluid reservoir, whereby fluid caught by said catcher means is returned to said fluid reservoir; characterized in that: said nozzles are such that the absorbing fluid is spouted upwards to create streams having peaks; the cross-sectional area of the upper part of said absorption tower is enlarged in cross-sectional area in the vicinity of said peaks to reduce flow velocity of the spouted streams and thereby promote the falling of liquid droplets; and that said catcher means is installed such that it serves to catch at least a portion of the absorbing fluid falling from said peaks while spreading like umbrellas.

The reason why the fluid level of the fluid reservoir is determined so as to be above the position of the nozzles is that the absorbing fluid is spouted from the nozzles by the action of the pressure head of the fluid stored in the fluid reservoir (i.e., the difference between the height of the fluid surface and the height of the nozzles).

Thus, since the absorbing fluid is spouted by the action of the pressure head of the fluid within the fluid reservoir, the necessity of using injection pumps having a high power load can be eliminated. Moreover, since the catcher means is installed at a position above the fluid level, and the absorbing fluid is spouted from the nozzles to a height above the catcher means, at least a portion of the absorbing fluid spouted from said peaks while spreading like umbrellas.

The catcher means used herein may comprise, for example, gutter-like members which are suitably arranged so as to pass the streams spouted upward but efficiently receive the absorbing fluid falling from the peaks of the streams while spreading like umbrellas; a cyclone-like means which catches the absorbing fluid by gathering the uppermost portions of the spouted streams in the neighborhood of the sidewall of the absorption tower; or other suitable means.

In this case, the proportion of the absorbing fluid caught by the catcher means should preferably be as high as possible, and it is ideal that the absorbing fluid is completely caught and returned. If some of the absorbing fluid falls down instead of being caught by the catcher means, the uncaught portion of the absorbing fluid may be handled, for example, by accumulating it in the lower part of the absorption tower and returning it to the fluid reservoir by means of a circulating pump having a low power load.

Moreover, in order that the peaks of the streams spouted upward from the nozzles may be raised above the fluid level of the fluid reservoir, flue gas is made to flow in the same upward direction as the absorbing fluid is spouted. Thus, the flow of the flue gas acts on the spouted streams so as to raise them above the fluid level.

Furthermore, the aforesaid circulation passage permits the absorbing fluid caught by the catcher means to flow into the fluid reservoir by its own weight. This circulation passage may comprise, for example, a trough or gutter which is open to the atmosphere and hence allows the circulating fluid to come into contact with the atmosphere. However, the circulation passage should preferably comprise a pipe or hose which is shielded from the atmosphere and hence has no possibility of allowing the concurrently flowing untreated flue gas to leak into the atmosphere.

In the gas-liquid contact apparatus of the present invention, mist collector means may be installed within the absorption tower at a position above the absorbing fluid spouting section thereof, and the mist collected by this mist collector means may be returned to the fluid reservoir.

Specifically, when the flue gas is made to flow in the same direction as the absorbing fluid is spouted, the amount of mist contained in the flue gas having passed through the spouted streams is increased. If the flue gas is discharged as it is, not only the absorbing fluid is wasted, but also the treated flue gas having the mist mixed therein is undesirably emitted out of the system. Accordingly, mist collector means is installed above the spouted streams for the purpose of collecting and returning the mist.

Moreover, the cross-sectional area of the upper part of the absorption tower is enlarged in the vicinity of the peaks of the spouted streams. This enlarged cross-sectional area reduces the flow velocity of the flue gas and thereby promotes the falling of liquid droplets from the spouted streams. Thus, the effect of recovering the absorbing fluid can be enhanced.

Moreover, the fluid reservoir may be made to function as an oxidation tank for effecting the oxidation reaction of the absorbing fluid. In a gas-liquid contact apparatus functioning as a wet flue gas desulfurizer, sulfur dioxide is absorbed into the absorbing fluid to form a sulfite. Then, this sulfite is oxidized by supplying air (oxygen) to the absorbing...
fluid. Where the gas-liquid contact apparatus of the present invention is applied, for example, to a wet flue gas desulfurizer or the like, the fluid reservoir may be made to function as an oxidation tank in which the absorbing fluid is oxidized by air (oxygen) supplied to this oxidation tank. This makes a separately installed oxidation tank unnecessary, resulting in a simplification of the whole equipment.

Moreover, the circulation passage for returning the absorbing fluid from the catcher means to the fluid reservoir may comprise a circulation pipe shielded from the atmosphere.

Specifically, where the fluid reservoir functions as an oxidation tank, the circulation passage comprising a trough or other member open to the atmosphere is not desirable because the untreated flue gas within the absorption tower diffuses into the atmosphere. Accordingly, in such circumstances, the circulation passage is formed of a circulation pipe shielded from the atmosphere so that the untreated flue gas flowing together with the circulating fluid may be introduced into the oxidation tank without diffusing into the atmosphere.

In this case, the circulation pipe shielded from the atmosphere may comprise, for example, a pipe or a hose.

Where the fluid reservoir functions as an oxidation tank, the circulation pipe may have a lower end extending downward and submerged in the absorbing fluid within the fluid reservoir, and an air pipe may be connected to the circulation pipe so that air (oxygen) is supplied to the absorbing fluid within the fluid reservoir simultaneously with the return of the absorbing fluid.

The air (oxygen) so supplied serves to effect oxidation reaction. When the air pipe is connected to the circulation pipe, the absorbing fluid flowing downward through the circulation pipe by its own weight causes air to be sucked in and entrained into the fluid reservoir, so that an air feed blower and related components may be omitted.

Moreover, when the lower end of the circulation pipe is submerged in the absorbing fluid within the fluid reservoir, air (oxygen) can be effectively introduced into the absorbing fluid.

Moreover, the flue gas is preferably made to flow at a high velocity of not less than 5 m/sec.

In the case of a conventional gas-liquid contact apparatus of the so-called liquid column type, the flow velocity of flue gas is usually not greater than 5 m/sec. In the gas-liquid contact apparatus of the present invention, a flow velocity of not less than 5 m/sec is employed. This not only enhances the effect of lifting the spouted streams of the absorbing fluid and thereby raises the peaks of the spouted streams higher, but also increases the amount of absorbing fluid staying in the flue gas (i.e., the holdup of the absorbing fluid). Moreover, the interior of the liquid droplets is sufficiently stirred to cause an increase in the absorption rate of the liquid droplets.

Furthermore, the velocity of the liquid droplets relative to the flue gas regarded as a viscous fluid is increased, so that the boundary film formed on the surface of the liquid droplets becomes thinner. For this and other reasons, the gas-liquid contact effect is enhanced to achieve higher desulfurization efficiency than conventional.

In this connection, FIG. 4 shows the results of an experiment in which, using a gas-liquid contact apparatus in accordance with the present invention, the relationship between the flow velocity (m/sec) of the flue gas and the degree of desulfurization (%) was examined by maintaining the circulation rate of the absorbing fluid and the height of liquid columns at certain fixed values. By this experiment, the present inventors have found that, if the flow velocity of the flue gas exceeds 5 m/sec, the degree of desulfurization is improved as the flow velocity becomes higher.

As described above, the gas-liquid contact apparatus of the present invention is characterized in that the fluid level of the fluid reservoir is determined so as to be above the position of the nozzles, catcher means for catching at least a portion of the absorbing fluid spouted by the action of pressure head at a position above the fluid level is installed, and the absorbing fluid caught by the catcher means is returned through a circulation passage. Thus, the necessity of using injection pumps having a high power load can be eliminated and, therefore, the operating cost can be reduced.

Moreover, if the mist collector means is returned to the fluid reservoir, the absorbing fluid can be used efficiently and the flue gas containing no mist can be discharged. Moreover, as the cross-sectional area of the upper part of the absorption tower is enlarged, the absorbing fluid can be recovered more effectively.

Moreover, the fluid reservoir is made to function as an oxidation tank, the overall construction of the equipment, for example, of a wet flue gas desulfurizer can be made more compact.

Moreover, when the circulation passage comprises a circulation pipe shielded from the atmosphere, the untreated flue gas is prevented from being emitted into the atmosphere. Moreover, when the circulation pipe has a lower end extending downward and submerged in the absorbing fluid within the fluid reservoir, and an air pipe is connected to the circulation pipe, air (oxygen) can be automatically and effectively supplied to the oxidation tank, and the equipment can be simplified.

Furthermore, if the flue gas is made to flow at a rate higher than a predetermined rate, an improvement in desulfurization efficiency can be achieved and the equipment can be made more compact.
BRIEF DESCRIPTION OF THE DRAWINGS

[0044]

FIG. 1 is a schematic view of an exemplary gas-liquid contact apparatus in accordance with the present invention;
FIG. 2 is a sectional view taken on line A-A in FIG. 1;
FIG. 3 is a perspective view of the catcher means used therein;
FIG. 4 is a graph showing the relationship between the flow velocity of flue gas and the degree of desulfurization, the flow velocity (in m/sec) of flue gas being plotted as abscissa and the degree of desulfurization (in %) as ordinate; and
FIG. 5 is a schematic view of a conventional gas-liquid contact apparatus.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

[0045] One embodiment of the present invention will be described hereinbelow with reference to the accompanying drawings.

FIG. 1 is a schematic view of an exemplary gas-liquid contact apparatus in accordance with the present invention,
FIG. 2 is a sectional view taken on line A-A in FIG. 1, and
FIG. 3 is a perspective view of the catcher means used therein.

[0046] The gas-liquid contact apparatus of the present invention can be applied, for example, to an absorption tower of a wet flue gas desulfurizer, and is constructed so as to bring about an improvement in a gas-liquid contact apparatus of the so-called liquid column type in which an absorbing fluid (e.g., a lime slurry) is spouted upward from nozzles and brought into contact with flue gas flowing therethrough so as to absorb sulfur dioxide into the absorbing fluid. In this connection, oxygen is supplied to the absorbing fluid having sulfur dioxide absorbed thereinto, so that the resulting sulfite is oxidized to form gypsum.

[0047] In an exemplary gas-liquid contact apparatus in accordance with the present invention, as illustrated in FIG. 1, an oxidation tank 2 serving as a fluid reservoir is installed in close proximity to an absorption tower 1, and an absorbing fluid 3 is stored in this oxidation tank 2. Where it is desired to recover the sulfite directly as a by-product, oxidation tank 2 need not serve for oxidation purposes, but may only function as a fluid reservoir.

[0048] Absorption tower 1 is equipped with header pipes 5 which communicate with oxidation tank 2 by means of a connecting pipe 4. This connecting pipe 4 is equipped with a valve 6 for opening or closing the pipe line, and the aforesaid header pipes 5 have a large number of nozzles 7 for spouting absorbing fluid 3 upward.

[0049] A flue gas inlet section 8 for introducing flue gas into absorption tower 1 is formed in the lower part thereof, and a flue gas outlet section 9 for discharging the flue gas from absorption tower 1 is formed in the upper part thereof. The flue gas introduced from flue gas inlet section 8 is made to flow upward through absorption tower 1, and thereby brought into gas-liquid contact with the spouted streams of the absorbing fluid. The treated flue gas is discharged from flue gas outlet section 9.

[0050] In the present invention, the flue gas is made to flow from flue gas inlet section 8 toward flue gas outlet section 9 as will be described later. Thus, the peaks of the streams spouted from nozzles 7 are raised and, at the same time, an improvement in desulfurization efficiency is achieved.

[0051] Moreover, a mist eliminator 10 serving as mist collector means is installed above the absorbing fluid injection region of absorption tower 1 so that any mist contained in the treated flue gas may be collected thereby. In addition, catcher means 11 as will be described later is installed in the upper middle part of absorption tower 1 so that at least a portion of absorbing fluid 3 spouted from nozzles 7 may be caught thereby.

[0052] Moreover, in order to return the caught portion of absorbing fluid 3 to oxidation tank 2, a circulation pipe 12 comprising a pipe or hose extends from catcher means 11 to oxidation tank 2.

[0053] Moreover, the cross-sectional area of absorption tower 1 is enlarged in the vicinity of the peaks of the spouted streams, so that this enlarged cross-sectional area reduces the flow velocity of the spouted streams and thereby promotes the falling of liquid droplets. At the same time, a circular trough 17 forming part of catcher means 11 as will be described later is installed by utilizing the step resulting from the enlargement of the cross-sectional area.

[0054] Furthermore, a recovery section 13 for receiving that portion of absorbing fluid 3 not caught by catcher means 11 is installed in the lower part of absorption tower 1. In order to return absorbing fluid 3 accumulated in this recovery section 13 to oxidation tank 2, a return pipe 14 is installed between recovery section 13 and oxidation tank 2. This return pipe 14 is equipped with a recovery pump 15.

[0055] As described previously, absorbing fluid 3 is stored in aforesaid oxidation tank 2. The level H of this absorbing fluid 3 is determined so as to be above the position of the aforesaid nozzles 7. This oxidation tank 2 is equipped with an agitator 16 for agitating absorbing fluid 3.

[0056] Moreover, a withdrawal line for withdrawing the slurry from oxidation tank 2, a feed line for replenishing absorbing fluid 3, and the like are also connected to oxidation tank 2, but they are not shown in FIG. 1 for the sake of simplicity.
[0057] Now, the aforesaid catcher means 11 is explained with further reference to FIGs. 2 and 3.

[0058] Catcher means 11 comprises, for example, a circular trough 17 formed on the step in the inner wall of absorption tower 1, and a plurality of gutter members 18 extending in parallel with the aforesaid header pipes 5. These circular trough 17 and gutter members 18 are positioned above the level H of absorbing fluid 3 within oxidation tank 2.

[0059] As illustrated, for example, in FIGs. 2 and 3, gutter members 18 are disposed so that they do not interrupt the streams spouted upward and, at the same time, they can effectively catch the absorbing fluid falling from the peaks of the streams while spreading like umbrellas. In the illustrated embodiment, gutter members 18 and header pipes 5 are arranged alternately, and each gutter member 18 is positioned halfway between adjacent header pipes 5.

[0060] Moreover, as illustrated in FIG. 2, the ends of each gutter member 18 are connected to circular trough 17 so as to communicate therewith. If necessary, additional consideration is given to gutter members 18. For example, in order to cause the received absorbing fluid to flow smoothly into circular trough 17, gutter members 18 are sloped so that the central part of each gutter member 18 is elevated above its ends (of the circular trough side).

[0061] As a matter of course, gutter members 18 may be disposed in any desired manner. So long as the spouted absorbing fluid can be effectively caught, gutter members 18 may be arranged so as to have two or more header pipes 5 interposed therebetween. Alternatively, gutter members 18 may be arranged like a lattice by disposing them both in a direction parallel to header pipes 5 and in a direction perpendicular thereto. Furthermore, it is also possible to install only a circular trough 17 on the sidewall of the absorption tower and omit gutter members 18.

[0062] The upper end of circulation pipe 12 is connected to the aforesaid circular trough 17, while the lower end of circulation pipe 12 is submerged in absorbing fluid 3 within oxidation tank 2 and extends to the neighborhood of the bottom thereof. Thus, the caught portion of absorbing fluid 3 is allowed to flow downward through circulation pipe 12 by its own weight and return to oxidation tank 2.

[0063] Moreover, an air pipe 20 is connected to this circulation pipe 12. Thus, while the absorbing fluid caught by catcher means 11 flows downward through circulation pipe 12 by its own weight, air is sucked in through air pipe 20 and entrained into oxidation tank 2.

[0064] Furthermore, a venting equalizer 21 is installed between oxidation tank 2 and absorption tower 1. Thus, the residual air present in the upper space of oxidation tank 2, which consists essentially of nitrogen gas, is conducted to flue gas outlet section 9 of absorption tower 1.

[0065] The operation of the gas-liquid contact apparatus having the above-described construction is described below.

[0066] As illustrated in FIG. 1, absorbing fluid 3 is fed to oxidation tank 2, and its level H is determined so as to be above the position of nozzles 7 and below the position of catcher means 11. In this condition, valve 6 in connecting pipe 4 is operated so as to cause oxidation tank 2 to communicate with header pipes 5. At the same time, flue gas is introduced from flue gas inlet section 8 at a high flow.

[0067] Thus, absorbing fluid 3 is spouted upward from nozzles 7 by the action of the pressure head defined by the difference (h) in height between the fluid level H of oxidation tank 2 and nozzles 7. Moreover, owing to the lifting effect of the flue gas introduced from flue gas inlet section 8 at a high flow velocity, the peaks of the spouted streams are further raised above fluid level H. Consequently, the spouted streams pass through the openings between gutter members 18 and rise to a position above fluid level H.

[0068] In the illustrated embodiment, the flow velocity of the flue gas is not less than 5 m/sec (and preferably in the range of 5 to 15 m/sec). This not only enhances the effect of lifting the spouted streams, but also brings about an improvement in desulfurization efficiency owing to an increase in gas-liquid contact efficiency.

[0069] After the spouted streams rise through the openings between gutter members 18 and reach their peaks, they fall down while spreading like umbrellas. The major portion of the absorbing fluid constituting the streams is caught by gutter members 18 and circular trough 17, and the remainder falls into recovery section 13.

[0070] That portion of absorbing fluid which is caught by catcher means 11 flows downward through circulation pipe 12 by its own weight and joins in absorbing fluid 3 within oxidation tank 2. On its way to oxidation tank, air is sucked in through air pipe 20 and entrained into the absorbing fluid 3 within oxidation tank 2.

[0071] Since the lower end of circulation pipe 12 is submerged in the absorbing fluid within oxidation tank 2, the air sucked in through air pipe 20 can be effectively introduced into the absorbing fluid.

[0072] On the other hand, that portion of absorbing fluid 3 which has fallen into recovery section 13 is returned to oxidation tank 2 by the operation of recovery pump 15 having a low power load.

[0073] In oxidation tank 2, agitator 16 is operated and the oxidation of absorbing fluid 3 is promoted by the air (oxygen) sucked in through air pipe 20. If necessary, additional air (oxygen) may be supplied through the bottom of oxidation tank 2.

[0074] That portion of absorbing fluid 3 which has been converted into a concentrated slurry as a result of the oxidation thereof is withdrawn through a withdrawal line (not shown) and transferred to a downstream step where it is subjected to a treatment for the formation of gypsum. Moreover, if necessary, fresh absorbing fluid 3 is replenished through a feed line (not shown).
The residual air present in the upper space of oxidation tank 2, which consists essentially of nitrogen gas, is conducted to the neighborhood of flue gas outlet section 9 of absorption tower 1 through venting equalizer 21.

On the other hand, the treated flue gas, from which sulfur dioxide has been removed as a result of the gas-liquid contact, flows toward the flue gas outlet section 9. Since the flow velocity of the flue gas is high, the treated flue gas contains a large amount of mist. However, the mist contained in the flue gas loses in velocity during passage through the section of enlarged cross-sectional area and hence tends to fall down. Moreover, the mist is collected during the passage of the flue gas through mist eliminator 10 and returned to oxidation tank 2 through a circulation passage (not shown).

In the above-described manner, absorbing fluid 3 can be circulated by spouting absorbing fluid 3 from nozzles 7 by the action of the pressure head h, without the need to install injection pumps having a particularly high power load. This makes it possible to reduce the operating cost. Moreover, the number of nozzles can also be decreased under certain conditions.

It is to be understood that the present invention is not limited to the above-described embodiment. It goes without saying that gas-liquid contact apparatus having substantially the same construction and producing the same effects as that of the present invention also come within the technical scope of the present invention as defined in the accompanying claims.

For example, catcher means 11 need not necessarily comprise gutter members.

Moreover, if the spouted streams can be almost completely caught by catcher means 11, the underlying recovery pump 15 and related components may become unnecessary.

Claims

1. A gas-liquid contact apparatus for the desulfurization and other treatment of a flue gas, comprising an absorption tower (1) through which flue gas flows;
   a fluid reservoir (2), and an absorbing fluid feed line (4) in fluid communication with said fluid reservoir (2) and with fluid spouting nozzles (7) in said absorption tower (1), wherein the fluid level of said reservoir (2) is determined so as to be above the position of said nozzles (7);
   an inlet (8) disposed in the lower part of said absorption tower (1) for introducing the flue gas into said absorption tower, such that said flue gas can flow upwardly through said absorption tower (1);
   catcher means (11) disposed in the absorption tower (1) at a position which is above said fluid level in the fluid reservoir (2), said catcher means serving to catch at least a portion of the absorbing fluid spouted from said nozzles (7);
   a circulation passage (12) in fluid communication with said catcher means (11) and said fluid reservoir (2), whereby fluid caught by said catcher means is returned to said fluid reservoir; characterized in that:
   said nozzles (7) are such that absorbing fluid (3) is spouted upwards to create streams having peaks;
   the cross-sectional area of the upper part of said absorption tower (1) is enlarged in cross-sectional area in the vicinity of said peaks to reduce flow velocity of the spouted streams and thereby promote the falling of liquid droplets; and that said catcher means (11) is installed such that it serves to catch at least a portion of the absorbing fluid falling from said peaks while spreading like umbrellas.

2. Apparatus as in claim 1 wherein said enlarged cross-sectional area of the upper part of the absorption tower is of such a magnitude that the flue gas flows at a velocity of not less than 5 m/sec.

3. Apparatus as in claim 2 wherein said cross-sectional area is such that said velocity is in the range of 5 to 15 m/sec.

4. Apparatus as in any one of claims 1 to 3 wherein said fluid reservoir (2) functions as an oxidation tank for effecting the oxidation reaction of the absorbing fluid.

5. Apparatus as in any one of claims 1 to 4 wherein said circulation passage (12) for returning the absorbing fluid from said catcher means (11) to said fluid reservoir (2) comprises a circulation pipe shielded from the atmosphere.

6. Apparatus as in any one of claims 1 to 4 wherein said circulation passage (12) for returning the absorbing fluid from said catcher means (11) to said fluid reservoir (2) has a lower end extending downward and submerged in the absorbing fluid (3) within said reservoir, and wherein an air pipe (20) is connected to said circulation passage (12) so that air is supplied to the absorbing fluid (3) within said fluid reservoir (2) simultaneously with return of the absorbing fluid.

7. Apparatus as in any one of claims 1 to 6 wherein mist collector means (10) is installed within the tower (1) at a position above the absorbing fluid spouting section thereof, there being means (21) whereby the collected mist is returned to the fluid reservoir.
Patentansprüche

1. Gas-Flüssigkeits-Kontakttiorrichtung für die Entschwefelung und andere Behandlungen eines Abgases, umfassend:

   einen Absorptionsschacht (1), durch welchen das Abgas strömt;

   ein Fluidreservoir (2) und eine Absorptionsfluidzuführleitung (4) in Fluidverbindung mit dem Fluidreservoir (2) und mit Fluid ausstoßenden Düsen (7) in dem Absorptionsschacht (1), wobei der Fluidlevel des Reservoirs (2) so festgelegt ist, dass er überhalb der Position der Düsen (7) liegt;

   einen in dem unteren Teil des Absorptionsschachts (1) angeordneten Einlass (8) zum Einführen des Abgases in den Absorptionsschacht, so dass das Abgas durch den Absorptionsschacht (1) nach oben strömen kann;

   eine Auffangeinrichtung (11), die in dem Absorptionsschacht (1) in einer Position angeordnet ist, die über dem Fluidlevel dem Fluidreservoir (2) liegt, wobei die Auffangeeinrichtung dazu dient, zumindest einen Teil des Absorptionsfluids, das aus den Düsen (7) ausgestoßen wird, aufzufangen;

   einen Zirkulationsdurchgang (12), der in Fluidverbindung mit der Auffangeinrichtung (11) und dem Fluidreservoir (2) steht, wodurch durch die Auffangeinrichtung aufgefangen wurde, dem Fluidreservoir zurückgeführt wird;

   dadurch gekennzeichnet, dass:

   die Düsen (7) derart ausgestaltet sind, dass Absorptionsfluid (3) nach oben ausgespritzt wird, um Strahle mit Scheitelpunkten zu erzeugen;

   der Querschnittsbereich des oberen Teils des Absorptionsschachts (1) in der Umgebung dieser Scheitelpunkte in Querschnittsbereich vergrößert ist, um die Strömungsgeschwindigkeit der ausgespritzten Strahlen zu reduzieren und dadurch das Herunterfallen von Flüssigkeitstropfen zu fördern;

   und dass die Auffangeinrichtung (11) derart installiert ist, dass sie dazu dient, zumindest einen Teil des Absorptionsfluids aufzufangen, das von den Scheitelpunkten herunterfällt, während sie sich wie Regenschirme ausbreiten.

2. Vorrichtung nach Anspruch 1, wobei der vergrößerte Querschnittsbereich des oberen Teils des Absorptionsschachts von einem derartigen Ausmaß ist, dass das Abgas mit einer Geschwindigkeit von nicht weniger als 5 m/sec strömt.

3. Vorrichtung nach Anspruch 2, wobei der Querschnittsbereich derart gestaltet ist, dass die Geschwindigkeit in dem Bereich von 5 bis 15 m/sec liegt.

4. Vorrichtung nach einem der Ansprüche 1 bis 3, wobei das Fluidreservoir (2) zum Bewirken der Oxidation des Absorptionsfluids als ein Oxidationsbehälter arbeitet.

5. Vorrichtung nach einem der Ansprüche 1 bis 4, wobei der Zirkulationsdurchgang (12) zum Rückführen des Absorptionsfluids von der Auffangeinrichtung (11) zu dem Fluidreservoir (2) ein Zirkulationsrohr umfasst, das von der Atmosphäre abgeschirmt ist.

6. Vorrichtung nach einem der Ansprüche 1 bis 4, wobei der Zirkulationsdurchgang (12) zum Rückführen des Absorptionsfluids von der Auffangeinrichtung (11) zu dem Fluidreservoir (2) ein unteres Ende aufweist, wobei ein Luftrohr (20) mit dem Zirkulationsdurchgang (12) verbunden ist, so dass dem Absorptionsfluid (3) innerhalb des Fluidreservoirs Luft zugeführt wird.

7. Vorrichtung nach einem der Ansprüche 1 bis 6, wobei eine Nebelsammleinrichtung (10) innerhalb des Schachtes (1), in einer Position überhalb des Absorptionsfluid-Ausspritzbereiches davon vorgesehen ist, wobei es eine Einrichtung (21) gibt, durch die der gesammelte Nebel zu dem Fluidreservoir zurückgeführt wird.

Revendications

1. Dispositif de contact gaz-liquide pour la désulfuration et autre traitement d’un effluent gazeux, comprenant:

   une tour d’absorption (1) à travers laquelle s’écoule l’effluent gazeux;

   un réservoir à liquide (2), et une conduite (4) d’alimentation en liquide absorbant, en communication pour liquide avec le dit réservoir à liquide (2) et avec des gicleurs (7) de projection de liquide placés dans ladite tour d’absorption (1), dans lequel le niveau de liquide dudit réservoir (2) est déterminé de manière à se situer
au-dessus de la position desdits gicleurs (7) ;
une admission (8) disposée dans la partie inférieure de ladite tour d’absorption (1), pour introduire l’effluent gazeux dans ladite tour d’absorption, de manière à ce que l’effluent gazeux puisse s’écouler vers le haut à travers ladite tour d’absorption (1) ;
un moyen de récupération (11) disposé dans la tour d’absorption (1), à une position qui se situe au-dessus dudit niveau du liquide dans le réservoir à liquide (2), ledit moyen de récupération servant à récupérer au moins une partie du liquide absorbant projeté depuis lesdits gicleurs (7) ;
un passage de circulation (12), en communication pour liquide avec ledit moyen de récupération (11) et ledit réservoir à liquide (2), par lequel le liquide récupéré par ledit moyen de récupération est renvoyé vers ledit réservoir à liquide ;
caractérisé en ce que
lesdits gicleurs (7) sont tels que le liquide absorbant (3) est projeté vers le haut, pour créer des jets présentant des sommets ;
la section transversale de la partie supérieure de ladite tour d’absorption (1) est agrandie au voisinage desdits sommets, pour réduire la vitesse d’écoulement des jets projetés, et ainsi favoriser la chute de gouttelettes de liquide ;
et en ce que ledit moyen de récupération (11) est installé de manière à ce qu’il serve à récupérer au moins une partie du liquide absorbant tombant depuis lesdits sommets, alors qu’il se déploie en parapluiue.

2. Dispositif selon la revendication 1, dans lequel la section transversale agrandie de la partie supérieure de la tour d’absorption est d’une grandeur telle que l’effluent gazeux s’écoule à une vitesse non inférieure à 5 m/sec.

3. Dispositif selon la revendication 2, dans lequel la section transversale est telle que ladite vitesse se situe dans la gamme de 5 à 15 m/sec.

4. Dispositif selon l’une quelconque des revendications 1 à 3, dans lequel ledit réservoir à liquide (2) fonctionne comme un réservoir d’oxydation, pour effectuer la réaction d’oxydation du fluide absorbant.

5. Dispositif selon l’une quelconque des revendications 1 à 4, dans lequel ledit passage de circulation (12) destiné à renvoyer le liquide absorbant depuis ledit moyen de récupération (11) vers ledit réservoir à liquide (2), comprend un tuyau de circulation protégé de l’atmosphère.

6. Dispositif selon l’une quelconque des revendications 1 à 4, dans lequel ledit passage de circulation (12) destiné à renvoyer le liquide absorbant depuis ledit moyen de récupération (11) vers ledit réservoir à liquide (2) présente une extrémité inférieure s’étendant vers le bas et immergée dans le liquide absorbant (3) contenu dans ledit réservoir, et dans lequel un tuyau à air (20) est relié audit passage de circulation (12), de sorte que de l’air est envoyé vers le liquide absorbant (3) contenu dans ledit réservoir à liquide (2), simultanément avec le retour du liquide absorbant.

7. Dispositif selon l’une quelconque des revendications 1 à 6, dans lequel un moyen (10) de collecte d’un brouillard est installé à l’intérieur de la tour (1), à une position située au-dessus de sa section de projection du liquide absorbant, un moyen (21) étant prévu pour renvoyer le brouillard récolté vers le réservoir à liquide.
**FIG. 4**

![Graph](image)

- **X-axis:** Flow velocity of flue gas (m/sec)
- **Y-axis:** Degree of desulfurization (%)