"A tank for liquids equipped with an overflow hydraulic circuit"

DESCRIPTION

Technical Field

The present invention relates to a tank for liquids equipped with an overflow hydraulic circuit. In particular, the invention relates to tank for liquids of any kind, equipped with an overflow circuit. The tank according to the invention finds application, for example, though not exclusively, for the storage of water intended for irrigation or feeding, for the storage of food liquids in general, such as wine, oil, milk, and for the storage of hydrocarbons.

Background Art

The use of tanks containing liquids is known in multiple sectors and human activities. For example, in the field of water for human or animal use, it is known to make storage tanks in order to maintain a sufficient reserve of liquid to meet the demand of users.

Typically, in areas where natural water sources are available, tanks are built for storage and to allow the withdrawal, over a certain period of time, of an amount of water that may be even greater than the supply capacity, i.e., the flow rate, of the natural source.

This practice is particularly common in territories where there is no availability of a water network distributed throughout the territory, or in areas where the demand for water exceeds, for limited intervals of time, such as for irrigation reasons, the flow rate of the supply source. Mountain areas, agricultural areas and arid regions are typical examples of such territories.

Storage tanks for liquids can be of various types, for example, they may include parallelepiped reservoirs, or cylindrical cisterns arranged with a vertical or horizontal axis. In addition, storage tanks can be installed in the open, or under roofs, such as canopies, or even buried underground. Depending on the type of liquid to be stored, suitable materials will also be used to make the tank. For example, in the case of drinking water or food liquids, materials suitable for contact with food substances will be used. Typical materials for tank construction are concrete, possibly coated internally with a paint layer, fiberglass, plastics, and stainless steel.

According to prior art, the storage tank is configured to receive liquid, e.g., water, from above and in such a way as to dispense liquid as needed from below through an outlet opening associated with a pipe. Typically, when the liquid level within the tank exceeds a certain predetermined level, for example due to the fact that while the intake of new liquid is in progress, the withdrawal has been interrupted for some time, the excess liquid is evacuated through a so-called overflow pipe. Normally, the overflow pipe is placed at an opening provided in the tank wall, at a height corresponding to the liquid level that is not desired to be exceeded. The overflow

pipe is therefore used to evacuate outside the tank the liquid that exceeds this predetermined level thereby reaching the opening provided in the tank wall.

According to this design concept, it is evident that the liquid exiting the tank through the overflow pipe, barring any stirring that may occur in the reservoir, e.g., as a result of convective motions, or due to the fall of new liquid entering the reservoir from above, is basically that which is at the surface and generally corresponds to the liquid that last reached the reservoir, e.g. from a natural water source. Conversely, the liquid withdrawn from the tank for use is that which is near the bottom of the tank. In the former case, therefore, the liquid dispersed as a result of the overflow will be the newer and presumably cleaner liquid, whereas in the latter case the liquid intended to be used will be the older one that has settled at the bottom of the tank for longer. Add to this the consideration that the liquid that exits from the overflow pipe of a tank containing in particular a supply of water for feeding purposes is only rarely intended for some kind of use. Often, in fact, because of the difficulty in identifying an appropriate destination and for reasons of cost, the excess liquid contained in the tank and exiting from the overflow circuit is simply dispersed outside the tank and thus essentially remains unused.

The described design concept according to prior art evidently results in the inconvenience that the liquid dispersed through the overflow pipe is the liquid which was introduced into the tank last and which, most likely, presents unaltered all the characteristics of the liquid that are desired to be delivered to users.

Particularly for food applications, e.g. water for human or animal consumption, the described design concept results in the drawback that the liquid delivered to the users is not the one with the properties closest to those of the liquid entering the tank, but it is the one with the properties acquired after storage, sometimes over a prolonged time, of the liquid inside the tank.

The object of the invention is to provide a solution to this problem of how to prevent the recent liquid from becoming dispersed from the overflow circuit and how to improve the quality of the liquid intended for use.

Another object of the invention is to provide a solution to the above problem that can be applied to basically any type of situation of use of liquid storage.

Not the least object of the invention is to provide a solution to the above problem that is economical to implement and is suitable for large-scale industrial use.

The above and other objects are achieved with the overflow hydraulic circuit for tanks as claimed in the appended claims.

Summary of Invention

The overflow hydraulic circuit for tanks according to the invention mainly comprises a liquid inlet pipe, a liquid outlet pipe, a liquid ascending pipe and a liquid descending pipe.

Preferably, the liquid inlet pipe is located at the top of the tank and is arranged to allow liquids, for example, water coming from a natural source, to be introduced into the tank.

In addition, the liquid inlet pipe preferably ends in a chamber located above the tank and closed by a door hinged to the walls of the chamber itself.

Preferably, the liquid outlet pipe is located near the base of the tank and is arranged to allow exit of the liquids from the tank towards the ascending pipe.

The liquid inlet pipe and the liquid outlet pipe are both in communication with the tank. Furthermore, the liquid inlet pipe is communication, or can be put in communication, depending on the circumstances, with a liquid source. The liquid source may be capable of delivering liquids continuously, such as when it is a natural water source, or at intervals, such as when it is a water supply network equipped with a closing valve.

According to the invention, the liquid ascending pipe communicates with the liquid outlet pipe and the liquid descending pipe communicates with the liquid ascending pipe.

In addition, these two pipes preferably extend vertically and in parallel to the horizontal plane of the ground on which the tank is placed. In the case, for example, where the tank includes a cylindrical vessel with a vertical axis, these two vertical pipes will therefore be parallel to the axis of the cylinder of the vessel.

According to the invention, the cross-section of the tank is preferably circular or more preferably elliptical, although it can take substantially any geometric shape.

The ascending pipe and the descending pipe may be made integrated into the tank wall, or they may comprise a corresponding pipe separate from the tank and arranged inside or outside the tank itself. In a particular embodiment of the invention, the tank may be made by the plastic molding technique and incorporate into the wall thickness at least part of the overflow circuit pipes according to the invention.

According to a preferred embodiment of the invention, the ascending pipe and the descending pipe are in communication with each other and define, at a junction section, a circuit portion having the shape of an inverted-U.

In addition, still according to a preferred embodiment of the invention, the base of the U is located near the top of the tank.

According to the invention, the descending pipe communicates with an air suction pipe provided with an air suction opening arranged at a height equal to or higher than the height of

said inverted-U-shaped portion.

Advantageously, according to the invention, due to the principle of communicating vessels, the liquid that is in the tank and whose level exceeds the height at which the inverted U-shaped portion is located, is evacuated through the overflow circuit by flowing through, in order, the outlet pipe, the ascending pipe, the inverted-U-shaped portion and the descending pipe.

Still according to the invention, advantageously, the air suction pipe allows air suction in the overflow circuit and, in particular, in the descending pipe, thereby preventing triggering of an effect of suction of the liquid when the level inside the tank has dropped below the inverted U-shaped portion of the overflow circuit. Such a suction effect would in fact result in the release of additional liquid through the circuit, this resulting in further emptying of the tank below the desired level for which the overflow circuit is intended.

As anticipated above, said air suction pipe may be integrated into the tank wall or it may comprise a pipe outside or inside the tank itself.

The descending pipe preferably communicates with a liquid discharge network provided near the tank, for example, a public stormwater runoff network. Alternatively, the descending pipe can be left free to allow the liquid to flow directly into the ground or to be conveyed into a dedicated sump. In all such cases, the descending pipe will preferably be equipped, at its outlet, with a filter or mesh to prevent foreign bodies, such as small animals, from either clogging the descending pipe or traveling up the descending pipe and reaching the tank.

The descending pipe preferably comprises an end portion facing in a substantially radial direction with respect to the tank, that is, in a direction substantially perpendicular to the direction of the descending pipe.

In a first embodiment, the descending pipe ends near the bottom of the tank and the end portion therefore extends in a plane near the base plane of the tank.

In a second embodiment, the descending pipe ends below the air suction pipe, near said air suction pipe.

In a preferred embodiment of the invention, the tank further comprises a vent pipe located at the top of the tank, typically at the upper base of the tank, for example, at an inspection lid, with the function of an air intake for air exchange in the volume inside the tank between the liquid level and the upper base.

This vent pipe preferably has the shape of a mushroom and incorporates a filter element, for example, implemented like a metallic mesh, to prevent foreign bodies from entering the tank.

In a preferred embodiment of the invention, the tank further comprises a pipe arranged at the

base of the tank, typically at the bottom of the tank, to allow the tank to be completely evacuated. Preferably, the outlet opening of the evacuation pipe is located adjacent to the bottom surface of the tank, to allow the tank to be completely evacuated, for example, for cleaning and washing operations.

Preferably, the outlet opening of the evacuation pipe communicates with a liquid discharge network provided near the tank, for example, a public stormwater runoff network. Alternatively, the pipe can be left free to allow the liquid to flow directly into the ground, or to be conveyed into a dedicated sump. In all such cases, the evacuation pipe will preferably be equipped at the outlet with a filter or mesh to prevent foreign bodies, such as small animals, from traveling up the evacuation pipe and reaching the tank.

Advantageously, according to the invention, the inverted U-shaped portion is located at a height corresponding to the liquid level that is not desired to be exceeded. Preferably, in several applications, to adequately utilize most of the holding capacity of the tank, the inverted U-shaped portion is located near the top of the tank.

According to a particular embodiment of the invention, the descending pipe comprises a three-way fitting in which a first way is connected to a first portion of the descending pipe arranged upstream of the fitting, a second way is connected to a second portion of the descending pipe arranged downstream of the fitting, and a third way is connected to the air suction pipe.

In some applications, especially when the tank is buried underground, for example, such as to conceal it from view, or to avoid excessive temperature changes inside the tank due to the weather seasons, it is provided that the air suction pipe will end inside the tank itself, so that the air sucked in the air suction pipe will come from the air volume present in the tank, above the level of the liquid contained therein.

In other applications, for example, when the tank is arranged outdoors in an open environment, it is provided that the air suction pipe will end outside the tank, so that the air sucked in the air suction pipe will come from the surrounding environment.

In addition, preferably, the air suction type comprises a filter element that prevents foreign bodies from entering the air suction pipe.

In a particular embodiment of the invention, the ascending pipe and/or the descending pipe extend(s) vertically above the inverted U-shaped portion of the circuit, so as to define a corresponding portion, open on top, of the ascending pipe and/or descending pipe, respectively.

Preferably, this portion of the ascending pipe and/or descending pipe extends vertically in height for a length sufficient to allow the pipe to be cleaned through the opening provided therein.

The opening of the portion extending above the inverted-U-shaped portion further comprises a closure or removable lid, to allow accessing the opening through which said cleaning operations are to be carried out.

According to a preferred embodiment of the invention, the outlet pipe comprises a three-way fitting in which a first way is connected to the tank, a second way is connected to the ascending pipe and a third way is connected to an evacuation pipe provided with a closing valve.

In a particular embodiment of the invention, the tank comprises a withdrawal pipe arranged near the bottom of the tank, for withdrawing liquid from the tank and sending it, for example, to the utilities located downstream of the tank.

The withdrawal opening of the withdrawal pipe is preferably located at a height higher than the height of the outlet pipe and this arrangement ensures that the liquid, such as drinking water, withdrawn through the withdrawal pipe is free of the impurities that settle at the bottom of the tank and are evacuated through the overflow pipe.

In a particular embodiment of the invention, the tank is further provided with an overflow safety outlet comprising a pipe opening into the tank and ending outside, preferably with a filter, for example a filter made of metallic mesh. The purpose of this pipe is to ensure exit of the liquid from the tank when its level exceeds the level of the overflow circuit, for example because one of the pipes of said circuit is clogged.

The overflow circuit may optionally further comprise a current generator that intercepts the flow of liquid coming down through the descending pipe. The generator comprises a turbine which is driven in rotation by the flow of liquid flowing through the pipe and generates a certain amount of electric current which becomes available, for example, to power an electronic circuit for controlling the functions of the overflow circuit. For example, the overflow circuit may be provided with sensors and a control unit possibly equipped with a display and capable of being controlled also in a remote manner for monitoring the proper functioning of the circuit.

In other applications, the overflow circuit may be provided with a liquid disinfection unit, for example an ozonizer for liquids, arranged on the outlet pipe intended for the utilities of the liquid contained within the tank.

The invention advantageously lends itself to implementation in installations having a single tank, or it can be part of a series of two or more tanks arranged in cascade, all or some of them being provided with the overflow circuit according to the invention.

In a further embodiment of the invention, the overflow circuit is used to create forced liquid recirculation within a generic tank, when the liquid reaches a predetermined level.

Recirculation takes place thanks to a recirculation pump, preferably an electric pump, or other suitable means, which introduces the liquid coming from the descending pipe of the overflow circuit back into the tank, preferably by precipitation from above, above the level of the liquid contained in the tank.

The introduction of the liquid into the tank can take place, for example, through a corresponding return ascending pipe through which the flow downstream of the recirculation pump is sent back into the tank. Preferably, the return ascending pipe is equipped with a filter to retain any impurities in the liquid return path inside the tank. The filter is preferably located upstream of the pump in the direction of flowing of the liquid, to retain the impurities before they reach the pump where they would risk damaging the parts thereof in relative movement. In addition, according to this embodiment of the invention, the return ascending pipe located downstream of the recirculation pump is preferably equipped, at its end opening into the tank, with a swinging hand shower that makes it possible to distribute the cascade of liquid re-introduced into the tank above the liquid level, over a surface larger than the level created inside the tank itself. The swinging movement can take place dynamically through a swing or swivel arm. The swinging or swiveling movement of the arm preferably takes place in a plane parallel to the plane of the liquid surface created inside the tank and can be imparted by motor-driven means. Alternatively, the arm can be mounted idly and be configured to be swung or swiveled under the effect of the pressure of the liquid circulating inside it.

This mode of operation with recirculation of the overflow circuit has proved particularly advantageous when it is convenient, for example for economic reasons, not to disperse the liquid contained in the tank to the outside.

Advantageously, according to this embodiment, the recirculation function of the overflow circuit is triggered only when the level of the liquid in the tank exceeds the predetermined level for triggering the overflow function. That is, in other words, no recirculation takes place when the liquid is below the predetermined level, whereas recirculation remains active and constant as long as the liquid level remains above the trigger level of the overflow circuit operation. In this way, advantageously, recirculation is prevented from moving the liquid when the tank is only partially filled and the sediment concentration is higher. Conversely, when the tank is full or nearly full, the overflow circuit with recirculation provides constant circulation of the liquid, and also provides for oxygenation of the liquid, particularly when it is provided that the return liquid falls from above.

This mode of operation is also advantageous when the contained liquid should preferably be

recirculated continuously to avoid prolonged stagnation, such as in the case of food liquids such as drinking water. However, the use of the overflow circuit with recirculation should not be understood as limited to this use, as it can be applied to any type of tank and liquid.

Still referring to this embodiment, it is possible to provide a solenoid valve arranged downstream of the return ascending pipe and capable of interrupting the flow of liquid towards the tank and distributing said flow outside the tank, possibly in a “backup” tank. The same effect can alternatively be achieved by equipping the descending pipe, upstream of the recirculation pump, with an opening to the outside equipped with a closing valve.

The recirculation pump is also preferably operated by means of a float switch placed in the tank, or a capacitive sensor that detects the presence of liquid in the return ascending circuit.

Further improvements to the tank may include providing a video surveillance system to monitor the contents of the tank. In this case, the tank is equipped with at least one video camera connected to a monitoring system. There may be at least one video camera, or more preferably two video cameras, a first video camera being intended to monitor the top of the tank and located near the inner zone of the tank, where most frequently the liquid level stands, and a second video camera being intended to monitor the bottom of the tank and located near the inner zone of the tank, where most frequently impurities precipitate and settle. In addition, the video camera is preferably equipped with a light source to illuminate the area monitored by its lens. Preferably, the video camera is associated with a control unit that activates the operation of the video camera at predetermined intervals and/or at the request of an operator. The video surveillance system preferably comprises a monitoring system provided with a display, for example a PC display, on which an operator is able to see the state of the inside of the tank. The monitoring system can be connected to the at least one video camera by means of a wired connection or a wireless connection. The video cameras can be of the immersion type or be placed outside the tank and arranged in a chamber separated from the inside of the tank by a transparent partition, for example made of glass or plastics. In addition, preferably, the video cameras are housed in a compartment formed in the wall of the tank and communicating with the outside through an opening and provided with a transparent wall, for example, made of glass or plastics. In this way, each video camera can be housed and removed for replacement or maintenance thereof without the need to empty the tank or dive therein, thus allowing the tank to continue operating.

The video cameras may also be of the static type or equipped with a moving lens to allow monitoring of a wider landscape.

A further improvement to the tank includes a bypass circuit capable of allowing the liquid

flow that reaches the tank through the inlet pipe to be occasionally or permanently deviated towards the outlet pipe, thereby preventing the liquid from reaching the inside of the tank itself. Thus, advantageously, maintenance can be performed in the tank without having to interrupt the flow of liquid to any utilities.

A further improvement to the tank includes a bypass circuit capable of allowing the liquid flow that reaches the tank through the inlet pipe to be occasionally or permanently deviated towards the outlet pipe, thereby preventing the liquid from reaching the inside of the tank itself. Thus, advantageously, maintenance can be performed in the tank without having to interrupt the flow of liquid to any utilities.

A further improvement to the tank consists in a cascade system that can be obtained by providing, inside the tank, vertical partitions to divide the tank into internal volumes in which the liquid level is differentiated. Appropriate overflow circuits with forced recirculation make it possible to maintain the desired liquid level while allowing the establishment of a horizontal liquid flow due to the cascades generated between one volume where the level is at a higher height and the adjacent volume where the height is lower.

The tank according to the invention may have any shape, for example, a cylindrical or parallelepiped shape, and preferably comprises an inclined bottom and, preferably, a convex lid. The inclined bottom is of advantage especially to enable the accumulation and subsequent evacuation of impurities from a delimited area of the tank bottom.

In a particular embodiment of the invention, the bottom of the tank has a concave shape. In this case, preferably, the liquid outlet pipe is located at the vertical wall of the tank near the concave bottom thereof.

A further improvement to the tank consists in a system for controlling the temperature of the liquid contained in the tank. This system includes refrigeration and/or heating means and is advantageous because it provides the opportunity to maintain a constant temperature inside the tank and thus maintain a temperature appropriate to the type of liquid contained therein. For example, for drinking water, it has proven beneficial for water to be maintained at a temperature above 4°C and below about 15-20°C that prevents the growth of algae and bacteria.

A further improvement to the tank consists of a system for controlling the properties of the liquid contained in the tank. This system includes analysis means preferably arranged communicating with a liquid outlet pipe of the tank. The analysis means consist of sensors, probes and analyzers for measuring parameters of the liquid, such as drinking water, and are capable of generating signals indicative of these parameters. A special electronic control unit for

processing the measured parameters communicates with a possibly remotely arranged monitoring center communicating with the control unit by means of wired or wireless transmission.

The tank may also be equipped, at the liquid withdrawal pipe, with a liquid flow rate metering device to provide an indication of the consumption of liquid withdrawn from the tank.

Brief Description of Drawings

Some preferred embodiments of the invention will be described with reference to the annexed drawings, in which:

Fig.1 shows the tank of a first embodiment of the invention;

Fig.2 shows the tanks of a second embodiment of the invention;

Fig.3 shows the tanks of a third embodiment of the invention;

Fig.4 shows the tank of a fourth embodiment of the invention;

Fig.5 shows the tank of a fifth embodiment of the invention;

Fig.6 shows the tank of a sixth embodiment of the invention;

Fig.7 shows the tank of a seventh embodiment of the invention.

In all Figures, the same reference numerals have been used, possibly preceded by the digit corresponding to the figure, to distinguish equal or functionally equivalent components.

Description of Embodiments

Referring to Fig.1, this illustrates a tank equipped with an overflow hydraulic circuit for tanks and vessels according to the invention. The tank is indicated with reference numeral 13 and the circuit as a whole is indicated with the reference numeral 11 in all Figures.

In the illustrated embodiment, the overflow circuit 11 comprises a liquid inlet pipe 15, a liquid outlet pipe 17, a liquid ascending pipe 19 and a liquid descending pipe 21.

The liquid inlet pipe 15 is arranged on top, at the upper base 13a of the tank 13, and is provided to enable the introduction of liquid, for example water coming from a natural source, into the tank 13.

The liquid inlet pipe 15 ends into a chamber 15a located above the tank 13 and closed by a door 15b hinged to the walls of the space itself at hinges 15c.

In the illustrated embodiment, the chamber 15a is formed inside a square-plan sump overlying the upper base 13a of the tank. The sump is open at the bottom and closed on top by the door 15b.

The liquid outlet pipe 17 is located near the lower base 13b of the tank 13 and is provided to allow exit of the liquids from the tank towards the ascending pipe 19.

The liquid inlet pipe 15 and the liquid outlet pipe 17 both communicate with the tank 13. In addition, in this embodiment, the liquid inlet pipe 15 communicates with a natural source of liquids (not shown).

According to the invention, the liquid ascending pipe 19 communicates with the liquid outlet pipe 17, and the liquid descending pipe 21 communicates with the liquid ascending pipe 19.

These two pipes 19, 21 also extend vertically and perpendicularly to the plane of the liquid inside the tank 13. In the illustrated case, the tank 13 comprises a cylindrical container with vertical axis and these two vertical pipes 19, 21 are therefore parallel to the axis "S" of the cylinder of the container 13.

The ascending pipe 19 and the descending pipe 21, in the illustrated embodiment, are made separated from the tank 13 and are located outside the tank itself. In addition, in the illustrated embodiment, said pipes 19, 21, as well as the other pipes of the overflow circuit 11, are made of plastics and are mutually connected through appropriate fittings.

In this illustrated embodiment of the invention, the tank 13 is obtained by overlaying three rings of reinforced concrete 13c joined together by cement mortar. The two opposite bases 13a and 13b of the tank 13 are also made of reinforced concrete and also joined to the well defined by the three rings 13c joined together by cement mortar.

According to this illustrated preferred embodiment of the invention, the ascending pipe 19 and the descending pipe 21 communicate with each other and define, at a junction section 23, a circuit portion having the shape on an inverted U.

Furthermore, still as can be seen from the example illustrated, the base of the U is located near the top of the tank 13 corresponding to the upper base 13a.

The descending pipe 21 communicates with an air suction pipe 25 provided with an air suction opening 27 arranged at a height equal to or higher than the height of the inverted-U-shaped junction portion 23.

Due to the principle of communicating vessels, the liquid that is in the tank and whose level exceeds the height at which the inverted U-shaped portion is located, is evacuated through the overflow circuit 11 by flowing through, in order, the outlet pipe 17, the ascending pipe 19, the inverted-U-shaped junction portion 23 and the descending pipe 21.

The air suction pipe 25 allows air suction in the overflow circuit 11 and, in particular, in the descending pipe 21, thereby preventing triggering of an effect of suction of the liquid (known as "carboy effect") when the level inside the tank 13 has dropped below the inverted U-shaped portion of the overflow circuit 11. Such a suction effect would in fact result in the release of

additional liquid through the overflow circuit 11, this resulting in further emptying of the tank 13 below the desired level for which the overflow circuit is intended.

In the illustrated example, the air suction pipe 25 is located outside the tank 13 and communicates with the internal volume of the tank 13 through the inlet opening 27.

The descending pipe 21 comprises an end portion 29 facing in a substantially radial direction with respect to the tank 13, i.e., substantially perpendicular with respect to the direction of the descending pipe 21.

The descending pipe 21 ends near the bottom of the tank 13 and the end portion 29 and therefore extends in a plane near the plane of the lower base 13b of the tank.

In the illustrated embodiment, the descending pipe 21 is free, to allow the liquid to flow out directly into the ground. The descending pipe 21 will therefore be provided at its outlet with a mesh 31 to prevent foreign bodies, such as small animals, from either clogging the descending pipe 21 or traveling up the descending pipe itself and reaching the tank 13.

According to the illustrated embodiment, the tank 13 further comprises a vent pipe 33 located at the top of the tank at the upper base 13a of the tank, with the function of an air intake for air exchange in the volume inside the tank between the liquid level and the upper base 13a.

This vent pipe 33 is preferably elbow-shaped and incorporates a filter element 33a consisting of a filter or a metallic mesh, to prevent foreign bodies from entering the tank 13.

The inverted-U-shaped portion 23 of the circuit is located at a height corresponding to the liquid level that is not desired to be exceeded inside the tank 13. As shown in Fig.1, in the illustrated embodiment, to make adequate use of most of the holding capacity of the tank, the inverted-U-shaped portion 23 of the circuit is located near the top of the tank corresponding to the upper base 13a.

The descending portion 21 comprises a three-way fitting 35 in which a first way is connected to a first portion of the descending pipe 21 arranged upstream of the fitting 35, a second way is connected to a second portion of the descending pipe 21 arranged downstream of the fitting 35, and a third way is connected to the air suction pipe 25.

As anticipated, the illustrated embodiment provides for the tank 13 to be buried underground, to conceal it from view and to avoid excessive temperature changes inside the tank due to the weather seasons. Under these circumstances, it is provided that the air suction pipe 25 will end and open inside the tank 13 itself, so that the air sucked in the air suction pipe 25 will come from the air volume present in the tank 13, above the level of the liquid contained therein.

In addition, the air suction pipe 25 comprises a filter element 37 that prevents foreign bodies

that may be present in the tank 13 from entering the air suction pipe 25.

The outlet pipe 17 comprises a three-way fitting 39 in which a first way is connected to the tank 13, a second way is connected to the ascending pipe 19 and a third way is connected to an evacuation pipe 41 provided with a closing valve 43.

The evacuation pipe 41 is located at the base of the tank 13, at the bottom 13b of the tank, to allow complete emptying of the tank itself. In the illustrated embodiment, the inlet opening 17a of the outlet pipe 17 is located adjacent the surface of the bottom of the lower base 13b of the tank, to allow complete emptying of the tank, for example for cleaning and washing operations.

In the illustrated embodiment, the outlet opening of the evacuation pipe 41 is left free, to allow the liquid to flow directly into the ground or to be conveyed into a dedicated sump. In addition, at the outlet of the evacuation pipe 41 there is arranged a mesh 41a to prevent foreign bodies, such as small animals, from traveling up the pipe itself and reaching the tank.

In the illustrated embodiment, the tank 13 finally comprises a withdrawal pipe 46, equipped with a closing valve 48 and located near the bottom of the tank, to withdraw the liquid and send it to the utilities situated downstream the tank 13, for example through an appropriate distribution network.

The withdrawal pipe 46 may also be equipped with a liquid flow rate metering device to provide a signal indicative of the consumption of liquid withdrawn from the tank.

The withdrawal opening 46a of the withdrawal pipe 46 is located at a height higher than the height of the opening of the outlet pipe 17. This arrangement ensures that the liquid, such as drinking water, withdrawn through the withdrawal pipe 46 is free of the impurities that settle at the bottom of the tank 13 and are evacuated through the overflow circuit 11.

In the illustrated embodiment, the tank 13 is further provided with an overflow safety outlet comprising a pipe 55 opening into the pipe 13 and ending outside with a filter, for example a made of metallic mesh. The purpose of the pipe 55 is to ensure exit of the liquid from the tank when its level exceeds the level of the overflow circuit 11, for example because one of the pipes of said circuit is clogged.

Still referring to Fig.1, the overflow circuit 11 further comprises a current generator 57 that intercepts the flow of liquid coming down through the descending pipe 21. The generator 57 comprises a turbine which is driven in rotation by the flow of liquid flowing through the pipe 21 and generates a certain amount of electric current which becomes available, for example, to power an electronic circuit for controlling the functions of the overflow circuit 11. For example,

the overflow circuit 11 may be provided with sensors and a control unit possibly equipped with a display and capable of being controlled also in a remote manner for monitoring the proper functioning of the overflow circuit 11.

Referring to Fig. 2, this illustrates a second embodiment of the overflow circuit 11 according to the invention. This embodiment differs from the one previously described with reference to Fig.1 in that the ascending pipe 19 and the descending pipe 21 extend vertically above the inverted-U-shaped portion of the circuit, so as to define corresponding upwardly open portions 45, 47 of the ascending and descending pipes, respectively,

The portions 45, 47 of the ascending and descending pipes extend vertically in height for a sufficient length to allow the corresponding pipe to be cleaned through the opening provided therein. The opening of the portions 45, 47 extending above the inverted-U-shaped portion 23, further comprises a removable closure 45a, 47a, to allow access to the opening through which the aforementioned cleaning operation can be carried out.

Also, still referring to this embodiment, the air suction pipe 25 comprises, outside the tank 13, an inspection closure 37a allowing access for the cleaning of the filter element 37.

Referring to Fig.3, this illustrates a third embodiment of the overflow circuit 11 according to the invention. This embodiment differs from the one previously described with reference to Fig.2 in that the air suction pipe 25 is open to the outside and ends with a filter element 38.

The embodiment shown in Fig.3 is suitable for the above-ground installation of the tank 13, for example for open air installation thereof. In this embodiment, the ascending pipe 19 is made of a transparent material and has a series of notches 51 formed on a portion of the ascending pipe 19 and intended to highlight the level reached by the liquid inside the pipe itself.

Referring to Fig.4, this illustrates a fourth embodiment of the overflow circuit 11 according to the invention. This embodiment differs from the one previously described with reference to Fig.3 in that the descending pipe 21 ends slightly below the inverted-U-shaped portion 23. This embodiment is particularly suitable for installations involving partial burial of the tank 13 in the ground. In this case, the end portion 29 of the descending pipe 21 will be at ground level and can be left freely open or associated with a sump for collecting the excess liquid that exits the overflow circuit 11.

Referring to Fig.5, this illustrates a further embodiment of the invention in which the overflow circuit 511 is used to create forced liquid recirculation within a generic tank 513.

In the illustrated embodiment, the forced liquid recirculation takes place by means of an electric pump 561, which introduces the liquid coming from the descending pipe 521 of the

overflow circuit back into the tank 513, by precipitation from above, above the level LQ of the liquid contained in the tank. A filter 562 is provided upstream of the pump 561 to retain any impurities carried by the liquid in the overflow circuit 511, thereby preventing them from penetrating into the pump 561 and back into the tank 513.

In the illustrated embodiment, the introduction of the liquid takes place through a corresponding return ascending pipe 563 through which the flow of liquid downstream of the pump 561 is sent back into the tank 513. In addition, according to this embodiment of the invention, the return ascending pipe 563 located downstream of the pump 561 is equipped, at the end that opens in the tank, with a swinging hand shower 565 that makes it possible to distribute the cascade of liquid re-introduced into the tank 513 above the liquid level LQ, over a surface larger than the level created inside the tank itself. In the illustrated embodiment, the swinging movement takes place dynamically through a swing arm 567 hinged to the return ascending pipe 563 and driven in rotation by an electric motor or by the pressure of the water flowing through the pipe itself.

This mode of operation of the recirculation circuit 511 has proved particularly advantageous when it is convenient, for example for economic reasons, not to disperse the liquid contained in the tank and flowing through the overflow circuit 511 to the outside.

This mode of operation is also advantageous when the liquid contained in the tank 513 should preferably be recirculated continuously to avoid prolonged stagnation of liquid, such as in the case of food liquids such as drinking water.

Still referring to this embodiment, there is provided a solenoid valve 569 capable of interrupting the flow of liquid towards the tank 513 and distributing said flow to the outside through an appropriate outlet 571.

Still referring to Fig.5, this also illustrates a video surveillance system to monitor the contents of the tank 513, especially when the substance contained therein is a transparent liquid. The tank 513 is equipped with a pair of video cameras 573a, 573b connected to a monitoring system. The first video camera 573a is intended to monitor the top of the tank 513 and is located near the inner zone of the tank 513, where most frequently the liquid level LQ stands. The second video camera 573b is intended to monitor the bottom of the tank 513 and is therefore located near the inner zone of the tank, where most frequently impurities precipitate and settle. The video surveillance system preferably comprises a monitoring system 575 provided with a display 577, on which an operator is able to see the state of the inside of the tank 513. In the illustrated embodiment, the monitoring system 575 is connected to the video cameras 573a,573b by means

of a wireless connection. Stille referring to the illustrated embodiment, the video cameras 573a,573b are housed in corresponding compartments 579a,579b formed in the wall of the tank 513 and provided with a transparent partition 580, for example made of glass or plastics, to allow the video camera to see the inside of the tank. The video cameras 535a,535b are housed in the compartments 579a,579b, respectively, which compartments communicate with the outside through an opening that can be closed by means of a door 581. In this way, advantageously, each video camera 535a,535b is housed and removed for replacement or maintenance thereof without the need to empty the tank 513 or dive therein, thus allowing the tank to continue operating.

Still referring to the embodiment illustrated in Fig.5, a further improvement to the tank includes a bypass circuit 583 capable of allowing the liquid flow that reaches the tank 513 through the inlet pipe 515 to be occasionally or permanently deviated towards the withdrawal pipe 546, thereby preventing the liquid from reaching the inside of the tank itself. Thus, advantageously, maintenance can be performed in the tank without having to interrupt the flow of liquid to any utilities. Said bypass circuit comprises a valve 585 that intercepts the flow of liquid coming from the inlet pipe, thus preventing it from entering the tank and deviating it into the pipe 587 of the bypass circuit which communicates with the withdrawal pipe 546.

The tank 513 shown in Fig.5 further comprises a control system for controlling the temperature of the liquid contained in the tank. This control system comprises refrigeration and/or heating means 589 and is advantageous because it provides the opportunity to maintain a constant temperature inside the tank and thus maintain a temperature appropriate to the type of liquid contained therein. For example, for drinking water, it has proven beneficial for water to be maintained at a temperature above 4°C and below about 15-20°C. In the illustrated embodiment, the refrigeration and/or heating means 589 comprise a heat exchanger 591 arranged in a region of the tank 513 so as to be submerged by the liquid contained in the tank during normal use of the tank itself. Said heat exchanger 591 is in fluid communication with a unit outside the tank 513 and not shown, capable of circulating, in a circuit associated with the heat exchanger 591, a coolant or heating liquid as circumstances require.

Still referring to the embodiment of Fig.5, the tank 513 further comprises a control system for controlling the properties of the liquid contained in the tank. This system includes analysis means 593 arranged communicating with the liquid outlet pipe 517 of the tank 513. The analysis means 593 consist of sensors, probes and analyzers for measuring parameters of the liquid, such as drinking water, and are capable of generating signals indicative of these parameters. A special electronic control unit 595 for processing the measured parameters is in communication with a

remote monitoring center by wireless transmission. In the illustrated embodiment, the analysis means 593 are housed in the control unit 595 and the remote monitoring center is housed within the monitoring system 575.

According to this embodiment, the liquid entering the tank 513 is recirculated by means of the overflow circuit with forced recirculation 511 when the level of the liquid in the tank exceeds a predetermined level, i.e. essentially when the level of the liquid exceeds the height at which the inverted U-shaped portion defined in the overflow circuit 511 is located.

Referring to Fig.6, this schematically illustrates a further embodiment of the tank according to the invention. In this embodiment, the tank 613 is made with a rectangular plan and includes a cascade system obtained by providing, inside the tank, a plurality of vertical partitions or separating walls, three in the illustrated example, 662a,662b,662c, which divide the internal volume of the tank 613 into internal sub-volumes 664a,664b,664c,664d in which the liquid level is differentiated. Appropriate overflow circuits with forced recirculation 611a,611b,611c,611d, i.e. of the type described with reference to the embodiment of Fig.5 and schematically shown by a dashed line in Fig.6, make it possible to maintain the desired liquid level while allowing the establishment of a horizontal liquid flow between the inlet pipe 615 and the outlet pipe 617 due to the cascades generated between a volume where the level is at a higher height and the adjacent volume where the height is lower.

According to this embodiment, the liquid entering each sub-volume 664a,664b,664c,664d of the tank 613 is recirculated by means of the corresponding overflow circuit with forced recirculation 611a,611b,611c,611d when the liquid level in the corresponding compartment exceeds a predetermined level, i.e. essentially when the liquid level exceeds the height at which the inverted-U-shaped portion defined in the corresponding overflow circuit is located.

Referring now to Fig.7, this illustrates a further embodiment of the invention in which the tank 713 is made with a rectangular plan and has a substantially parallelepiped overall shape. In this embodiment, the tank 713 is equipped with at least one overflow circuit with forced recirculation, indicated with reference numeral 711, of the type illustrated with reference to Fig.5.

Said circuit 711 comprises an ascending pipe 719, a descending pipe 721 and a junction section 723, which together form an arrangement having the shape of an inverted U. An air suction pipe 725 equipped with a filter 737 is arranged opening inside the tank 713.

The descending pipe 721 communicates inferiorly with a return ascending circuit provided with a perimetral connecting pipe 788 establishing communication among a plurality of return ascending pipes 790.

The descending pipe 721 communicates, through a junction pipe 794, with a filter 784 capable of retaining the impurities contained in the liquid circulating in the overflow circuit. Through a second junction pipe 796, the filter 784 communicates with a pump 782, which transfers the liquid coming from the overflow circuit towards the perimetral pipe 788 to reintroduce said liquid into the tank 713 through the ascending pipes 790.

According to this embodiment the liquid entering the tank 713 through the opening 715 is recirculated by means of the overflow circuit with forced recirculation when the liquid level exceeds a predetermined level, i.e. essentially when the liquid level exceeds the height at which the inverted-U-shaped portion defined by the portion 725 of the overflow circuit is located.

Appropriate outlet ports 792 provided with grids are provided at the top of the tank for letting out the recirculated liquid coming from the ascending pipes 790 inside the tank 713.

In all the embodiments of the tank according to the invention, the tank may have any shape, for example, a cylindrical or parallelepiped shape, and preferably comprises an inclined bottom and, preferably, a convex lid. The inclined bottom is of advantage especially to enable the accumulation and subsequent evacuation of impurities from a delimited area of the tank bottom.

In a particular embodiment of the invention, the bottom of the tank has a concave shape. In this case, preferably, the liquid outlet pipe is located at the vertical wall of the tank near the concave bottom thereof.

Industrial Applications

The tank according to the invention, in its various embodiments described, can be employed in various sectors and for various types of liquids. For example, the tank according to the invention finds advantageous application in the construction of storage tanks for aqueducts and water reservoirs in general, both static and moving, such as those provided on boats. One particular field of application is in the water sector for water storage for creating reservoirs in both public and private settings. For example, the tank according to the invention is suitable for use in creating reserves of spring water intended for food or agriculture, even in remote locations, particularly where it is useful to maintain constant recirculation of the stored liquid.

The tank as described and illustrated is susceptible to many variations and modifications, falling under the same inventive principle.

= = = = =

CLAIMS

1. Tank (13; 513; 613; 713) for liquids, equipped with an overflow hydraulic circuit (11; 511; 611; 711) comprising:

- a liquid inlet pipe (15) located at the top of the tank (13);
- a liquid outlet pipe (17) located at the base of the tank (13);
- a liquid ascending pipe (19) communicating with the outlet pipe (17);
- a liquid descending pipe (21) communicating with the ascending pipe (19);
- wherein said ascending pipe (19) and said descending pipe (21) define an inverted-U-shaped circuit portion (23), and
- wherein the descending pipe (21) communicates with an air suction pipe (25) provided with an air suction opening (27) arranged at a height equal to or higher than the height of said inverted-U-shaped portion.

2. Tank according to claim 1, wherein the inverted-U-shaped circuit portion (23) is located near the top of the tank (13).

3. Tank according to claim 1 or 2, wherein the descending pipe (21) comprises a three-way fitting (35) in which a first way is connected to a first portion of the descending pipe located upstream of the fitting, a second way is connected to a second portion of the descending pipe located downstream of the fitting, and a third way is connected to the air suction pipe (25).

4. Tank according to claim 1 or 2 or 3, wherein the air suction pipe (25) ends inside the tank (13) so that the air sucked into the air suction pipe (25) comes from the air volume present in the tank (13) above the level of the liquid contained therein.

5. Tank according to claim 1 or 2 or 3, wherein the air suction pipe (25) ends outside the tank (13) so that the air sucked into the air suction pipe (25) comes from the environment outside the tank (13).

6. Tank according to any of the preceding claims, wherein the air suction pipe (25) comprises a filter element (37) preventing foreign bodies from entering the air suction pipe (25).

7. Tank according to any of the preceding claims, wherein the ascending pipe (19) extends vertically above the inverted-U-shaped circuit portion (25) so as to define a corresponding ascending pipe portion (45), and wherein said ascending pipe portion comprises an opening provided with a removable inspection closure (45a).

8. Tank according to any of the preceding claims, wherein the descending pipe (21) extends vertically above the inverted-U-shaped circuit portion so as to define a corresponding descending

pipe portion (47), and wherein said descending pipe portion comprises an opening provided with a removable inspection closure (47a).

9. Tank according to any of the preceding claims, wherein the outlet pipe (17) comprises a three-way fitting (39) in which a first way is connected to the tank (13), a second way is connected to the ascending pipe (19) and a third way is connected to an evacuation pipe (41) provided with a closing valve (43).

10. Tank according to any of the preceding claims, wherein the tank (13) comprises a vent pipe (33) located at the top of the tank at the upper base (13a) of the tank and having the function of an air vent for air exchange in the volume within the tank, between the level of the liquid and the upper base (13a).

11. Tank according to claim 1, wherein the overflow circuit (511;611;711) is used to create to create forced liquid recirculation within a generic tank (513;613;713) by means of a pump (561;782) that introduces the liquid coming from the descending pipe (521; 721) back into the tank (513;613;713), by precipitation from above, above the above the level ("LQ") of the liquid contained in the tank (513;613;713).

12. Tank according to claim 11, wherein the introduction of the liquid takes place by means of a corresponding return ascending pipe (563) through which the flow downstream of the pump (561) is sent back into the tank (513;613;713), and wherein the return ascending pipe (563) located downstream of the pump (561) is equipped, at the end that opens in the tank, with a swinging hand shower (565) that makes it possible to distribute the cascade of liquid re-introduced into the tank above the liquid level, over a surface larger than the level created inside the tank itself.

13. Tank according to claim 1, wherein the tank is provided with a video surveillance system to monitor the contents of the tank, said system comprising at least one video camera (573a,573b) connected to a monitoring system (575) provided with a display (577) on which an operator is able to see the state of the inside of the tank.

14. Tank according to claim 13, wherein the at least one video camera (573a,573b) is housed in a compartment (579a,579b) formed in the wall of the tank and communicating with the outside through an opening, and wherein the compartment is further equipped with a transparent wall (580), whereby the video camera can be housed and removed for replacement or maintenance thereof without the need to empty the tank or dive therein, thus allowing the tank to continue operating.

15. Tank according to claim 1, wherein the tank comprises a cascade system obtained by

providing, inside the tank, vertical partitions (662a,662b,662c) to divide the tank into internal volumes in which the liquid level is differentiated and wherein overflow circuits with forced recirculation (611a,611b,611c,611d) make it possible to maintain the desired liquid level while allowing the establishment of a horizontal liquid flow due to the cascades generated between one volume where the level is at a higher height and the adjacent volume where the height is lower.

16. Tank according to claim 1, wherein the tank (713) is made with a rectangular plan, has a substantially parallelepiped overall shape and is equipped with at least one overflow circuit with forced recirculation (711), and wherein the descending pipe (721) communicates inferiorly with a return ascending circuit provided with a perimetral connecting pipe (788) establishing a communication among a plurality of return ascending pipes (790).

= = = = =