

DESCRIPTION**TITLE: Installation for storing and treating cryogenic fluid**

This invention relates to the field of cryogenic fluids, and more particularly to the storage and treatment of such cryogenic fluids.

- 5 The gaseous hydrocarbons at ambient temperature and atmospheric pressure, such as natural gas and petroleum gas, are liquefied at cryogenic temperatures, i.e. temperatures below -25°C , so as to facilitate their transport and/or their storage. The liquefied hydrocarbons, also known as cryogenic fluids in liquid form or cryogenic liquids, are then placed in tanks in a structure.
- 10 However, such tanks are never perfectly insulated, so evaporation of the cryogenic liquid is inevitable. The phenomenon of natural evaporation is called boil-off, and the gas resulting from this evaporation is called boil-off gas (BOG). The tanks of the structure thus contain both the cryogenic liquid in a lower portion of the tank, and the gas resulting from the evaporation of this cryogenic liquid in an upper portion of the tank.
- 15 Inside the tank, the temperature of the cryogenic liquid is not homogeneous, and a hot upper layer forms in contact with the gas resulting from the evaporation of the cryogenic liquid. Such a hot upper layer induces the formation of vapor within the tank on the one hand and increases the pressure within this tank on the other.

- 20 The present invention fits into this context by providing an effective and economical means of mixing the cryogenic liquid present within the tank, so as to reduce the pressure within the tank.

- 25 The main object of the present invention is thus an installation for storing and treating cryogenic fluid comprising at least one cryogenic fluid storage tank comprising a tank bottom and a tank headspace, a consumption and/or treatment system, a line for loading and/or unloading the cryogenic fluid in liquid form configured to connect at least the tank bottom to a storage terminal, a line for supplying the consumption and/or treatment system with a fuel prepared from a gas resulting from the evaporation of the cryogenic fluid contained in liquid form in the storage tank, the supply line connecting at least the tank headspace to the consumption and/or treatment system and comprising at least one
- 30 compressor arranged between the storage tank and the consumption and/or treatment system, the cryogenic fluid storage and treatment installation comprising a pipe connected at a first end to the supply line between the compressor and the consumption and/or

treatment system, the pipe being connected by a second end to the bottom of the tank, the pipe having a control member for controlling the circulation of gas within the pipe.

The storage and treatment installation described in this invention is integrated into a structure, for example. It is configured for the circulation of a cryogenic fluid in liquid form on the one hand, and for the circulation of a gas resulting from the evaporation of this cryogenic fluid in liquid form on the other hand, both the cryogenic fluid in liquid form and the gas being stored within one or more storage tanks of the storage and treatment installation. In particular, the cryogenic liquid is stored in the bottom of the tank, while the gas resulting from the evaporation of the cryogenic liquid is stored in the headspace of the tank. The terms "bottom of the tank" and "headspace of the tank" are used here to refer to areas of the storage tank, with the bottom of the tank corresponding to a lower portion of the tank and the tank headspace corresponding to the upper portion.

The tank may be a storage tank at atmospheric pressure or a storage tank with a maximum pressure of 6, preferably 9 bar.

In order to fill or empty the tank, the storage and treatment installation comprises a loading and/or unloading line through which the cryogenic fluid circulates in its liquid form. According to the embodiments, the loading and/or unloading line connects the storage tank to a storage terminal, for example a storage terminal located on a coastline, to a production unit or to a consumer network. By "loading or unloading" we mean that this line is used either for the loading cryogenic fluid from the storage terminal or the production unit towards the storage tank, or for unloading cryogenic fluid from the storage tank towards the storage terminal or the consumption network, or for both loading and unloading at different times. The storage terminal is at least configured for storing cryogenic fluid in liquid form.

A consumption and/or treatment system in the storage and treatment installation is configured to be supplied from the tank. According to the embodiments, the consumption and/or treatment system may take the form of an engine to produce electricity, a mechanical power or heat; a gas export network; or a re-liquefaction unit. This consumption and/or treatment system is supplied, for example, with a fuel in gaseous form, which in this case corresponds to the gas resulting from the evaporation of the cryogenic fluid in liquid form. To this end, the storage and treatment installation comprises a supply line connecting the storage tank to the consumption and/or treatment system. This supply line is configured to be traversed by the gas resulting from the evaporation of the cryogenic fluid in liquid form, i.e. by the cryogenic fluid in its gaseous form. In order to supply the consumption and/or treatment system with fuel at a suitable pressure, the supply line is equipped with a

compressor, which allows to adjust the pressure of the gas resulting from the evaporation of the cryogenic fluid in liquid form before it is delivered to the consumption and/or treatment system.

5 The fuel is chosen from chemical species such as hydrogen, natural gas, ethane, ethylene, petroleum gas, ammonia and mixtures thereof.

One end of the supply line opens into the tank headspace, while one end of the loading and/or unloading line opens into the tank bottom.

10 In order to prevent the formation of a hot upper layer within the cryogenic fluid in liquid form in a portion of this cryogenic fluid in liquid form, which is in contact or close to the gas, i.e. in contact or close to the tank headspace, the storage and treatment installation is configured to implement a bubbling phenomenon. This bubbling phenomenon consists of creating eddies within the tank in order to mix the cryogenic fluid in liquid form, and in particular the hot upper layer, with the rest of the cryogenic fluid in liquid form.

15 The bubbling phenomenon is obtained here by injecting the gas resulting from the evaporation of the cryogenic fluid after it has passed through the compressor. To do this, the storage and treatment installation comprises a pipe, a first end of which is arranged on the supply line between the compressor and the consumption and/or treatment system. This pipe therefore diverts at least some of the gas resulting from the evaporation of the cryogenic fluid in liquid form, which would otherwise be delivered to the consumption and/or treatment system. At its second end, the pipe is connected to the tank bottom to inject the gas into the cryogenic fluid in liquid form, for optimum mixing of this cryogenic fluid in liquid form. Depending on the embodiments, the pipe is connected directly or indirectly to the tank bottom.

25 The pipe also has a control member for controlling the circulation of the gas resulting from the evaporation of the cryogenic fluid in liquid form within the pipe. This control member is a control valve. The control member has a closed state wherein it prevents the gas from circulating and an open state wherein it allows the gas to circulate. In the open state of the control member, the gas resulting from the evaporation of the cryogenic fluid in liquid form is returned towards the tank bottom and therefore takes part in the bubbling phenomenon.

30 According to one example of embodiment, the presence of the pipe allows the consumption and/or treatment system to be supplied and the bubbling phenomenon to take place independently or simultaneously.

According to an optional characteristic of the invention, the second end of the pipe is connected to the loading and/or unloading line.

This is a first embodiment of the invention, wherein the pipe joins the loading and/or unloading line, which itself opens into the tank bottom. The pipe is therefore indirectly
5 connected to the tank bottom by means of the loading and/or unloading line.

In this first embodiment, the gas resulting from the evaporation of the cryogenic fluid in liquid form passes through the loading and/or unloading line through which the cryogenic fluid in liquid form otherwise circulates. This reduces costs and overall dimension requirements by reusing a line already present in the architecture of the storage and
10 treatment installation. The loading and/or unloading line may be used when cryogenic fluid in liquid form is not being loaded or unloaded into the tank, wherein case the loading and/or unloading line empties by gravity or by flushing the gas into the storage tank and may therefore be used to circulate the gas resulting from the evaporation of the cryogenic fluid in liquid form.

15 According to an optional characteristic of the invention, the second end of the pipe opens into the tank bottom.

According to an optional characteristic of the invention, the second end of the pipe opens into the bottom of the tank in the form of a bubbling ramp.

This corresponds to a second embodiment, wherein the pipe joins the tank bottom directly.
20 The gas resulting from the evaporation of the cryogenic fluid in liquid form then circulates through a dedicated pipe. This allows the bubbling phenomenon to take place even during loading and/or unloading of the cryogenic fluid in liquid form.

According to an optional characteristic of the invention, the pipe is configured so that the gas resulting from the evaporation of the cryogenic fluid passes through it.

25 According to an optional characteristic of the invention, the cryogenic fluid storage and treatment installation comprises a first measuring device for measuring the pressure within the tank and/or the temperature of the cryogenic fluid in liquid form within the tank.

The pressure and/or temperature measuring device may be used to measure either the pressure in the tank as a whole, for example by performing a measurement of the tank
30 headspace, or the temperature of the cryogenic fluid in liquid form in the tank bottom, or both pressure and temperature.

According to an optional characteristic of the invention, the cryogenic fluid storage and treatment installation comprises a second measuring device for measuring the pressure of the gas resulting from the evaporation of the cryogenic fluid at the outlet of the compressor.

5 The measuring device for measuring the pressure of the gas resulting from the evaporation of the cryogenic fluid in liquid form is a second measuring device. It is configured to acquire the pressure on the compressor outlet line.

According to an optional characteristic of the invention, the cryogenic fluid storage and treatment installation comprises a control system configured to open or close the control member as a function of a value acquired by the first and/or second measuring device.

10 The control system is a centralized device. It is configured to open or close the control member either as a function of a value acquired by the first pressure and/or temperature measuring device, or as a function of a value acquired by the second device measuring the pressure of the gas resulting from the evaporation of the cryogenic fluid, or preferably as a function of both these values.

15 In a cryogenic fluid storage and treatment installation, it is possible that during loading or unloading operations of the cryogenic fluid in liquid form between the storage tank and the storage terminal, the loading and/or unloading line is not at a suitable temperature and that, as a result, the cryogenic fluid in liquid form vaporizes during its loading and/or its unloading. This type of temperature adaptation problem is particularly important in
20 cryogenic fluid storage and treatment installations, which are equipped with lines of considerable length, for example of the order of 300 meters. The cryogenic fluid storage and treatment installation described in this invention solves this problem by providing temperature conditioning or cooling of the loading and/or unloading line.

25 According to an optional characteristic of the invention, the cryogenic fluid storage and treatment installation comprises at least one valve.

This valve is configured to authorize or prevent the circulation of cryogenic fluid in liquid form within the loading and/or unloading line. In some embodiments, the valve is positioned on the loading and/or unloading line. In other embodiments, the valve is positioned on the storage terminal.

30 In particular, the valve allows to control the delivery of cryogenic fluid in liquid form from the storage terminal towards the storage tank via the loading and/or unloading line, or vice versa, in order to cool the loading and/or unloading line and thus adapt its temperature to the loading and unloading operations.

According to an optional characteristic of the invention, the control device is a first control member, the storage and treatment installation comprising at least one second control member.

5 The control members, or control valves, are carried by the pipe. They are capable of allowing or preventing the passage of gas resulting from the evaporation of cryogenic fluid in liquid form within the pipe or preventing the circulation of cryogenic fluid in liquid form from the loading and/or unloading line within the pipe. The presence of two control members on the pipe allows better control of the circulation within the pipe by modulating the closure of each of these two control members independently of each other, and also limits the risk of
10 cryogenic fluid in liquid form leaking towards the supply line.

The first control member and/or the second control member are dependent on a means of determining the temperature of the cryogenic fluid circulating within the loading and/or unloading line.

15 According to an optional characteristic of the invention, the storage and treatment installation comprises a control unit configured to open or close the control member, preferably a first control member and a second control member.

The control unit is capable of driving both the first control member and the second control member. The control unit may switch the control members from an open state to a closed state. The control unit ensures that cryogenic fluid in liquid form is evacuated within the
20 loading and/or unloading line when it is desired to circulate gas resulting from the evaporation of cryogenic fluid in liquid form.

According to an optional characteristic of the invention, the storage and treatment installation comprises at least one means for determining the temperature of the cryogenic fluid circulating on the loading and/or unloading line.

25 This means of determining the temperature is positioned on the loading and/or unloading line. The temperature determination means is positioned in the vicinity of the pipe, for example. According to one example, the temperature determination means is installed at the level of the second end of the pipe, in other words at the intersection of the pipe and the loading and/or unloading line.

30 In yet another example, the temperature determination means is installed between the second end of the pipe and the storage terminal. According to yet another example, the temperature determination means is installed between the second end of the pipe and a first intersection of a main line making up the loading and/or unloading line. Alternatively, the

temperature determination means is installed on the pipe between the second end of the pipe and the second control member.

According to an optional characteristic of the invention, the control unit is configured to drive the control member, preferably the first control member and the second control member as a function of a temperature measured by the temperature determination means.
5 In particular, this temperature is measured within the loading and/or unloading line.

According to an optional characteristic of the invention, the control unit is configured to drive the control member, preferably the first control member and the second control member as a function of a state of the valve.

10 Depending on the embodiments, this valve is carried by the loading and/or unloading line or by the storage terminal.

According to an optional characteristic of the invention, the pipe slopes between the supply line and the loading and/or unloading line.

Such a slope facilitates the gravity flow of cryogenic fluid in liquid form within the pipe. The
15 slope here is a downward slope.

According to an optional characteristic of the invention, the storage and treatment installation comprises a bypass channel configured so that the gas resulting from the evaporation of the cryogenic fluid in liquid form bypasses the compressor.

The bypass channel is thus created to bypass the compressor. This allows the gas resulting
20 from the evaporation of the cryogenic fluid in liquid form to be circulated in a loop within the storage and treatment installation until it reaches a temperature suitable for use in the loading and/or unloading line.

The invention also relates to a structure configured for transporting and/or storing cryogenic fluid, comprising a cryogenic fluid storage and treatment installation as
25 mentioned above.

The structure may be a floating structure or a land-based structure. By way of example, the structure may be, depending on the embodiments a vessel for storing and transporting liquefied natural gas, for example an LNG carrier, a vessel using liquefied natural gas as a fuel (or LFS for *liquefied natural gas fueled vessel*), a floating gas production, storage and
30 unloading unit (or FLNG for *floating liquid natural gas*), a floating storage regasification unit (FRSU), a gravity-based structure (GBS), an onshore tank or a port storage structure. The liquefied natural gas, for example, is stored on the structure for use as structure fuel.

The invention also relates to a method for using a cryogenic fluid storage and treatment installation according to any one of the preceding claims, during which the control member of the pipe is opened in order to send gas resulting from the evaporation of the cryogenic fluid to the tank bottom and is closed in order to prevent gas resulting from the evaporation of the cryogenic fluid from being returned to the tank bottom.

The method for using the storage and treatment installation involves implementing bubbling when this is necessary to mix the cryogenic fluid in liquid form within the tank, switching the control member into its open state when such bubbling is useful and, on the contrary, moving the control member into its closed state when bubbling is not necessary.

According to an optional characteristic of the invention, the opening and the closing of the control member is governed by the control system.

In other words, the switching of the control member from its closed state to its open state and vice versa is controlled by the control system.

According to an optional characteristic of the invention, the use method comprises a first step during which the control system calculates a theoretical pressure within the tank from a temperature measured by the first pressure and/or temperature measuring device, a second step during which the control system calculates a difference between the theoretical pressure and an actual pressure measured within the tank by the first pressure and/or temperature measuring device, and a third step during which the control system compares the difference with a threshold value.

The first step, the second step and the third step correspond to the verification of a first parameter required to drive the control member. This first parameter depends at least on the pressure within the storage tank. This pressure may be measured directly or calculated from the temperature of the cryogenic fluid in liquid form in the storage tank.

According to an optional characteristic of the invention, the use method comprises a first step during which the control system calculates a theoretical temperature of the cryogenic fluid in liquid form within the tank from a pressure measured by the first pressure and/or temperature measuring device, a second step during which the control system calculates a difference between the theoretical temperature and an actual temperature measured within the tank by the first pressure and/or temperature measuring device, and a third step during which the control system compares the difference with a threshold value.

This is an alternative, wherein the first parameter depends on the temperature of the cryogenic fluid in liquid form within the tank.

According to an optional characteristic of the invention, the use method comprises a comparison phase during which the control system compares a pressure of the gas resulting from the evaporation of the cryogenic fluid measured by the second pressure measuring device at the outlet of the compressor with a range of operating pressure values of the consumption and/or treatment system.

This comparison phase corresponds to the verification of a second parameter required to drive the control member. The range of operating pressure values for the consumption and/or treatment system depends on the nature of this consumption and/or treatment system. For example, it is between 0.5 and 2.5 bar for a burner, between 4 and 8, preferably 16 bar for a motor supplying electricity, or between 14 and 18 bar for a motor used for XDF-type propulsion.

According to an optional characteristic of the invention, the control system commands the opening of the control member when the pressure measured is within the range of operating pressure values of the consumption and/or treatment system.

In other words, if the pressure measured at the compressor outlet is within the range of values corresponding to the nature of the consumption and/or treatment system, the control system commands the control member to switch from its closed state to its open state, or to remain in its open state. The gas resulting from the evaporation of the cryogenic fluid in liquid form then circulates through the pipe to the storage tank, where it undergoes the bubbling operation. In its open state, the control member is either partially open or fully open as required. Outside the above range of values, the control member is in its closed state and bubbling does not occur. The gas resulting from the evaporation of the cryogenic fluid in liquid form is thus returned towards the storage tank only if the consumption and/or treatment system does not need it as fuel.

According to an optional characteristic of the invention, the control system commands the opening of the control member if the difference compared during the third step between the theoretical pressure and the actual pressure measured within the tank by the first pressure and/or temperature measuring device is greater than the threshold value.

The gas resulting from the evaporation of the cryogenic fluid in liquid form is only returned towards the storage tank if the pressure within the storage tank is too high, and therefore requires bubbling to mix the cryogenic fluid in liquid form in order to reduce the pressure. For example, the control system commands the control member to open if there is a difference of at least 20 mbar between the theoretical pressure and the actual pressure measured.

According to an optional characteristic of the invention, the control system commands the opening of the control member if the difference compared during the third step between the theoretical pressure and the actual pressure measured within the tank by the first pressure and/or temperature measuring device is greater than the threshold value.

- 5 For example, the control system commands the control member to open if there is a difference of at least 0.2°C between the theoretical temperature and the actual temperature measured.

According to an optional characteristic of the invention, the use method comprises a step during which different measurements of the pressure and/or temperature in the storage
10 tank are performed by the first pressure and/or temperature measuring device, and a step during which the control system compares a rate of change of the pressure and/or temperature with a reference value.

In other words, the control system commands the opening of the control member and therefore the implementation of bubbling when, on the basis of measurements of the
15 pressure and a derivative of these pressure values, or on the basis of measurements of the temperature and a derivative of these temperature values, the control system detects a rapid rise in pressure and/or temperature within the storage tank.

According to an optional characteristic of the invention, the control system commands the closure of the control member if the difference compared during the third step between the
20 theoretical pressure and the actual pressure measured within the tank by the first pressure and/or temperature measuring device is less than the threshold value.

According to an optional characteristic of the invention, the control system commands the closure of the control member if the difference compared during the third step between the
25 theoretical temperature and the actual temperature measured within the tank by the first pressure and/or temperature measuring device is less than the threshold value.

The control system operates according to a simultaneous check; as soon as the pressure and/or temperature within the storage tank reach values that do not require the bubbling
method to be implemented, the control system commands the closing of the control member, even if the check of the second parameter, namely the pressure at the compressor
30 outlet, was compatible with the opening of the control member.

According to an optional characteristic of the invention, the use method comprises a step of driving the control member by the control unit, preferably the first control member and the second control member.

According to an optional characteristic of the invention, during the driving step, the control unit verifies a temperature of the gas resulting from the evaporation of the cryogenic fluid in liquid form which circulates within the loading and/or unloading line.

5 The control unit compares this temperature with a threshold value. If the temperature measured in the loading and/or unloading line is higher than the threshold value, the first control member and the second control member are in their open state. If the temperature measured in the loading and/or unloading line is below the threshold value, the first control member and the second control member are in their closed state.

10 According to an optional characteristic of the invention, a time delay is provided between the switching of the first control member from its open state to its closed state and the switching of the second control member from its open state to its closed state.

This time delay ensures that the cryogenic fluid in liquid form is evacuated from the pipe, so that no fluid is trapped between the two control members.

15 According to an optional characteristic of the invention, the use method comprises a step of loop circulation of the gas resulting from the evaporation of the cryogenic fluid in liquid form.

The loop circulation step brings the loading and/or unloading line to a temperature suitable for loading and/or unloading operations. During this loop circulation step, the cryogenic fluid in liquid form is taken from the storage tank, using a pump if necessary. The cryogenic fluid in liquid form circulates in the loading and/or unloading line where it vaporizes, forming gas resulting from the evaporation of the cryogenic fluid in liquid form. As a result, the loading and/or unloading line is cooled to a temperature suitable for loading and/or unloading operations. The gas resulting from the evaporation of the cryogenic fluid in liquid form then circulates in the pipe and in the supply line to the bypass channel in order to bypass the compressor, then it is returned towards the storage tank and more precisely towards the headspace of this storage tank. "Loop" means that the gas resulting from the evaporation of the cryogenic fluid in liquid form bypasses the consumption and/or treatment system and the storage terminal.

30 According to an optional characteristic of the invention, during the driving step by the control unit, the first control member and/or the second control member switch from their open state to their closed state if the control unit detects an open state of the valve.

This ensures that when cryogenic fluid in liquid form is about to be loaded or unloaded from or towards the storage terminal, at least one of the control members is closed so that this cryogenic fluid in liquid form does not enter the supply line.

According to an optional characteristic of the invention, during the driving step by the control unit, the first control member and/or the second control member switch from their open state to their closed state if the temperature determination means detect a temperature below a threshold value.

A temperature below the threshold value indicates the presence of cryogenic fluid in liquid form in the loading and/or unloading line, which requires at least one of the control members to be closed.

Other characteristics, details and advantages of the invention will become clearer on reading the following description, on the one hand, and examples of embodiments given by way of indication and non-limitation with reference to the attached drawings, on the other hand, wherein:

[Fig. 1] schematically illustrates a cryogenic fluid storage and transport installation, shown here in a first embodiment wherein a pipe is connected at a first end to a supply line and at a second end to a loading and/or unloading line;

[Fig. 2] illustrates, schematically, a first variant of the first embodiment of the storage and transport installation shown in Figure 1;

[Fig. 3] illustrates, schematically, a second variant of the first embodiment of the storage and transport installation shown in Figure 1;

[Fig. 4] schematically illustrates a second embodiment of the storage and transport installation shown in Figure 1, wherein the pipe is connected at its first end to the supply line and opens at its second end directly into a cryogenic fluid storage tank.

The characteristics, variants and the different embodiments of the invention may be associated with one another in various combinations, insofar as they are not incompatible or mutually exclusive. In particular, it will be possible to imagine variants of the invention comprising only a selection of characteristics described hereinafter in isolation from the other characteristics described, if this selection of characteristics is sufficient to confer a technical advantage and/or to differentiate the invention from the prior art.

In the figures, the elements common to several figures retain the same reference. Figures 1 to 4 illustrate, schematically, a storage and treatment installation 1 according to the

invention, such a storage and treatment installation 1 being integrated within a structure such as a floating structure or an onshore structure.

The storage and treatment installation 1 is configured to operate a cryogenic fluid circulation. To this end, the cryogenic fluid in liquid form L is stored in at least one storage tank 2 of the storage and treatment installation 1.

As the thermal insulation of the storage tank 2 is not perfect, some of the cryogenic fluid in liquid form L evaporates naturally and forms a gas G resulting from the evaporation of the cryogenic fluid in liquid form. The storage tank 2 therefore comprises both the cryogenic fluid in liquid form L and the gas G resulting from the evaporation of the cryogenic fluid in liquid form, a separation between these two fluids being represented in the figures by a dotted horizontal line. The cryogenic fluid is methane, for example.

In the figures, the storage and treatment installation 1 has a single storage tank 2. It is understood that the description which follows in relation to this storage tank 2 may be applied, mutatis mutandis, to other storage tanks for embodiments wherein the structure has several storage tanks.

The storage tank 2 is delimited by a bottom wall 4, which corresponds to its lowest wall. From this bottom wall 4 extends an area of tank bottom 6, which corresponds for example to at least half the height of the storage tank 2 measured perpendicularly to the bottom wall 4. At least the tank bottom 6 is configured for storing cryogenic fluid in liquid form L. Conversely, gas G resulting from the evaporation of cryogenic fluid in liquid form is stored in a tank headspace 8, which corresponds to its uppermost portion. The tank headspace 8 extends from a top wall 10 opposite the bottom wall 4.

The storage and treatment installation 1 is connected to a storage terminal 12 located outside the structure, for example on a coastline. The storage terminal 12 is an example given here for illustrative purposes only; it may be envisaged, without departing from the scope of the invention, that the storage and treatment installation 1 is instead connected to a production unit or a consumer network. The storage terminal 12 may store at least cryogenic fluid in liquid form L. In some embodiments, the storage terminal 12 may store both cryogenic fluid in liquid form L and gas G resulting from the evaporation of cryogenic fluid in liquid form.

More specifically, the storage and treatment installation 1 is connected to the storage terminal 12 at least by means of a loading and/or unloading line 14. This loading and/or unloading line 14 allows the cryogenic fluid L to circulate in liquid form between the storage

tank 2 and the storage terminal 2. Thus, during a structure loading operation, the cryogenic fluid in liquid form L is conveyed through the loading and/or unloading line 14 from the storage terminal 12 towards the storage tank 2, and conversely, during an unloading operation, the cryogenic fluid in liquid form L circulates within this loading and/or unloading line 14 from the storage tank 2 towards the storage terminal 12.

The cryogenic fluid storage and treatment installation 1 is equipped with at least one valve 11, which is illustrated in Figure 2 as being carried by the storage terminal 12. This valve 11 may alternate between an open state and a closed state. In its open state, the valve 11 allows the cryogenic fluid in liquid form L to be loaded and/or unloaded from the storage terminal 12 towards the storage tank 2 for the loading or vice versa from the storage tank 2 towards the storage terminal 12 for the unloading. In its open state, the valve 11 allows cryogenic fluid in liquid form L to switch through the loading and/or unloading line 14. Alternatively, and not shown, the valve 11 is positioned on the loading and/or unloading line 14 on the vessel, for example at the level of the connection with the storage terminal 12.

As may be seen from the figures, the loading and/or unloading line 14 comprises a plurality of conduits 16 which open into the storage tank 2. More specifically, the loading and/or unloading line 14 comprises a first conduit 16A, a second conduit 16B and a third conduit 16C which extend at least partially within the storage tank 2. In a case not shown, the line 16C is not present in the installation. These conduits are branches on a main line 13 of the loading and/or unloading line 14. The second conduit 16B is connected to this main line 13 at a first intersection 17A, while the first conduit 16A and the third conduit 16B are both connected to the main line at a common second intersection 17B. More specifically, the first conduit 16A is connected to the main line of the loading and/or unloading line 14 at the level of the second intersection 17B, the third conduit 16C itself being connected to the first conduit 16A between this second intersection 17B and the storage tank 2.

The first conduit 16A and the second conduit 16B open into the tank bottom 6, at the vicinity of the bottom wall 4. The second conduit 16B is equipped with a pump 18, which in particular facilitates the unloading of the cryogenic fluid in liquid form L. The pump 18 is arranged at one end of the second conduit 16B, for example in an area between the bottom wall 4 and a plane parallel to it at a distance of three meters from it. In contrast, the third conduit 16C opens into the tank headspace 8, in the vicinity of the top wall 10. The presence of conduits 16 opening out at different heights in the storage tank 2 has the effect of facilitating the loading of cryogenic fluid in liquid form L, which may thus be carried out by one and/or other of the first conduit 16A and the third conduit 16C.

In addition to the loading and/or unloading line 14, the storage and treatment installation 1 comprises a supply line 20. This supply line 20 is configured for the circulation of gas G resulting from the evaporation of the cryogenic fluid in liquid form. The supply line 20 connects the storage tank 2 to a consumption and/or treatment system 22 of the storage and treatment installation 1. This consumption and/or treatment system 22 is, for example, an engine configured to be supplied with a fuel formed by the gas G resulting from the evaporation of the cryogenic fluid in liquid form. The supply line 20 opens into the storage tank 2; more specifically, it is connected to the top wall 10 of the storage tank 2. Between the storage tank 2 and the consumption and/or treatment system 22, the supply line 14 is equipped with a compressor 24. This compressor 24 is used to adjust the pressure of the gas G resulting from the evaporation of the cryogenic fluid in liquid form prior to its delivery to the consumption and/or treatment system 22.

According to the invention, the storage and treatment installation 1 comprises a pipe 26 configured for the circulation of the gas G resulting from the evaporation of the cryogenic fluid in liquid form. This pipe 26 is connected to the supply line 20. More specifically, the pipe 26 extends between a first end 28 and a second end 30, its first end 28 being connected to the supply line 20 between the compressor 24 and the consumption and/or treatment system 22. It is understood that pipe 26 provides a means for the gas G resulting from the evaporation of the cryogenic fluid in liquid form to bypass the consumption and/or treatment system 22. In other words, the pipe 26 is a bypass line with respect to the consumption and/or treatment system 22.

The gas G resulting from the evaporation of the cryogenic fluid in liquid form circulating within the pipe 26 is configured to be returned to the storage tank 2. To this end, the second end 30 of the pipe 26 is connected to the storage tank 2 and more particularly to the tank bottom 6. According to the embodiments, the second end 30 is connected directly or indirectly to the tank bottom 6. Figure 1 illustrates a first embodiment, Figure 2 illustrates a first variant of the first embodiment, Figure 3 illustrates a second variant of the first embodiment and Figure 4 illustrates a second embodiment. Unless otherwise stated or unless there is an obvious incompatibility, characteristics described in relation to one of these variants or one of these embodiments may, without departing from the scope of the invention, apply to another variant or another embodiment.

In Figures 1 to 3, the second end 30 of the pipe 26 is connected to the loading and/or unloading line 14. In the variants shown in Figures 1 and 2, the second end 30 is connected between the storage terminal 12 and the first intersection 17A for the second conduit 16B.

In the alternative shown in Figure 3, the second end 30 is connected to the first conduit 16A, between the second conduit 16B and the top wall 10 of the storage tank 2. In this variant of Figure 3, the gas G resulting from the evaporation of the cryogenic fluid in liquid form does not circulate within the main line 13 of the loading and/or unloading line 14; instead, it
5 passes through a dedicated pipe 32. This dedicated pipe 32 is a portion of the pipe 26 arranged in parallel with the main line 13.

In the second embodiment shown in Figure 4, the pipe 26 does not open into the loading and/or unloading line 14. In this second embodiment, the gas G resulting from the evaporation of the cryogenic fluid in liquid form circulates through the dedicated pipe 32
10 which opens into the tank bottom 6. Alternatively, the second end 30 of the pipe 26 is equipped with a bubbling ramp or an ejector.

Whatever the embodiment, the storage and treatment installation 1 is equipped with a control system 34. This control system 34 is configured to decide whether the gas G resulting from the evaporation of the cryogenic fluid in liquid form should be delivered to
15 the consumption and/or treatment system 22 or returned towards the storage tank 2. To this end, the control system commands a control member 36 located on the pipe 26. This control member 36 takes the form of a valve which has either a closed state wherein the passage of gas G resulting from the evaporation of the cryogenic fluid in liquid form within the pipe 26 is prevented, or an open state wherein the passage of gas G resulting from the
20 evaporation of the cryogenic fluid in liquid form is authorized. It is understood that in the closed state of the control member 36, all of the gas G resulting from the evaporation of the cryogenic fluid in liquid form is delivered to the consumption and/or treatment system 22, whereas in its open state, on the other hand, the gas G resulting from the evaporation of the cryogenic fluid in liquid form may partly be delivered to the consumption and/or treatment
25 system and partly circulate in the pipe 26 and return to the storage tank 2. The control system 34 thus commands the switching from the closed state to the open state of the control member 36 or conversely the passage from its open state to its closed state. When the gas G resulting from the evaporation of the cryogenic fluid in liquid form is returned towards the storage tank 2, it takes part in a bubbling phenomenon which will be described
30 in more detail below in relation to a method for using the storage and treatment installation 1.

The control system 34 decides whether to open or close the control member 36 as a function of certain parameters measured or calculated within the storage and treatment installation 1. To achieve this, the storage and treatment installation 1 comprises various measuring

devices. In terms of these measuring devices, the storage and treatment installation 1 has a first measuring device 38, or first pressure and/or temperature measuring device 38, configured to acquire values within the storage tank 2, and a second measuring device 40, or second pressure measuring device 40, configured to acquire values at the outlet of the compressor 24.

The first measuring device 38 is configured to acquire the pressure within the storage tank 2 and/or the temperature of the cryogenic fluid in liquid form L within the storage tank 2. This first measuring device 38 comprises both a pressure sensor 38A and a temperature sensor 38B. The second measuring device 40 is configured to acquire the pressure of the gas G resulting from the evaporation of the cryogenic fluid in liquid form as it leaves the compressor 24. This second measuring device 40 is a pressure sensor.

It should be noted that in the first variant illustrated in Figure 2, the storage and treatment installation 1 comprises a control unit 35. In this variant, the control unit 35 is shown separately from the control system 34, but a control system 34 integrating the control unit 35 or performing its functions may be envisaged without departing from the scope of the invention.

In the first variant illustrated in Figure 2, the control member corresponds to a first control member 36A. The storage and treatment installation 1 also comprises a second control member 36B, also located on the pipe 26. The control unit 35 is capable of controlling the first control member 36A and the second control member 36B. Although the storage and treatment installation 1 is shown here with two control members 36A, 36B, other variants of embodiment may also be envisaged wherein there would be a different number of control members, for example only the first control member 36A or even three control members.

Here, in the presence of two control members, the first control member 36A is positioned closer to the first end 28 of the pipe 26 than to its second end 30, and conversely the second control member 36B is closer to the second end 30 of the pipe 26 than to its first end 28. Consequently, the first control member 36A is closer to the supply line 20 than to the loading and/or unloading line 14, and the second control member 36B is closer to the loading and/or unloading line 14 than to the supply line 20.

The first control member 36A and the second control member 36B are able to assume independently of each other the closed state wherein they prevent the circulation of the gas G resulting from the evaporation of the cryogenic fluid in liquid form and the open state wherein they allow its circulation. Thus, in their open state, the first control member 36A and the second control member 36B allow the circulation of the gas G resulting from the

evaporation of the cryogenic fluid in liquid form in the pipe 26 so that said gas may circulate from the supply line 20 to the loading and/or unloading line 14 by means of the pipe 26. In their second position, the first control member 36A and the second control member 36B prevent the circulation of the gas G resulting from the evaporation of the cryogenic fluid in liquid form in the pipe 26 so that said gas may not circulate between the supply line 20 and the loading and/or unloading line 14.

The presence of the first control member 36A and the second control member 36B provides an additional safety between the loading and/or unloading line 14, which is a "liquid" line, and the supply line 20, which is a "steam" line. When each of these lines operates independently of the other, the cryogenic fluid in liquid form L circulating in the loading and/or unloading line 14 must not reach the supply line 20 at the risk of damaging the storage and treatment installation 1 and the items of equipment arranged on the supply line 20, such as the compressor 24. Also, by positioning two control members 36A, 36B on the pipe 26, we ensure in particular that there is no risk of leakage which may result from a malfunction or a failure of one of the two control members.

As illustrated in the figures, at the level of the pipe 26, the supply line 20 is arranged at a greater vertical distance from the storage tank 2 than a vertical distance between this storage tank 2 and the loading and/or unloading line 14. In other words, the supply line 20 is above the loading and/or unloading line 14. Due to the aforementioned arrangement of the control members 36A, 36B, with the first control member 36A closer to the supply line 20 and the second control member 36B closer to the loading and/or unloading line 14, the cryogenic fluid in liquid form L contained in the pipe 26 may flow by gravity from the first control member 36A to the second control member 36B. In other words, the pipe 26 descends from the supply line 20 to the loading and/or unloading line 14 so as to facilitate the flow of the cryogenic fluid in liquid form L which circulates within it.

Additionally or alternatively, the flow of the cryogenic fluid in liquid form L within the pipe 26 from the supply line 20 to the loading and/or unloading line 14 may be facilitated by a particular orientation of the pipe 26. Here, this pipe 26 is oriented so as to present a non-zero angle with respect to the horizontal, said angle being measured between a straight line extending along the pipe 26 and a horizontal line extending between the supply line 20 and the loading and/or unloading line 14, said angle being oriented towards a floor of the structure. In the context of this particular orientation of the pipe 26, the supply line 20 may be arranged either above the loading and/or unloading line 14, below the loading and/or unloading line 14 or at the same vertical distance from the storage tank 2 as the latter.

In the first variant shown in Figure 2, the storage and treatment installation 1 comprises a bypass channel 42. As shown in Figure 2, the bypass channel 42 is configured to bypass the compressor 24. The bypass channel 42 is connected to the supply line 20 both upstream and downstream of the compressor 24. In other words, a first end of the bypass channel 42 is connected to the supply line 20 between the storage tank 2 and the compressor 24, and a second end of the bypass channel 42 is connected to the supply line 42 between the compressor 24 and the pipe 26.

The bypass channel 42 is equipped with a control valve 44. The control valve 44 is capable of alternating between an open state and a closed state. In its open state, the control valve 44 allows a cryogenic fluid in liquid form L to circulate through the bypass channel 42. The cryogenic fluid in liquid form L then bypasses the compressor 24. On the other hand, in its closed state, the control valve 44 prevents the cryogenic fluid in liquid form L from passing through the bypass channel 42. In this case, the cryogenic fluid in liquid form L passes through the compressor 24.

The presence of the bypass channel 42 within the storage and treatment installation 1 allows the loading and/or unloading line 14 to be brought up to temperature prior to loading and/or unloading operations of the storage tank 2, this bringing up to temperature preventing undesirable vaporization of the cryogenic fluid in liquid form L during such operations.

To do this, the storage and treatment installation 1 allows the cryogenic fluid in liquid form L to circulate within the loading and/or unloading line 14. This circulation allows the loading and/or unloading line 14 to be cooled and, in turn, leads to the vaporization of the cryogenic fluid in liquid form L, which then becomes gas G resulting from the evaporation of the cryogenic fluid in liquid form. As will be explained later, the cryogenic fluid in liquid form L used for this purpose may be taken from the storage tank 2 or come from the storage terminal 12, depending on the embodiment. The cryogenic fluid in liquid form L circulates in the loading and/or unloading line 14, which it cools by vaporizing, then it returns towards the storage tank 2 in the form of gas G resulting from the evaporation of the cryogenic fluid in liquid form via the bypass channel 42.

As mentioned previously, the first control member 36A and the second control member 36B are governed by the control unit 35. This control unit 35 drives the control members 36A, 36B during the bringing up to temperature of the loading and/or unloading line 14 so as to cause them to switch into their open state or into their closed state as a function of measurements collected in particular by a means of determining the temperature

equipped to the storage and treatment installation 1. The temperature determination means 37 is more precisely at least one temperature sensor for the cryogenic fluid circulating within the loading and/or unloading line 14. To this end, the temperature determination means 37 is placed on the loading and/or unloading line 14 between the storage tank 2 and the pipe 26. The temperature determination means 37 is located close to the second end 30 of the pipe 26 which is connected to the loading and/or unloading line 14. The temperature determination means 37 is located, for example, at a distance from the second end 30 of the pipe 26 of less than 20 meters, preferably less than ten meters and very preferably less than 7 meters. Alternatively, the temperature determining means 37 may be positioned on the pipe 26, between the second member 36B and the loading and/or unloading line 14. Alternatively, the temperature determination means 37 may be positioned on the loading and/or unloading line 14 between the pipe 26 and the storage terminal 12.

The temperature determination means 37 is configured to measure the temperature of the cryogenic fluid circulating in the loading and/or unloading line 14. Depending on its position within the loading and/or unloading line 14, either the temperature determination means 37 measures the temperature of the cryogenic fluid circulating upstream of the second end 30 of the pipe 26, i.e. between the storage tank 2 and this second end 30 of the pipe 26, or the temperature determination means 37 measures the temperature of the cryogenic fluid circulating downstream of the second end 30 of the pipe 26, i.e. between this second end 30 of the pipe 26 and the storage terminal.

The control unit 35 communicates with the temperature determination means 37 in such a way that the control unit 35 is able to collect at least one datum relating to the temperature of the cryogenic fluid circulating in the loading and/or unloading line 14 by means of the temperature determination means 37.

When the loading and/or unloading line 14 is brought up to temperature, when the temperature determining means 37 detects a temperature within the loading and/or unloading line 14 below a threshold value, the control unit 35 commands the control members 36A, 36B to switch to their closed state. The temperature threshold value indicates, for example, that the loading and/or unloading line 14 is at a temperature suitable for loading and/or unloading operations. The temperature threshold value that causes the control members 36A, 36B to close is, for example, between -50 and -150°C. More specifically, the threshold temperature value is, for example, of the order of -100°C plus or minus 10%. Generally speaking, if the temperature acquired in the loading and/or unloading line 14 is higher than the threshold value, the first control member 36A and the

second control member 36B are in their open state. If the temperature acquired in the loading and/or unloading line 14 is below the threshold value, the first control member 36A and the second control member 36B are in their closed state.

5 There is a noticeable time delay between the first control member 36A switching from its open state to its closed state and the second control member 36B switching from its open state to its closed state. When the temperature below the threshold value is detected in the loading and/or unloading line 14, the first control member 36A switches to its closed state before the second control member 36B. In other words, there is a delay in the second control member 36B switching to its closed state compared with the first control member 36A. Such
10 a delay is, for example, 30 seconds plus or minus 10 seconds. This time delay prevents the cryogenic fluid in liquid form L from being trapped in the pipe 26 between the first control member 36A and the second control member 36B. This prevents pressure build-up in a confined area of the installation between two valves.

It should also be noted that the control unit 35 may drive the first control member 36A and
15 the second control member 36B as a function of a state of the valve 11 equipped to the storage terminal 12 or the storage and treatment installation 1 according to the invention. As detailed above, this valve 11 allows the loading and/or unloading of cryogenic fluid in liquid form L in its open state but prevents such loading and/or unloading in its closed state. The valve 11 may also be used to circulate cryogenic fluid in liquid form L within the loading
20 and/or unloading line 14 in order to bring it up to temperature, at least for the portion located between the storage terminal 12 and the pipe 26. In this case, the valve 11 may be driven by the control unit 35 to switch from its closed state to its open state in order to allow cryogenic fluid in liquid form L to circulate from the storage terminal 12 to the pipe 26 in order to cool the loading and/or unloading line 14. It is then necessary for the control
25 members 36A, 36B to be driven by the control unit 35 to be in their open state. The gas G resulting from the evaporation of the cryogenic fluid in liquid form obtained during the vaporization of the cryogenic fluid in liquid form L within the loading and/or unloading line 14 may thus circulate in the pipe 26, then pass into the supply line 20, pass through the bypass channel 42 and reach the storage tank 2. Significantly, in the context of bringing up
30 to temperature using the cryogenic fluid from the storage terminal 12, the driving of the control members 36A, 36B by the control unit 35 is however slaved to the temperature measurements performed by the temperature determination means 37; thus, the control members 36A, 36B are driven to switch into their closed state when the temperature acquired by the temperature determination means 37 is below the threshold value.

In the case of operations involving the loading and/or unloading of cryogenic fluid in liquid form L from or towards the tank 2, and no longer in the context of bringing up to temperature, the control unit 35, on detecting the open state of the valve 11, commands the first control member 36A and the second control member 36B to switch to their closed state.

- 5 A method for using the storage and treatment installation 1 will now be described. This method of use allows, when required, to implement the bubbling phenomenon mentioned above in order to mix the cryogenic fluid in liquid form L within the storage tank 2 and thus to reduce the pressure within this storage tank 2.

10 During the use method, the control member 36 is opened by the control system 34 when a given pressure is reached within the storage tank 2 and a given pressure is reached at the outlet of the compressor 24. It is understood that these two pressures correspond to parameters verified by the control system 34 prior to the control member switching into its open state.

15 Checking the pressure within the storage tank 2 corresponds to the first parameter checked by the control system 34. Such a check comprises several steps. In a first step, which corresponds to a first step, the temperature sensor 38B measures a temperature of the cryogenic fluid in liquid form L within the storage tank 2, and the control system 34 calculates a theoretical pressure within the storage tank 2 from the temperature measured by the temperature sensor 38B. This theoretical pressure is calculated, for example, by a
20 theoretical pressure calculator in the control system 34. It corresponds to a pressure if the cryogenic fluid in liquid form L were perfectly mixed within the storage tank 2. In an alternative embodiment, during the first step the pressure sensor 38A of the first measuring device 38 measures a pressure within the storage tank 2, and the control system 34 calculates a theoretical temperature of the cryogenic fluid in liquid form L from the pressure
25 measured by the pressure sensor 38A.

In a second step, the pressure sensor 38A of the first measuring device 38 measures the pressure inside the storage tank 2 and the control system 34 compares it with the theoretical pressure calculated in the first step. The control system 34 then obtains a pressure value which corresponds to a difference between the theoretical pressure and the measured
30 pressure. It should be noted that in certain alternative embodiments, the use method dispenses with temperature measurement by the temperature sensor 38B, the pressure sensor 38A then taking measurements separated by defined time intervals with a view to determining a rate of variation of the pressure within the storage tank 2. In the alternative embodiment described above, during the second step the temperature sensor 38B of the

first measuring device 38 measures the temperature of the cryogenic fluid in liquid form L within the storage tank 2 and the control system 34 compares it with the theoretical temperature calculated during the first step. The control system 34 then obtains a temperature value which corresponds to a difference between the theoretical temperature and the measured temperature.

During a third step of checking the first parameter, the control system 34 compares the difference between the theoretical pressure and the measured pressure with a known threshold value, which is for example between 20 and 100 millibars. In the alternative embodiment, the control system 34 compares the difference between the theoretical temperature and the measured temperature with a known threshold value.

At the same time as checking the first parameter, the control system 34 checks a second parameter, which corresponds to checking the pressure at the outlet of the compressor 24.

The pressure sensor 40 measures the pressure of the gas G resulting from the evaporation of the cryogenic fluid in liquid form as it leaves the compressor 24. The control system 34 then compares this pressure measured by the pressure sensor 40 with a range of operating pressure values for the consumption and/or treatment system. If the pressure measured is within the range of values, the consumption and/or treatment system 22 receives the gas G resulting from the evaporation of the cryogenic fluid in liquid form which it requires. The control system 34 therefore commands the opening of the control member 36 in order to convey the gas G resulting from the evaporation of the cryogenic fluid in liquid form towards the storage tank 2 to perform the bubbling phenomenon.

It is understood from the above that when both the first parameter and the second parameter are met, the control member 36 is opened by the control system 34 in order to send the gas G resulting from the evaporation of the cryogenic fluid in liquid form into the storage tank 2 for carrying out the bubbling. This gas G resulting from the evaporation of the cryogenic fluid in liquid form in the storage tank 2 for carrying out the bubbling corresponds to an excess of gas not required for the needs of the consumption and/or treatment system 22. Otherwise, the control member 36 remains in its closed state and there is no return of the gas G resulting from the evaporation of the cryogenic fluid in liquid form towards the storage tank 2.

In addition, if the first parameter is not met during the check, the control system 34 commands the closure of the control member 36, even if the second parameter is met during the check. Conversely, if the second parameter is not met when the second parameter is checked, the control system 34 commands the control member 36 to close, even if the first

parameter is met when the second parameter is checked. In other words, the control system 34 implements the opening of the control member 36 on condition that the first and second parameters are met.

5 When the control member 36 is in its open state, the compressor 24 may adapt its flow rate and more particularly increase it in order to meet the requirements of the consumption and/or treatment system 22 for gas G resulting from the evaporation of the cryogenic fluid in liquid form.

10 It should be noted that in the case of the first variant illustrated in Figure 2, the use method also allows to bring up to temperature the loading and/or unloading line 14 mentioned above, on the basis of a temperature measurement within the loading and/or unloading line 14 and/or on the basis of a state of the valve 11 of the storage terminal 12 or of the storage installation according to the invention.

The bringing up to temperature of the loading and/or unloading line 14 may be adjusted during a loop circulation operation. During this operation, the cryogenic fluid in liquid form 15 L is extracted from the storage tank 2 using the pump 18. The cryogenic fluid in liquid form L circulates in the loading and/or unloading line 14, within which it vaporizes so as to form gas G resulting from the evaporation of the cryogenic fluid in liquid form. This gas G resulting from the evaporation of the cryogenic fluid in liquid form passes through the pipe 26, the supply line 20 and then bypasses the compressor 24 via the bypass channel 42. The 20 passage of the gas G resulting from the evaporation of the cryogenic fluid in liquid form via the bypass channel 42 is driven by the control valve 44, which must be in its open state. The gas G resulting from the evaporation of the cryogenic fluid in liquid form then flows into the headspace 8 of the storage tank 2. The loop circulation operation is implemented until a suitable temperature is reached within the loading and/or unloading line 14.

25 For this variant implementing temperature conditioning, the use method may comprise a driving step during which the control unit 35 drives a switching from the open state to the closed state of the first control member 36A and of the second control member 36B, or conversely a switching from their closed state to their open state.

30 The driving step is dependent, for example, on a sub-step for measuring the temperature within the loading and/or unloading line. During this sub-step, the temperature determination means 37 monitors the temperature of the cryogenic fluid within the loading and/or unloading line 14 near the second end 30 of the pipe 26. The control unit 35 then compares the acquired temperature value with a threshold temperature value. If the temperature measured in the loading and/or unloading line 14 by the temperature

- determining means 37 is higher than the threshold value, then the control unit 35 drives the switching of the first control member 36A and of the second control member 36B in their open state. Conversely, if the temperature measured in the loading and/or unloading line 14 by the temperature determination means 37 is lower than the threshold value, the control
- 5 unit 35 drives the first control member 36A and the second control member 36B to switch to their closed state. Such a temperature below the temperature threshold value may indicate the presence of cryogenic fluid in liquid form L within the loading and/or unloading line 14. In this case, implementing the temperature conditioning of the loading and/or unloading line 14 is prevented until the temperature exceeds the threshold value.
- 10 Alternatively or additionally, when it is desired to use the cryogenic fluid in liquid form L from the storage terminal 12 to perform the temperature conditioning, the step of driving by the control unit 35 is dependent on a sub-step of opening the valve 11 of the storage terminal 12 or of the loading and/or unloading line 14 of the storage and treatment installation 1.
- 15 On the contrary, apart from bringing the loading and/or unloading line 14 up to temperature, if the control unit 35 detects an open state of this valve 11, there is a risk of the presence of cryogenic fluid in liquid form L within the loading and/or unloading line 14 due to a loading and/or unloading operation of cryogenic fluid in liquid form L towards or from
- 20 control member 36A and the second control member 36B in their closed state. Implementing the temperature conditioning of the loading and/or unloading line 14 is then prevented as long as the cryogenic fluid in liquid form L is circulating within the loading and/or unloading line 14 for loading and/or unloading operations.
- The present invention thus proposes a cryogenic fluid storage and treatment installation
- 25 within which the presence of a pipe and a control member allows to use, if necessary, a gas resulting from the evaporation of the cryogenic fluid in liquid form in order to carry out a bubbling operation serving to mix the cryogenic fluid in liquid form when stored in a tank.
- However, the present invention is not limited to the means and configurations described and illustrated herein, and also extends to any equivalent means and configurations, as well
- 30 as to any technically operative combination of such means.

CLAIMS

1. An installation (1) for storing and treating cryogenic fluid comprising at least one cryogenic fluid storage tank (2) comprising a tank bottom (6) and a tank headspace (8), a consumption and/or treatment system (22), a line (14) for loading and/or unloading the cryogenic fluid in liquid form (L) configured to connect at least the tank bottom (6) to a storage terminal (12), a line (20) for supplying the consumption and/or treatment system (22) with a fuel prepared from a gas resulting from the evaporation of the cryogenic fluid contained in liquid form (G) in the storage tank (2), the supply line (20) connecting at least the tank headspace (8) to the consumption and/or treatment system (22) and comprising at least one compressor (24) arranged between the storage tank (2) and the consumption and/or treatment system (22), the cryogenic fluid storage and treatment installation (1) comprising a pipe (26) connected at a first end (28) to the supply line (20) between the compressor (24) and the consumption and/or treatment system (22), the pipe (26) being connected by a second end (30) to the tank bottom (6), the pipe (26) having a control member (36) for controlling the circulation of gas (G) within the pipe (26).
2. The installation (1) for storing and treating cryogenic fluid according to the preceding claim, wherein the second end (30) of the pipe (26) is connected to the loading and/or unloading line (14).
3. The installation (1) for storing and treating cryogenic fluid according to claim 1, wherein the second end (30) of the pipe (26) opens into the tank bottom (6).
4. The installation (1) for storing and treating cryogenic fluid according to any one of the preceding claims, wherein the pipe (26) is configured so that the gas resulting from the evaporation of the cryogenic fluid (G) passes through it.
5. The installation (1) for storing and treating cryogenic fluid according to any one of the preceding claims, comprising a first measuring device for measuring the pressure within the tank (2) and/or the temperature (38) of the cryogenic fluid in liquid form (L) within the tank (2).
6. The installation (1) for storing and treating cryogenic fluid according to the preceding claim, comprising a second measuring device (40) for measuring the pressure of the gas resulting from the evaporation of the cryogenic fluid (G) at the outlet of the compressor (24).
7. The installation (1) for storing and treating cryogenic fluid according to any one of claims 5 and 6, comprising a control system (34) configured to open or close the control

member (36) as a function of a value acquired by the first and/or second measuring device (38, 40).

8. The installation (1) for storing and treating cryogenic fluid according to the preceding claim, wherein the control member (36) is a first control member (36A), the
5 storage and treatment installation comprising at least one second control member (36B).
9. The installation (1) for storing and treating cryogenic fluid according to any of the preceding claims, comprising at least one valve (11).
10. 10. The installation (1) for storing and treating cryogenic fluid according to any one of the preceding claims, comprising at least one means for determining the temperature (37) of the cryogenic fluid circulating on the loading and/or unloading line (14).
11. The installation (1) for storing and treating cryogenic fluid according to any one of the preceding claims, comprising at least one control unit (35) configured to open or close the control member (36), preferably a first control member (36A) and a second control member (36B).
- 15 12. The installation (1) for storing and treating cryogenic fluid according to the preceding claim, wherein the control unit is configured to drive the control member (36), preferably the first control member (36A) and the second control member (36B) as a function of a temperature measured by the temperature determination means (37).
- 20 13. The installation (1) for storing and treating cryogenic fluid according to any one of the preceding claims in combination with claim 11, wherein the control unit is configured to drive the control member (36), preferably the first control member (36A) and the second control member (36B) as a function of a state of the valve (11).
- 25 14. The installation (1) for storing and treating cryogenic fluid according to any one of the preceding claims, wherein the pipe (26) slopes between the supply line (20) and the loading and/or unloading line (14).
15. A structure configured for transporting and/or storing cryogenic fluid, comprising a cryogenic fluid storage and treatment installation (1) according to any one of the preceding claims.
- 30 16. A use method for using a cryogenic fluid storage and treatment installation (1) according to any one of claims 1 to 14, during which the control member (36) of the pipe (26) is opened in order to send gas resulting from the evaporation of the cryogenic fluid (G)

to the tank bottom (6) and is closed in order to prevent gas resulting from the evaporation of the cryogenic fluid (G) from being returned to the tank bottom (6).

17. The use method according to the preceding claim in combination with claim 7, wherein the opening and the closing of the control member (36) is governed by the control system (34).

18. The use method according to the preceding claim, comprising a first step during which the control system (34) calculates a theoretical pressure within the tank (2) from a temperature measured by the first pressure and/or temperature measuring device (38), a second step during which the control system (34) calculates a difference between the theoretical pressure and an actual pressure measured within the tank (2) by the first pressure and/or temperature measuring device (38), and a third step during which the control system (34) compares the difference with a threshold value.

19. The use method according to claim 17, comprising a first step during which the control system (34) calculates a theoretical temperature of the cryogenic fluid in liquid form (L) within the tank (2) from a pressure measured by the first pressure and/or temperature measuring device (38), a second step during which the control system (34) calculates a difference between the theoretical temperature and an actual temperature measured within the tank (2) by the first pressure and/or temperature measuring device (38), and a third step during which the control system (34) compares the difference with a threshold value.

20. 20. The use method according to claim 17, comprising a step during which measurements of the pressure and/or temperature in the storage tank (2) are performed by the first pressure and/or temperature measuring device (38), and a step during which the control system (34) compares a rate of change of the pressure and/or temperature with a reference value.

21. The use method according to any one of claims 17 to 20, comprising a comparison phase during which the control system (34) compares a pressure of the gas resulting from the evaporation of the cryogenic fluid (G) measured by the second pressure measuring device (40) at the outlet of the compressor (24) with a range of operating pressure values of the consumption and/or treatment system (22).

22. The use method according to the preceding claim, wherein the control system (34) commands the opening of the control member (36) when the pressure measured is within the range of operating pressure values of the consumption and/or treatment system (22).

23. The use method according to the preceding claim in combination with claim 18, wherein the control system (34) commands the opening of the control member (36) if the difference compared during the third step between the theoretical pressure and the actual pressure measured within the tank (2) by the first pressure and/or temperature measuring device (38) is greater than the threshold value.

24. The use method according to the preceding claim in combination with claim 19, wherein the control system (34) commands the opening of the control member (36) if the difference compared during the third step between the theoretical temperature and the actual temperature measured within the tank (2) by the first pressure and/or temperature measuring device (38) is greater than the threshold value.

25. The use method according to any one of claims 16 to 24 for using a cryogenic fluid storage and treatment installation (1) according to claim 11, comprising a step of driving the control member (36) by the control unit (35), preferably the first control member (36A) and the second control member (36B).

26. The method according to claim 25, during which a time delay is provided between the switching of the first control member (36A) from its open state to its closed state and the switching of the second control member (36B) from its open state to its closed state.

27. The method according to any one of claims 25 to 26 in combination with claim 10, wherein during the driving step by the control unit (35), the first control member (36A) and/or the second control member (36B) switch from their open state to their closed state if the temperature determination means (37) detects a temperature below a threshold value.