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Title: PLANT FOR CHLOR-ALKALI ELECTROLYSIS OF A BRINE AND A PROCESS FOR USING IT

Abstract: Movable chlor-alkali electrolysis plant for electrolysis of a brine into a depleted brine, containing at least one chlor-
alkali electrolysis module and at least two different modules for the treatment of the brine and/or of the depleted brine, wherein the
chlor-alkali electrolysis module and the treatment modules are connected to each other allowing that the operation of the plant can
be started with only one treatment module or with any combination of two or more treatment modules, and that at any time one of
the treatments can be switched off and/or an additional treatment can be added, and/or the order of the treatments can be modified.
Plant for chlor-alkali electrolysis of a brine and a process for using it

This application claims priority to European application No. 13162066.8 filed on April 3, 2013, the whole content of this application being incorporated herein by reference for all purposes.

The present invention relates to a plant for chlor-alkali electrolysis of a brine.

Plants for chlor-alkali electrolysis of brines are well known. The brine used may be obtained by dissolving a salt, preferably rock salt, in water or may be a by-product from a chemical process. Such plants usually generate depleted brines that have to be disposed of or recycled to the electrolysis. Although treatments for purifying such brines and/or depleted brines exist, their impact on the chlor-alkali electrolysis process remains often unpredictable because such process is complex and extremely sensitive to even low amounts of impurities in the brine. In addition, such plants are dedicated to the manufacture of high volumes of specific products, like chlorine, and they exhibit low if not nil flexibility in process conditions and/or part arrangements.

The object of the present invention is to provide a chlor-alkali electrolysis plant which does not present these drawbacks.

The invention therefore relates to a movable chlor-alkali electrolysis plant for electrolysis of a brine into a depleted brine, containing at least one chlor-alkali electrolysis module and at least two different modules for the treatment of the brine and/or of the depleted brine, wherein the chlor-alkali electrolysis module and the treatment modules are connected to each other allowing that the operation of the plant can be started with only one treatment module or with any combination of two or more treatment modules, and that at any time one of the treatments can be switched off and/or an additional treatment can be added, and/or the order of the treatments can be modified.

The movable chlor-alkali electrolysis plant according to the invention is named indifferently movable chlor-alkali electrolysis plant or movable electrolysis plant or electrolysis plant or plant in the text of the present application.

Similarly, the chlor-alkali electrolysis module is named indifferently chlor-alkali electrolysis module or electrolysis module.
One first important feature of the electrolysis plant according to the invention is its flexibility. This flexibility allows a rapid testing of various configurations for the electrolysis module, modules for treatment of the brine and modules for treatment of the depleted brine, which are parts of the electrolysis plant. This also allows assessing the relevancy of the various brine treatments independently or according to any combination, with minimum dismantling/reassembling operations, if any, of parts of the electrolysis plant, leading to a concomitant gain in time evaluation.

Such rapid testing of brine and/or depleted brine treatments in the plant according to the invention prior to implementation of brines in an industrial chlorine production plant would further guarantee:

- a lower risk of shutdown of the industrial plant due to brine inadequacy and/or effluents issues;
- the success of recycling depleted brines in electrolysis plants;

with positive economical consequences.

The electrolysis plant according to the invention is preferably a plant for the production of chlorine and more preferably a chlor-alkali membrane electrolysis plant for the production of chlorine.

By brine, one intends to denote any aqueous composition containing a metal chloride salt, which is to be submitted to the electrolysis in the electrolysis plant according to the invention.

The brine is preferably an alkaline metal chloride, an alkaline-earth metal chloride or any mixture thereof, more preferably an alkaline metal chloride, still more preferably sodium chloride, potassium chloride or any mixture thereof and most preferably sodium chloride.

When the brine is an aqueous composition containing sodium chloride, i.e. a sodium chloride brine, the brine can originate from any source. The brine is preferably selected from a brine from an industrial process for manufacturing chlorine, a brine from an epoxide manufacturing process, preferably ethylene oxide, propylene oxide, butylene oxide or epichlorohydrin, and more preferably epichlorohydrin, a brine from an epoxide derivative manufacturing process, preferably epoxy resin, a brine from a process for manufacturing a chlorinated organic product, preferably 1,2-dichloroethane or 1,2-dichloroethylene, and more preferably 1,2-dichloroethane, a brine from a process for manufacturing a monoisocyanate or a polyisocyanate, preferably 4,4'-methylenediphenyl diisocyanate (MDI), toluene diisocyanate (TDI) or hexamethylene-1,6-
diisocyanate (HDI), a brine from a process for manufacturing a polycarbonate, preferably 2,2-bis(4-hydroxyphenyl)propane polycarbonate (bisphenol A polycarbonate), and any mixture thereof.

By depleted brine, one intends to denote a brine as described here above which has been depleted in salt after the electrolysis in the electrolysis plant according to the invention.

The electrolysis plant according to the invention comprises preferably one electrolysis module.

The electrolysis plant according to the invention comprises preferably one module for the treatment of the brine.

The electrolysis plant according to the invention comprises preferably one module for the treatment of the depleted brine, and more preferably two modules for the treatment of the depleted brine. The two modules for the treatment of the depleted brine are preferably connected to each other allowing that they can be combined in series.

The electrolysis plant according to the invention comprises more preferably one electrolysis module and one module for the treatment of the brine.

The electrolysis plant according to the invention comprises yet more preferably one electrolysis module, one module for the treatment of the brine and two modules for the treatment of the depleted brine. The module for the treatment of the brine and the two modules for the treatment of the depleted brine are preferably connected to each other allowing a way that they can be combined in series.

In the electrolysis plant according to the invention, the switch of the connections between the modules can be carried out by means of valves arrangements allowing by-pass of one or more modules, possibly associated with anti-return valves. Such valves arrangements can be manually or automatically, preferably automatically operated.

In the electrolysis plant according to the invention, the modules for treating the brine and/or the depleted brine preferably comprises at least one unit selected from a unit (A) for adjusting the salt concentration of the brine, a unit (B) for removing fine solid particles from the brine, a unit (C) for removing carbonate ions from the brine, a unit (D) for removing iron and aluminium from the brine, a unit (E) for removing calcium and magnesium from the brine, a unit (F) for removing iodide from the brine, a unit (G) for removing bromide from the brine, a unit (H) for removing silicon from the brine, a unit (I) for removing chlorine
from the brine, a unit (J) for removing chlorate from the brine, a unit (K) for removing sulphates from the brine, a unit (L) for removing organic compounds from the brine, a unit (M) for removing mercury from the brine and a unit (N) for removing ammonia from the brine.

In the electrolysis plant according to the invention:

- the adjustment of the salt concentration of the brine in unit (A) is preferably at least by salt addition to the brine;
- the removal of fine solid particles from the brine in unit (B) is preferably at least by filtration;
- the removal of carbonate ions from the brine in unit (C) is preferably at least by acidification and venting;
- the removal of iron and aluminium from the brine in unit (D) is preferably at least by filtration;
- the removal of calcium and magnesium from the brine in unit (E) is preferably at least by ion exchange;
- the removal of iodide from the brine in unit (F) is preferably at least by oxidation and ion exchange;
- the removal of bromide from the brine in unit (G) is preferably at least by oxidation;
- the removal of silicon from the brine in unit (H) is preferably at least by precipitation and filtration;
- the removal of chlorine from the brine in unit (I) is preferably at least by acidification, stripping and adsorption;
- the removal of chlorate from the brine in unit (J) is preferably at least by acid addition followed by stripping and adsorption and/or by catalytic hydrogenation;
- the removal of sulphate from the brine in unit (K) is preferably at least by precipitation and filtration, or by nanofiltration with membranes;
- the removal of organic compounds from the brine in unit (L) is preferably at least by oxidation;
- the removal of mercury from the brine in unit (M) is preferably at least by precipitation, ion-exchange reduction or adsorption; and
- the removal of ammonia from the brine in unit (N) is preferably at least by pH adjustment, oxidation and stripping.

Those units are such as described in patent application filed the same day as the present application in the name of SOLVAY S.A., entitled "Plant for
chlor-alkali electrolysis and a process for using it", the entire content of which is herein incorporated by reference.

In the electrolysis plant according to the invention, the module for treating the brine more preferably comprises at least one of units (A) to (H) and (K) to (N), more preferably at least one of units (A) to (E). The units (A) to (E) are preferably connected according to the sequence A < B < C < D < E. Another module for treating the brine can comprise at least one unit (L) for removing organic compounds from the brine.

In the electrolysis plant according to the invention, the modules for treating the depleted brine preferably comprise at least one unit selected from a unit (I) for removing chlorine from the brine and a unit (J) for removing chlorate from the brine.

In the electrolysis plant according to the invention, it is more preferred that the plant comprises one module for treating the depleted brine which comprises at least one unit selected from a unit (I) for removing chlorine from the brine and a unit (J) for removing chlorate from the brine.

In the electrolysis plant according to the invention, it is preferred that the electrolysis module contains at least one electrolyzer. The electrolyser more preferably contains at least two different separator-electrode assemblies and wherein the two separators of the two different separator-electrode assemblies are both a diaphragm or a membrane or are one diaphragm and one membrane, and the two separator-electrode assemblies differ from each other by at least one of the following features:

- They contain a different separator
- They contain a different membrane,
- They contain a different diaphragm,
- They contain a different anode,
- They contain a different cathode.

The electrolyser is such as described in patent application filed the same day as the present application in the name of SOLVAY S.A., entitled "Chlor-alkali electrolysis plant and a process for using it", the entire content of which is herein incorporated by reference.

The electrolysis module contains also more preferably at least one electrical current rectifier and at least one tank for storing the brine.

In the electrolysis plant according to the invention, it is preferred that one or more of the electrolysis module and of the module for the treatment of the
brane and/or the depleted brine is equipped with one or more sensors for monitoring one or more parameters such as temperature, pressure, voltage, current, flow rate, electrolyte composition or fluid level. Said sensors are preferably interconnected with one or more first computers. Said first computers are preferably linked to one or more second computers in a control room via a communication network. Said control room is preferably remote from the movable electrolysis unit.

In the movable chlor-alkali electrolysis plant according to the invention, it is preferred that the chlor-alkali electrolysis module is mounted on a first support which can be moved as a whole, the module for a treatment of the brine is mounted on a second support which can be moved as a whole, the module for a treatment of the depleted brine is mounted on a third support which can be moved as a whole.

One important feature of the electrolysis plant according to the invention is that it is mobile or expressed in a better way movable. By mobile/movable, one intends to denote that the plant can be transported from one site to another one with minimal handling, i.e. minimal amount of dismantling/assembling operations.

By as a whole, it is intended to mean that a minimal dismantling of the electrolysis module or of the treatment module is needed, before moving the electrolysis plant. By minimal dismantling, it is intended to mean that at most 10% by weight, preferably at most 5% by weight, more preferably at most 1% by weight of the electrolysis module mounted on the first, of the module for the treatment of the brine mounted on the second support or of the module for the treatment of the depleted brine mounted on the third support, is dismantled before moving the plant.

In the movable electrolysis plant according to the invention, the first support, the second support and the third support can be distinct or can be the same. It is preferred that the first support, the second support and the third support are distinct.

In the movable electrolysis plant according to the invention, the support can be of any type. This support must be resistant enough to accommodate the weight of the module. It must be rigid enough to be moved when moved with the module. The support is preferably a metallic support. The support is more preferably a container or a platform. First, second and third supports are therefore more preferably a container or a platform. Examples of platforms are
platforms constituted by a basis only or those comprising further a vertical axis on each of the four corner.

In case the first support, the second support and the third support are distinct, one of them can be a container and the other a platform, both of them can be a container or both of them can be a platform.

The support mounted module is more preferably assembled in a container, preferably a standardized-size container, or on a platform, preferably a standard-size platform. The support mounted module is most preferably assembled in a container, preferably a standardized-size container.

The module is therefore advantageously easily transported by transporting the container with its content or the platform with its content.

Transportation can be by road, by rail, by air, by sea, or by any combination thereof. Transportation is preferably by road since industrial sites are more easily accessible by road than by any other transportation means. The other means like by air, by sea or by rail, can however be envisioned at least for part of the transportation itinerary which is intermediate between the sites.

The movable electrolysis plant according to the invention can therefore be transported with a truck and discharged from the truck with usual mechanical means. An example of usual mechanical means is a fork-lift truck. Another example is a crane.

In the movable electrolysis plant according to the invention, the support has advantageously dimensions adapted to transportation.

Standard-size containers can be of any type. Standard-size platforms can be of any type. Such types are for example as disclosed in International Standard ISO 6346 managed by the International Container Bureau.

Standard-size containers are preferably selected from Standard 20', upgraded 20', Standard 40', High Cube 40', Open Top 20', Open Top 40', Reefer 20', Reefer 40', Reefer High Cube 40', Flat Rack 20', Flat Rack 40', Flat Rack Collapsible 20' or Flat rack Collapsible 40', which characteristics are disclosed in http://www.foreign-trade.com/reference/ocean.cfm.

Standard-size platforms are preferably selected from Platform 20', Platform 40', Chassis 23'6", Chassis 33' Tri-axle or Chassis 40' Gooseneck, which characteristics are disclosed at http://www.foreign-trade.com/reference/ocean.cfm.
The movable electrolysis plant according to the invention is therefore advantageously not a plant deposited in a metallic frame or in a container or on a platform for transportation and separated from it for being used.

In the movable electrolysis plant according to the invention, the support mounted electrolysis module usually exhibits an external envelope having a length lower than or equal to 12.50 m, a width lower than or equal to 2.50 m and a height lower than or equal to 3.50 m. The support mounted electrolysis module has usually a weight lower than or equal to 40000 kg.

In the movable electrolysis plant according to the invention, the support mounted module for a treatment of the brine and the support mounted module for the treatment of the depleted brine, usually exhibit an external envelope having a length lower than or equal to 12.50 m, a width lower than or equal to 2.50 m and a height lower than or equal to 3.50 m. The support mounted module for a treatment of the brine and the one for a treatment of the depleted brine have usually a weight lower than or equal to 40000 kg.

By external envelope, one intends to mean the minimal parallelepiped volume which can contain the support mounted electrolysis module or the support mounted module for a treatment of the brine or the support mounted module for a treatment of the depleted brine.

In the movable electrolysis plant according to the invention, both the support mounted electrolysis, the support mounted module for a treatment of the brine and the support mounted module for a treatment of the depleted brine, exhibit an external envelope as mentioned here above.

Each of the support mounted electrolysis module and the support mounted module for a treatment of the brine and depleted brine exhibits at least one of the following features:

- an external envelope having a length lower than or equal to 5.89 m, a width lower than or equal to 2.33 m, a height lower than or equal to 2.38 m, preferably lower than or equal to 2.28 m and a weight lower than or equal to 21727 kg;

- an external envelope having a length lower than or equal to 5.89 m, a width lower than or equal to 2.31 m, preferably lower than or equal to 2.28 m, a height lower than or equal to 2.38 m, preferably lower than or equal to 2.28 m and a weight lower than or equal to 28120 kg.

- an external envelope having a length lower than or equal to 12.01 m, a width lower than or equal to 2.33 m, preferably lower than or equal to 2.28 m, a
height lower than or equal to 2.38 m, preferably lower than or equal to 2.28 m and a weight lower than or equal to 26780 kg.
- an external envelope having a length lower than or equal to 12.01 m, a width lower than or equal to 2.33 m, a height lower than or equal to 2.69 m, preferably lower than or equal to 2.56 m and a weight lower than or equal to 26512 kg;
- an external envelope having a length lower than or equal to 5.89 m, a width lower than or equal to 2.31 m, preferably lower than or equal to 2.28 m, a height lower than or equal to 2.33 m, preferably lower than or equal to 2.18 m and a weight lower than or equal to 21600 kg;
- an external envelope having a length lower than or equal to 12.01 m, a width lower than or equal to 2.33 m, a height lower than or equal to 2.33 m, preferably lower than or equal to 2.26 m and a weight lower than or equal to 26630 kg;
- an external envelope having a length lower than or equal to 5.38 m, a width lower than or equal to 2.26 m, a height lower than or equal to 2.26 m, preferably lower than or equal to 2.20 m and a weight lower than or equal to 20756 kg;
- an external envelope having a length lower than or equal to 11.48 m, a width lower than or equal to 2.226 , a height lower than or equal to 2.18 m, preferably lower than or equal to 2.13 m and a weight lower than or equal to 25526 kg;
- an external envelope having a length lower than or equal to 11.35 m, a width lower than or equal to 2.28 m, a height lower than or equal to 2.48 m, preferably lower than or equal to 2.43 m and a weight lower than or equal to 28120 kg;
- an external envelope having a length lower than or equal to 5.61 m, a width lower than or equal to 2.20 m, a height lower than or equal to 2.23 m and a weight lower than or equal to 27722 kg;
- an external envelope having a length lower than or equal to 12.06 m, a width lower than or equal to 2.08 m, a height lower than or equal to 1.95 m and a weight lower than or equal to 38918 kg;
- an external envelope having a length lower than or equal to 5.63 m, a width lower than or equal to 2.20 m, a height lower than or equal to 2.23 m and a weight lower than or equal to 27722 kg;
- 10 -

- an external envelope having a length lower than or equal to 12.06 m, a width lower than or equal to 2.08 m, a height lower than or equal to 1.95 m and a weight lower than or equal to 38918 kg;
- an external envelope having a length lower than or equal to 6.07 m, a width lower than or equal to 2.43 m, a height lower than or equal to 2.23 m and a weight lower than or equal to 23993 kg;
- an external envelope having a length lower than or equal to 12.19 m, a width lower than or equal to 2.43 m, a height lower than or equal to 1.95 m and a weight lower than or equal to 30117 kg;
- an external envelope having a length lower than or equal to 8.25 m and a weight lower than or equal to 17955 kg;
- an external envelope having a length lower than or equal to 12.7 m and a weight lower than or equal to 20227 kg;
- an external envelope having a length lower than or equal to 9.97 m and a weight lower than or equal to 17955 kg;
- an external envelope having a length lower than or equal to 12 m and a weight lower than or equal to 20227 kg.

In the electrolysis plant according to the invention, it is preferred that the support mounted electrolysis module, the support mounted module for a treatment of the brine and the support mounted module for a treatment of the depleted brine are assembled in the same container or in separate containers, preferably in separate containers, on a first site and transported, preferably by road, to a second site.

In a second embodiment, the invention relates to the use of the electrolysis plant according to the invention for chlorine production.

In a third embodiment, the invention relates to a process for chlorine production comprising electrolyzing a brine in an electrolysis plant electrolysis plant according to the invention, wherein the brine is selected from a brine from an industrial process for manufacturing chlorine, a brine from an epoxide manufacturing process, preferably ethylene oxide, propylene oxide, butylene oxide or epichlorohydrin, and more preferably epichlorohydrin, a brine from an epoxide derivative manufacturing process, preferably epoxy resin, a brine from a process for manufacturing a chlorinated organic product, preferably 1,2-dichloroethane or 1,2-dichloroethylene, and more preferably 1,2-dichloroethane, a brine from a process for manufacturing a monoisocyanate or a polyisocyanate, preferably 4,4’-methylenediphenyl diisocyanate (MDI), toluene diisocyanate
(TDI) or hexamethylene-1,6-diisocyanate (HDI), a brine from a process for manufacturing a polycarbonate, preferably 2,2-bis(4-hydroxyphenyl)propane polycarbonate (bisphenol A polycarbonate), and any mixture thereof.

In a fourth embodiment, the invention relates to a process for chlorine production comprising electrolyzing a entering brine into a depleted brine, in an electrolysis plant according to the invention, comprising feeding at least one first vessel intermittently with a brine, subjecting this brine to at least one treatment in order to obtain the entering brine, feeding at least one electrolyser continuously with the entering brine in order to obtain the depleted brine, and withdrawing continuously the depleted brine from said electrolyser.

Should the disclosure of any patents, patent applications, and publications which are incorporated herein by reference conflict with the description of the present application to the extent that it may render a term unclear, the present description shall take precedence.

Figure 1 is intended to illustrate the invention without, however, limiting it. Figure 1 is an example of an electrolysis plant according to the invention. It comprises an electrolysis module (1), a module for treating a brine (2), which comprises at least one of units (A) to (H) and (K), (M), (N) as described above, and two treatment modules for treating a depleted brine (3) and (4), which comprises for treatment module (3), at least one of units (I) and (J) as described above and for treatment (4), at least one unit (L) as described above. Those modules are interconnected via a series of lines (5) to (16) and a series of valves (22) to (32). The plant also comprises lines (17) to (21) and (38) not connecting the modules and valves (33) to (37) and (39) to bypass some modules.

Various plant configurations which can be obtained by opening and closing valves are presented in the following Table.

The first four configurations are explained here below. The others can be easily understood therefrom.

A first configuration of the electrolysis plant according to the invention is obtained when valves (34), (23) and (36) are open and the other are closed. In such configuration, the plant consists of the electrolysis module (1) and the treatment of the depleted brine (3). The electrolysis module (1) is supplied with a brine from lines (17), (18) and (5), and the treatment module (3) is supplied via lines (6) and (7). The brine fed from line (17) is from any source. The treated depleted brine exits the treatment module (3) from line (20) and is sent to storage or to discharge.
A second configuration of the electrolysis plant according to the invention is obtained when valves (33), (22), (23) and (36) are open and the other are closed. In such configuration, the plant consists of the electrolysis module (1), the treatment module of brine (2), and the treatment of the depleted brine (3). The electrolysis module (1) is supplied with a brine from line (5), and the treatment module (3) is supplied via line (6) and (7). The treatment module (2) is supplied with a brine from line (17). The brine fed from line (17) is from any source. The treated depleted brine exits the treatment module (3) from line (20) and is sent to storage or to discharge.

A third configuration of the electrolysis plant according to the invention is obtained when valves (33), (22), (23), (26) and (28) are open and the other are closed. In such configuration, the plant consists of the electrolysis module (1), the treatment module of brine (2), and the treatment module of the depleted brine (3). The electrolysis module (1) is supplied with a brine from line (5), and the treatment module (3) is supplied via line (6) and (7). The treatment module (2) is partially supplied with brine from line (17) and partially with brine from line (13). The brine fed from line (17) is from any source. The treated depleted brine exits the treatment module (3) from line (11) and is sent back to module (2).

A fourth configuration of the electrolysis plant according to the invention is obtained when valves (33), (39), (22), (23), (25), (26) and (28) are open and the other are closed. In such configuration, the plant consists of the electrolysis module (1), the treatment module of brine (2), the treatment module of the depleted brine (3), and the treatment module of the depleted brine (4). The electrolysis module (1) is supplied with brine from line (5), and the treatment module (3) is supplied via line (6), (7) and (9). The treatment module (2) is supplied with brine from line (13), and the treatment module (4) is supplied via line (38). The brine fed from line (38) is from any source. The treated depleted brine exits the treatment module (3) from line (11) and is sent back to module (2).
<table>
<thead>
<tr>
<th>Configuration</th>
<th>Valves opened</th>
<th>Lines opened</th>
<th>Modules used</th>
<th>Brine</th>
<th>Depleted brine</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>(34),(23),(36)</td>
<td>(17),(18),(5),(6),(7),(20)</td>
<td>(1),(3)</td>
<td>From any source</td>
<td>To storage or discharge</td>
</tr>
<tr>
<td>2</td>
<td>(33),(22),(23),(36)</td>
<td>(17),(5),(6),(7),(20)</td>
<td>(1),(2),(3)</td>
<td>From any source via (2)</td>
<td>To storage or discharge</td>
</tr>
<tr>
<td>3</td>
<td>(33),(22),(23),(26),(28)</td>
<td>(17),(5),(6),(7),(11),(13)</td>
<td>(1),(2),(3)</td>
<td>From any source via (2)</td>
<td>Recycled to (2)</td>
</tr>
<tr>
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<td>(33),(39),(22),(23),(25),(26),(28)</td>
<td>(17),(5),(6),(7),(9),(11),(13),(38)</td>
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<td>From any source via (2)</td>
<td>Recycled to (2)</td>
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<td>From any source,</td>
<td>To storage or discharge</td>
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<tr>
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<td>From any source via (2)</td>
<td>Recycled to (2)</td>
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<td>(33),(22),(23),(29),(30),(32)</td>
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<td>(1),(3),(4)</td>
<td>From any source via (2)</td>
<td>Recycled to (2)</td>
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<tr>
<td>8</td>
<td>(34),(24),(25),(36)</td>
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<td>From any source,</td>
<td>To storage or discharge</td>
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<td>9</td>
<td>(22),(34),(24),(25),(26),(28)</td>
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<td>Any source, From (2)</td>
<td>Recycled to (2)</td>
</tr>
<tr>
<td>10</td>
<td>(33),(22),(23),(29),(37)</td>
<td>(17),(5),(6),(7),(10),(21)</td>
<td>(1),(2),(3),(4)</td>
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CLAIMS

1. Movable chlor-alkali electrolysis plant for electrolysis of a brine into a depleted brine, containing at least one chlor-alkali electrolysis module and at least two different modules for the treatment of the brine and/or of the depleted brine, wherein the chlor-alkali electrolysis module and the treatment modules are connected to each other allowing that the operation of the plant can be started with only one treatment module or with any combination of two or more treatment modules, and that at any time one of the treatments can be switched off and/or an additional treatment can be added, and/or the order of the treatments can be modified.

2. Movable chlor-alkali electrolysis plant according to claim 1 comprising one chlor-alkali electrolysis module, one module for the treatment of the brine and two modules for the treatment of the depleted brine.

3. Movable chlor-alkali electrolysis plant according to claim 2, wherein the two modules for the treatment of the depleted brine are connected to each other allowing that they can be combined in series.

4. Movable chlor-alkali electrolysis plant according to claim 3, wherein the module for the treatment of the brine and the two modules for the treatment of the depleted brine are connected to each other allowing that they can be combined in series.

5. Movable chlor-alkali electrolysis plant according to any one of claims 1 to 4, wherein the modules for treating the brine and/or the depleted brine preferably comprises at least one unit selected from a unit (A) for adjusting the salt concentration of the brine, a unit (B) for removing fine solid particles from the brine, a unit (C) for removing carbonate ions from the brine, a unit (D) for removing iron and aluminium from the brine, a unit (E) for removing calcium and magnesium from the brine, a unit (F) for removing iodide from the brine, a unit (G) for removing bromide from the brine, a unit (H) for removing silicon from the brine, a unit (I) for removing chlorine from the brine, a unit (J) for removing chlorate from the brine, a unit (K) for removing sulphates from the brine, a unit (L) for removing organic compounds from the brine, a unit (M) for
removing mercury from the brine and a unit (N) for removing ammonia from the brine.

6. Movable chlor-alkali electrolysis plant according to claim 5, wherein:

- the adjustment of the salt concentration of the brine in unit (A) is at least by salt addition to the brine;

- the removal fine solid particles from the brine in unit (B) is at least by filtration;

- the removal of carbonate ions from the brine in unit (C) is at least by acidification and venting;

- the removal of iron and aluminium from the brine in unit (D) is at least by filtration;

- the removal of calcium and magnesium from the brine in unit (E) is at least by ion exchange;

- the removal of iodide from the brine in unit (F) is at least by oxidation and ion exchange;

- the removal of bromide from the brine in unit (G) is at least by oxidation;

- the removal of silicon from the brine in unit (H) is at least by precipitation and filtration;

- the removal of chlorine from the brine in unit (I) is at least by acidification, stripping and adsorption;

- the removal of chlorate from the brine in unit (J) is at least by acid addition followed by stripping and adsorption and/or by catalytic hydrogenation;

- the removal of sulphate from the brine in unit (K) is at least by precipitation and filtration, or by nanofiltration with membranes;

- the removal of organic compounds from the brine in unit (L) is at least by oxidation;
- 16 -

- the removal of mercury from the brine in unit (M) is at least by precipitation, ion-exchange reduction or adsorption; and

- the removal of ammonia from the brine in unit (N) is at least by pH adjustment, oxidation and stripping.

7. Movable chlor-alkali electrolysis plant according to either claim 5 or 6, wherein the module for treating the brine comprises at least one of units (A) to (H) and (K) to (N).

8. Movable chlor-alkali electrolysis plant according to any one of claim 5 to 7, wherein the modules for treating the depleted brine comprise at least one unit selected from a unit (I) for removing chlorine from the brine and a unit (J) for removing chlorate from the brine.

9. Movable chlor-alkali electrolysis plant according to claim 8, wherein the plant comprises one module for treating the depleted brine which comprises at least one unit selected from a unit (I) for removing chlorine from the brine and a unit (J) for removing chlorate from the brine.

10. Movable chlor-alkali electrolysis plant according to any one of claims 1 to 9, wherein the electrolysis module contains at least one electrolyzer, wherein the electrolyser contains at least two different separator-electrode assemblies and wherein the two separators of the two different separator-electrode assemblies are both a diaphragm or a membrane or are one diaphragm and one membrane, and the two separator-electrode assemblies differ from each other by at least one of the following features:

- They contain a different separator

- They contain a different membrane,

- They contain a different diaphragm,

- They contain a different anode,

- They contain a different cathode.

11. Movable chlor-alkali electrolysis plant according to any one of claims 1 to 10, wherein one or more of the chlor-alkali electrolysis module and of the
module for the treatment of the brine and/or the depleted brine is equipped with one or more sensors for monitoring one or more parameters such as temperature, pressure, voltage, current, flow rate, electrolyte composition or fluid level.

12. Movable chlor-alkali electrolysis plant according to any one of claims 1 to 11, wherein the chlor-alkali electrolysis module is mounted on a first support which can be moved as a whole, the module for a treatment of the brine is mounted on a second support which can be moved as a whole, the module for a treatment of the depleted brine is mounted on a third support which can be moved as a whole.

13. Movable chlor-alkali electrolysis plant according to claim 12, wherein the first, second and third supports are a container of a platform.

14. Use of the movable chlor-alkali electrolysis plant according to any one of claims 1 to 13 for chlorine production.

15. Process for chlorine production comprising electrolyzing a brine in the movable chlor-alkali electrolysis plant according to any one of claims 1 to 13, wherein the brine is selected from a brine from an industrial process for manufacturing chlorine, a brine from an epoxide manufacturing process, preferably ethylene oxide, propylene oxide, butylene oxide or epichlorohydrin, and more preferably epichlorohydrin, a brine from an epoxide derivative manufacturing process, preferably epoxy resin, a brine from a process for manufacturing a chlorinated organic product, preferably 1,2-dichloroethane or 1,2-dichloroethylene, and more preferably 1,2-dichloroethane, a brine from a process for manufacturing a monoisocyanate or a polyisocyanate, preferably 4,4’-methylene-diphenyl diisocyanate (MDI), toluene diisocyanate (TDI) or hexamethylene-1,6-diisocyanate (HDI), a brine from a process for manufacturing a polycarbonate, preferably 2,2-bis(4-hydroxyphenyl)propane polycarbonate (bisphenol A polycarbonate), and any mixture thereof.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. C25B15/08 C25B1/46 C25B9/08

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)

C25B

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Date of the actual completion of the international search

25 June 2014

Date of mailing of the international search report

03/07/2014

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
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Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Hammerstei n, G
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