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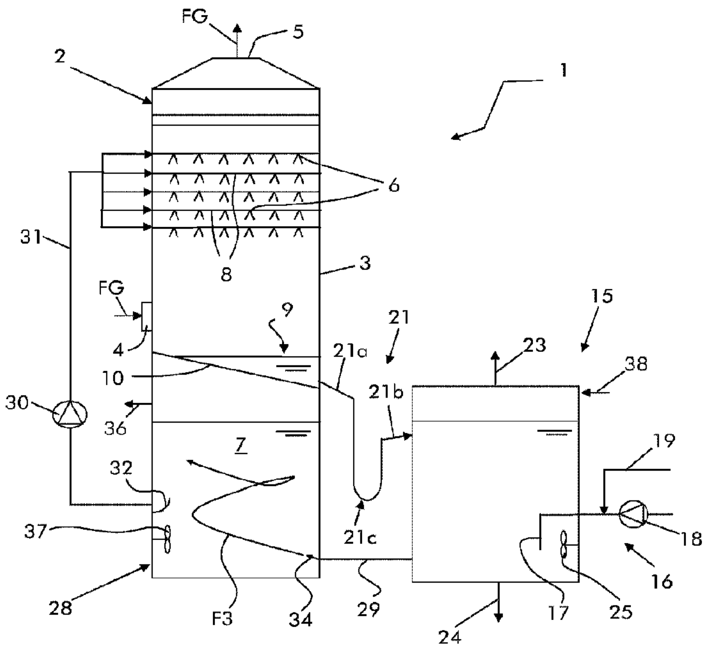
(54) **Titre : SYSTEME POUR L'ELIMINATION DE SOUFRE D'UN GAZ DE CARNEAU**
(54) **Title: SYSTEM FOR SULPHUR REMOVAL FROM A FLUE GAS**



(57) **Abrégé/Abstract:**
The system (1) for sulphur removal from a flue gas (FG), the system (1) comprising an absorber (2) comprising a vessel (3) having an inlet (4) and an outlet (5) for the flue gas (FG), nozzles (6) for spraying a slurry (7) through the flue gas (FG) and a slurry accumulation zone (9) at the lower part of the absorber (2), a reaction tank (15) having an oxidizing gas supply (16) into it and connected to the slurry accumulation zone (9), a buffer tank (28) connected to the reaction tank (15) and to the nozzles (6), for receiving the slurry (7) from the reaction tank (15) and supply the nozzles (6) with the slurry (7). The slurry accumulation zone (9) is connected to the reaction tank (15) by a duct (21) comprising a gas lock. The buffer tank (28) is connected to the reaction tank (15) by a communicating vessel passage (29).

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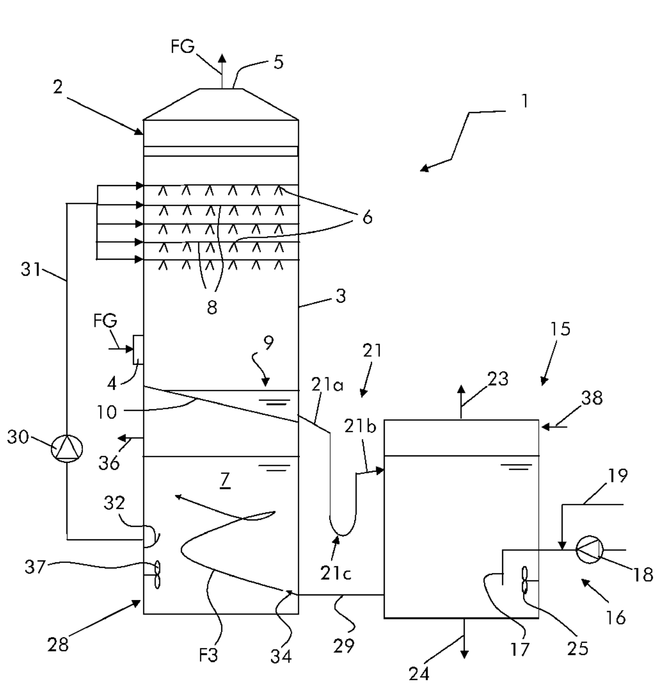
Fig. 1



(57) Abstract: The system (1) for sulphur removal from a flue gas (FG), the system (1) comprising an absorber (2) comprising a vessel (3) having an inlet (4) and an outlet (5) for the flue gas (FG), nozzles (6) for spraying a slurry (7) through the flue gas (FG) and a slurry accumulation zone (9) at the lower part of the absorber (2), a reaction tank (15) having an oxidizing gas supply (16) into it and connected to the slurry accumulation zone (9), a buffer tank (28) connected to the reaction tank (15) and to the nozzles (6), for receiving the slurry (7) from the reaction tank (15) and supply the nozzles (6) with the slurry (7). The slurry accumulation zone (9) is connected to the reaction tank (15) by a duct (21) comprising a gas lock. The buffer tank (28) is connected to the reaction tank (15) by a communicating vessel passage (29).

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SYSTEM FOR SULPHUR REMOVAL FROM A FLUE GAS

TECHNICAL FIELD

The present invention relates to a system for sulphur removal from a flue gas. The flue gas can for example be a flue gas generated in a boiler of a power plant for electric power generation. The boiler can burn a fossil fuel, such as coal.

BACKGROUND

Power plants can have a boiler that generates steam that is expanded in a steam turbine. The boiler further generates flue gas that is treated to remove impurities before the flue gas is vented into the atmosphere.

In order to reduce carbon dioxide emission into the atmosphere (carbon dioxide has a negative environmental impact), the boiler can burn a fossil fuel with pure or substantially pure oxygen, in presence of recirculated flue gas (oxy fuel combustion). Oxyfuel combustion allows generation of flue gas having a high content of carbon dioxide, to make it easier carbon dioxide separation and sequestration.

Since the flue gas has high content of carbon dioxide, the flue gas treatment systems downstream of the boiler must be so designed in order to prevent flue gas contamination with air or other gases, because this would dilute the carbon dioxide and would increase the effort for carbon dioxide separation.

Often the fossil fuel used in boilers (e.g. coal, but also other fossil fuels, such as oil) contains sulfur that during combustion generates SO_2, SO_3 and other sulphur compounds. These compounds can give corrosion problems (within the power plant) or acid rains (if vented) and must thus be removed from the flue gas.

Often, sulphur compounds are removed from the flue gas by reacting them with lime and/or limestone, generating calcium sulfite $CaSO_3$; calcium sulfite is then oxidized into calcium sulfate $CaSO_4$ (gypsum) with air; calcium sulfate is then removed.

Oxidation of calcium sulfite into calcium sulfate must be done preventing oxygen from contaminating the flue gas.

US 8 337 790 discloses a system for sulphur removal having an absorber and a separate container with an oxidation chamber and a buffer chamber connected via an overflow. During operation the reaction chamber receives a suspension containing calcium sulfite $CaSO_3$ from the absorber; air is supplied into the reaction chamber to oxidize the calcium sulfite into calcium sulfate $CaSO_4$ that precipitates and is removed from the oxidation chamber. The sulphur free suspension passes to the buffer chamber by overcoming the overflow and is fed back to the absorber via a pump.

Since the reaction chamber and the buffer chamber are defined in one and the same tank, the air supplied into the reaction chamber is also above the suspension contained in the buffer chamber; this causes risks that air bubbles reach the absorber.

SUMMARY

An aspect of the invention includes providing a system that counteracts the risks that air reaches the absorber.

These and further aspects are attained by providing a system in accordance with the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristics and advantages will be more apparent from the description of a preferred but non-exclusive embodiment of the system, illustrated by way of non-limiting example in the accompanying drawings, in which:

Figures 1 and 2 show a side schematic view and a schematic cross section through the buffer tank and reaction tank of the system in an embodiment of the invention;

Figures 3 and 4 show the system in further embodiments of the invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

With reference to the figures, these show a system 1 for sulphur removal from a flue gas.

The system 1 comprises an absorber 2 comprising a vessel 3 having an inlet 4 and an outlet 5 for the flue gas.

At the upper part of the absorber 2, nozzles 6 for spraying slurry 7 through the flue gas are provided. For example the nozzles 6 are connected to pipes or grids 8.

A slurry accumulation zone 9 is provided at the lower part of the absorber 2. The slurry accumulation zone 9 is below the inlet 4.

The slurry accumulation zone 9 can have an inclined bottom 10; preferably the inclined bottom 10 has a lower side facing the vessel wall.

The system further has a reaction tank 15 and a buffer tank 28. The reaction tank 15 and buffer tank 28 are separate tanks.

The reaction tank 15 is connected to the slurry accumulation zone 9, to receive slurry from the absorber 2; in addition, the reaction tank 15 has an oxidizing gas supply 16 into it. The oxidizer gas supply 16 can e.g. comprise a lance 17 fed with air by a compressor or fan 18; additionally, water can be added via a connection 19.

The slurry accumulation zone 9 is connected to the reaction tank 15 by a duct 21 comprising a gas lock. The gas lock can be any duct configuration or device that counteracts gas passage at least from the reaction tank 15 to the slurry accumulation zone 9.

For example, the gas lock comprises one or more inclined descending duct portions 21a, 21b of the duct 21 from the slurry accumulation zone 9 and reaction tank 15. In addition, the gas lock preferably also comprises a syphon 21c. In this case the syphon 21c is preferably connected between the descending inclined duct portions 21a, 21b.

The reaction tank 15 further has a vent 23 to draw the air and drainage 24 for removing solid precipitate generated during oxidation. An agitator 25 (or more agitators 25) for the slurry contained in the reaction tank is typically also provided.

The buffer tank 28 is connected to the reaction tank 15 and to the nozzles 6, for receiving slurry from the reaction tank 15 and supply the nozzles 6 with the slurry.

The buffer tank 28 is connected to the reaction tank 15 by a communicating vessel passage 29. This way the level of the slurry in the reaction tank 15 and in the buffer tank 28 is the same. The communicating vessel passage 29 is provided at the lower parts of the reactor tank 15 and buffer tank 28.

The buffer tank 28 is connected to the nozzles 6 via a pump 30 and piping 31 connected to the pipes or grids 8. The buffer tank 28 houses a baffle 32 to shield the pump suction.

In one embodiment, the reaction tank 15 has a circular or elliptical or curved cross section (the figures show a circular cross section), and the communicating vessel passage 29 is eccentrically connected to the reaction tank 15; preferably the communicating vessel passage 29 is substantially tangentially connected to the reaction tank 15 (figure 2).

Likewise, preferably the buffer tank 28 has a circular or elliptical or curved cross section (circular in the figures) and the communicating vessel passage 29 is eccentrically connected to the buffer tank 28; preferably the communicating vessel passage 29 is substantially tangentially connected also to the reactor tank 15 (figure 2).

In contrast, the duct 21 can be connected to the vessel 3 and reactor tank 15 at the centre or substantially at the centre thereof (but this is not mandatory and this connection can be any).

The communicating vessel passage 29 has nozzles 34 for supplying slurry into the buffer tank 28; these nozzles 34 face upwards. This configuration advantageously gives the slurry an ascending movement that enhances separation of possible residual air bubbles.

In addition a vent 36 is provided at the upper part of the buffer tank 28 and an agitator 37 (or more agitators 37) at a lower part thereof.

The reaction tank 15 and the buffer tank 28 are separate tanks, i.e. they are defined by different vessels. Preferably the buffer tank 28 is defined within the vessel 3 and at the bottom of the vessel 3; in this case the vessel 3 has a wall (that can be the bottom 10 of the slurry accumulation zone 9) that isolates the absorber 2 from the buffer tank 28.

The operation of the system is apparent from that described and illustrated and is substantially the following.

Flue gas FG containing sulphur dioxide SO_2 is supplied into the absorber 2 via the inlet 4 and passes through the absorber 2. Slurry containing calcium carbonate $CaCO_3$ is sprayed via the nozzles 6 to contact the flue gas and remove the sulphur dioxide SO_2 forming calcium sulphite, according to the reaction

$$SO_2 + CaCO_3 \rightarrow CaSO_3 + CO_2.$$

Flue gas deprived from sulphur dioxide is discharged from the outlet 5.

The slurry now containing calcium sulphite $CaSO_3$ accumulates in the slurry accumulation zone 9 and passes via the duct 21 into the reaction tank 15.

The particular configuration of the duct 21 (with one or more inclined portions 21a and 21b and possibly with the syphon 21c and/or with additional devices) prevents air to pass from the reaction tank 15 into the slurry accumulation zone 9.

In the reaction tank 15 air is supplied via the lance 17; possibly also water in supplied via the connection 19 and fresh lime or limestone can be supplied with a supply 38.

In the reaction tank 15 the air supplied from the lance 17 oxidizes the calcium sulphite $CaSO_3$ into calcium sulphate $CaSO_4$, also with the help of the agitator 25 that helps mixing the slurry.

The calcium sulphate $CaSO_4$ (gypsum) precipitates and is removed through the drainage 24.

The slurry passes from the reaction tank 15 into the buffer tank 28 via the communicating vessel passage 29, which guarantees that the level of the slurry within the reaction tank 15 and buffer tank 28 is the same.

In addition, since the communicating vessel passage 29 is tangentially connected to the reaction tank 15, the slurry moving out from the reaction tank 15 causes rotation of the slurry within the reaction tank 15, as indicated by arrow F1. This further helps air separation within the reaction tank.

Air is removed from the reaction tank 15 via the vent 23.

The slurry within the buffer tank 28 is agitated by the agitator 37. In addition, since the communicating vessel passage 29 is tangentially connected also to the buffer tank 28, the slurry fed into the buffer tank 28 causes the slurry rotation within the buffer tank 28, as indicated by arrow F2. This helps air separation within the buffer tank 28.

Moreover, the nozzles 34 give the slurry supplied into the buffer tank 28 an upwards movement (as indicated by arrow F3) that further helps air separation.

Air is removed from the buffer tank 28 via the vent 36.

In addition, thanks to the shape of the reaction tank 15 and buffer tank 28 the risks of recirculation zones and material deposit within the reaction tank 15 and buffer tank 28 is reduced.

The ducting 31 then supplies the slurry (without air) to the nozzles 6.

The system can counteract air passage into the flue gas, because the air is supplied into the reactor tank 15 and is removed from the reactor tank 15 via the vent 23. Air cannot enter the buffer tank 28, because of the communicating vessel passage 29. In addition, even if some air enters the buffer tank 28, this air is separated from the slurry (thanks to the nozzles 34, tangential communicating vessel passage 29 and agitator 37) and is removed via the vent 36 and is not supplied into the absorber via the nozzles 6.

Advantageously, when the system is started the slurry immediately circulates from the reaction tank 15 to the buffer tank 28 thanks to the communicating vessel passage 29; for this reason the size of the reaction tank 15 can be optimized according to the reaction time and the size of the buffer tank 28 can be optimized according to the design constrains and can also be small.

In contrast, according to US 8 337 790, before slurry passage from the reaction chamber to the buffer chamber occurs, the piping between the buffer chamber and the nozzles of the absorber has to be filled with slurry. For this reason the buffer chamber must be quite large and since the reaction chamber and the buffer chamber are defined in one and the same tank, the size of the reaction chamber cannot be optimized according to the reaction time.

In the following specific embodiments of the system are described.

EMBODIMENT 1 - figures 1 and 2

The first embodiment has the absorber 2 and the buffer tank 28 defined within one and the same vessel 3, while the reaction tank 15 is a separate tank. The connection between the slurry accumulation zone 9 and the reaction tank 15 is done through the duct 21 having the inclined portions 21a, 21b and the syphon 21c.

EMBODIMENT 2 - figure 3

The second embodiment has the absorber 2 defined in the vessel 3, while the buffer tank 28 and the reaction tank 15 are a separate tanks. The vessel 3 overlaps the buffer tank 28. The connection between the slurry accumulation zone 9 and the reaction tank is done through inclined duct portions 21a, 21b.

EMBODIMENT 3 - figure 4

The third embodiment has the absorber 2 defined in the vessel 3, while the buffer tank 28 and the reaction tank 15 are separate tanks. The vessel 3 is apart from the buffer tank 28. The connection between the slurry accumulation zone 9 and the reaction tank 15 is done through a duct 21 having a syphon 21c.

Naturally the features described may be independently provided from one another.

CLAIMS

1. A system for sulphur removal from a flue gas containing sulphur oxides, the system comprising

an absorber comprising a vessel having an inlet and an outlet for the flue gas,

nozzles for spraying a slurry through the flue gas and a slurry accumulation zone at the lower part of the absorber,

a reaction tank having an oxidizing gas supply into it for oxidizing the slurry containing sulfur components removed from the flue gas and connected to the slurry accumulation zone,

a buffer tank connected to the reaction tank and to the nozzles, for receiving the slurry from the reaction tank and for supplying the nozzles with the slurry,

at least a pump connecting the buffer tank to the nozzles,

wherein the slurry accumulation zone is connected to the reaction tank by a duct comprising a gas lock for counteracting gas passage, and wherein the buffer tank is connected to the reaction tank by a communicating vessel passage,

wherein the reaction tank has a circular or elliptical cross section, the buffer tank has a circular or elliptical cross section, and the communicating vessel passage is

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tangentially connected to the reaction tank or the buffer tank.

2. The system of claim 1, wherein the gas lock comprises portions of the duct that are inclined downwardly from the slurry accumulation zone and the reaction tank.

3. The system of claim 2, wherein the gas lock comprises a syphon.

4. The system of claim 1, wherein the slurry accumulation zone has an inclined bottom.

5. The system of claim 1, wherein the buffer tank houses at least a baffle to shield the pump suction.

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Fig. 1

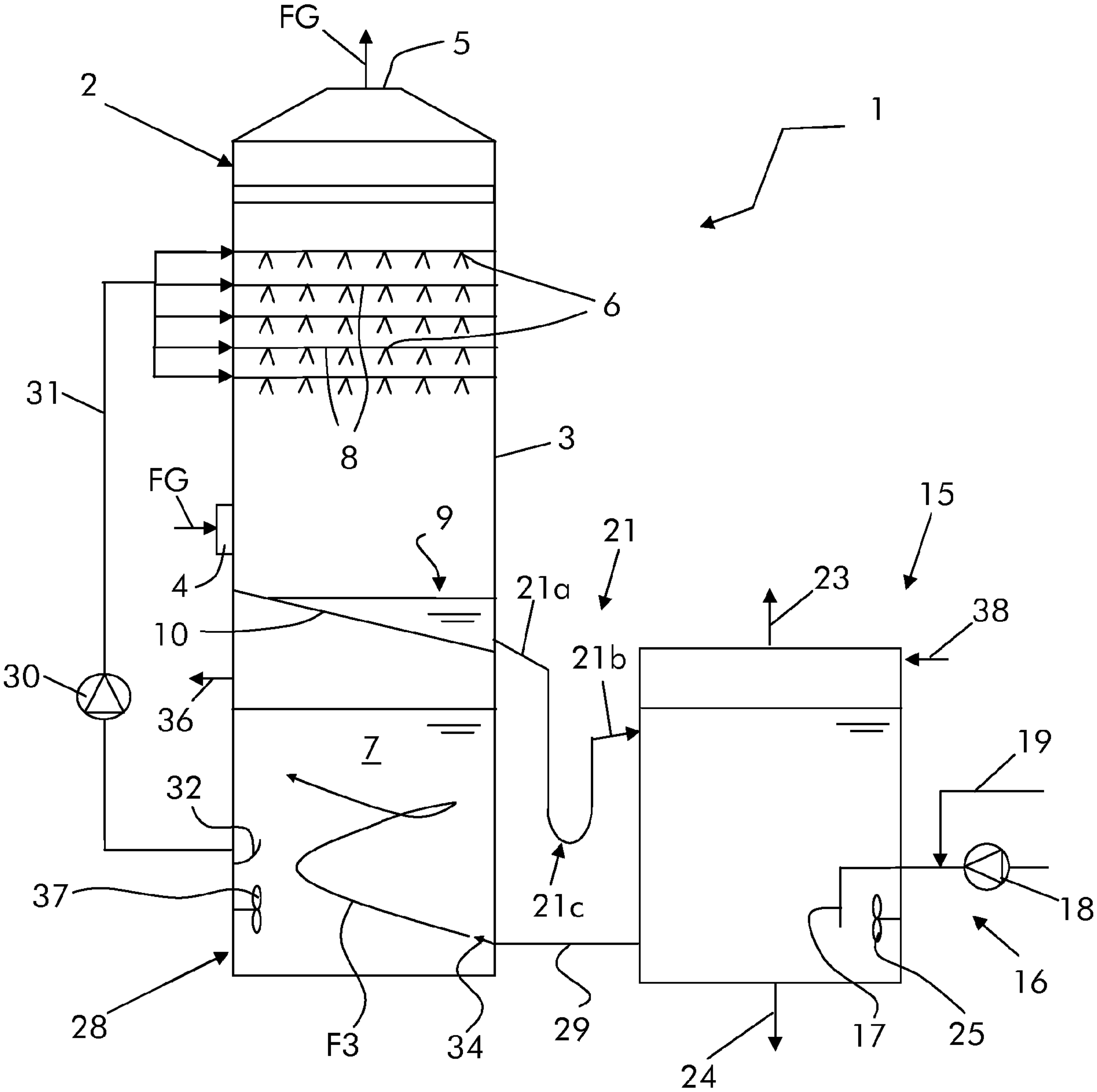
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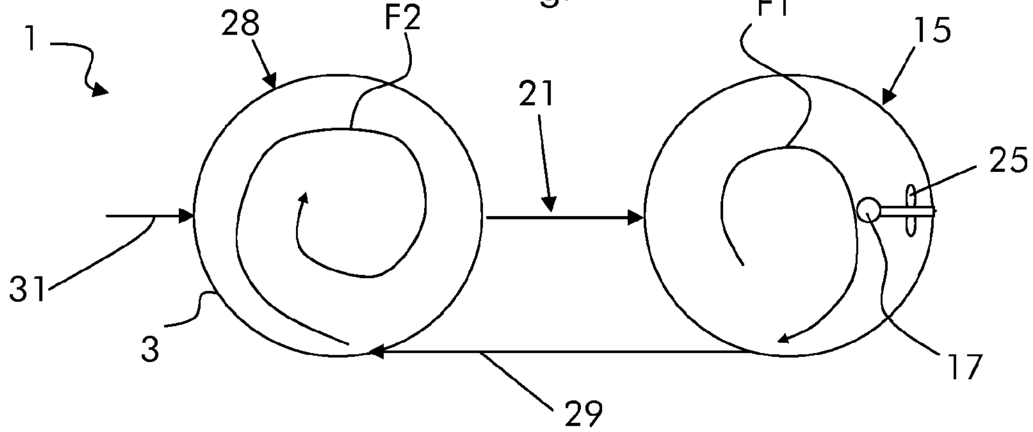
Fig. 2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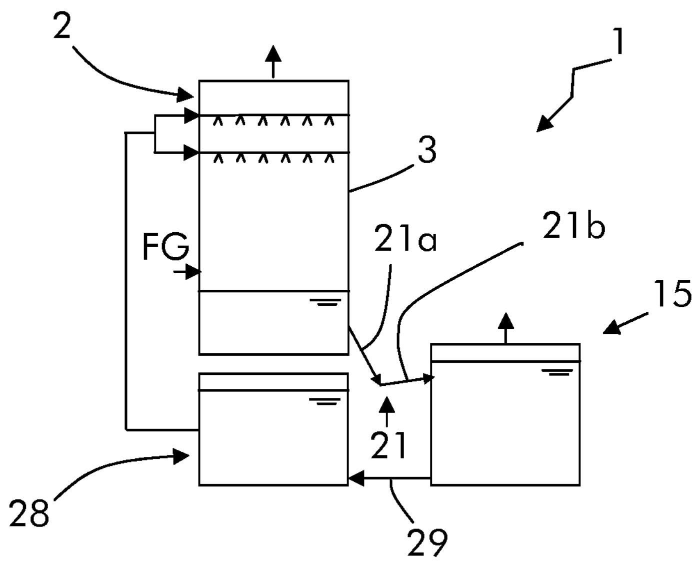


Fig. 3

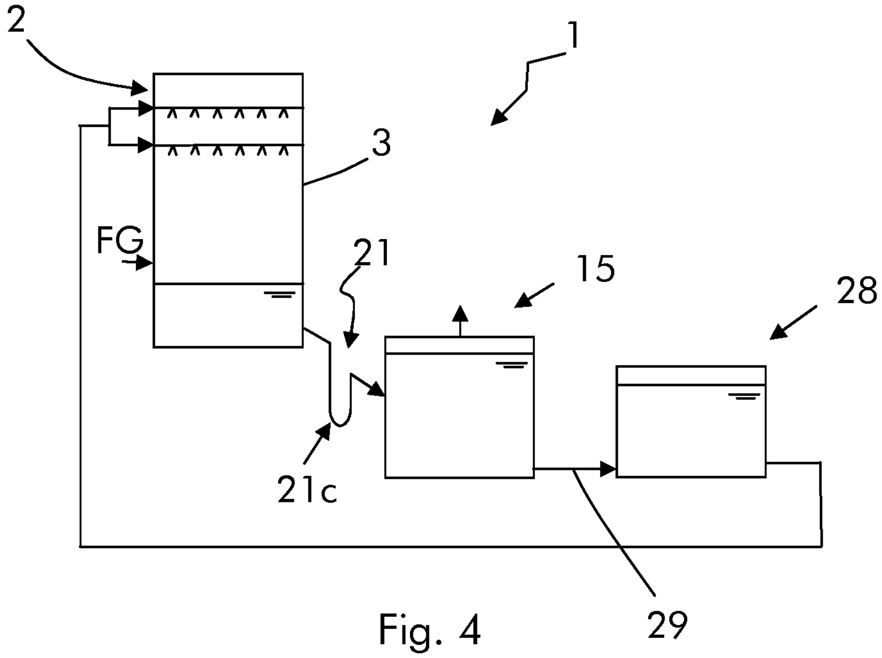
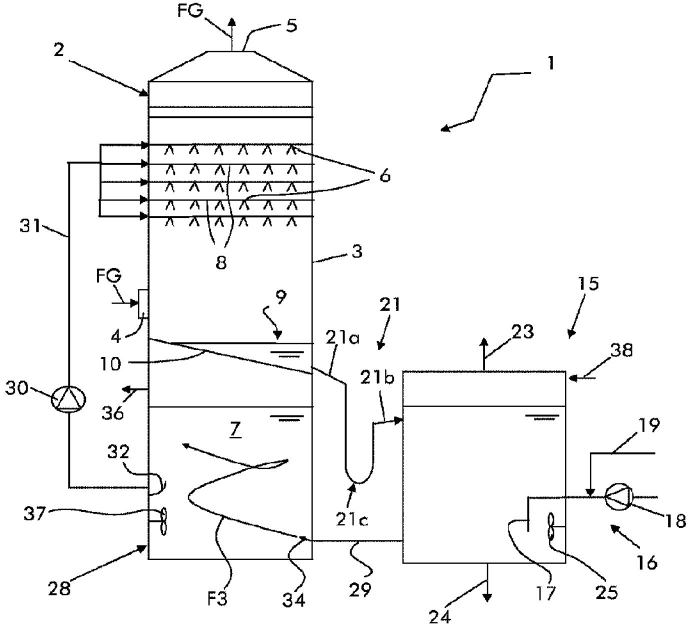


Fig. 4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