(54) Title: DEVICE AND METHOD FOR DISSOLVING A CHEMICAL SUBSTANCE IN WATER

(57) Abstract: Device (1/1’) and method for additive supplementing/treatment (chlorination) of water, a solid chemical substance (2) is placed inside the loading chamber (10) of a container (3) above a collecting portion (8) and a jet of water is emitted by a dispersion unit (14) onto the solid chemical substance (2) so as to produce a solution which is sucked through an outlet (8a) by means of a Venturi (5a) arranged below the container (3); the Venturi (5a) also reduces the pressure inside the container (3).
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TECHNICAL FIELD
The present invention relates to a device and a method for dissolving a solid chemical substance in water. The present invention furthermore relates to a plant comprising a device for dissolving a chemical substance in water.

The present invention is advantageously applied in the treatment of water for swimming pools, drinking water, industrial water and water in general, in particular but not exclusively, for optimal dissolution of solid derivatives of chlorine (calcium hypochlorite, isocyanurates, their mixtures or derivatives, etc.), to which the following discussion will explicitly refer without loss of generality.

The use of the present invention is particularly advantageous in small-sized plants (for domestic use, for example).

CONTEXT OF THE INVENTION
In the field of devices for dissolving a solid chemical substance in water, in particular in the field of water chlorination, a device is known and used comprising a closed container, which has a collecting portion for holding a water solution; perforated support means (or in any case permeable to liquids), which are arranged above the collecting portion and are suitable for supporting the solid chemical substance; and means for feeding the water arranged above the support means for directing at least one jet of water onto the solid chemical substance to be dissolved.

The treated (chlorinated) water obtained by means of said dissolution is usually left in the cited container until it is fed to the tank; for this reason, the solid chemical substances dissolved can precipitate, creating deposits inside
the container. Normally the solid chemical substances comprise calcium hypochlorite and, consequently, inside the container deposits can be created consisting mainly of calcium sulphate and calcium carbonate. Said undesired deposits tend to accumulate, in particular, in correspondence to the connections providing the hydraulic communication between the chlorinated water collecting portion and the ducts of an external hydraulic circuit which comprises the above-mentioned tank.

To remedy the periodic need to eliminate said deposits via the manual intervention of an operator, which entails interruption of operation of the device and, therefore, treatment of the water in the tank, in the past, mixing means were provided, such as mechanical stirrers, propeller or blade, or nozzle stirrers (fed by a respective blower or a pump), arranged in correspondence to the collecting portion suitable for maintaining stirring of the chlorinated water contained in it.

Said solution, although effective, involves additional installation costs and only reduces, without eliminating completely, the need to periodically suspend operation of the device for dissolving (chlorinator) and feeding the treated/additive-mixed water to the tank in order to carry out cleaning and maintenance of the mechanical parts composing the stirrers or the blower/pump to feed the flow to the nozzles. Furthermore, said solution can involve a significant consumption of energy, especially when there is a large volume of water to be stirred.

It should furthermore be noted that, often, the known dissolution devices comprise floats, the mechanisms of which are at least partially submerged in the treated (chlorinated) water. Said mechanisms, in addition to being relatively complex and, consequently, increasing the overall dimensions and cost of the devices, tend to get damaged particularly
frequently both due to phenomena of corrosion and deposits of salts.

During dissolution of the solid chemical substance, gases may be emitted. The development of gases may produce bad smells and/or the outflow of quantities of highly concentrated solutions (of chlorine). This can be harmful or in any case unpleasant for the users.

Furthermore, these gases, if not appropriately managed (vented), can lead to an uncontrolled increase in the pressure inside the container and, possibly, explosion of the container itself.

Aim of the present invention is to produce a device, a plant and a method for dissolving a solid chemical substance, which overcome at least partially the drawbacks of the state of the art and are, at the same time, safe for the operators, reliable, and simple and inexpensive to produce.

SUMMARY
In accordance with the present invention a device, a plant and a method are provided as described in the following independent claims and, preferably, in any one of the subsequent dependent claims depending directly or indirectly on the independent claims.

BRIEF DESCRIPTION OF THE FIGURES
The invention is described below with reference to the accompanying drawings, which illustrate non-limiting implementation examples, where:
- figure 1 is a lateral section of a device produced according to the present invention;
- figure 2 schematically illustrates a plant produced according to the present invention and comprising the device of figure 1; and
- figure 3 is a lateral schematic section of an alternative embodiment of a device produced according to the present invention.

5 EMBODIMENTS OF THE INVENTION
In figure 1, the number 1 indicates overall a device for dissolving a solid chemical substance 2, in particular, but not exclusively, for the chlorination of water (for swimming pools, drinking water, industrial water and water in general).

The device 1 comprises a container 3 (substantially cylindrical, preferably with circular section), inside which the solid chemical substance 2 (for chlorination) is dissolved in water so as to obtain a water solution, a feeding system 4 to convey water into the container 3, and a discharge unit 5 to convey the water solution from the container 3 to an external hydraulic circuit 6 comprising, typically, a swimming pool (or, in general, a tank) 7 (the hydraulic circuit 6 and the swimming pool (or tank) 7 are schematically illustrated in figure 2).

The container 3 is arranged vertically, is provided with a collecting portion 8 (figure 1), which is designed to convey the water solution towards an outlet 8a of the container 3. In particular, the outlet 8a is arranged below the collecting portion 8. According to the embodiment illustrated, the collecting portion 8 (has at least one part which) is tapered towards the outlet 8a.

The container 3 is delimited at the top by a cover 9, which is arranged in contact with the container 3.

In particular, the container 3 has an opening 9a (upper). In use, the operator can place the solid chemical substance 2 inside the container 3 via the opening 9a (when the cover 9 is in the opening position - i.e. removed from the opening 9a).
During operation of the device 1, the cover 9 is kept in its own closing position. When the cover 9 is in its own closing position, the opening 9a and the cover 9 are in contact with each other (substantially fluid-tight). In particular, when the cover 9 is in its closing position, the cover 9 completely obstructs the opening 9a.

To improve the connection (seal) between the cover 9 and the opening 9a, the cover 9 can be screwed (in the closed position, screwed) to the opening 9a.

Between the opening 9a and the cover 9 a gasket 9b is positioned suitable for maintaining the coupling between the opening 9a and the cover 9 fluid-tight. The gasket 9b follows the profile of the opening 9a (and/or of the cover 9).

The device 1, furthermore, comprises a loading chamber 10, which is arranged above the collecting portion 8 inside the container 3 and is designed to hold the solid chemical substance 2 for treatment (chlorination) of the water. In particular, the solid chemical substance 2 is in the form of tablets and can contain one or more of the following: calcium hypochlorite, isocyanurates, bromochloro dimethylhydantoin (BCDMH), sodium persulphate and their derivatives (or other substances in solid form in the form of tablets to be dissolved).

According to further embodiments not illustrated, the solid chemical substance 2 can contain other types of salts.

The loading chamber 10 has at least one bottom wall 11 permeable to liquids (in particular, perforated) suitable for supporting at the bottom the solid chemical substance 2. The bottom wall 11 delimits the bottom of the loading chamber 10.

The dimension of the holes of the wall 11 is chosen according
to the solid chemical substance 2; in particular, when the solid chemical substance is in the form of tablets, the dimensions of the holes of the wall 2 are chosen according to the dimension of the tablets.

According to a variation not illustrated, the chamber 10 has at least one lateral wall, in particular permeable to liquids (more precisely, perforated), suitable for laterally containing the solid chemical substance 2. Advantageously, the chamber 10 has a downward tapering shape (in particular, frustoconical). In this case, according to some embodiments, the holes of the lateral wall extend to a distance of 5-15 cm from the bottom wall 11.

The taper angle is selected so as to favour progressive descent, by gravity, of the tablets of the solid chemical substance 2 placed in the loading chamber 10 towards a dissolving portion thereof.

According to further variations not illustrated, the loading chamber 10 has a shape chosen from the group consisting of: substantially conical, substantially frusto-pyramidal, substantially pyramidal.

The device 1 furthermore comprises the water dispersion unit 14, which is positioned above the bottom wall 11, in particular inside the loading chamber 10, and is suitable for directing at least one jet of water towards the solid chemical substance 2 (contained in the dissolving portion). In particular, the dispersion unit 14 comprises a spray head 17 (advantageously height-adjustable with respect to the bottom wall 11) which (is arranged in correspondence to an upper end of the dissolving portion and) is suitable for directing the water downwards and/or laterally, but not upwards (substantially so as not to wet any solid chemical substance 2 positioned above the spray head 17). In the presence of solid
chemical substances with high solubility (such as calcium hypochlorite), the spray head 17 is positioned at 5-15 cm from the bottom wall 11. In the presence of solid chemical substances with low solubility (for example, trichloroisocyanurate), the spray head 17 can also be arranged in a higher position, also above the overall mass of the solid chemical substance 2 to be dissolved. The position (in particular, the height) of the spray head 17 can therefore be modified.

The collecting portion 8 comprises a bottom portion 18 having a shape substantially (conical or frustoconical) tapering downwards. Advantageously, the taper angle of the lateral wall of the bottom portion 18 favours the flow of the liquid (water solution or water loaded with the solute; for example chlorinated water, when chlorine-based substances are used) downwards (towards the outlet 8a) and to the inlet of the discharge unit 5 to continue towards the external hydraulic circuit 6, reducing the probability of formation of deposits of precipitated salts.

According to embodiments not illustrated, the bottom portion 18 has a shape chosen from the group consisting of: pyramidal, frusto-pyramidal.

Advantageously, the collecting portion 8 has a substantially circular horizontal section.

The feed system 4 comprises a duct 19 for conveying the water coming from the external hydraulic circuit 6 to the device 1. More precisely, the duct 19 fluidly (hydraulically) connects the external hydraulic circuit 6 to a T-joint 19a.

The feed system 4 furthermore comprises a duct 19b to convey the water (more precisely part of the water) coming from the external hydraulic circuit 6 (namely from the joint 19a) to a
T-joint 20 (figure 1). The feed system 4 furthermore comprises a dispersion duct 21 for conveying the water from the joint 20 to the dispersion unit 14, and a feed duct 22 for conveying the water from the joint 20 to the collecting portion 8.

The dispersion duct 21 hydraulically communicates with the dispersion unit 14. The duct 22 has an end opening 23 arranged in the collecting portion 8. Through the opening 23, in use, a jet of water is emitted suitable for limiting the formation of deposits inside the collecting portion 8.

Advantageously, the duct 22 (more precisely, the opening 23) is arranged and oriented so that the jet of water emitted from it (substantially in a horizontal direction) is directed against a inner surface IS of the container 3 (in correspondence to the collecting portion 8).

In particular, the duct 22 (more precisely, the opening 23) is directed (substantially in a horizontal direction) along an inner surface IS of the container 3 (in correspondence to the collecting portion 8). In this way, the flow of the jet of water over the majority of the surface IS of the container 3 in correspondence to the collecting portion 8 (in particular, below the opening 23) is facilitated. The water flow determines a sort of rinsing of the surface IS and consequent further and significant reduction of the risk of deposits.

It is important to point out that the flow of water coming from the external hydraulic circuit 6 via the duct 22 is maintained substantially continuous (and constant). In this way, the precipitation of salts, mainly calcium carbonate and calcium sulphate (if calcium hypochlorite or similar products are used) and, consequently, the creation of deposits inside the collecting portion 8 becomes relatively difficult.
A flow of water coming from the external hydraulic circuit 6 and fed by means of a pump 24 (figure 2) to the feed system 4 is distributed, in use, between the dispersion duct 21 and the duct 22 according to the degree of opening of a regulating valve 25 provided on the dispersion duct 21. The degree of opening of the regulating valve 25 is regulated manually by an operator or automatically by a control unit 26 (figure 2) which is activated in timed mode or according to the detection of a concentration value (of the chemical substance), said detection being obtained by means of an appropriate sensor 27 arranged for example in the external hydraulic circuit 6. According to particular embodiments, in use, when the sensor 27 detects a relatively low concentration, the control unit 26 commands the regulating valve 25 (specifically, it increases the degree of opening of the regulating valve 25) so as to increase the flow of liquid through the dispersion unit 14; when the sensor 27 detects a relatively high concentration, the control unit 26 commands the regulating valve 25 (specifically, it decreases the degree of opening of the regulating valve 25) so as to reduce (and if necessary block) the flow of liquid towards the dispersion unit 14.

According to specific embodiments, the regulating valve 25 is of the open/closed type. When the sensor 27 detects a concentration below a given value, the regulating valve 25 is opened; when the sensor 27 detects a concentration above a given value, the regulating valve is closed.

In actual use, the discharge unit 5 is substantially always open and allows substantially continuous discharge of the liquid that passes through the device 1 (water solution – chlorinated water) to the external hydraulic circuit 6.

In other words, during operation of the device 1, there is a substantially continuous flow of liquid (water and/or water solution) coming out of the collecting portion 8 through the
It should be noted that, advantageously, the maximum flow rate of the outlet 8a is greater than or equal to the maximum flow rate of the duct 22. In practice, there is substantially no accumulation of liquid in the collecting portion 8. In particular, there is a very slight accumulation (maximum one or two cm) or (more precisely) no liquid in the collecting portion 8. The fact that there is almost no accumulation of liquid (more or less stagnant) further limits the possibility of formation of deposits.

The discharge unit 5 is suitable for determining a vacuum (pressure drop) inside the container 3, in particular, it is suitable for bringing the pressure inside the container 3 to below 1 atm (more precisely between approximately 0.9 atm and 0.7 atm). This reduces (substantially eliminates) the risks of explosion and emission of bad smells or toxic substances.

The device 1, furthermore, comprises a safety (inflow) valve 29. In particular, the valve 29 is suitable for permitting the inlet of air (from the outside) into the container 3 if the pressure inside the container 3 drops below a predetermined limit value (for example, below 0.7 atm). More specifically, the valve 29 comprises (in particular, is) an injection check valve. The presence of the valve 29 significantly reduces the risk of collapse or implosion of the container 3; the valve 29 furthermore allows a sort of air cushion to be maintained above the collecting portion which prevents the container being filled with water and the solid chemical substance 2 being submerged.

The discharge unit 5 comprises a duct 32, which hydraulically connects the outlet 8a (or the bottom portion 18) to the external hydraulic circuit 6. More specifically, the duct 32 extends between the joint 19a and the external hydraulic circuit 6 so that the water coming from the duct 19 passes through the duct 32.
When, in use, liquid (water) is fed to the container 3 (through the duct 19b), the discharge unit 5 sucks the liquid (water solution - and/or water) through the outlet 8a. The discharge unit 5 sucks the liquid so that there is substantially no accumulation of liquid in the collecting portion 8. In particular, there is a very slight accumulation (maximum one or two cm) or (more precisely) no liquid in the collecting portion 8.

According to the embodiment illustrated, the discharge unit 5 comprises a Venturi 5a (which is arranged along the duct 32). Advantageously, the Venturi 5a is arranged in correspondence to the outlet 8a (below the container 3). In this way the footprint of the device 1 is considerably reduced.

The discharge unit 5 and the feed system 4 are configured so that (when operating at full capacity) the quantity of liquid sucked in the unit of time by the discharge unit 5 from the container 3 is approximately equal to the quantity of liquid fed in the unit of time to the container 3 (in particular, from the duct 19b).

In this way, the risk of accumulation of liquid in the collecting portion 8 is reduced and, consequently, the risk of formation of deposits.

The sensor 27 is suitable for detecting the concentration of solute in the water solution present in the external hydraulic circuit 6 upstream of a duct 32 of the discharge unit 5. According to the embodiment illustrated, the sensor 27 is arranged in the swimming pool (or tank) 7.

The control unit 26 is electrically connected to the regulating valve 25, to the pump 24 and to the sensor 27.
According to some embodiments, the control unit 26 is suitable for operating the regulating valve 25 according to the detections of the sensor 27 so as to maintain the concentration of solute in the water of the swimming pool (or tank) 7 (i.e. in the water present in the external hydraulic circuit 6) between a minimum concentration and a maximum concentration. In particular, in use, when the concentration of solute detected by the sensor 27 is relatively near the minimum concentration, the control unit 26 modifies the degree of opening of the regulating valve 25, altering the ratio between the flow rates of the dispersion contribution and the recirculation contribution so as to favour the dispersion contribution. Consequently, a larger quantity of solid chemical substance 2 is dissolved, thus obtaining a larger quantity of concentrated water solution which falls into the collecting portion 8 and, from it, proceeds continuously through the discharge unit 5 towards the external hydraulic circuit 6 (and then to the swimming pool or tank 7).

On the other hand, when the concentration of solute detected by the sensor 27 is relatively near the maximum concentration, the control unit 26 modifies the degree of opening of the regulating valve 25, altering the ratio between the flow rates of the dispersion contribution and the recirculation contribution so as to favour the recirculation contribution. Consequently, a smaller quantity of solid substance 2 is dissolved, while a larger quantity of water with a low solute concentration passes into the collecting portion 8, as described previously.

The device 1 also comprises an internal control unit suitable for controlling opening of the regulating valve 25 (in timed mode). According to some embodiments, when the control unit 26 is present, operation of the regulating valve 25 is commanded by the control unit 26 and not by the internal control unit.
The feed system 4 comprises a manual valve 35, which is arranged along the duct 19; the degree of opening of said valve determines the maximum flow rate of the feed system 4 (i.e. of the duct 19).

Figure 3 illustrates a variation of the device 1. This variation relates to a device 1' for dissolution similar to the device 1 of figure 1 with parts marked with the same reference numbers distinguishing the corresponding parts of the device 1. The device 1' differs from the device 1 in some of the aspects described below.

In this case, in use, the solid chemical substance 2 is dissolved by immersion. In particular, inside the container 3 a substantially constant level $L$ of liquid (water - water solution) is maintained. The solid chemical substance 2 is immersed in the liquid where it gradually dissolves. The water solution thus obtained is drawn whenever necessary by the discharge unit 5 comprising a duct 36.

The device 1' is particularly suitable for dissolving chemical substances 2 with low solubility (for example, trichloroisocyanurate).

Inside the container 3 a perforated basket 37 is arranged suitable for containing the solid chemical substance 2. The basket 37 has one or more perforated lateral walls and a perforated base wall. The basket 37 is advantageously open at the top so as to facilitate introduction of the solid chemical substance 2.

The duct 36 has one end 36a open (facing downwards and) arranged inside the container 3 (in correspondence to level $L$) through which, in use, the contents of the container 3 are sucked so as to reduce the pressure and draw the liquid present inside the container 3. The suction occurs due to the
Venturi 5a. The end 36a acts as an outlet from the container 3.

Also in this case, the discharge unit 5 brings the pressure inside the container 3 to below 1 atm (in particular, between 0.7 and 0.9 atm).

It should be noted that the outlet (or more precisely, the open end 36a) is positioned above the loading area (more precisely above the basket 37) where the solid chemical substance 2 is arranged. In this way, the water (coming from the feed system 4, more precisely from the duct 21') submerges (at least partially) the solid chemical substance 2 (before being able to reach the outlet).

In other words, in use (at full operating capacity), during dissolution, the liquid is kept at the level \( L \) in a substantially constant manner. The level \( L \) is defined (delimited) by the (position of the) outlet (end 36a).

The device 1' comprises a duct 21', which extends from the duct 19 (in particular from the T-joint 19a) directly into the container 3. The duct 21' is suitable for conveying the water into the container 3.

The duct 21' has a discharge section 21'a provided with an open end (facing downwards and) arranged inside the container 3 (below the level \( L \)). The duct 21' also has a curved connecting section 21'b (between the section 21'a and a main section directly fluidly connected to the duct 19).

The device 1' also comprises the safety valve 29 having substantially the same operation as described for device 1.

The regulating valve 25' (in particular a solenoid valve) is arranged along the duct 21'. The regulating valve 25' is
suitable for regulating the quantity of water fed to the container 3. More specifically, the regulating valve 25' is suitable for distributing the proportions of water coming from the duct 19 between the duct 21' and the Venturi 5a.

Whenever the valve 25' is opened, the water is fed to the container 3. When the water (or, more precisely, the water solution) present in the container 3 reaches (and/or exceeds) the level L, the discharge unit 5 begins to draw the water solution through the duct 36 (due to the vacuum created by the Venturi 5a). At full operating capacity, the level of the liquid (water and/or water solution) is just above or just below the level L.

When the valve 25' is closed, the water is not fed to the container 3. In this way the discharge unit 5 does not draw the water solution through the duct 36 (as the level of the liquid in the container 3 is below the level L). However (where the passage of water through the Venturi 5a continues) the unit 5 lowers the pressure inside the container 3 (sucking air) until a limit pressure is reached at which the safety valve 29 is activated (bringing in air from the outside).

More specifically, when the valve 25' is closed after a period of opening (during which the water solution has been drawn by the unit 5), the discharge unit 5 continues to draw the water solution until the level of the liquid drops below the level L.

The section 21'a has a vent opening 38 arranged in correspondence to an end opposite to the mentioned open end. More precisely, the opening 38 is arranged in correspondence to the section 21'b.

The device 1' also comprises a check valve 39 arranged along the duct 21' (in particular along its main section upstream,
with respect to the water feed direction, of the section 21'b).

The valve 39 (and the opening 38) is suitable for preventing the water solution (and/or gases developed during the dissolution) from reaching the solenoid valve 25'.

Furthermore, the device 1 comprises a discharge valve 40 which is arranged below the container 3 and, when open, allows emptying of the container 3. In particular, the valve 40 is arranged between the container 3 and the Venturi 5a and, when open, allows the container 3 and the Venturi 5a to be fluidly connected.

It should be noted that both the device 1 and the device 1' are without internal moving parts (i.e. arranged inside the container 3). In particular, there are no parts with mechanisms such as, for example, a system of floats.

According to a further embodiment of the present invention, a plant 49 is provided comprising the device 1 (or the device 1') and the external hydraulic circuit 6 as defined above. The external hydraulic circuit 6 is hydraulically connected to the feed system 4 (more precisely, to the duct 19) downstream of the pump 24 and has a filter 50 arranged between the swimming pool (or tank) 7 and the feed system 4 (in particular, the duct 19). More precisely, the filter 50 is arranged between the pump 24 and the feed system 4 (in particular, the duct 19). The duct 32 is hydraulically connected to the external hydraulic circuit 6 downstream of the pump 24 and upstream of the swimming pool (or tank) 7 (with respect to the liquid flow direction). The duct 32 is connected by means of a manual valve 51 to the external hydraulic circuit 6.

The valves 35 and 51 can be closed when, for example, a maintenance operation has to be carried out on the device 1.
The maximum flow rate of the discharge unit 5 is, advantageously, higher than or approximately equal to the maximum flow rate of the duct 19. In this way, the risk of accumulation of liquids in the collecting portion 8 (figure 1) is reduced.

The plant 49 (figure 2) furthermore comprises a valve 52, which is suitable for defining the flow rate of the duct 19. The valve 52 is arranged along the hydraulic circuit 6 between the ducts 19 and 32.

Figure 2 schematically illustrates the device 1 (of figure 1). According to different embodiments, the plant 49 comprises the device 1' (of figure 3) instead of the device 1.

It should be noted that (normally), in use, the level of liquid in the collecting portion 8 remains lower than the loading chamber 10. In other words, the support means (more precisely, the wall 11) of the solid chemical substance 2 are arranged above the level of the liquid contained in the collecting portion 8. In use (therefore), the solid chemical substance 2 is kept above the level of the liquid contained in the collecting portion 8.

According to some embodiments not illustrated, the feed system 4 comprises a safety valve which during normal operation of the device 1 (or 1') is kept open and remains closed when the device 1 is de-activated. In particular, said safety valve is suitable for permitting or blocking the flow of water towards the spray head 17 and the water emission means (more precisely, the duct 22 and the opening 23) in correspondence to the chamber 8. In particular, the safety valve is arranged between the connections 19a and 20.
The presence of said safety valve prevents, when the device 1 is not working, the container 3 from filling with water (or simply the level of the liquid inside the collecting portion 8 from reaching the loading chamber 10).

According to embodiments not illustrated, the suction means (more precisely, the Venturi 5a) of the discharge unit 5 are arranged at a considerable distance from the container 3.

From the above it can be deduced that the device 1 and the plant 49 present considerable advantages with respect to the state of the art. These include: lower risk of formation of deposits in the container 3; lower risk of bad-smelling and/or hazardous emissions; low risk of implosion; absence of moving parts (inside the container 3); and substantial elimination of the risk of explosion.
CLAIMS

1. A device for dissolving a solid chemical substance in water; the device (1; 1') comprises a container (3), which is suitable for holding a solid chemical substance (2) and has an outlet (8a; 36a); a feeding system (4) for conveying water into the container (3) and causing it to come into contact with the solid chemical substance (2); and a discharge unit (5) for conveying liquid to a hydraulic circuit (6) through the outlet (8a) of the container (3); the device being characterised in that said discharge unit (5) is suitable for determining a vacuum inside the container (3), which is substantially fluid-tight.

2. A device as claimed in claim 1, wherein the discharge unit (5) comprises sucking means (5a), which are suitable for sucking the liquid through the outlet (8a) and reducing the pressure inside the container (3) to below 1 atm.

3. A device as claimed in one of the preceding claims and comprising an opening (in particular an upper opening) (9a) and a blocking device (9), which is mobile and obstructs the opening (9a) in a fluid-tight manner, when it is arranged in its closing position; and a safety valve (29), which is suitable for allowing the inlet of air (from the outside) into the container (3), if the pressure inside the container (3) drops below a predetermined limit value.

4. A device as claimed in one of the preceding claims, wherein the container (3) presents a collecting portion (8) for conveying liquid to the outlet (8a) and a loading chamber (10), which is arranged above the collecting portion (8), is suitable for holding the solid chemical substance (2), and is provided with support means (11), which are suitable for supporting the solid chemical substance (2); the feeding system (4) comprising a water dispersion unit (14) for
directing at least one first water jet onto said solid chemical substance (2); the outlet (8a) is arranged beneath the collecting portion (8).

5. A device as claimed in claim 4, according to one of the preceding claims, wherein the container (3) has a collecting portion (8); the feeding system (4) comprises feeding means (19, 19b, 21, 22, 23) for conveying water to the collecting portion (8) in a substantially continuous manner.

6. A device as claimed in claim 5, wherein the feeding means (19, 19b, 21, 22, 23) comprise emission means (22, 23) for emitting at least one second jet of water against an internal surface (IS) of the container (3) in correspondence to the collecting portion (8), so as to reduce the risk of formation of deposits inside the collecting portion (8).

7. A device as claimed in one of the claims from 5 to 6, wherein the feeding means (19, 19b, 21, 22, 23) comprise emission means (22, 23) for emitting at least one second jet of water; the emission means (22, 23) are configured and oriented so that the second jet of water is at least partially substantially horizontal and is directed along an internal surface (IS) of the container (3) in correspondence to the collecting portion (8), so as to reduce the risk of formation of deposits inside the collecting portion (8).

8. Device as claimed in one of the claims from 1 to 3, wherein the container (3) has a collection area (37), in correspondence to which the solid chemical substance (2) is arranged; the outlet (36a) being at least partially arranged above the collection area (37); the feed system (4) is suitable for conveying water into the container (3), so as to at least reach the outlet (36a).

9. A device as claimed in one of the preceding claims,
wherein the discharge unit (5) comprises a Venturi (5a), which is arranged in correspondence to the container (3) and is suitable for reducing the pressure inside the container (3) to below 1 atm and sucking the liquid through said outlet (8a; 36a).

10. - Device as claimed in one of the preceding claims, wherein the feed system (4) comprises a safety valve which during normal operation of the device (1; 1') is kept open and remains closed when the device (1; 1') is de-activated.

11. - A method for dissolving a solid chemical substance (2) in water, so as to obtain a water solution and treat a hydraulic circuit (6); the method entails dissolving the solid chemical substance in a device (1; 1') comprising a container (3) which has an outlet (8a; 36a) and is suitable for holding the solid chemical substance (2); the method comprising: a dissolving step, during which water is caused to come into contact with the solid chemical substance (2), so as to obtain the water solution; a discharge step, during which the water solution is conveyed from said outlet (8a; 36a) of the container (3) to the hydraulic circuit (6); the method being characterised in that, during said dissolving and discharge steps, the container (3) is kept at a pressure below 1 atmosphere.

12. - A method as claimed in claim 11, wherein the pressure below 1 atmosphere inside the container (3) is obtained by means of suction through said outlet (8a; 35a).

13. - A method as claimed in claim 11 or 12, wherein the device (1; 1') comprises a discharge unit (5) which determines a vacuum inside the container (3) which is substantially fluid-tight and, during the discharge step, sucks the water solution.
14. - A method as claimed in one of the claims from 11 to 13, wherein the dissolving step is carried out so as to obtain the water solution, in which the solid chemical substance is partially immersed; during the discharge step, the water solution, in which the solid chemical substance is at least partially immersed, is sucked.

15. - A method as claimed in claim 14, wherein, during the discharge step, the water solution has a level within the container (3) such as to cover the solid chemical substance (2); the water solution being drawn through said outlet arranged above the solid chemical substance (2).

16. - A method as claimed in one of the claims from 11 to 13, wherein the container (3) has a collecting portion (8) for conveying the chlorinated solution to the outlet (8a); and a loading chamber (10), which is arranged above the collecting portion (8), is suitable for holding the solid chemical substance (2) and is provided with support means (11) which are suitable for supporting the solid chemical substance (2); during the dissolving step, a jet of water is directed, in particular from above, against the solid chemical substance (2).

17. - A method as claimed in claim 16, wherein at least one second jet of water is kept substantially continuous inside the collecting portion (8).

18. - A method as claimed in one of the claims from 11 to 17, wherein the device (1, 1') is defined as the device (1, 1') for dissolving a solid chemical substance in water of one of the claims from 1 to 9.

19. - A plant comprising a device (1) for dissolving a solid chemical substance (2) and a hydraulic circuit (6) as defined according to one of the claims from 1 to 8.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

**INV. C02F1/68**

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) C02F

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, COMPENDEX, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>WO 2009/063160 A1 (GAFFEY TECHNICAL SERVICES LTD [GB]; GAFFEY PHI LI P [GB]) 22 May 2009 (2009-05-22) figures 1, 4 page 1, line 3 - line 6 page 3, line 26 - page 7, line 11 page 10, line 18 - line 29</td>
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**X** Further documents are listed in the continuation of Box C.

**X** See patent family annex.

**Notes:**
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
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**Date of the actual completion of the international search:** 21 January 2013

**Date of mailing of the international search report:** 01/02/2013

**Name and mailing address of the ISA/Authorized officer:**

European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel: (+31-70) 340-2040, Fax: (+31-70) 340-3016

Janssens, Christophe
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