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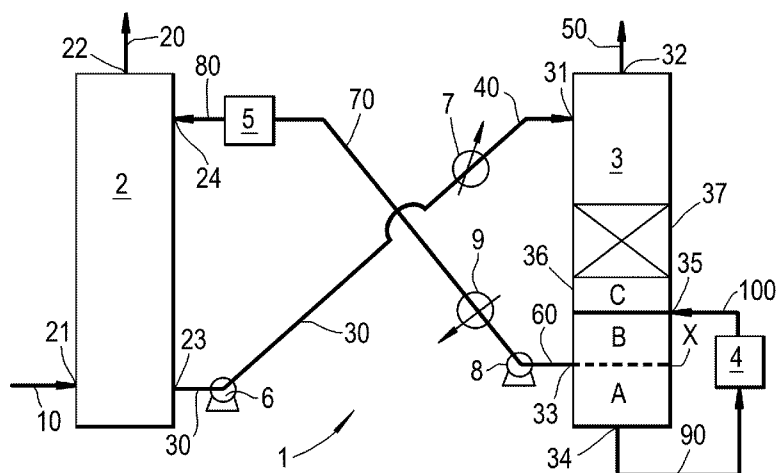
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(54) **Title:** METHOD FOR REMOVING A CONTAMINANT FROM A CONTAMINATED STREAM

Fig.1



(57) **Abstract:** The present invention provides a method of removing a contaminant, e.g. CO₂ and/or H₂S, from a contaminated stream (10). The contaminated stream (10) is contacted in an absorber (2) with an absorbent solution (80), thereby obtaining a contaminant-depleted stream (20) and a contaminant-enriched absorbent stream (30). The contaminant-enriched absorbent stream (30) is separated in a regenerator (3), thereby obtaining a contaminant-depleted absorbent stream (60) at a bottom of the regenerator (3), and a contaminant-enriched stream (50). The contaminant-depleted absorbent stream (60) forms a lower layer of a first liquid phase (A) and a higher layer of a second liquid phase (B). The first liquid phase (A) and the second liquid phase (B) are removed simultaneously at the interface (X) of these liquid phases. The contaminant-depleted absorbent stream (60) is reused.

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METHOD FOR REMOVING A CONTAMINANT FROM A CONTAMINATED
STREAM

The present invention relates to a method for removing a contaminant from a contaminated stream, in particular a contaminated gas stream.

Various methods are known to remove contaminating components, such as water, liquid hydrocarbons (also called "condensate"), hydrates, carbon dioxide (CO₂) and/or hydrogen sulphide (H₂S), SO₂, COS, mercaptans (RSH) and other organic sulphur species, from a gas stream such as a natural gas stream. The methods may be based on physical and/or chemical separation techniques. Physical separation techniques use differences in e.g. boiling, condensation and/or freezing points of the various contaminating components to selectively remove one or more of these components in a fractionating column, or differences in density to separate components with different densities by gravity (e.g. gravity settler), by a swirling flow (e.g. in a cyclonic separator) or by spinning flow (e.g. in a centrifugal separator). Chemical separation techniques may employ selective absorption or catalytic reactions to convert a contaminating component into a composition that can be easily separated.

When the contaminants are removed using an absorbent component, at least a contaminant-depleted stream and a contaminant-enriched absorbent stream are obtained. The contaminant-depleted stream may be further subjected to further processing steps, if desired, before being sent to its intended end-use. The contaminant-enriched absorbent stream is typically regenerated in order to be able to reuse the absorbent.

A suitable process for removing CO₂ and/or H₂S from a gas comprising CO₂ and/or H₂S is disclosed in EP 2 283 911 A1.

5 A problem that may occur in the known absorbent regeneration processes is that after removing the contaminant from the contaminant-enriched absorbent stream the resulting contaminant-depleted absorbent stream may form two liquid phases under the prevailing conditions. In case the contaminant-depleted absorbent stream is subsequently drawn off and reused in the contaminant absorption process, the absorbent stream may not have the right ratio of components as one phase is predominantly removed. This problem of liquid phase separation under regeneration conditions has been
10 acknowledged in e.g. paragraph [0014] of WO 2007/021532.

15 In Figures 1 and 6 of US 2010/0132551 an emulsion 8 is withdrawn from the regeneration column and liquid phase separation is performed in an extra separation device B1. Streams 9 and 10 are withdrawn from device B1 using two separate outlets (and pumps) for the two separate liquid phases. Additionally, stream 6 is withdrawn from the regeneration column. Streams 9 and 6 are combined and recycled as stream 4 to the absorber. In Figure 5 of US 2010/0132551 liquid phase separation is
20 performed in a downcomer in collection tray P in the regeneration column and streams 9 and 10 are withdrawn using two separate outlets (and pumps) for the two separate liquid phases.

25 In Figure 1 of US4251494 an extra reboiler 30 is used for phase separation. Two separate streams 16 and 18, with different compositions, are withdrawn from reboiler 30 and recycled at different heights of the absorber.
30

It is an object of the present invention to solve or at least minimize the above issue of phase separation, in particular during the regeneration of a contaminant-enriched absorbent stream.

5 Another object is to provide a method which requires less phase separation devices, outlets and pumps as compared to the prior art.

It is a further object of the present invention to provide an alternative method of removing a contaminant, in particular CO₂ and/or H₂S, etc., from a contaminated stream.

One or more of the above or other objects are achieved according to the present invention by providing a method of removing a contaminant, in particular CO₂ and/or H₂S, from a contaminated stream, the method at least comprising the steps of:

- (a) providing a contaminated stream (10), preferably a gaseous contaminated stream;
- (b) contacting the contaminated stream (10) in an absorber (2) with an absorbent solution (80), thereby obtaining a contaminant-depleted stream (20) and a contaminant-enriched absorbent stream (30);
- (c) separating the contaminant-enriched absorbent stream (30) in a regenerator (3), thereby obtaining
 - 25 - a contaminant-depleted absorbent stream (60) at a bottom of the regenerator (3) and
 - a contaminant-enriched stream (50),the contaminant-depleted absorbent stream (60) forming a lower layer of a first liquid phase (A) and a higher layer of a second liquid phase (B) at the bottom of the regenerator (3);
- (d) simultaneously removing the first liquid phase (A) and the second liquid phase (B) at the interface (X) of

the lower layer of the first liquid phase (A) and the higher layer of the second liquid phase (B) using a liquid outlet (33); and

(e) reusing the contaminant-depleted absorbent stream (60) as removed in step (d).

It has been surprisingly found according to the present invention that by simultaneously removing the lower layer of the first liquid phase and the higher layer of the second liquid phase at the interface (X) of these liquid phases using the same outlet, the two liquid phases are removed in the same ratio as they are formed, ensuring that the absorbent content of the removed stream remains substantially constant over time.

An advantage of the present invention is that this controlled removal of liquid phases can be done without the need for two or more separate outlets (with associated pumps) or additional process control. Also, no mechanical agitation in order to create a finely dispersed emulsion of the phases is required (with optional use of emulsion stabilizers).

In step (a) of the method of the present invention, a contaminated stream, preferably a gaseous contaminated stream, is provided.

The contaminated stream is not limited in any way (in terms of composition, phase, etc.) and may for example be a natural gas stream, a combustion gas, synthesis gas, an air stream, etc.; the contaminated stream may also be a contaminated liquid hydrocarbon stream such as a contaminated LPG stream. Preferably, the contaminated stream is a methane-rich stream such as natural gas, containing at least 30 wt.% methane, preferably at least 50 wt.% methane. The person skilled in the art will readily understand that the contaminant is not limited to

certain compounds and may include a broad variety of compounds such as carbon dioxide (CO₂) and/or hydrogen sulphide (H₂S), SO₂, COS, mercaptans (RSH) and other organic sulphur species. However, the present invention is in particular suitable for the removal of CO₂ and/or H₂S from a contaminated gas stream such as natural gas or a combustion gas.

In step (b), the contaminated stream is contacted in an absorber with an absorbent solution, thereby obtaining a contaminant-depleted stream and a contaminant-enriched absorbent stream. Typically, the contaminant-depleted stream is obtained at the top of the absorber and subsequently removed. The contaminant-depleted stream may be further processed if needed before it is sent to its end use. Usually, the contaminant-enriched absorbent stream is obtained at the bottom of the absorber. As the person skilled in the art is familiar with the design and functioning of an absorber, this is not further discussed here in detail. Preferably, the absorber is operated at a temperature in the range from 10 to 100°C, more preferably from 20 to 80°C, even more preferably from 20 to 70°C. Typically, the absorber is operated at a pressure in the range from 1.0 to 110 bar, more preferably from 20 to 90 bar.

Preferably, the absorbent solution in step (b) is an aqueous absorbent solution comprising water and an absorbent component. In step (b), the absorbent solution is preferably a single phase. The absorbent solution may comprise two or more absorbent components. The one or more absorbent components are not limited in any way. Usually, the one or more absorbent components are amine compounds. Suitable absorbent solutions have been extensively described in the prior art, see for example

A.L. Kohl and F.C. Riesenfeld, 1974, Gas Purification, 2nd edition, Gulf Publishing co. Houston and R.N. Maddox, 1974, Gas and Liquid sweetening, Campbell Petroleum Series. Hence, the absorbent components are not further described here in detail.

In step (c), the contaminant-enriched absorbent stream is separated in a regenerator, thereby obtaining - a contaminant-depleted absorbent stream at a bottom of the regenerator and

- a contaminant-enriched stream, the contaminant-depleted absorbent stream forming a lower layer of a first liquid phase (A) and a higher layer of a second liquid phase (B) at the bottom of the regenerator (3).

The first liquid phase (A) has a higher density than the second liquid phase (B). This is the case when the contaminated stream (10) is a gaseous contaminated stream, and also when the contaminated stream (10) is a liquid contaminated stream, e.g. LPG or another light density stream comprising hydrocarbons with 3 or 4 carbon atoms.

The regenerator serves to separate the absorbent solution and the (one or more) contaminant(s), for example using one or more flash vessels, a column or a combination thereof. As the person skilled in the art is familiar with the design and functioning of a regenerator, this is not further discussed here in detail. Typically, the regenerator is operated at a temperature sufficiently high to ensure that a substantial amount of contaminant is liberated from the contaminant-enriched absorbent stream. Preferably, the regenerator is operated at a temperature in the range from 60 to 170°C, more preferably from 70 to 160°C, even

more preferably from 100 to 140°C. Typically, the regenerator is operated at a pressure in the range from 0.001 to 50 bar, more preferably from 1.0 to 30 bar.

Typically the contaminant-enriched stream is obtained at the top of the regenerator and is subsequently removed from the regenerator for further processing, if needed. The contaminant-depleted absorbent stream is obtained at a bottom of the regenerator, as the regenerator may comprise several vessels or draw-off trays. Hence, the person skilled in the art will understand that the term "bottom" as meant according to the present invention refers to a place in the regenerator vessel where liquid accumulates; the bottom is (although preferably it is) not necessarily the absolute bottom of the regenerator vessel, but may also be a local bottom such as a draw-off tray. If the regenerator consist of one vessel or column (which it preferably does from the viewpoint of simplicity), the contaminant-depleted absorbent stream is typically obtained at the (absolute) bottom thereof.

The lower layer of a first liquid phase (A) and the higher layer of a second liquid phase (B) are formed under the prevailing conditions in the regenerator. Preferably, the first liquid phase as formed in step (c) is a water-enriched phase and the second liquid phase is a water-depleted phase. The second water-deplete phase may comprise various absorbent components (and is typically amine rich).

In step (d), the first liquid phase (A) and the second liquid phase (B) of the contaminant-depleted absorbent stream are simultaneously (but as separate phases) removed (typically from the bottom of the regenerator). This removal is performed using the same single liquid outlet. Of course, more than one liquid

outlet may be present for simultaneously removing the first and second liquid phases.

A short time after the beginning with the removal of the first and second liquid phases, the two liquid phases are removed in the same ratio as they are formed, ensuring that the absorbent content of the removed stream remains substantially constant over time. Also, as a result, the interface of the first and second liquid phases will be situated at the height level of the outlet.

Hence, a short time after the beginning with the removal of the first and second liquid phases, the two liquid phases are removed at the interface (X) of the lower layer of the first liquid phase (A) and the higher layer of the second liquid phase (B) using the same single liquid outlet.

Preferably, the liquid outlet in step (d) is located above at least $1/20$ of the liquid height in the bottom of the regenerator (or relevant vessel thereof), preferably above at least $1/10$, more preferably above at least $1/4$. This, to allow that the two separate liquid phases are simultaneously removed via the liquid outlet in a controlled manner; if a minimum volume of liquid is not present above the liquid outlet, a substantial amount of gas may be removed with the liquid phases thereby disturbing the ratio of the liquid phases in the stream removed through the liquid outlet in step (d). Also, if a minimum volume of liquid is not present, this may potentially cause sub-optimal or even hazardous operating conditions in downstream equipment, such as pumps and heat exchangers. A minimum amount of liquid above the liquid outlet avoids the occurrence of large scale slug flow of both liquid phases, wherein both liquid phases

are withdrawn in alternating 'slugs' of lighter and heavier phase, by creating a stable interface.

Preferably the liquid outlet in step (d) is located above at least $1/20$ of the liquid height in the bottom of the regenerator, preferably above at least $1/10$, more preferably above at least $1/4$. Additionally or alternatively, the liquid outlet in step (d) preferably is located below at most $19/20$ of the liquid height in the bottom of the regenerator, preferably below at most $9/10$, more preferably below at most $3/4$.

According to a preferred embodiment of the method according to the present invention, a part of the first liquid phase is removed from the regenerator, heated and reintroduced into the regenerator at a point above the interface of the first liquid phase and the second liquid phase; preferably the removed part of the first liquid phase is reintroduced at a point above the second liquid phase.

Also, it is preferred that the liquid outlet in step (d) comprises an element for avoiding liquid flow along the wall and into the liquid outlet. This, to avoid that the ratio of the liquid phases in the stream as removed in step (d) is disturbed. Preferably, said element also ensures that the liquid flow of the first liquid phase and the second liquid phase through the liquid outlet is substantially horizontal. Also it is preferred that the liquid outlet in step (d) comprises a splash protector, to prevent disturbance of the interface between the first and second liquid phases. The person skilled in the art will understand that the element can be shaped in various ways to avoid liquid flow along the wall and/or splashing as described above. As an example, the element may comprise a baffle plate or the like located just above

the liquid outlet. Also, the liquid outlet may be sticking into the vessel, as a result of which the liquid outlet opening is at a selected distance from the wall of the vessel.

5 In step (e), the contaminant-depleted absorbent stream as removed in step (d) is reused. The contaminant-depleted absorbent stream may be reused in several places but is preferably at least partly reused in the absorber of step (b) as the absorber solution.

10 According to a preferred embodiment, the contaminant-depleted absorbent stream as removed in step (d) is cooled before reusing in step (e), thereby obtaining a cooled contaminant-depleted absorbent stream. By sufficient cooling of the contaminant-depleted absorbent stream as removed in step (d) the two separate liquid phases form a single phase which is of benefit in the absorber. Hence, typically, the cooled contaminant-depleted absorbent stream is a single phase. The person skilled in the art will readily understand that the amount of cooling needed for forming the single phase will depend on the composition of the absorbent stream; also, the person skilled in the art will understand how to determine the suitable amount of cooling.

20 Further, it is preferred that the cooled contaminant-depleted absorbent stream is passed to a collector before reusing in step (e), in particular if the contaminant is to be reused in the absorber. Typically, the collector will be a simple vessel; the volume of collector vessel is typically at least the volume of the two liquid phases as formed in step (c).

30 Preferably, the optionally cooled contaminant-depleted absorbent stream is reused in the absorber as the absorbent solution.

Hereinafter the invention will be further illustrated by the following non-limiting drawings. Herein shows:

Fig. 1 a schematic embodiment of a method according to the present invention;

Fig. 2 a close-up of the bottom of the regenerator as used in Fig. 1; and

Figs 3-6 close-ups of alternative embodiments of a bottom of the regenerator as used in Fig. 1.

For the purpose of this description, same reference numbers refer to same or similar components. Also, a single reference number will be assigned to a line as well as to a stream carried in that line.

Fig. 1 shows a simplified embodiment of a method in accordance with the present invention for removing a contaminant from a contaminated stream 10. An apparatus 1 is shown comprising an absorber 2, a regenerator 3, a reboiler 4, a collector 5, pumps 6 and 8 and heat exchangers 7 and 9. Pump 6 is preferred in case of operation of the absorber 2 below about 5 bara; at higher absorber pressures, pump 6 is typically not present.

During use, the (preferably gaseous) contaminated stream 10 is, after feeding via inlet 21, contacted in the absorber 2 with an absorbent solution 80 fed via inlet 24, thereby obtaining a contaminant-depleted stream 20 (removed at overhead outlet 22) and a contaminant-enriched absorbent stream 30 (removed at bottom outlet 23).

The contaminant-enriched absorbent stream 30 is sent (using pump 6, if present; otherwise by the positive pressure difference between absorber 2 and regenerator 3) to the regenerator 3, via a heat exchanger 7 in which the contaminant-enriched absorbent stream 30 is heated to obtain a heated contaminant-enriched absorbent stream 40.

The person skilled in the art will readily understand that the regenerator 3 may be a single vessel or column or may instead comprise several vessels and columns; in the embodiment of Figure 1, the regenerator comprises a single column (with packing 37). The heated contaminant-enriched absorbent stream 40 is fed into regenerator 3 at inlet 31 and separated in the regenerator 3, thereby obtaining a contaminant-depleted absorbent stream 60 at the bottom of the regenerator 3 and a contaminant-enriched stream 50 which is removed at overhead outlet 32. The contaminant-depleted absorbent stream 60 forms two separate phases in the regenerator 3 (which in the embodiment of Fig. 1 are collected at the bottom thereof), viz. a lower layer of a first water-enriched liquid phase A and a higher layer of a second water-depleted (and typically amine rich) liquid phase B (which is further explained in Fig. 2).

The first liquid phase A and the second liquid phase B of the contaminant-depleted absorbent stream 60 are simultaneously removed at the liquid outlet 33 of the regenerator 3; as a result, a short time after the beginning with the removal of the first and second liquid phases, the two liquid phases A,B are removed in the same ratio as they are formed, ensuring that the absorbent content of the removed stream 60 remains substantially constant over time. Also, as a result, the interface X of the first liquid phase A and the second liquid phases B will be situated at the height level of the outlet 33.

Subsequently, the removed contaminant-depleted absorbent stream 60 is reused. In the embodiment of Figure 1, the contaminant-depleted absorbent stream 60 is reused in the absorber 2 as the absorbent solution 80 fed via inlet 24.

In the embodiment of Figure 1, the contaminant-depleted absorbent stream 60 is cooled before being reused in the absorber 2, thereby obtaining a cooled contaminant-depleted absorbent stream 70; this cooling allows the two separate liquid phases A,B to form a single phase. Further, the cooled contaminant-depleted absorbent stream 70 is passed to a collector 5 before being reused in the absorber 2.

In the embodiment of Figure 1, a part 90 of the first liquid phase A is removed (at outlet 34) from the regenerator 3, heated in a reboiler or heater 4 and reintroduced as stream 100 into the regenerator 3 at a point (inlet 35) above the interface X of the first liquid phase A and the second liquid phase B. Preferably, the stream 100 is reintroduced at a point above the second liquid phase B (see e.g. Fig. 3).

Figure 2 shows a close-up of the bottom of the regenerator 3 as used in Fig. 1. As can be seen, liquid is drawn off at interface X of the first liquid phase A and the second liquid phase B of the contaminant-depleted absorbent stream 60. Typically, the area C above the second liquid phase B is filled with gas. Preferably, and as shown, the outlet 33 is positioned as a side draw-off outlet having an opening placed at a distance from the wall 36 of the regenerator 3. Alternatively (see also Fig. 5), the outlet 33 may be a (substantially vertical) pipe inserted from the bottom of the regenerator 3.

Further, and as shown, the outlet 33 is located above at least $1/20$ of the liquid height in the bottom of the regenerator 3, preferably above at least $1/10$, more preferably above at least $1/4$.

If desired, the liquid outlet 33 comprises an element (not shown in Fig. 1; cf. plate 38 in Fig. 3) for

avoiding liquid flow along the wall 36 and into the liquid outlet 33. Further, the liquid outlet 33 may comprise a splash protector (not shown in Fig. 1; see plate 39 in Fig. 4) to prevent disturbance of the interface X between the first liquid phase A and the second liquid phase B.

Figures 3-6 show close-ups of alternative embodiments of a bottom of the regenerator 3 as used in Fig. 1.

In Figure 3, the outlet 33 opens at the wall 36 of the regenerator 3 (so not at a distance from the wall 36 as in Fig. 2). Further, in the embodiment of Figure 3, a plate 38 is placed just above the outlet 33 for avoiding liquid flow along the wall 36 and into the outlet 33.

In Figure 4, the regenerator 3 is provided with a (anti-)splash plate 39 and a (substantially vertically arranged) baffle plate 41. The baffle plate 41 is provided with openings 42. The baffle plate 41 assists in creating a stabile interface X between the first liquid phase A and the second liquid phase B, at least near the outlet 33.

In Figure 5, the outlet 33 is a (substantially vertically arranged) pipe inserted from the bottom of the regenerator 3. If desired, further internals such as plate 38 (see Fig. 3), splash plate 39 and baffle plate 41 (see Fig. 4) may be present in the embodiment of Figure 5.

In Figure 6, the bottom of the regenerator 3 is in the form of a draw-off tray 51 (and hence is not the absolute bottom of the regenerator 3). The draw-off tray 51 is provided with channels 52 allowing gas passage through the tray 51; hence the area D below the tray 51 and the area C above the second liquid phase C are in gas communication.

The person skilled in the art will readily understand that many modifications may be made without departing from the scope of the invention. Further, the person skilled in the art will readily understand that, while
5 the present invention in some instances may have been illustrated making reference to a specific combination of features and measures, many of those features and measures are functionally independent from other features and measures given in the respective embodiment(s) such
10 that they can be equally or similarly applied independently in other embodiments.

C L A I M S

1. A method of removing a contaminant, in particular CO₂ and/or H₂S, from a contaminated stream (10), the method at least comprising the steps of:

(a) providing a contaminated stream (10), preferably a
5 gaseous contaminated stream;

(b) contacting the contaminated stream (10) in an absorber (2) with an absorbent solution (80), thereby obtaining a contaminant-depleted stream (20) and a contaminant-enriched absorbent stream (30);

10 (c) separating the contaminant-enriched absorbent stream (30) in a regenerator (3), thereby obtaining

- a contaminant-depleted absorbent stream (60) at a bottom of the regenerator (3) and

- a contaminant-enriched stream (50),

15 the contaminant-depleted absorbent stream (60) forming a lower layer of a first liquid phase (A) and a higher layer of a second liquid phase (B) at the bottom of the regenerator (3);

(d) simultaneously removing the first liquid phase (A) and the second liquid phase (B) at the interface (X) of
20 the lower layer of the first liquid phase (A) and the higher layer of the second liquid phase (B) using a liquid outlet (33); and

(e) reusing the contaminant-depleted absorbent stream
25 (60) as removed in step (d).

2. The method according to claim 1, wherein the absorbent solution (80) in step (b) is an aqueous absorbent solution comprising water and an absorbent component.

30 3. The method according to claim 2, wherein the first liquid phase (A) as formed in step (c) is a water-

enriched phase and the second liquid phase (B) is a water-depleted phase.

4. The method according to any one of claims 1-3, wherein the liquid outlet (33) in step (d) is located
5 above at least $1/20$ of the liquid height in the bottom of the regenerator (3), preferably above at least $1/10$, more preferably above at least $1/4$.

5. The method according to any one of claims 1-4, wherein the liquid outlet (33) in step (d) is located
10 below at most $19/20$ of the liquid height in the bottom of the regenerator (3), preferably below at most $9/10$, more preferably below at most $3/4$.

6. The method according to any one of claims 1-5, wherein a part (90) of the first liquid phase (A) is
15 removed from the regenerator (3), heated and reintroduced into the regenerator (3) at a point above the interface (X) of the lower layer of the first liquid phase (A) and the higher layer of the second liquid phase (B), preferably above the higher layer of the second liquid
20 phase (B).

7. The method according to any one of claims 1-6, wherein the liquid outlet (33) in step (d) comprises an element (38) for avoiding liquid flow along the wall (36) and into the liquid outlet (33).

8. The method according to any one of claims 1-7, wherein the liquid outlet (33) in step (d) comprises a splash protector (39).

9. The method according to any one of claims 1-8, wherein the contaminant-depleted absorbent stream (60) as
30 removed in step (d) is cooled before reusing in step (e), thereby obtaining a cooled contaminant-depleted absorbent stream (70).

10. The method according to claim 9, wherein the cooled contaminant-depleted absorbent stream (70) is a single phase.

5 11. The method according to claim 10, wherein the cooled contaminant-depleted absorbent stream (70) is passed to a collector (5) before reusing in step (e).

12. The method according to any one of claims 1-11, wherein the optionally cooled contaminant-depleted absorbent stream (60,70,80) is reused in the absorber (2)
10 as the absorbent solution (80).

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Fig.1

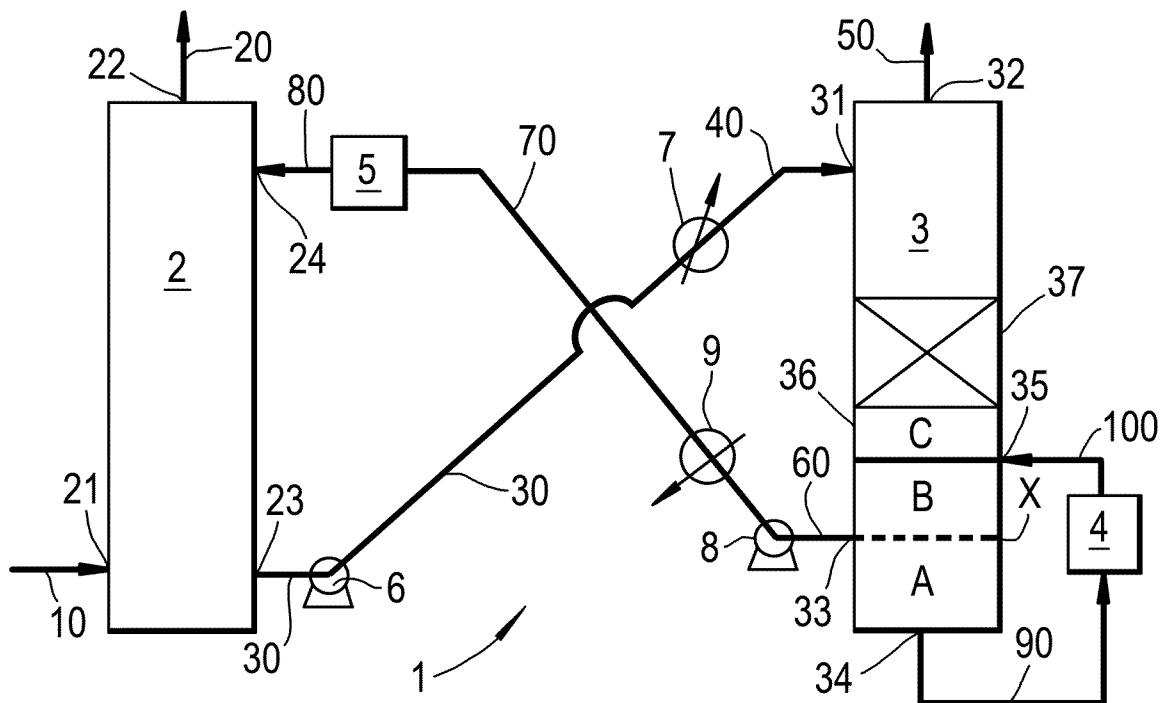
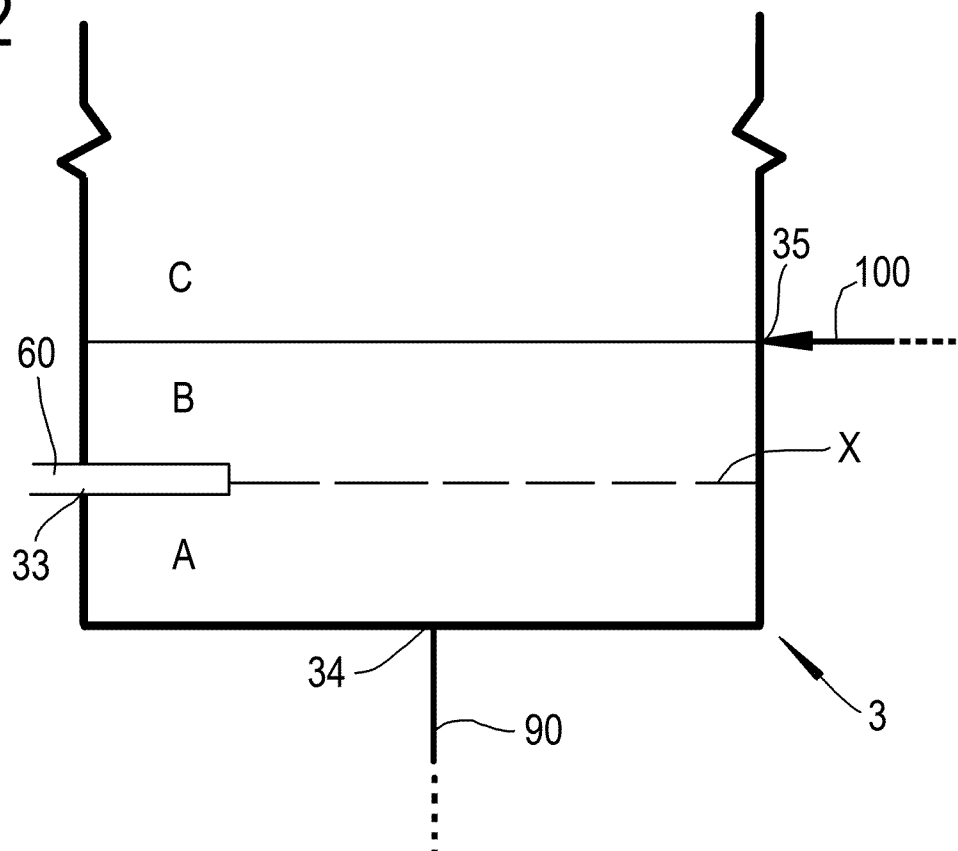


Fig.2



2/3

Fig.3

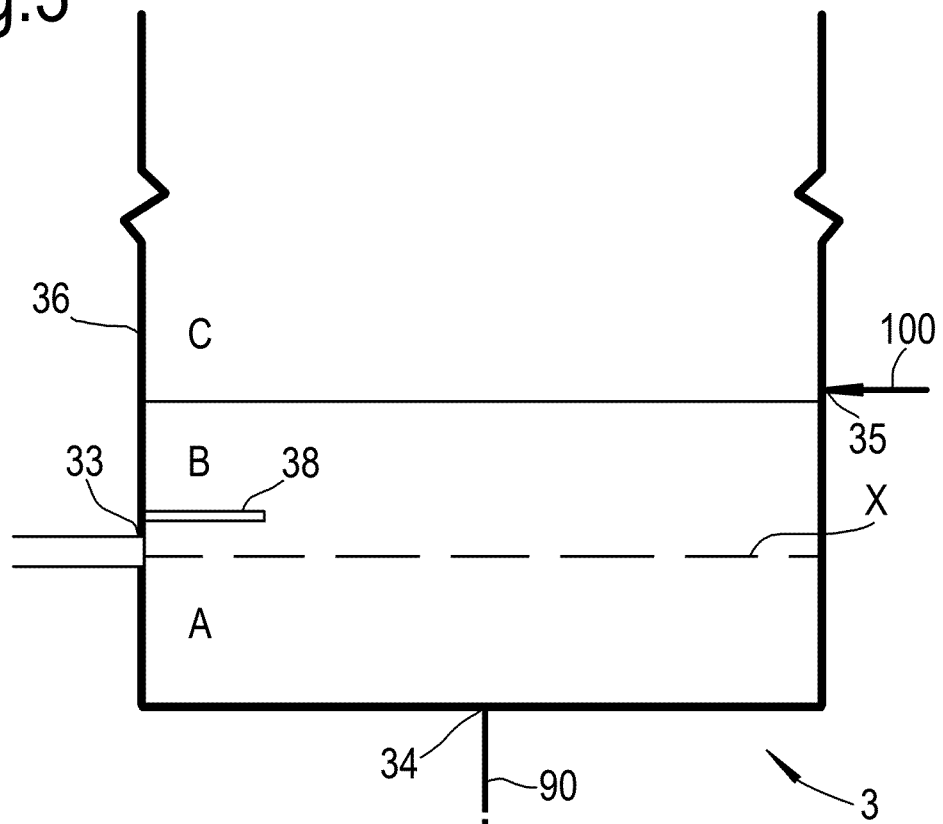
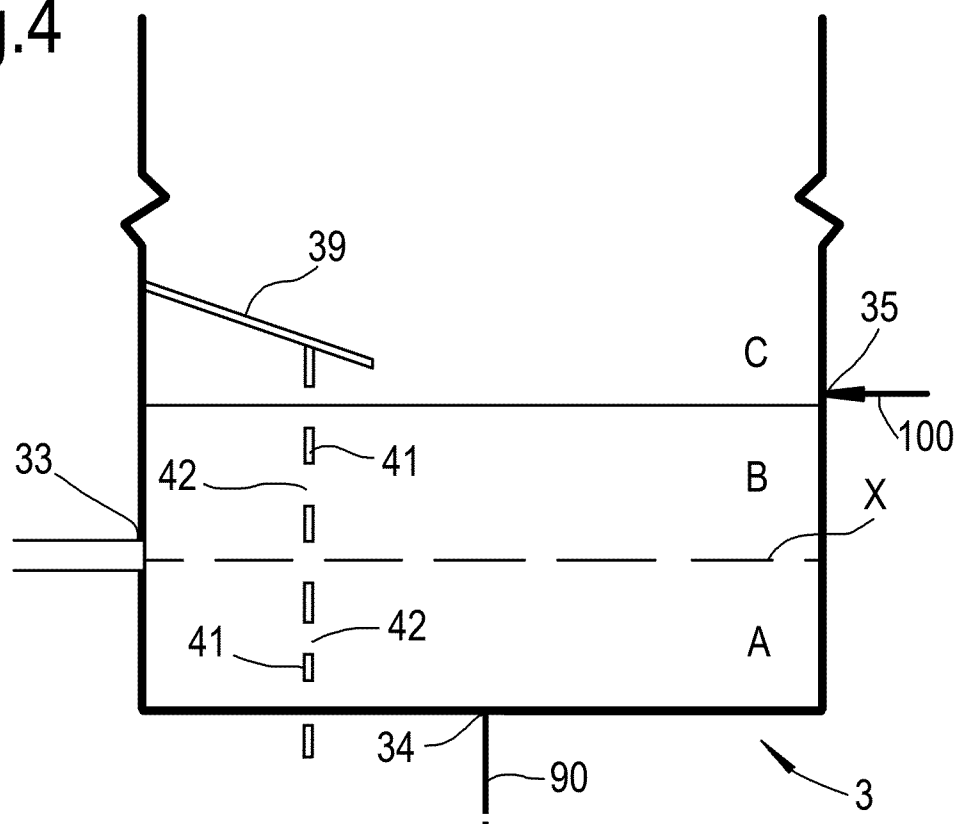


Fig.4



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Fig.5

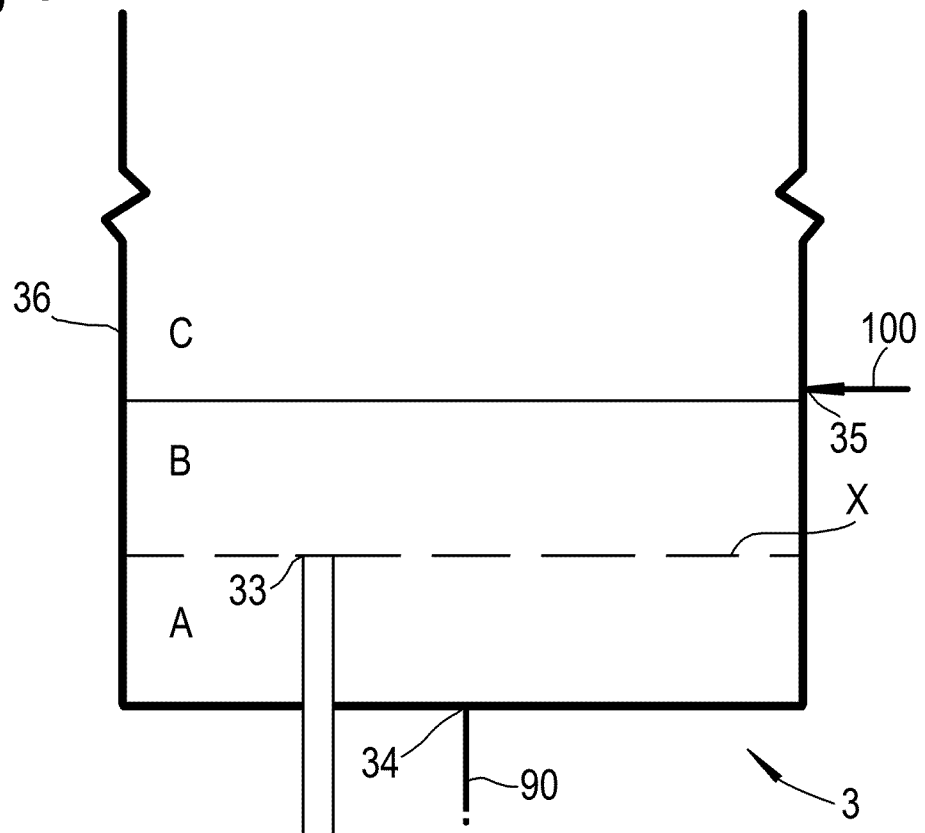
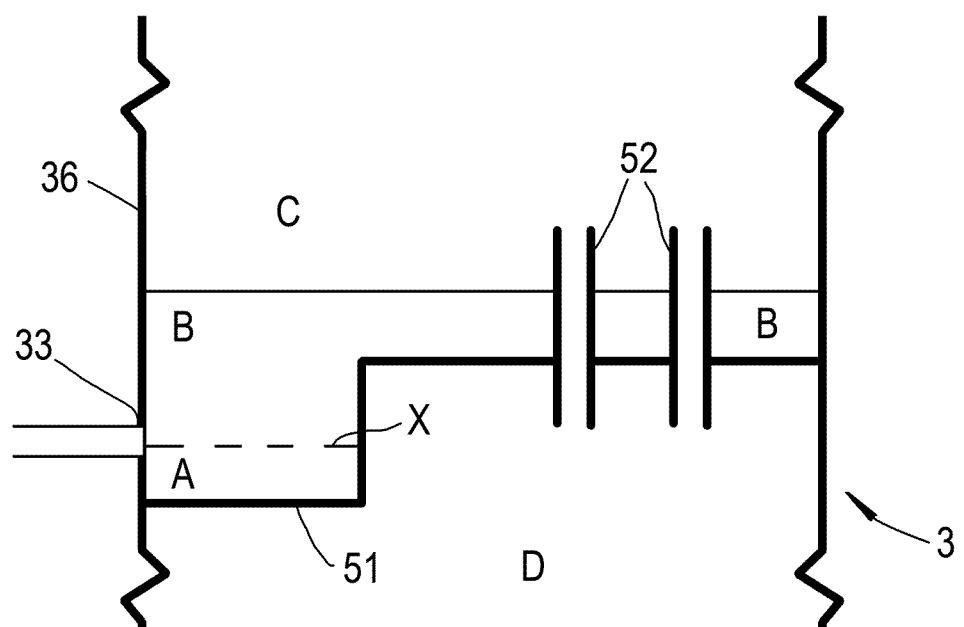


Fig.6



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/076836

A. CLASSIFICATION OF SUBJECT MATTER
INV. B01D53/14 B01D53/78 B01D53/96
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/132551 A1 (BOUILLON PIERRE-ANTOINE [FR] ET AL) 3 June 2010 (2010-06-03) cited in the application	1-5, 7-10,12
Y	paragraphs [0021], [0028], [0038]; figures 1,6	11
X	US 4 251 494 A (SAY GEOFFREY R) 17 February 1981 (1981-02-17) columns 1,4,5; figure 1	1-7,9,12
Y	US 2009/199709 A1 (ROJEY ALEXANDRE [FR] ET AL) 13 August 2009 (2009-08-13) abstract; figure 1	11
A	US 2008/173176 A1 (DUESEL BERNARD F [US] ET AL) 24 July 2008 (2008-07-24) figure 2	7,8
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

7 March 2014

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18/03/2014

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/076836

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No

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