

DEVICE FOR PRODUCING AND TREATING A GAS STREAM THROUGH A VOLUME OF LIQUID, AND FACILITY AND METHOD IMPLEMENTING SAID DEVICE

Technical field

5 The present invention relates to the production and treatment of a stream of air through a volume of liquid. It is applicable in varied fields, for example, and non-exhaustively, the recovery of calories in a gas stream, and in particular in a hot air stream or in industrial fumes, the production of a gas stream that is heated or cooled upon passing through said volume of liquid, producing a gas stream whose temperature
10 is controlled and/or whose absolute humidity is controlled, the humidification or dehumidification of a gas stream, the cleanup or filtering of a gas stream, the heating or air-conditioning of a site or industrial, service sector or household building, control of the hygrometry of a site or industrial, service sector or household building. The produced gas stream can also be used to cool, heat, humidify or dehumidify any type of object or
15 surface.

Prior art

 The use of a liquid, for example water, to treat, and in particular to heat or cool, a gas stream by heat exchange between the liquid and the gas stream, with placement of
20 the gas stream and the liquid in direct contact, is an old technique, which has the advantage of being eco-friendly, since it in particular avoids implementing heat transfer fluids of the coolant type. The heating or cooling of the gas stream, and in particular an air stream, can for example be intended to produce a gas stream having a controlled temperature and/or intended to produce a gas stream having a controlled absolute
25 humidity.

 A first known solution for carrying out this technique consists of passing the gas stream through a curtain of fine droplets of the liquid or through an exchange surface permeable to the gas and containing this liquid, for example a textile material imbibed
30 with water, or circulating the gas stream in contact with moistened plates. The main

drawback of this type of solution lies in the very low energy yield of the heat exchange between the liquid and the gas stream, and the low air flow rates able to be obtained.

A second known solution consists of passing the gas stream, and in particular the air stream, directly through a volume of liquid contained in an enclosure, by injecting the air stream in the liquid volume, below the surface of said liquid volume. This type of solution is for example described in international patent application WO 2006/138287, American patent US 4,697,735 (figure 3), and German patent application DE 101 53 452. This second technical solution has the advantage of making it possible to achieve an energy yield of the heat exchanges between the liquid and the gas stream higher than the first technical solution. Nevertheless, the solutions described in these publications do not make it possible to work with high gas flow rates, and do not make it possible to treat large volumes of gas quickly, and the energy yield of the heat exchanges between the liquid and the gas flow remains low. More particularly, the solutions described in these publications are for example not suitable for effectively and quickly cooling gas streams at high temperatures, for example industrial fumes, or for quickly and effectively recovering calories in a gas stream.

In American patent US 5,908,491, a device is also proposed making it possible to clean the air by passing it in a volume of water so as to filter the dust contained in the air. This device includes a closed enclosure, which contains said volume of water, and which is placed under vacuum so as to aspirate air from the outside and create, by aspiration, a stream of air passing through the volume of water contained in the enclosure. This solution does not make it possible to work with high air flow rates. Furthermore, it is not used, and is also not suitable, to effectively perform a calorie transfer between the stream of air and the volume of water with high air flow rates.

Object of the invention

One object of the invention is to propose a new technical solution that makes it possible to improve the production and treatment of the gas stream through a volume of liquid contained in an enclosure, and in particular that allows effective treatment of a gas stream with high flow rates.

Brief description of the invention

The invention thus first relates to a device for producing and treating a gas stream, said device including an enclosure, of which the lower part is submerged in a liquid supply open at the top and includes at least one liquid intake opening, which makes it possible to place the lower part of the enclosure in communication with the liquid supply, such that the submerged lower part of the enclosure contains a volume of this liquid, on the one hand, and which includes at least one opening for discharging a gas stream, positioned above the surface of the volume of liquid contained in the enclosure, on the other hand; the device further includes means for producing and injecting a gas stream including at least one injection conduit, of which a lower part is submerged in the volume of liquid contained in the submerged lower part of the enclosure, and extends in the upper part inside the enclosure outside said volume of liquid; said injection conduit includes, in its submerged lower part, at least one discharge opening positioned below the surface of said volume of liquid; said means for producing and injecting a gas stream include a compressor connected to the non-submerged part of the injection conduit or to the discharge opening of the enclosure, and make it possible, during operation, to create and introduce an incoming gas stream, coming from outside the enclosure, in the non-submerged part of the injection conduit, with a flow rate of at least 100 m³/h, and such that said incoming gas stream passes through the discharge opening of the submerged lower part of the injection conduit, and is introduced into said volume of liquid contained in the submerged lower part of the enclosure, below the surface of said volume of liquid, and such that an outgoing gas stream, treated by direct contact with said volume of liquid, rises inside the enclosure outside the injection conduit and is discharged outside said enclosure, passing through the discharge opening of the enclosure.

A second object of the invention relates to a device for producing and treating a gas stream, said device including an enclosure, of which the lower part is submerged in a liquid supply and includes at least one liquid intake opening, which makes it possible to place the lower part of the enclosure in communication with the liquid supply, such that the submerged lower part of the enclosure contains a volume of this liquid, on the one hand, and which includes at least one opening for discharging a gas stream,

positioned above the surface of the volume of liquid contained in the enclosure, on the other hand; the device further includes means for producing and injecting a gas stream including at least one injection conduit, of which a lower part is submerged in the volume of liquid contained in the submerged lower part of the enclosure, and extends in
5 the upper part inside the enclosure outside said volume of liquid; said injection conduit includes, in its submerged lower part, at least one discharge opening positioned below the surface of said volume of liquid; said means for producing and injecting a gas stream include a compressor connected to the non-submerged part of the injection conduit, and make it possible, during operation, to create and introduce an incoming
10 gas stream, coming from outside the enclosure, in the non-submerged part of the injection conduit, with a flow rate of at least 100 m³/h, and such that said incoming gas stream passes through the discharge opening of the submerged lower part of the injection conduit, and is introduced into said volume of liquid contained in the submerged lower part of the enclosure, below the surface of said volume of liquid, and
15 such that an outgoing gas stream, treated by direct contact with said volume of liquid, rises inside the enclosure outside the injection conduit and is discharged outside said enclosure, passing through the discharge opening of the enclosure.

A third object of the invention relates to a device for producing and treating a gas stream, said device including an enclosure, of which the lower part is submerged in a
20 liquid supply and includes at least one liquid intake opening, which makes it possible to place the lower part of the enclosure in communication with the liquid supply, such that the submerged lower part of the enclosure contains a volume of this liquid, on the one hand, and which includes at least one opening for discharging a gas stream, positioned above the surface of the volume of liquid contained in the enclosure, on the other hand;
25 the device further includes means for producing and injecting a gas stream including at least one injection conduit, of which a lower part is submerged in the volume of liquid contained in the submerged lower part of the enclosure, and extends in the upper part inside the enclosure outside said volume of liquid; said injection conduit includes, in its submerged lower part, at least one discharge opening positioned below the surface of
30 said volume of liquid; said means for producing and injecting a gas stream make it possible, during operation, to create and introduce an incoming gas stream, coming

from outside the enclosure, in the non-submerged part of the injection conduit, with a flow rate of at least 100 m³/h, and without modifying the outside pressure above the liquid of the supply outside the enclosure, and such that said incoming gas stream passes through the discharge opening of the submerged lower part of the injection conduit, and is introduced into said volume of liquid contained in the submerged lower part of the enclosure, below the surface of said volume of liquid, and such that an outgoing gas stream, treated by direct contact with said volume of liquid, rises inside the enclosure outside the injection conduit and is discharged outside said enclosure, passing through the discharge opening of the enclosure.

The invention also relates to a facility making it possible to recover calories in an incoming gas stream, said facility including one or the other of the aforementioned devices, wherein the temperature of the liquid is lower than the temperature of the incoming gas stream in the enclosure, and an energy recovery system making it possible to recover at least part of the calories captured in the liquid from the supply of said device.

The invention also relates to a facility including at least two upstream and downstream facilities for recovering calories in a gas stream previously described, which are mounted in a cascade, such that the gas stream leaving the device of the upstream facility is at least partially, and preferably completely, used as incoming gas stream of the device of the downstream facility.

Another object of the invention is a method for heating and/or cooling and/or humidifying and/or dehumidifying a site, using at least one aforementioned device, which is arranged such that the incoming gas stream that is introduced into the enclosure of the device is an air stream, and the air stream leaving the device is introduced inside the site.

Another object of the invention is a method for producing a gas stream, in particular an air stream, from an incoming gas stream, and in particular an incoming air stream, in which an aforementioned facility is used, and for heating, at least part of the calories captured in the liquid supply is used.

Another object of the invention is a method for recovering calories in the air of a site or dehumidifying a site with calorie recovery, using an aforementioned facility, in

which the incoming gas stream that is introduced into the enclosure of the device of the facility is an air stream coming at least partially from the inside of the site.

Another object of the invention is a method for creating a buffer zone inside the site in which the humidity and/or dust content is controlled, characterized in that an
5 aforementioned device is used that is arranged such that the incoming gas stream in the enclosure of the device is an air stream, at least partially from outside the site, and wherein the air stream leaving the enclosure of the device is introduced at least partially into the site.

Another object of the invention is a method for filtering and/or cleaning up the gas
10 stream, and in particular an air stream, using at least one aforementioned device, or aforementioned facility, such that an incoming gas stream containing particles and/or pollutants is introduced into the enclosure of the device and at least part of these particles and/or pollutants are captured in the liquid of the supply of the device.

More particularly, the incoming gas stream contains industrial fumes, and in
15 particular high-temperature industrial fumes.

According to a second aspect, the invention aims to propose a new technical solution allowing effective recovery of the calories in a gas stream by implementing high gas stream flow rates.

The invention thus also relates to a facility making it possible to recover calories
20 in an incoming gas stream and including a device for producing and treating said incoming gas stream (F) and an energy recovery system; said device includes an enclosure, which contains a volume of liquid whose temperature is below the temperature of the gas stream entering the enclosure, and which includes at least one opening for discharging a gas stream positioned above the surface of said volume of
25 liquid; said device further includes means for producing and injecting a gas stream that make it possible, during operation, to create and introduce the incoming gas stream, coming from outside the enclosure, into said volume of liquid contained in the enclosure, below the surface of said volume of liquid, such that an outgoing gas stream, treated by direct contact with said volume of liquid, rises inside the enclosure and is
30 discharged outside said enclosure, passing through the discharge opening of the enclosure; said energy recovery system makes it possible to recover at least part of the

calories captured in the liquid; the means for producing and injecting a gas stream include at least one injection conduit, a lower part of which is submerged in the volume of liquid contained in the enclosure, and extends at the upper part to the inside of the enclosure outside said volume of liquid; said injection conduit includes, in its submerged
 5 lower part, at least one discharge opening positioned below the surface of said volume of liquid; the means for producing and injecting a gas stream include a compressor and make it possible to create and introduce said incoming gas stream (F) in the non-submerged part of said injection tube with a flow rate of at least 100 m³/h.

The invention also relates to a facility making it possible to recover calories in an
 10 incoming gas stream and including a device for producing and treating said incoming gas stream and an energy recovery system; said device includes an enclosure, which contains a volume of liquid whose temperature is lower than the temperature of the gas stream entering the enclosure, and which includes at least one discharge opening for a gas stream positioned above the surface of said liquid volume; said device further
 15 includes means for producing and injecting a gas stream that make it possible, during operation, to create and introduce the incoming gas stream, coming from outside the enclosure, into said volume of liquid contained in the enclosure, below the surface of said volume of liquid, and such that an outgoing gas stream, treated by direct contact with said volume of liquid, rises inside the enclosure and is discharged outside said
 20 enclosure while passing through the discharge opening of the enclosure; said system making it possible to recover at least part of the calories captured in the liquid; the enclosure includes one or several baffles, which make it possible to circulate the gas stream leaving the volume of liquid up to the discharge opening, by causing it to undergo one or several changes of direction, so as to prevent liquid from being sprayed
 25 through the discharge opening.

According to this second aspect, the invention also relates to:

- a facility including at least two upstream and downstream facilities for recovering calories in a gas stream that were described above, and which are mounted in a cascade, such that the gas stream leaving the device of the
 30 upstream facility is at least partially, and preferably completely, used as incoming gas stream for the device of the downstream facility;

- a method for producing a gas stream, in particular an air stream, from an incoming gas stream, and in particular an incoming air stream, in which an aforementioned facility is used, and at least some of the calories captured in the liquid are used for heating;
- 5 - a method for recovering calories in the air of a site or dehumidifying a site with calorie recovery, using an aforementioned facility, and in which the incoming gas stream that is introduced into the enclosure of the device of the facility is an air stream, at least partially from inside the site;
- 10 - a method for creating a buffer zone inside a site in which the humidity and/or the dust content is controlled, characterized in that an aforementioned facility is used, the device of the facility being arranged such that the incoming gas stream in the enclosure of the device is an air stream, at least partially from outside the site, and the outgoing air stream of the enclosure of the device is at least partially introduced into the site;
- 15 - a method for filtering and/or cleaning up a gas stream, and in particular an air stream, using an aforementioned facility, and wherein an incoming gas stream containing particles and/or pollutants is introduced into the enclosure of the device of the facility and at least part of these particles and/or pollutants is captured in the liquid of the device.

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Brief description of the figures

The features and advantages of the invention will appear more clearly upon reading the following detailed description of several specific alternative embodiments of the invention, these particular alternative embodiments being described as non-limiting
25 and non-exhaustive examples of the invention, and in reference to the appended drawings, in which:

- Figure 1 schematically shows a first alternative embodiment of the device according to the invention making it possible to produce and treat a gas stream through a volume of liquid.

- Figure 2 schematically shows a second alternative embodiment of the device according to the invention making it possible to produce and treat a gas stream through a volume of liquid.
- Figure 3 schematically shows a third alternative embodiment of part of the device according to the invention making it possible to produce and treat a gas stream through a volume of liquid.
- Figure 4 schematically shows a fourth alternative embodiment of part of the device according to the invention making it possible to produce and treat a gas stream through a volume of liquid.
- Figure 5 schematically shows a first alternative of a facility implementing the device of figure 1, and making it possible to recover calories in a gas stream.
- Figure 6 shows a second alternative of a facility implementing the device of figure 1, making it possible to recover calories in a gas stream.
- Figure 7 schematically shows a third alternative of a facility implementing the device of figure 1, and making it possible to recover calories in a gas stream.
- Figure 8 schematically shows a fourth alternative of a facility implementing two devices of figure 1 in a cascade, and making it possible to recover calories in a gas stream.
- Figure 9 schematically shows a fifth alternative of a facility implementing the device of figure 1, and making it possible to recover calories in a gas stream.
- Figure 10 schematically shows an alternative of a facility implementing the device of figure 1, and making it possible to create a buffer zone whose humidity or dust content is controlled.

Detailed description of the invention

In reference to the specific alternative embodiment of figure 1, the device 1 for producing and treating a gas stream includes an enclosure 10, or a supply 11 of liquid L open in the upper part, and for example a water supply, and means 12 for producing and injecting an incoming gas stream F in a volume V of liquid contained in the enclosure 10.

The invention is not limited to the implementation of water as liquid L, but extends to any other type of liquid. As non-limiting and non-exhaustive examples, it may be interesting to use a liquid L whose solidification temperature at atmospheric pressure is lower than 0°C, for example water containing additives, such as salts, carbohydrates, glycol. It may also be interesting to use oil as the liquid L.

The enclosure 10 comprises an upper wall 10a and a side wall 10b defining an inner chamber 10c, and includes, at its lower end, a liquid intake opening 10d with a large section. In another alternative, this opening 10d with a large section could be replaced by several liquid intake openings with a smaller section.

The lower part 10e of the enclosure 10 is submerged in the volume of liquid L contained in the supply 11, without touching the bottom 11a of the liquid supply 11.

The liquid intake opening 10d makes it possible to place the lower part 10e of the enclosure 10 in communication with the liquid supply 11, such that the submerged lower part 10e of the enclosure contains part of this liquid L, in the form of a volume V of liquid.

The enclosure 10 also comprises at least one discharge opening 10g for a gas stream, which is positioned above the surface S of the volume V of liquid contained in the enclosure 10, and which, in the illustrated example, is arranged near the upper wall 10a of the enclosure 10.

The means 12 for producing and injecting a gas flow F include at least one injection conduit 120, a lower part of which 120a is submerged in the volume V of liquid contained in the submerged lower part 10e of the enclosure 10, and extends in the upper part inside the enclosure 10 outside said volume V of liquid.

In this particular example, this injection conduit 120 is formed by a vertical rectilinear tube, which crosses through the upper wall 10a of the enclosure 10, and which is open at both its upper and lower ends.

This injection conduit 120 thus includes, in its submerged lower part 120a, at least one discharge opening 120c positioned below the surface S of said volume V of liquid, and above the level of the liquid intake opening 10d of the submerged lower part 10e of the enclosure 10.

The submersion depth H1 of the injection conduit 120 and the liquid, i.e., the distance H1 between the opening 120c and the surface S of the volume V of liquid, is smaller than the submersion depth H2 of the enclosure in the liquid supply 11, i.e., the height H2 of the volume V of liquid in the enclosure 10.

5 The means 12 for producing and injecting a gas stream F further include aeraulic means 121, which, during operation, make it possible to create and introduce an incoming gas stream F, coming from outside the enclosure 10, in the non-submerged upper part 120b of the injection conduit. In the particular alternative of figure 1, these aeraulic means 121 more particularly include a gas compressor 121a, the outlet of
10 which is connected to the upper intake opening 120d of the injection conduit 120 by a channel 121b, and the intake of which is connected to an intake tubing 121c communicating with the outside of the enclosure 10. This compressor 121a makes it possible to create a gas stream F by aspiration, and to introduce this pressurized gas stream F into the injection conduit 120 through the upper intake opening 120d of the
15 injection conduit 120.

The compressor 121a may be known type of gas compressor making it possible to create a gas stream (centrifugal fan, axial fan, pump, etc.).

The invention advantageously makes it possible to work with a gas flow rate at the outlet of the compressor 121a that may be high, and in particular greater than 100
20 m³/h, more particularly greater than 1,000 m³/h, and still more particularly, in certain applications, greater than 10,000 m³/h.

When the compressor 121a is operating, the gas stream F created by the compressor 121a is introduced, under pressure, into the injection conduit 120 through the upper intake opening 120d of this conduit, passes through the discharge opening
25 120c of the submerged lower part of the injection conduit 120, and is introduced into said volume V of liquid contained in the submerged lower part 10e of the enclosure 10, below the surface S of said volume V of liquid, without modifying the outside pressure above the liquid L of the supply 11 outside the enclosure 10. Thus, in the particular case that is illustrated, when the compressor 121a is operating, the outside pressure above
30 the liquid L of the supply 11 outside the enclosure 10 is not modified and remains equal to the atmospheric pressure.

More particularly, the gas stream F is introduced into said volume of liquid V while being oriented downward.

The compressor 121a is selected so as to create a gas stream F with a pressure in the injection conduit 120, above the liquid, that is higher than the liquid column H1 in the submerged part 120a of the injection conduit 120, such that the gas can be discharged in the volume V of liquid outside the injection conduit 120.

The gas that is introduced into the volume of liquid V passes through the volume V of liquid while rising toward the surface S of said volume of liquid V, under the effect of the speed of the gas and the buoyancy, and emerges inside the enclosure 10 and outside the injection conduit 120 while forming an outgoing gas flow F', which has been treated by direct contact with said volume V of liquid. This outgoing gas flow F' rises inside the enclosure 10, outside the injection conduit 120, and is discharged outside said enclosure 10 while passing through the discharge opening 10g of the enclosure 10.

More particularly, the submersion depths H1 and H2 are sized, in particular relative to the pressure of the gas in the injection conduit 120 above the liquid, such that all of the gas, which is introduced in the volume V of liquid contained in the submerged lower part 10e of the enclosure 10, rises in the volume of liquid V and emerges in the enclosure 10 above the liquid and outside the injection conduit 120, without part of the gas passing through the lower intake opening 10d of the enclosure 10, in the volume of liquid situated outside the enclosure 10. When the temperature of the volume of liquid V in the enclosure 10 is different from the temperature of the gas stream F before it is introduced into the volume V of liquid, heat exchanges occur between the gas and the liquid through sensible heat and latent heat.

When the temperature T_{Liquid} of the volume of liquid is below the initial temperature T_{Initial} of the gas stream F before introduction in the volume of liquid, the gas stream F' is cooled. More particularly, the temperature of the outgoing gas stream F' is substantially the temperature T_{Liquid} of the volume of liquid. This concomitantly results in the air stream of gas F' leaving the device 1 being dehumidified relative to the incoming gas stream F, the absolute humidity (water weight per volume of air) in the outgoing gas stream F' being lower than the absolute humidity of the incoming gas stream F.

Conversely, when the temperature T_{Liquid} of the volume of liquid is higher than the initial temperature T_{Initial} , the outgoing gas stream F' is heated. This concomitantly results in the outgoing gas stream F' leaving the device 1 having been humidified relative to the incoming gas stream F , the absolute humidity (water weight per volume of air) in the outgoing gas stream F' being higher than the absolute humidity of the incoming gas stream F .

The submersion depth $H1$ of the injection conduit 120 must be large enough for the treatment of the gas stream by passing through the volume of liquid V , and more particularly for, if applicable, the heat transfer between the liquid and the gas injected into the volume of liquid V to be effective and sufficient, and if necessary to allow the gas stream F' cooled or heated by the liquid to be at a temperature close to, and preferably substantially identical to, that of the liquid. Conversely, this submersion depth $H1$ must not be too great so as to avoid oversizing the compressor 121a. The depth $H1$ is thus preferably comprised between 20 mm and 200 mm, and is preferably comprised between 30 mm and 50 mm. The invention is not, however, limited to these specific values.

Likewise, for better effectiveness, the height $H2$ of the liquid volume V must preferably not be too great, and will preferably be less than 500 mm, and more particularly comprised between 40 mm and 500 mm. The invention is not, however, limited to these particular values.

In another application, the device 1 according to the invention can be used to filter or clean up the incoming gas stream F by passing through a volume of liquid V . In this application, the temperature of the liquid volume can be higher or lower than the temperature of the incoming gas stream F , or be substantially equal to the temperature of the incoming gas stream F . When the temperature of the liquid volume is substantially equal to the temperature of the incoming gas stream F , at the outlet of the device 1, a filtered or cleaned up outgoing gas stream F' is produced that has not been heated or cooled, but is substantially at the same temperature as the incoming gas stream F .

Figure 2 shows another alternative embodiment of a device 1' according to the invention in which the injection conduit 120 is defined between a vertical wall P inside the enclosure 10 and by a part of the side wall 10c of the enclosure 10.

Figure 3 shows another alternative embodiment of a device 1" according to the invention, only the enclosure 10 and the compressor 121a being shown in this figure, the liquid supply 11 not being shown. In this alternative, the side wall 10c of the enclosure 10 is tubular, but could have any other geometry in the context of the invention.

In this alternative of figure 3, the enclosure 10 includes, in its upper part 10f that is not intended to be submerged in a liquid, several plates 14, 14', 14" serving as baffles. These plates 14, 14', 14" are fastened to the inside of the enclosure 10, one above the other, with a space between plates 14, so as to form several superimposed chambers E1, E2, E3 and E4. Each plate 14, 14', 14" is in sealed contact over the entire periphery with the side wall 10c of the enclosure 10. During operation, when the lower part of the enclosure is submerged in a liquid supply, the first chamber E1 is defined by the surface of the volume V of liquid to be contained inside the enclosure and the lower plate 14. The second chamber E2 is defined by the lower plate 14 and the intermediate plate 14'. The third chamber E3 is defined by the intermediate plate 14' and the upper plate 14". The fourth chamber E4 is defined by the upper plate 14" and the upper wall 10a of the enclosure 10.

The number of plates 14, 14', 14" and chambers E1, E2, E3 and E4 is not limiting with respect to the invention, the device 1 being able to include a single plate 14 defining two chambers or more than three plates defining more than four chambers.

Each plate 14, 14', 14" includes a through opening 140 having substantially the same section as the injection conduit 120. These through openings 140 are aligned vertically, and the injection conduit 120 is passed through these openings 140, the conduit 120 being in sealed contact over the entire outer periphery with each plate 14, 14', 14" at each passage opening 140 of the tube.

Each plate 14, 14', 14" also includes at least one through opening 141 making it possible to place two adjacent chambers in communication with one another, and thus

allowing the passage of a gas stream F' leaving the volume of liquid V from one chamber to the other from the lower chamber E1 to the discharge opening 101.

These openings 141 are vertically offset relative to one another and are not aligned with the air discharge opening 101 of the enclosure 10, so as to cause said air stream F' to undergo several changes of direction.

During operation, the lower part 10e of the enclosure 10 being submerged in a liquid supply 11, the air stream F' leaving the volume of liquid V rises inside the enclosure 10 while circulating through the baffles 14, 14', 14'', and undergoing several successive changes of direction, then is discharged outside the enclosure 10 through the discharge opening 10g.

Figure 4 shows another alternative that differs from that of figure 3 in that the air compressor 121a is connected to the air discharge opening 10g of the enclosure 10, and creates the gas stream F entering by aspiration through the intake opening 120d of the injection conduit 120, and no longer by blowing.

In the two alternatives of figures 3 and 4, when the turbulence occurs in the volume of liquid V, this turbulence potentially being significant and being able to cause drops of liquid to be sprayed, which are driven by the outgoing gas stream F', the baffles 14, 14', 14'' form an obstacle on the path of these drops and make it possible, owing to the successive changes in direction of the air imposed by the baffles, to prevent the liquid from being sprayed through the discharge opening 10g outside the enclosure at the same time as the outgoing air stream F'. Owing to the baffles 14, 14', 14'', no drop of liquid is spread outside the enclosure. As a result, advantageously, the flow rates of the air streams F and F' can be very high and/or the volume of the enclosure can be small, which reduces the bulk of the device, while avoiding spraying drops of liquid outside the enclosure of the device.

Figure 5 shows a facility for recovering calories in a gas stream F, which implements the device 1 of figure 1. Of course, it is also possible, in order to produce this facility, to use the devices of figures 2 to 4.

In this facility of figure 5, the supply 11 of liquid L is for example a water supply, and is optionally equipped with a water treatment unit 110 that for example makes it possible to keep the pH of the water at a controlled value, and for example a neutral pH,

and/or to filter the water L to remove the impurities or pollutants. The facility is further equipped with a system 2, of the heat pump type, that allows the recovery of part of the calories from the liquid L of the supply 11.

This system 2 for recovering calories more particularly includes a heat transfer fluid circulating in a closed circuit 20. Said closed circuit 20 comprises an evaporator 21 submerged in the liquid L of the supply 11, a condenser 22 positioned outside the supply 11 of liquid, a compressor 23 inserted between the outlet of the evaporator 21 and the inlet of the condenser 22, an expander 24 inserted between the outlet of the condenser 22 and the inlet of the evaporator 21.

During operation, a hot and/or wet gas stream F is created by the compressor 121a by aspiration through the intake tubing 120c. This gas stream F is created by aspiration, for example from the surrounding air inside or outside a building, or so as to capture the hot and/or wet fumes produced by a chimney or an apparatus, and in particular by an industrial chimney.

The temperature T_{liquid} of the liquid L, and for example the water, in the supply 11 is lower than the initial temperature of the gas stream F. When it passes in the volume of liquid V contained in the enclosure 10 of the device, the gas is cooled and dehumidified, the gas F' leaving the device 1 being at a lower temperature than the incoming gas stream F and the absolute humidity (water weight per volume of air) in the outgoing gas stream F' being lower than the absolute humidity of the incoming gas stream F. This outgoing gas stream F' is for example oriented back toward the outside of the building or toward a zone (inside or outside) where one needs cold and less humidity.

When the gas passes in the volume of liquid V, it cedes calories to the volume of liquid V, owing on the one hand to the sensible heat related to the temperature deviation of the gas F and the liquid 11, and on the other hand to the latent heat related to the steam that is contained in the gas F and that condenses in the liquid 11. The greater the temperature difference is between the liquid 11 and the incoming gas stream F, the more calories one recovers in the liquid 11. These calories are captured by and distributed in the supply 11 of liquid with the largest volume. The increase in the temperature of the liquid L in the supply 11 resulting therefrom makes it possible to heat

the heat transfer fluid, which circulates in vapor state in the evaporator 21. All or part of the calories contributed to the liquid L of the supply 11 by the incoming gas stream F are therefore recovered by heating the heat transfer fluid in the evaporator 21, which contributes to lowering the temperature of the liquid supply 11, and are transferred to the condenser 22 at which the heat transfer fluid condenses to the liquid state and returns the heat.

When the gas stream F contains pollutants soluble in the liquid in the supply 11 or particles (for example, gas stream F formed from polluting industrial fumes), the supply 11 of liquid L advantageously makes it possible to capture at least part of these pollutants or particles, and to produce a cleaner outgoing stream F'.

The facility of figure 5 can more particularly be used to treat high-temperature industrial fumes (for example, at 1,000°C) by cooling them to below 100°C, and cleaning them, and by recovering a significant portion of the calories from these industrial fumes via the supply 11 of liquid and the energy recovery system 2.

Figure 6 shows an energy recovery facility, which differs from figure 5 in that the energy recovery system 2' directly uses the liquid L from the supply 11 as heat transfer liquid, and makes it possible to supply, in a closed loop, an energy storage reservoir 25 (for example, an additional liquid supply) or a device 25 (for example, heat pump or the like) making it possible to recover the calories stored in the liquid 11 by heat exchange. The energy recovery system 2' thus includes a closed circuit in which part of the liquid L of the supply serving as heat transfer fluid circulates.

Figure 7 shows a facility for recovering energy, which differs from figure 5 by the implementation, in the energy recovery system 2", of an intermediate exchanger 26 in which a heat transfer fluid circulates in a closed loop. One part 26a of the intermediate exchanger 26 is submerged in the liquid 11, and another part 26b is situated outside the liquid L and allows a heat transfer with the heat transfer fluid in the evaporator 21 to the outside of the supply 11 of liquid L.

Non-limiting example applications of the invention of the facilities of figures 5 to 7

Example 1: Recycling toward the outside of tainted air inside a residence or a site with energy recovery

The air inside the residence or the site contains about 60% relative humidity and is at a temperature of about 20°C. The supply 11 contains water at a temperature of about 3°C. The energy recovered in the water per m³ of air is:

Sensible heat: about 20 KJ/m³

5 Latent heat: about 10 KJ/m³

Example 2: Energy recovery in air containing about 80% relative humidity and at a temperature of about 50°C.

The supply 11 contains water at a temperature of about 6°C. The energy recovered in the water per m³ of air is:

10 Sensible heat: about 54 KJ/m³

Latent heat: about 152 KJ/m³

Figure 8 shows a multi-staged facility that includes two facilities I1, I2 that are similar to the facility of figure 5 and that are mounted in a cascade, the gas stream F' leaving the upstream facility I1 being used as incoming gas stream F for the downstream facility I2.

This multi-staged facility of figure 8 is particularly suitable for cooling and recovering energy in several successive steps in high-temperature gas streams, for example industrial fumes.

Figure 9 shows an energy recovery facility, and if applicable, air dehumidification facility inside a site or residence 3, which operates in a closed circuit, the outgoing air stream F' that has been cooled, and if applicable dehumidified, being reinjected into said site 3. In this facility, the air that is reintroduced into the site is reheated beforehand by heat exchange with the condenser 22 of the energy recovery system 2. Another part of the energy transferred to the condenser 22 can be recovered elsewhere (arrow A).

25 Non-exhaustively and non-limitingly, the site 3 can for example be a covered pool. The site 3 can also be any type of site containing people or animals, the facility also allowing the recovery of energy from human or animal activities.

Figure 10 shows an energy recovery facility that makes it possible to create an inside buffer zone 4, in which the humidity or dust concentration in the air is controlled. In this facility, the outgoing air stream F' that has been dehumidified and/or filtered by passing in the volume V of water is heated by a heat treatment unit 5 before it is

introduced into the inner buffer zone 4. In this facility, the energy recovery system 2 is optional.

In the alternative embodiments illustrated in the appended figures, the discharge opening 120c of the injection circuit 120 is positioned above the level of the liquid intake opening 10d of the lower submerged part 10e of the enclosure. In another alternative, the discharge opening 120c of the injection conduit 120 can be positioned at or below the level of the liquid intake opening 10d of the submerged lower part 10e of the enclosure 10.

In the alternative embodiments illustrated in the appended figures, the level of liquid L in the enclosure 10 is the same inside the injection conduit 120 or outside the injection conduit 120. In another alternative, it is possible to implement a hydraulic pump to pump liquid in the supply 11 and to introduce this pumped liquid into the enclosure 10, outside the injection conduit 120, such that the submersion depth H1 of the injection conduit 120 (i.e., the height H1 of liquid in the injection conduit 120) is constantly lower than the height H2 of liquid in the enclosure 10 and outside the injection conduit 120. In this case, the discharge opening 120c of the injection conduit 120 can be positioned at the same level as or below the level of the liquid intake opening 10d of the submerged lower part 10e of the enclosure 10.

In the alternative embodiment illustrated in the appended figures, the supply 11 is formed by an open tub in the upper part. In another alternative, the tub or equivalent means forming the supply 11 can be closed.

CLAIMS

1. A device for producing and treating a gas stream (F), said device including an enclosure (10), of which the lower part (10e) is submerged in a liquid (L) supply (11) open at the top and includes at least one liquid intake opening (10d), which makes it possible to place the lower part of the enclosure in communication with the liquid supply, such that the submerged lower part (10e) of the enclosure contains a volume (V) of this liquid, on the one hand, and which includes at least one opening (10g) for discharging a gas stream, positioned above the surface (S) of the volume (V) of liquid contained in the enclosure, on the other hand, the device further including means for producing and injecting a gas stream (F) including at least one injection conduit (120), of which a lower part (120a) is submerged in the volume (V) of liquid contained in the submerged lower part of the enclosure, and extends in the upper part inside the enclosure (10) outside said volume (V) of liquid, said injection conduit (120) including, in its submerged lower part, at least one discharge opening (120c) positioned below the surface (S) of said volume (V) of liquid, said means for producing and injecting a gas stream (F) include a compressor (121a) connected to the non-submerged part (120b) of the injection conduit (120) or to the discharge opening (10g) of the enclosure (10), and make it possible, during operation, to create and introduce an incoming gas stream (F), coming from outside the enclosure (10), in the non-submerged part (120b) of the injection conduit (120), with a flow rate of at least 100 m³/h, and such that said incoming gas stream (F) passes through the discharge opening (120c) of the submerged lower part of the injection conduit (120), and is introduced into said volume (V) of liquid contained in the submerged lower part of the enclosure, below the surface (S) of said volume (V) of liquid, and such that an outgoing gas stream (F'), treated by direct contact with said volume (V) of liquid, rises inside the enclosure (10) outside the injection conduit (120) and is discharged outside said enclosure (10), passing through the discharge opening (10g) of the enclosure.
2. A device for producing and treating a gas stream (F), said device including an enclosure (10), of which the lower part (10e) is submerged in a liquid (L) supply (11)

and includes at least one liquid intake opening (10d), which makes it possible to place the lower part of the enclosure in communication with the liquid supply, such that the submerged lower part (10e) of the enclosure contains a volume (V) of this liquid, on the one hand, and which includes at least one opening (10g) for discharging a gas stream, positioned above the surface (S) of the volume (V) of liquid contained in the enclosure, on the other hand; the device further includes means for producing and injecting a gas stream (F) including at least one injection conduit (120), of which a lower part (120a) is submerged in the volume (V) of liquid contained in the submerged lower part of the enclosure and extends in the upper part inside the enclosure (10) outside said volume (V) of liquid, said injection conduit (120) including, in its submerged lower part, at least one discharge opening (120c) positioned below the surface (S) of said volume (V) of liquid, said means for producing and injecting a gas stream (F) including a compressor (121a) connected to the non-submerged part (120b) of the injection conduit (120), and which makes it possible, during operation, to create and introduce an incoming gas stream (F), coming from outside the enclosure (10), in the non-submerged part (120b) of the injection conduit (120), with a flow rate of at least 100 m³/h, and such that said incoming gas stream (F) passes through the discharge opening (120c) of the submerged lower part of the injection conduit (120), and is introduced into said volume (V) of liquid contained in the submerged lower part of the enclosure, below the surface (S) of said volume (V) of liquid, and such that an outgoing gas stream (F'), treated by direct contact with said volume (V) of liquid, rises inside the enclosure (10) outside the injection conduit (120) and is discharged outside said enclosure (10), passing through the discharge opening (10g) of the enclosure.

3. The device according to any one of the preceding claims, wherein said means for producing and injecting a gas stream (F) make it possible, during operation, to create and introduce said incoming gas stream (F), coming from outside the enclosure (10), in the non-submerged part (120b) of the injection conduit (120), without modifying the outside pressure above the liquid (L) of the supply (11) outside the enclosure (10).

4. A device for producing and treating a gas stream (F), said device including an enclosure (10), of which the lower part (10e) is submerged in a liquid supply (11) and includes at least one liquid intake opening (10d), which makes it possible to place the lower part of the enclosure in communication with the liquid supply, such
5 that the submerged lower part (10e) of the enclosure contains a volume (V) of this liquid, on the one hand, and which includes at least one opening (10g) for discharging a gas stream, positioned above the surface (S) of the volume (V) of liquid contained in the enclosure, on the other hand, the device further including means for producing and injecting a gas stream (F) including at least one injection
10 conduit (120), of which a lower part (120a) is submerged in the volume (V) of liquid contained in the submerged lower part of the enclosure, and extends in the upper part inside the enclosure (10) outside said volume (V) of liquid, said injection conduit (120) including, in its submerged lower part, at least one discharge opening (120c) positioned below the surface (S) of said volume (V) of liquid, said means for
15 producing and injecting a gas stream (F) make it possible, during operation, to create and introduce an incoming gas stream (F), coming from outside the enclosure (10), in the non-submerged part (120b) of the injection conduit (120), with a flow rate of at least 100 m³/h, and without modifying the outside pressure above the liquid (L) of the supply (11) outside the enclosure (10), and such that said incoming gas
20 stream (F) passes through the discharge opening (120c) of the submerged lower part of the injection conduit (120), and is introduced into said volume (V) of liquid contained in the submerged lower part of the enclosure, below the surface (S) of said volume (V) of liquid, and such that an outgoing gas stream (F'), treated by direct contact with said volume (V) of liquid, rises inside the enclosure (10) outside the
25 injection conduit (120) and is discharged outside said enclosure (10), passing through the discharge opening (10g) of the enclosure.
5. The device according to claim 4, wherein the means for producing and injecting a gas stream (F) include a compressor (121a) that is connected to the non-submerged part (120b) of the injection conduit (120).

6. The device according to claim 4, wherein the means for producing and injecting a gas stream (F) include a compressor (121a) that is connected to the discharge opening (10g) of the enclosure (10).
7. The device according to any one of the preceding claims, wherein the supply (11) of liquid is open at the upper part, and more particularly includes an open tub at the upper part.
8. The device according to any one of the preceding claims, wherein the supply (11) of liquid, outside the enclosure (10), is at atmospheric pressure, including during the operation of the means for producing and injecting the incoming gas stream (F).
9. The device according to any one of the preceding claims, wherein the discharge opening (120c) of the injection conduit (120) is positioned at the same level as the liquid intake opening (10d) of the submerged lower part (10e) of the enclosure (10) or above the level of the liquid intake opening (10d) of the submerged lower part (10e) of the enclosure (10).
10. The device according to any one of the preceding claims, wherein the injection conduit (120) makes it possible to introduce the gas stream (F) into said volume (V) of liquid by steering it downward.
11. The device according to any one of the preceding claims, wherein the enclosure (10) includes one or several baffles (14; 14'; 14''), which make it possible to circulate the gas stream (F') leaving the volume (V) of liquid up to the discharge opening (10g), by having it undergo one or several changes of direction, so as to prevent liquid from being sprayed through the discharge opening (10g).
12. The device according to claim 11, wherein each baffle (14, 14', 14'') is a plate that is fastened to the inside of the enclosure while being in sealed contact over its entire periphery with the enclosure (10), and which includes at least one through opening (141) for the passage of the outgoing gas stream (F') through the plate.
13. The device according to claim 12, including several baffles (14, 14', 14'') whereof the through openings (141) are not aligned with the air discharge opening (101) of the enclosure (10).
14. The device according to any one of claims 11 or 12, wherein each baffle (14, 14', 14'') includes a through opening (140) for the passage of the injection conduit (120),

and the injection conduit (120) is passed through said through opening (140) of each baffle (14, 14', 14''), while being in sealed contact over its entire outer periphery with the baffle at each through opening.

15. The device according to any one of the preceding claims, wherein the submersion
5 depth (H1) of the injection conduit is smaller than the height (H2) of the volume (V) of liquid in the enclosure (10) outside the injection conduit (120).
16. The device according to any one of the preceding claims, wherein the submersion depth (H1) of the injection conduit is comprised between 20 mm and 200 mm, preferably comprised between 30 mm and 50 mm.
- 10 17. The device according to any one of the preceding claims, wherein the height (H2) of the volume (V) of liquid in the enclosure (10) outside the injection conduit (120) is smaller than 500 mm, and preferably greater than 40 mm.
18. The device according to any one of the preceding claims, wherein the means for producing and injecting (121) a gas stream make it possible to create and introduce
15 said incoming gas stream (F) with a flow rate of at least 1,000 m³/h, and more particularly with a flow rate of at least 10,000 m³/h.
19. The device according to any one of the preceding claims, wherein the ratio between the flow rate of the incoming gas stream (F) in the enclosure (10) and the volume (V) of liquid contained in the enclosure (10) is greater than 10⁴h⁻¹.
- 20 20. The device according to any one of the preceding claims, wherein the temperature of the liquid (T_{liquid}) is lower than the temperature (T_{initial}) of the gas stream (F) entering the enclosure (10).
21. The device according to any one of claims 1 to 19, wherein the temperature (T_{liquid}) of the liquid (L) is higher than the temperature (T_{initial}) of the incoming gas stream (F)
25 entering the enclosure (10).
22. The device according to any one of the preceding claims, wherein the liquid (L) is water.
23. The device according to any one of claims 1 to 21, wherein the liquid (L) is a liquid whose solidification temperature at atmospheric pressure is lower than 0°C.
- 30 24. A facility making it possible to recover calories in an incoming gas stream (F), said facility including the device set out in claim 20 and an energy recovery system (2; 2';

2") making it possible to recover at least part of the calories captured in the liquid (L) from the supply (11) of said device.

25. The facility according to claim 24, wherein the energy recovery system (2; 2") includes a closed circuit (20) in which a heat transfer fluid circulates, and which
5 comprises an evaporator (21 or 26a) allowing a heat exchange with the liquid (L) in the supply (11).

26. The facility according to claim 25, wherein the evaporator (21 or 26a) is submerged in the liquid (L) of the supply (11).

27. The facility according to claim 24, wherein the energy recovery system (2') includes
10 a closed circuit in which part of the liquid (L) from the supply serving as a heat transfer fluid circulates.

28. A facility including at least two upstream (I1) and downstream (I2) facilities for recovering calories in a gas stream (F) that are according to any one of claims 24 to 27, and which are mounted in a cascade, such that the gas stream (F') leaving the
15 device of the upstream facility (I1) is at least partially, and preferably completely, used as incoming gas stream (F) of the device of the downstream facility (I2).

29. A method for heating and/or cooling and/or humidifying and/or dehumidifying a site, using at least one device as set out in any one of claims 1 to 23, and which is arranged such that the incoming gas stream (F) that is introduced into the enclosure
20 (10) of the device is an air stream, and the air stream (F') leaving the device is introduced inside the site.

30. The method according to claim 29, wherein the incoming air stream (F) that is introduced into the enclosure (10) comes at least partially from outside the site.

31. The method according to any one of claims 29 or 30, wherein the incoming air
25 stream (F) that is introduced in the enclosure (10) comes at least partially from inside the site.

32. A method for producing a gas stream (F'), and in particular an air stream, from an incoming gas stream (F), and in particular an incoming air stream, in which a facility according to any one of claims 24 to 28 is used, and for heating, at least part of the
30 calories captured in the liquid supply (11) is used.

33. A method for recovering calories in the air of a site or dehumidifying a site with calorie recovery, using a facility according to any one of claims 24 to 28, in which the incoming gas stream (F) that is introduced into the enclosure (10) of the device of the facility is an air stream coming at least partially from the inside of the site.
- 5 34. The method according to claim 33, wherein the air stream (F') leaving the device is at least partially introduced inside the site, after optionally having been heated.
35. The method according to claim 33, wherein the air stream (F') leaving the device is at least partially introduced inside the site, after having been heated using the energy recovery system (2'') of the facility.
- 10 36. A method for creating a buffer zone inside the site in which the humidity and/or dust content is controlled, characterized in that a device according to any one of claims 1 to 23 is used that is arranged such that the incoming gas stream (F') in the enclosure (10) of the device is an air stream coming at least partially from outside the site, and wherein the air stream (F') leaving the enclosure (10) of the device is introduced at
- 15 least partially into the site.
37. The method according to claim 36, wherein the air stream (F') leaving the enclosure (10) of the device is heated before being introduced into the site.
38. A method for filtering and/or cleaning up a gas stream, and in particular an air stream, using at least one device according to any one of claims 1 to 23, or a facility
- 20 according to any one of claims 24 to 28, such that an incoming gas stream (F) containing particles and/or pollutants is introduced into the enclosure (10) of the device and at least part of these particles and/or pollutants are captured in the liquid (L) of the supply (11) of the device.
39. The method according to claim 38, wherein the incoming gas flow (F) contains
- 25 industrial fumes, and in particular high-temperature industrial fumes.
40. A facility making it possible to recover calories in an incoming gas stream (F) and including a device for producing and treating said incoming gas stream (F) and an energy recovery system (2; 2'; 2''), said device including an enclosure (10), which contains a volume (V) of liquid whose temperature (T_{liquid}) is below the temperature (T_{initial}) of the gas stream (F) entering the enclosure (10), and which includes at least
- 30 one opening (10g) for discharging a gas stream positioned above the surface (S) of

said volume (V) of liquid, said device further including means (121) for producing and injecting a gas stream that make it possible, during operation, to create and introduce the incoming gas stream (F), coming from outside the enclosure (10), into said volume (V) of liquid contained in the enclosure, below the surface (S) of said volume (V) of liquid, such that an outgoing gas stream (F'), treated by direct contact with said volume (V) of liquid, rises inside the enclosure (10) and is discharged outside said enclosure (10), passing through the discharge opening (10g) of the enclosure, said energy recovery system (2; 2'; 2'') making it possible to recover at least part of the calories captured in the liquid (L), characterized in that the means (121) for producing and injecting a gas stream include at least one injection conduit (120), a lower part (120a) of which is submerged in the volume (V) of liquid contained in the enclosure, and extends at the upper part to the inside of the enclosure (10) outside said volume (V) of liquid, said injection conduit (120) including, in its submerged lower part, at least one discharge opening (120c) positioned below the surface (S) of said volume (V) of liquid, and in that the means (121) for producing and injecting a gas stream include a compressor (121a) and make it possible to create and introduce said incoming gas stream (F) in the non-submerged part of said injection tube with a flow rate of at least 100 m³/h.

41. The facility according to claim 40, wherein the lower part (10e) of the enclosure (10) is submerged in a supply (11) of liquid (L) and includes at least one liquid intake opening (10d), which makes it possible to place the lower part of the enclosure in communication with the liquid supply, such that the submerged lower part (10e) of the enclosure contains said volume (V) of liquid.

42. The facility according to claim 41, wherein the compressor (121a) is connected to the non-submerged part (120b) of the injection conduit (120) or to the discharge opening (10g) of the enclosure (10).

43. The facility according to any one of claims 41 or 42, wherein the supply (11) of liquid (L) is open in the top part.

44. The facility according to any one of claims 41 or 42, wherein the supply (11) of liquid (L) includes an open tub in the top part.

45. The facility according to any one of claims 41 to 44, wherein said means for producing and injecting a gas stream (F) make it possible, during operation, to create and introduce said incoming gas flow (F), coming from outside the enclosure (10), into the non-submerged part (120b) of the injection conduit (120), without
5 modifying the outside pressure above the liquid (L) of the supply (11) outside the enclosure (10).
46. The facility according to any one of claims 41 to 45, wherein the supply (11) of liquid, outside the enclosure (10), is at atmospheric pressure, including during the operation of the means for producing and injecting the incoming gas flow (F).
- 10 47. The facility according to any one of claims 41 to 46, wherein the discharge opening (120c) of the injection conduit (120) is positioned at the same level as the liquid intake opening (10d) of the submerged lower part (10e) of the enclosure (10) or above the level of the liquid intake opening (10d) of the submerged lower part (10e) of the enclosure (10).
- 15 48. The facility according to any one of claims 40 to 47, wherein the gas stream (F) is introduced into said volume (V) of liquid while being steered downward.
49. The facility according to any one of claims 40 to 48, wherein the energy recovery system (2; 2") includes a closed circuit (20) in which a heat transfer fluid circulates, and which comprises an evaporator (21 or 26a) allowing a heat exchange with the
20 liquid (L).
50. The facility according to claim 49, wherein the evaporator (21 or 26a) is submerged in the liquid (L).
51. The facility according to any one of claims 40 to 50, wherein the energy recovery system (2') includes a closed circuit in which part of the liquid (L) with a heat transfer
25 fluid function circulates.
52. The facility according to any one of claims 40 to 51, wherein the enclosure (10) includes one or several baffles (14; 14'; 14"), which make it possible to circulate the outgoing gas stream (F') leaving the volume (V) of liquid up to the discharge opening (10g), while having it undergo one or several changes of direction, so as to prevent
30 liquid from being sprayed through the discharge opening (10g).

53. The facility according to claim 52, wherein each baffle (14, 14', 14'') is a plate that is fastened to the inside of the enclosure while being in sealed contact over its entire periphery with the enclosure (10), and which includes at least one through opening (141) for the passage of the outgoing gas stream (F') through the plate.
- 5 54. The facility according to claim 53, including several baffles (14, 14', 14''), the through openings (141) of which are not aligned with the air discharge opening (101) of the enclosure (10).
55. The facility according to any one of claims 53 or 54, wherein each baffle (14, 14', 14'') includes a through opening (140) for the passage of the injection conduit (120),
 10 and the injection conduit (120) is passed through said through opening (140) of each baffle (14, 14', 14''), while being in sealed contact over its entire outside periphery with the baffle of each through opening.
56. The facility according to any one of claims 40 to 55, wherein the submersion depth (H1) of the injection conduit (120) is smaller than the height (H2) of the volume (V) of
 15 liquid in the enclosure (10) outside the injection conduit (120).
57. The facility according to any one of claims 40 to 56, wherein the injection depth (H1) of the incoming gas stream (F) entering the volume (V) of liquid is comprised between 20 mm and 200 mm, and preferably between 30 mm and 50 mm.
58. The facility according to any one of claims 40 to 57, wherein the height (H2) of the
 20 volume (V) of liquid in the enclosure (10), outside the injection conduit (120), is smaller than 500 mm, and preferably larger than 40 mm.
59. The facility according to any one of claims 40 to 58, wherein the means for producing and injecting (121) a gas stream make it possible to create and introduce said incoming gas stream (F) with a flow rate of at least 1,000 m³/h, and more
 25 particularly with a flow rate of at least 10,000 m³/h.
60. The facility according to any one of claims 40 to 59, wherein the ratio between the flow rate of the incoming gas stream (F) in the enclosure (10) and the volume (V) of liquid contained in the enclosure (10) is greater than 10⁴h⁻¹.
61. The facility according to any one of claims 40 to 60, wherein the liquid (L) is water.
- 30 62. The facility according to any one of claims 40 to 61, wherein the liquid (L) is a liquid whose solidification temperature at atmospheric pressure is lower than 0°C.

63. A facility including at least two upstream (I1) and downstream (I2) facilities for recovering calories in a gas stream (F) that are according to any one of claims 40 to 62, and which are mounted in a cascade, such that the gas stream (F') leaving the device of the upstream facility (I1) is at least partially, and preferably completely, used as incoming gas stream (F) for the device of the downstream facility (I2).
64. A method for producing a gas stream (F'), in particular an air stream, from an incoming gas stream (F), and in particular an incoming air stream, in which a facility according to any one of claims 40 to 63 is used, and at least some of the calories captured in the liquid (L) are used for heating.
65. A method for recovering calories in the air of a site or dehumidifying a site with calorie recovery, using a facility according to any one of claims 40 to 63, and in which the incoming gas stream (F) that is introduced into the enclosure (10) of the device of the facility is an air stream coming at least partially from inside the site.
66. The method according to claim 65, wherein the air stream (F') leaving the device is at least partially introduced inside the site, after optionally having been heated.
67. The method according to claim 65, wherein the air stream (F') leaving the device is at least partially introduced inside the site, after having been heated using the energy recovery system (2") of the facility.
68. A method for creating a buffer zone inside a site in which the humidity and/or the dust content is controlled, characterized in that a facility according to any one of claims 40 to 63 is used, the device of the facility being arranged such that the incoming gas stream (F') in the enclosure (10) of the device is an air stream, at least partially from outside the site, and the outgoing air stream (F') of the enclosure (10) of the device is at least partially introduced into the site.
69. The method according to claim 68, wherein the outgoing air stream (F') from the enclosure (10) of the device is heated before being introduced into the site.
70. A method for filtering and/or cleaning up a gas stream, and in particular an air stream, using a facility according to any one of claims 40 to 63, and wherein an incoming gas stream (F) containing particles and/or pollutants is introduced into the enclosure (10) of the device of the facility and at least part of these particles and/or pollutants is captured in the liquid (L) of the device.

71. The method according to claim 70, wherein the incoming gas stream (F) contains industrial fumes, and in particular high-temperature industrial fumes.

72. A facility making it possible to recover calories in an incoming gas stream (F) and including a device for producing and treating said incoming gas stream (F) and an energy recovery system (2; 2'; 2''), said device including an enclosure (10), which contains a volume (V) of liquid whose temperature (T_{liquid}) is lower than the temperature (T_{initial}) of the incoming gas stream (F) in the enclosure (10), and which includes at least one discharge opening (10g) for a gas stream positioned above the surface (S) of said liquid volume (V), said device further including means (121) for producing and injecting a gas stream that make it possible, during operation, to create and introduce the incoming gas stream (F), coming from outside the enclosure (10), into said volume (V) of liquid contained in the enclosure, below the surface (S) of said volume (V) of liquid, such that an outgoing gas stream (F'), treated by direct contact with said volume of liquid (V), rises inside the enclosure (10) and is discharged outside said enclosure (10) by passing through the discharge opening (10g) of the enclosure, and said system (2; 2'; 2'') making it possible to recover at least part of the calories captured in the liquid (L), characterized in that the enclosure (10) includes one or several baffles (14; 14'; 14''), which make it possible to circulate the gas flow (F') leaving the volume (V) of liquid up to the discharge opening (10g), while having to undergo one or several changes of direction, so as to prevent liquid from being sprayed through the discharge opening (10g).

73. The facility according to claim 72, wherein each baffle (14, 14', 14'') is a plate that is fastened to the inside of the enclosure while being in sealed contact over its entire periphery with the enclosure (10), and which includes at least one through opening (141) for the passage of the outgoing gas stream (F') through the plate.

74. The facility according to claim 73, including several baffles (14, 14', 14''), the through openings (141) of which are not aligned with the air discharge opening (101) of the enclosure (10).

75. The facility according to any one of claims 72 to 74, wherein the means (121) for producing and injecting a gas stream include at least one injection conduit (120), a

lower part (120a) of which is submerged in the volume (V) of liquid contained in the enclosure, and extends in the upper part inside the enclosure (10) outside said volume (V) of liquid, said injection conduit (120) including, in its submerged lower part, at least one discharge opening (120c) positioned below the surface (S) of said volume (V) of liquid.

76. The facility according to claim 75, wherein each baffle (14, 14', 14'') includes a through opening (140) for the passage of the injection conduit (120), and the injection conduit (120) is passed through said through opening (140) of each baffle (14, 14', 14''), while being in sealed contact over its entire outer periphery with the baffle at each through opening.

77. The facility according to any one of claims 72 to 76, wherein the lower part (10e) of the enclosure (10) is submerged in a supply (11) of liquid (L) and includes at least one liquid intake opening (10d), which makes it possible to place the lower part of the enclosure in communication with the liquid supply, such that the submerged lower part (10e) of the enclosure contains said volume (V) of liquid.

78. The facility according to claim 77, wherein the means (121) for producing and injecting a gas stream include a compressor (121a) that is connected to the non-submerged part (120b) of the injection conduit (120) or to the discharge opening (10g) of the enclosure (10).

79. The facility according to any one of claims 77 or 78, wherein the supply (11) of liquid (L) is open at the top part.

80. The facility according to any one of claims 77 or 78, wherein the supply (11) of liquid (L) includes an open tub at the upper part.

81. The facility according to any one of claims 77 to 80, wherein said means for producing and injecting a gas stream (F) make it possible, during operation, to create and introduce said incoming gas stream (F), coming from outside the enclosure (10), without modifying the outside pressure above the liquid (L) of the supply (11) outside the enclosure (10).

82. The facility according to any one of claims 77 to 81, wherein the liquid supply (11), outside the enclosure (10), is at atmospheric pressure, including during the operation of the means for producing and injecting the incoming gas stream (F).

83. The facility according to any one of claims 77 to 82, wherein the discharge opening (120c) of the injection conduit (120) is positioned at the same level as the liquid intake opening (10d) of the submerged lower part (10e) of the enclosure (10) or above the level of the liquid intake opening (10d) of the submerged lower part (10e) of the enclosure (10).
84. The facility according to any one of claims 72 to 83, wherein the gas stream (F) is introduced into said volume (V) of liquid while being steered downward.
85. The facility according to any one of claims 72 to 84, wherein the energy recovery system (2; 2'') includes a closed circuit (20) in which a heat transfer fluid circulates, and which comprises an evaporator (21 or 26a) allowing a heat exchange with the liquid (L).
86. The facility according to claim 85, wherein the evaporator (21 or 26a) is submerged in liquid (L).
87. The facility according to any one of claims 72 to 86, wherein the energy recovery system (2') includes a closed circuit in which part of the liquid (L) with a heat transfer fluid function circulates.
88. The facility according to claim 75, wherein the submersion depth (H1) of the injection conduit (120) is smaller than the height (H2) of the volume (V) of liquid in the enclosure (10) outside the injection conduit (120).
89. The facility according to any one of claims 72 to 88, wherein the injection depth (H1) of the incoming gas stream (F) entering the volume (V) of liquid is comprised between 20 mm and 200 mm, and preferably between 30 mm and 50 mm.
90. The facility according to any one of claims 72 to 89, wherein the height (H2) of the volume (V) of liquid in the enclosure (10), outside the injection conduit (120), is smaller than 500 mm, and preferably larger than 40 mm.
91. The facility according to any one of claims 72 to 90, wherein the means for producing and injecting (121) a gas stream make it possible to create and introduce said incoming gas stream (F) with a flow rate of at least 100 m³/h, more particularly with a flow rate of at least 1,000 m³/h, and still more particularly with a flow rate of at least 10,000 m³/h.

92. The facility according to any one of claims 72 to 91, wherein the ratio between the flow rate of the incoming gas stream (F) in the enclosure (10) and the volume (V) of liquid contained in the enclosure (10) is greater than 10^4h^{-1} .
93. The facility according to any one of claims 72 to 92, wherein the liquid (L) is water.
- 5 94. The facility according to any one of claims 72 to 93, wherein the liquid (L) is a liquid whose solidification temperature at atmospheric pressure is lower than 0°C .
95. A facility including at least two upstream (I1) and downstream (I2) facilities for recovering calories in a gas stream (F) that are according to any one of claims 72 to 94, and are mounted in a cascade, such that the outgoing gas stream (F') leaving
10 the device of the upstream facility (I1) is used at least in part, and preferably in whole, as incoming gas stream (F) of the device of the downstream facility (I2).
96. A method for producing a gas stream (F'), and in particular a stream of air, from an incoming gas stream (F), and in particular an incoming stream of air, in which a facility is used according to any one of claims 72 to 94, and at least part of the
15 calories captured in the liquid (L) is used for heating.
97. A method for recovering calories in the air of a site or dehumidifying a site with calorie recovery, using a facility according to any one of claims 72 to 94, wherein the incoming gas stream (F) that is introduced into the enclosure (10) of the device of the facility is a stream of air, at least partially from inside the site.
- 20 98. The method according to claim 97, wherein the outgoing stream of air (F') leaving the device is at least partially introduced inside the site, after optionally having been heated.
99. The method according to claim 97, wherein the outgoing stream of air (F') leaving the device is least partially introduced inside the site, after having been heated using
25 the energy recovery system (2") of the facility.
100. A method for creating a buffer zone inside a site in which the humidity and/or dust content is controlled, characterized in that a facility according to any one of claims 72 to 94 is used, the device of the facility being arranged such that the incoming gas stream (F') in the enclosure (10) of the device is an air stream, coming
30 at least partially from outside the site, and wherein the air stream (F') leaving the enclosure (10) of the device is introduced at least partially into the site.

101. The method according to claim 100, wherein the outgoing stream of air (F') leaving the enclosure (10) of the device is heated before being introduced in the site.

102. A method for filtering and/or cleaning up a gas stream, in particular a stream of air, using a facility according to any one of claims 72 to 94, and wherein an incoming
5 gas stream (F) containing particles and/or pollutants is introduced into the enclosure (10) of the device of the facility and at least part of these particles and/or pollutants is captured in the liquid (L) of the device.

103. The method according to claim 102, wherein the incoming gas stream (F) contains industrial fumes, and in particular high-temperature industrial fumes.