SEALED AND THERMALLY INSULATING TANK

Technical field

The invention relates to the field of sealed and thermally insulating tanks with membranes. In particular, the invention relates to the field of sealed and thermally insulating tanks for the storage and/or transport of low-temperature fluids, such as tanks for the transport of Liquefied Petroleum Gas (also called LPG) at a temperature for example between -50°C and 0°C, or for the transport of Liquefied Natural Gas (LNG) at approximately -162°C at atmospheric pressure. These tanks can be installed on land or on a floating structure. In the case of a floating structure, the tank may be intended for the transport of liquefied gas or to receive liquefied natural gas used as fuel for propulsion of the floating structure.

Technological background

In the technology of membrane-type sealed and thermally insulating tanks, a supporting structure, for example the hull of a ship, provides supporting walls whose inner surface is covered with a multilayer structure forming the sealed and thermally insulating wall of the tank, this multilayer structure comprising one or more sealed membranes and one or more thermally insulating barriers interposed between the supporting wall and the sealed membrane(s).

When the tank is filled with a low-temperature fluid, the thermal leaks which exist through the tank wall typically bring the inner surface of the supporting structure to a temperature lower than the temperature of the ambient atmosphere. If moisture-laden ambient air has been able to enter the interior space of the supporting structure, particularly between the supporting structure and the tank wall, this low temperature facilitates a phenomenon of condensation and water runoff on the inner surface of the supporting structure.

It is therefore advisable to provide a drainage system to avoid accumulation of water or other liquids on the bottom supporting wall.

KR-A-20150120701 discloses a membrane tank for LNG whose bottom supporting wall comprises a drain hole.

Abstract

An idea on which the invention is based is to increase the effectiveness of a drain hole by guiding a runoff or flow of liquid on the inner surface of the supporting structure towards the drain hole.

For this purpose, the invention provides a sealed and thermally insulating tank for the storage or transport of a cold fluid, the tank comprising supporting walls defining a supporting structure and tank walls attached on an inner surface of the supporting walls, in which each tank wall comprises a sealed membrane and a thermally insulating barrier fitted between the sealed membrane and the supporting wall,

in which the supporting structure comprises a bottom supporting wall presenting one or more drain holes passing through the bottom supporting wall to enable draining of the supporting structure,

in which the bottom supporting wall carries a projecting flange to guide a flow of liquid to the drain hole, the projecting flange extending along the edges of the bottom supporting wall at a distance from the edges of the bottom supporting wall continuously on substantially the whole periphery of the bottom supporting wall, the projecting flange being covered by the thermally insulating barrier of the tank wall attached on the bottom supporting wall.

Thanks to these characteristics, the projecting flange can confine the liquid which streams downwards along the side walls of the supporting structure in a border area located between the projecting flange and the edges of the bottom supporting wall, and thus facilitate the flow of this liquid towards the drain hole.

In advantageous embodiments, such a tank may present one or more of the following characteristics.

In one embodiment, the projecting flange is interrupted at said drain hole or each drain hole to allow the flow of liquid to pass towards the drain hole. Thanks to the break(s) in the projecting flange at the drain hole(s), the liquid, for example condensation water, flowing into the border area of the bottom supporting wall located on the outer side of the projecting flange and the liquid flowing into a central

area of the bottom supporting wall located on the inner side of the projecting flange can also reach the drain hole whatever its position, i.e. in the central area, in the border area or straddling the central area and the border area.

In an alternative embodiment, the projecting flange can be continuous and separate drain holes can be provided on both sides of the projecting flange.

In one embodiment, the projecting flange is close to the edge of the bottom supporting wall, for example at a distance from the edge of the bottom supporting wall which is less than one tenth of the dimension of the bottom supporting wall in a direction perpendicular to the corresponding edge of the supporting wall. In one embodiment, the distance between the projecting flange and the edge of the bottom supporting wall is less than 1 metre.

Thanks to these characteristics, the border area is much smaller than the central area of the supporting wall. Thus, for example in the event of entry of seawater due to a problem in the watertightness of a side supporting wall of the ship, for example as a result of a collision or a welding fault during construction, the small size of the border area enables the water to be brought rapidly into the drain hole, facilitating detection of the presence of water. In one embodiment, the drain hole is equipped with a water presence sensor.

Numerous materials may be suitable for producing the projecting flange. In one embodiment, the projecting flange comprises a bead made of a polymer resin adhering on the bottom supporting wall. Various polymer resins can be used for this purpose, particularly polyurethane resins and epoxy resins. In one embodiment, the projecting flange comprises a series of metal parts welded on the bottom supporting wall. These metal parts can be for example bars or rods welded end to end or with an overlap to form a continuous outline, except at the drain hole(s).

Metal parts can also be used in combination with polymer resin beads to form the projecting flange. In this case, the polymer resin beads can in particular be used to produce sealed joints between the metal parts, which avoids the need to make these sealed joints by welding.

The supporting structure may present various geometries, for example a substantially spherical shape or a prismatic shape, preferably with a flat bottom supporting wall. In one embodiment, the supporting structure comprises at least one side supporting wall, vertical or slanting, connected to an edge of the bottom

supporting wall on a ridge of the supporting structure, the projecting flange being positioned parallel to the ridge. The angle between the two supporting walls forming the ridge can have various values, for example 90°, 135° or another value.

In one embodiment, the thermally insulating barrier of the tank wall is manufactured in a modular way using juxtaposed insulating blocks on each supporting wall, particularly the bottom supporting wall, so as to substantially cover the inner surface of the bottom supporting wall. Such insulating blocks may in particular comprise corner structures and/or flat insulating blocks. Such a modular construction presents the advantage of leaving gaps between the juxtaposed insulating blocks. In the areas in which flow of the liquids needs to be facilitated, these gaps can be arranged as flow channels, for example by leaving free spaces or by using porous insulating materials in these gaps.

In one embodiment, the thermally insulating barrier of the tank wall attached on the bottom supporting wall comprises a plurality of corner structures arranged along the ridge of the supporting structure, each corner structure comprising a first wing covering a border area of the bottom supporting wall and a second wing inclined with respect to the first wing and covering a border area of the side supporting wall. The angle of inclination between the two wings is typically equal to the angle between the two supporting walls forming the ridge. Thanks to these characteristics, the manufacturing of the thermally insulating barrier on the ridge(s) of the supporting structure can be carried out in a simple way using the corner structures, which can be prefabricated.

The projecting flange can be positioned in various ways with respect to the thermally insulating barrier. In one embodiment, the projecting flange is positioned under the first wing of the corner structures, for example along an outer side of the first wing of the corner structures opposite the ridge of the supporting structure. In another embodiment, the projecting flange is positioned under flat insulating blocks attached on the bottom supporting wall. Thanks to these characteristics, the projecting flange, particularly when it is made of polymer resin, can simultaneously guide the flow, support the thermally insulating barrier and act as a shim to compensate for differences between the inner surface of the bottom wall and a flat theoretical surface serving as a positioning reference for the thermally insulating barrier.

In one embodiment, the projecting flange comprises a bead made of a polymer resin deposited on and adhering on the face of the corner structures designed to be opposite the supporting structure.

Such a polymer resin bead can be formed in one piece, for example by depositing on the supporting wall. Alternatively, it can be formed by successive interconnected sections. In this case, the corner structures can be positioned along the ridge of the supporting structure in the form of a row comprising intermediate spaces, blocks of insulating material being inserted in the intermediate spaces between the corner structures of the row. In this case, the projecting flange comprises bead sections made of the polymer resin deposited on and adhering on the face of the corner structures designed to be opposite the supporting structure and connecting sections made of the polymer resin deposited on and adhering on the face of the blocks of insulating material designed to be opposite the supporting structure, so that the connecting sections connect the bead sections to each other.

In one embodiment, a strip of flexible insulating sealing material is inserted in a remaining part of the intermediate space so as to limit heat transfers by convection.

In another embodiment, the projecting flange is positioned between two rows of insulating blocks, for example between the first wing of the corner structures and the flat insulating blocks.

In one embodiment, the thermally insulating barrier of the tank wall attached on the bottom supporting wall comprises a rigid plate straddling the ridge of the supporting structure and presenting a first edge bearing on the bottom supporting wall and a second edge bearing against the side supporting wall, the projecting flange consisting of a bead of polymerisable resin fitted between the first edge of the rigid plate and the bottom supporting wall to attach the first edge of the rigid plate to the bottom supporting wall by adhesion.

Preferably in this case, a second, discontinuous bead of polymerisable resin is placed between the second edge of the rigid plate and the side supporting wall to attach the second edge of the rigid plate to the side supporting wall by adhesion.

Advantageously, the thermally insulating barrier of the tank wall comprises flat insulating blocks attached on the bottom supporting wall and on the side

supporting wall so as to substantially cover the inner surface of the bottom supporting wall and of the side supporting wall, the rigid plate being fitted between a row of the flat insulating blocks attached on the bottom supporting wall and a row of the flat insulating blocks attached on the side supporting wall, and a flexible insulating material also being fitted on the rigid plate between the row of the flat insulating blocks attached on the bottom supporting wall and the row of the flat insulating blocks attached on the side supporting wall.

The drain hole(s) can be positioned in various ways on the bottom supporting wall and with respect to the projecting flange. In one embodiment, a drain hole is located in line with the projecting flange, the projecting flange being interrupted at the edge of the drain hole.

In one embodiment, the edges of the bottom supporting wall are located on an outer side of the projecting flange and a drain hole is located on an inner side of the projecting flange opposite the outer side.

Preferably in this case, the thermally insulating barrier of the tank wall comprises flat insulating blocks attached on the bottom supporting wall on the inner side of the projecting flange, and a flat insulating block located between a break in the projecting flange and the drain hole comprises a recess defining a flow channel in a lower surface of the flat insulating block, the flow channel extending transversely to the projecting flange.

In embodiments, the bottom supporting wall is flat and presents a rectangular or trapezoidal shape, particularly in a front tank of a ship.

The tanks described above can be used in various types of installations such as shore installations or in a floating structure such as an LNG carrier or other ship. In one embodiment, the supporting structure is the hull of a ship, the drain hole being located near an edge of the bottom supporting wall located towards the rear of the ship.

The invention also provides a ship for the transport of a cold liquid product, the ship comprising a hull and an aforementioned tank in which the supporting structure consists of the hull of the ship.

The invention also provides a process of loading or unloading of such a ship, in which a cold liquid product is routed through the insulated pipes from or to a floating or shore-based storage facility to or from the tank of the ship.

The invention also provides a transfer system for a cold liquid product, the system comprising the aforementioned ship, insulated pipes fitted so as to connect the tank installed in the hull of the ship to a floating or shore-based storage facility and a pump to cause a flow of cold liquid product through the insulated pipes from or to the floating or shore-based storage facility to or from the tank of the ship.

Brief description of figures

The invention will be better understood, and other purposes, details, characteristics and advantages thereof will become clearer, in the course of the following description of several specific embodiments of the invention, given only as an illustration and in a non-restrictive way, in reference to the appended drawings.

- **Figure 1** is a perspective view of a prismatic supporting structure in which a sealed and thermally insulating tank can be constructed.

- **Figure 2** is a sectional view of the tank wall according to a first embodiment, along line II-II in Figure 1.

- **Figure 3** is a sectional view of the tank wall according to the first embodiment, along line III-III in Figure 1.

- **Figure 4** is a view similar to Figure 2 showing the tank wall according to a second embodiment.

- **Figure 5** is a sectional view of the tank wall according to the second embodiment, along line V-V in Figure 1.

- **Figure 6** is an enlarged perspective view of area VI of Figure 1 showing the tank wall according to a third embodiment.

- **Figure 7** is a sectional view of the tank wall according to the third embodiment, along line VII-VII in Figure 6.

- **Figure 8** is a sectional view of the tank wall according to the third embodiment, along line VIII-VIII in Figure 6.

- **Figure 9** is a perspective view of the tank wall according to a variant of the third embodiment, showing the drain hole and a flow channel formed in the lower surface of an insulating housing.

- **Figure 10** is a schematic cutaway illustration of an LNG carrier ship and a loading/unloading terminal for this ship.

- **Figure 11** is a perspective view of a detail of the tank wall according to the second embodiment.

- **Figure 12** is a perspective view of another detail of the tank wall according to the second embodiment.

- **Figure 13** is a perspective view of an insert which can be used in the tank wall according to the second embodiment.

Detailed description of embodiments

Figure 1 is a perspective view of a supporting structure 1 of generally prismatic shape which can be formed by the hull of a liquefied gas transport ship and is designed to receive a multilayer modular covering on its inner surface to form a sealed and thermally insulating tank.

The supporting structure 1 comprises metal supporting walls, namely in this case a flat bottom wall 2, a flat ceiling wall 3 parallel to the bottom wall 2, two flat transverse end walls perpendicular to the axis of the ship, namely a front transverse wall 4 and a rear transverse wall 5, and two opposing longitudinal walls formed each time by three flat parts, namely a lower bevel part 6, a vertical part 7 and an upper bevel part 8. The bevel parts are inclined around the longitudinal axis of the ship, for example at an angle of 45°. The supporting walls are joined at ridges 9 which are shown as continuous lines or broken lines in figure 1, depending on whether they are visible or hidden.

A projecting flange 10 is formed on the inner surface of the bottom wall 2, which in this case is rectangular. The projecting flange 10 runs along the four edges of the bottom wall 2 at a short distance from these edges, so as to delimit a border area 15 in which the water which runs off along the transverse end walls or the longitudinal walls can thus be confined.

The projecting flange 10 is interrupted only at two drain holes 11, which are located near the rear transverse wall 5 in the example shown. In other words, the

projecting flange 10 has a straight section 101 which extends continuously along the front edge of the bottom wall 2, two straight sections 102 and 103 which extend continuously along each of the two side edges of the bottom wall 2 and whose front ends are connected in a continuous way to the two ends of the straight section 101, and a straight section 104 which extends along the rear edge of the bottom wall 2, the two ends of which are connected in a continuous way to the rear ends of the two straight sections 102 and 103. The straight section 104 is interrupted twice in this example.

In figure 1, the projecting flange 10 has the overall shape of a rectangular frame. This shape can be modified, particularly with rounded sections at the corners of the bottom wall 2. The main function of the projecting flange 10 is to guide the runoff water in the border area 15 to the drain holes 11, and therefore to prevent this runoff water from migrating to the central section 14 of the bottom wall 2.

Each drain hole 11 passes through the thickness of the bottom wall 2 and opens into a drain pipe 12 carrying the drained liquids towards an evacuation system, not shown. The projecting flange 10 is in this case interrupted on the edges of the two drain holes 11. Thus, each drain hole 11 can collect both liquids from the border area 15 and liquids from the central area 14 of the bottom wall 2 located on the other side of the projecting flange 10.

In the case of a ship tank, following the unloading of the cargo from the tank, the ship's ballast tanks can be filled so as to incline the hull of the ship with a slope towards the rear, which causes the liquid accumulated in the border area 15 of the bottom wall all around the projecting flange 10 to flow by gravity towards the drain holes 11 located in the rear section of the tank.

A description will now be given of several embodiments of the projecting flange 10 and several embodiments of the multilayer modular covering forming the tank wall. The combinations disclosed below are not limitative and each embodiment of the projecting flange can be used with the various embodiments of the multilayer modular covering.

A first embodiment is shown in figures 2 and 3. The projecting flange 10 is in this case formed by elongated metal parts 20 welded on the bottom wall 2. The metal part 20 can be seen in cross section in figure 2. The metal part 20 is not cut in figure 3, but its end face located at the edge of the hole 11 is visible.

The tank wall consists of prefabricated modular insulating blocks, juxtaposed on the supporting walls. These modular insulating blocks include flat insulating blocks 21 to cover the flat areas and corner insulating blocks 22 to cover the ridge areas. An insulating block 21 or 22 incorporates each time a secondary insulating barrier element 23, a secondary sealed barrier element 24 and a primary insulating barrier element 25. The insulating blocks 21 and 22 can be attached on the supporting structure in various ways, by gluing and/or by means of mechanical attachments, for example bolts and nuts.

The corner insulating block 22 comprises two wings bent at an angle equal to the angle between the bottom wall 2 and the adjacent side wall, namely 135° at the ridge 29 between the bottom wall 2 and the lower bevel part 6 in figure 2, and 90° at the ridge 28 between the bottom wall 2 and the rear transverse wall 5 in figure 3.

The projecting flange 10 is positioned each time between a row of the corner insulating blocks 22 which covers the ridge 28, 29 and a row of flat insulating blocks 21 which rests on the bottom wall 2 next to the row of the corner insulating blocks 22. The metal parts 20 thus provide a positioning stop for the end face of the wing of the corner insulating block 22 which rests on the bottom wall 2, facilitating the installation of the corner insulating blocks 22. A bead of polymerisable resin 27, for example epoxy putty, can be placed along the side of the metal parts 20 oriented towards the corner insulating blocks 22, to precisely adjust the position of the corner insulating blocks 22 with respect to the metal parts 20. The bead of polymerisable resin 27 can also seal the joint between two successive metal parts 20, particularly if these parts are not welded together. Lastly, as can be seen in figure 2, the bead of polymerisable resin 27 can also be placed at least partially under the wing of the corner insulating block 22 which rests on the bottom wall 2, to serve as a shim to compensate for the unevenness of the supporting structure.

A heat-insulating lining 31, for example in glass wool or other material, is positioned between the two rows of insulating blocks above the projecting flange 10 to minimise the empty spaces in the secondary insulating barrier.

The primary sealing membrane 26 is positioned on the upper face of the insulating blocks 21 and 22 and can be produced in various ways. Other details

concerning embodiments of the sealing membranes and the insulating blocks can be found in the publications FR-A-2691520, US-A-5586513 and US-A-6035795.

The second embodiment shown in figures 4 and 5 will now be described. The same reference figures designate elements similar or identical to those in figures 2 and 3 and will not be described again.

In the second embodiment, the projecting flange 10 is exclusively formed by a bead of polymerisable resin 30.

The bead of polymerisable resin 30 is placed under the wing of the corner insulating block 22 which rests on the bottom wall 2, at the end of the wall away from ridge 28 or 29. Here again, in addition to confining the runoff water, the bead of polymerisable resin 30 can serve as a shim to compensate for the unevenness of the supporting structure.

The bead of polymerisable resin 30 can be an epoxy putty. The putty is a pasty material consisting of an epoxy resin and a hardener which hardens the putty after application. The putty is applied on the face of the insulating blocks designed to be opposite the supporting structure. Before the putty has hardened, the insulating blocks are installed. The putty is crushed in this installation. Rigid shims, represented by number 34 in figure 11, can be placed on the supporting wall to control the final thickness of the putty and ensure the flatness of the surface of the insulating blocks placed on the same supporting wall.

As can be seen in figures 4, 5 and 11, the corner structure 22 can be formed by two parts attached together, namely a main part 32 and an added part 33 which extends parallel to the ridge along the outer face of the main part 32 oriented in the opposite direction to the ridge. The added part 33 takes the form of an elongated parallelepiped block of the same thickness as the main part 32 and attached by gluing or another means against the outer face of the main part 32. Its width can be customised to take into account the dimensional tolerances of the supporting wall.

In this case, the polymerisable resin bead 30 can be fitted under the added part 33 of the corner structures 22. This facilitates the fitting of the polymerisable resin bead 30. More precisely, the assembly of the corner structures 22 begins with the installation of the main parts 32, without the added parts 33. The corner structures 22 are positioned in the form of a row along the ridge. The added parts 33

are installed in a second stage, being previously covered with successive portions of the polymerisable resin bead 30 on their inner face. The added parts 33 are thus glued simultaneously against the bottom wall 2 and against the main parts 32 of the corner structures 22.

As can be seen in figure 12, when the row of the corner structures 22 presents intermediate spaces 35, which is preferred to facilitate the assembly of the tank wall, the bead sections 36 located under the successive corner structures 22 are not necessarily sufficient to form a continuous flange. For example, the intermediate space 35 may be 10 to 50 mm wide, particularly approximately 30 mm. To connect the bead sections 36, connecting sections 37 also made of polymerisable resin are used. The bead sections 36 and the connecting sections 37 jointly form the polymerisable resin bead 30 in this case.

As the height of the polymerisable resin bead 30, particularly of the connecting sections 37, is not necessarily sufficient to perform the flow drainage function without any risk of overflow, an insert 38 is used in the intermediate space 35 between two corner structures 22 to elevate the projecting flange at this point. The insert 38 is preferably glued by its side faces to the added parts 33 of the corner structures 22 and to the bottom wall 2 via the connecting section 37 of the polymerisable resin bead. It reaches for example a height of approximately 50 mm.

As can be seen in figure 13, the insert 38 may comprise, in a similar way to the corner structures 22, a rigid bottom plate 39, for example made of plywood, and a covering layer of insulating polymer foam 46, which are assembled by gluing. The connecting section 37 of the polymerisable resin bead is initially deposited on the face of the bottom plate 39 designed to be opposite the supporting structure.

Preferably, a strip of flexible insulating sealing material, for example in glass wool, is inserted in the spaces between the corner structures 22 and the flat insulating blocks 21 and in the remaining part of the intermediate space 35, so as to limit heat transfers by convection. Between two corner structures 22, the combination of the insert 38 in a lower part of the intermediate space 35 and a flexible strip in the remaining part of the intermediate space 35 allows liquid flow guidance to be obtained without any risk of overflow while leaving the possibility for the corner structures 22 to move or deform slightly in the intermediate space 35, particularly in response to the deformations of the bottom wall 2 at sea.

The primary sealing membrane is omitted in figures 4 and 5. Other details concerning embodiments of the sealing membranes and the insulating blocks can be found in the publications WO-A-2014167214 and WO-A-2017006044.

The third embodiment will now be described in reference to figures 6 to 9. The same reference figures designate elements similar or identical to those in figures 1 to 5 and will not be described again.

Figure 6 shows the ridges 28 and 29 joining at a corner of the supporting structure. Along each edge 28, 29, the tank wall comprises a series of rigid plates 40, for example in plywood. The rigid plate 40 straddles the ridge 28 or 29 of the supporting structure and presents a first edge glued on the bottom wall 2 by means of a bead of polymerisable resin 41 and a second edge glued against the lower bevel part 6 or the transverse wall 4 or 5 by means of a bead of polymerisable resin 42. The bead of polymerisable resin 41 is continuous and constitutes the projecting flange 10. The bead of polymerisable resin 42 is discontinuous so as not to prevent water runoff to the bottom wall 2.

The thermally insulating barrier of the tank wall consists in this case of insulating housings 43, for example in wood, filled with an insulating material such as glass wool, perlite or other material. The insulating housings 43 are juxtaposed on the supporting walls so as to substantially cover the inner surface of the supporting structure. In figures 7 and 8, the rigid plate 40 is each time fitted between a row of insulating housings 43 attached on the bottom wall 2 and a row of insulating housings 43 attached on the transverse wall 4 or 5 or the longitudinal wall. A heat-insulating lining 45, for example in glass wool or another flexible insulating material, is also fitted on the rigid plate 40 between the two rows of insulating housings 43.

Figure 9 shows an insulating housing 50 which can be positioned on the bottom wall 2 at the drain hole 11 when the drain hole is distant from the projecting flange, formed here by the bead of polymerisable resin 41 under the rigid plate 40. Here, the drain hole 11 is offset towards the central area 14 of the bottom wall 2. The other insulating housings are omitted from this figure for reasons of legibility.

The insulating housing 50 is located between the rigid plate 40 and the drain hole 11 and comprises a recess in its lower plate defining a flow channel 51 with a rectangular section passing through the whole width of the insulating housing 50. The flow channel 51 extends transversely to the bead of polymerisable resin 41.

The bead of polymerisable resin 41 presents a break, not shown, at one end of the flow channel 51 oriented towards the rigid plate 40, to allow the water or the liquid from the border area 15 to flow out through the flow channel 51 to the drain hole 11.

Figure 6 also shows anchor plates 60 which are welded on the bottom wall 2 and the bevel part 6 to attach a ring for connection of the sealed membranes, according to the known technique.

The rigid plates 40 and the bead of polymerisable resin 41 under them are interrupted on each anchor plate 60, but the bead of polymerisable resin 41 is connected in a sealed way to the two faces of each anchor plate 60. In addition, at the ridge 29, it can be seen that the anchor plates 60 present openings 61 to create a passage for the liquid.

The sealing membranes are omitted in figures 7 and 8. Other details concerning embodiments of the sealing membranes and the insulating housings can be found in the publications FR-A-2867831 and FR-A-2798358.

As can be seen in figure 9, the drain hole or each drain hole 11 is preferably covered by a grille 55 to filter possible solid waste and stop it from entering the evacuation system.

In reference to figure 10, a cutaway view of an LNG carrier ship 70 shows a sealed and insulated tank 71 of generally prismatic shape mounted in the double hull 72 of the ship. The wall of the tank 71 comprises a primary sealed barrier designed to be in contact with the liquefied gas contained in the tank, a secondary sealed barrier fitted between the primary sealed barrier and the double hull 72 of the ship, and two insulating barriers fitted respectively between the primary sealed barrier and the secondary sealed barrier and between the secondary sealed barrier and the double hull 72. In a simplified version, the ship comprises a single hull.

In conventional manner, loading/unloading pipes 73 positioned on the upper deck of the ship can be connected, by means of appropriate connectors, to a maritime or port terminal to transfer a liquefied gas cargo from or to the tank 71.

Figure 10 shows an example of a maritime terminal comprising a loading and unloading station 75, a subsea pipeline 76 and a shore installation 77. The loading and unloading station 75 is a fixed offshore installation comprising a mobile arm 74 and a tower 78 which supports the mobile arm 74. The mobile arm 74

carries a bundle of insulated flexible pipes 79 which can be connected to the loading/unloading pipes 73. The adjustable mobile arm 74 fits all LNG carrier sizes. A connection pipe (not shown) extends inside the tower 78. The loading and unloading station 75 enables loading and unloading of the LNG carrier 70 from or to the shore installation 77. This installation comprises liquefied gas storage tanks 80 and connection pipes 81 connected by the undersea pipeline 76 to the loading or unloading station 75. The undersea pipeline 76 allows the transfer of the liquefied gas between the loading or unloading station 75 and the shore installation 77 over a long distance, for example 5 km, allowing the LNG carrier 70 to be kept at a long distance from the coast during the loading and unloading operations.

To generate the pressure necessary for the transfer of the liquefied gas, pumps on board the ship 70 and/or pumps equipping the shore installation 77 and/or pumps equipping the loading and unloading station 75 are used.

The use of the verb “contain”, “comprise” or “include” and conjugated forms thereof does not exclude the presence of other elements or steps other than those stated in a claim. The use of the indefinite article “a” or “an” for an element or step does not exclude, unless otherwise stated, the presence of a plurality of such elements or steps.

In the claims, any reference sign within parentheses should not be interpreted as limiting the claim.

CLAIMS

1. A sealed and thermally insulating tank for the storage or transport of a cold fluid, the tank comprising supporting walls defining a supporting structure (1) and tank walls attached on an inner surface of the supporting walls, in which each tank wall comprises a sealed membrane and a thermally insulating barrier fitted between the sealed membrane and the supporting wall,

in which the supporting structure comprises a bottom supporting wall (2) presenting a drain hole (11) passing through the bottom supporting wall to enable draining of the supporting structure,

in which the bottom supporting wall carries a projecting flange (10) to guide a flow of liquid to the drain hole, the projecting flange extending along the edges of the bottom supporting wall (2) at a distance from the edges of the bottom supporting wall continuously on the whole periphery of the bottom supporting wall, the projecting flange (10) being covered by the thermally insulating barrier of the tank wall attached on the bottom supporting wall.

2. A sealed and thermally insulating tank for the storage or transport of a cold fluid, the tank comprising supporting walls defining a supporting structure (1) and tank walls attached on an inner surface of the supporting walls, in which each tank wall comprises a sealed membrane and a thermally insulating barrier fitted between the sealed membrane and the supporting wall,

in which the supporting structure comprises a bottom supporting wall (2) presenting a drain hole (11) passing through the bottom supporting wall to enable draining of the supporting structure,

in which the bottom supporting wall carries a projecting flange (10) to guide a flow of liquid to the drain hole, the projecting flange extending along the edges of the bottom supporting wall (2) at a distance from the edges of the bottom supporting wall and is interrupted only at said drain hole,

the projecting flange (10) being covered by the thermally insulating barrier of the tank wall attached on the bottom supporting wall.

3. The tank according to claim 1 or 2, in which the projecting flange (10) comprises a bead (41, 30, 27) made of a polymer resin adhering on the bottom supporting wall (2).

4. The tank according to any one of claims 1 to 3, in which the projecting flange (10) comprises a series of metal parts (20) welded on the bottom supporting wall (2).

5. The tank according to any one of claims 1 to 4, in which the supporting structure comprises at least one side supporting wall (4, 5, 6), vertical or slanting, connected to an edge of the bottom supporting wall (2) on a ridge (28, 29) of the supporting structure, the projecting flange being positioned parallel to the ridge.

6. The tank according to claim 5, in which the thermally insulating barrier of the tank wall attached on the bottom supporting wall comprises a plurality of corner structures (22) fitted along the ridge of the supporting structure, each corner structure (22) comprising a first wing covering a border area of the bottom supporting wall (2) and a second wing inclined with respect to the first wing and covering a border area of the side supporting wall (4, 5, 6).

7. The tank according to claim 6, in which the projecting flange is positioned under the first wing of the corner structures (22), along an outer side of the first wing of the corner structures opposite the ridge (28, 29) of the supporting structure.

8. The tank according to claim 6, in which the thermally insulating barrier of the tank wall also comprises a plurality of flat insulating blocks (21) attached on the bottom supporting wall so as to substantially cover the inner surface of the bottom supporting wall (2), and in which the projecting flange (10) is positioned between the first wing of the corner structures (22) and the flat insulating blocks (21).

9. The tank according to claim 5, in which the thermally insulating barrier of the tank wall attached on the bottom supporting wall comprises a rigid plate (40) straddling the ridge of the supporting structure and presenting a first edge bearing on the bottom supporting wall and a second edge bearing against the side supporting

wall, the projecting flange consisting of a bead of polymerisable resin (41) fitted between the first edge of the rigid plate and the bottom supporting wall (2) to attach the first edge of the rigid plate to the bottom supporting wall by adhesion.

10. The tank according to claim 9, in which the thermally insulating barrier of the tank wall comprises flat insulating blocks (43) attached on the bottom supporting wall (2) and on the side supporting wall (4, 5, 6) so as to substantially cover the inner surface of the bottom supporting wall and of the side supporting wall, the rigid plate (40) being fitted between a row of the flat insulating blocks attached on the bottom supporting wall and a row of the flat insulating blocks attached on the side supporting wall, a flexible insulating material (45) also being fitted on the rigid plate (40) between the row of the flat insulating blocks attached on the bottom supporting wall and the row of the flat insulating blocks attached on the side supporting wall.

11. The tank according to claim 7, in which the projecting flange (10) comprises a bead (30) made of a polymer resin deposited on and adhering on the face of the corner structures (22) designed to be opposite the supporting structure.

12. The tank according to claim 11, in which the corner structures (22) are positioned along the ridge of the supporting structure in the form of a row comprising intermediate spaces (35) and in which blocks of insulating material (38) are inserted in the intermediate spaces (35) between the corner structures (22) of the row,

the projecting flange (10) comprising bead sections (36) made of the polymer resin deposited on and adhering on the face of the corner structures (22) designed to be opposite the supporting structure and connecting sections (37) made of the polymer resin deposited on and adhering on the face of the blocks of insulating material (38) designed to be opposite the supporting structure, so that the connecting sections (37) connect the bead sections (36) to each other.

13. The tank according to claim 13, in which a strip of flexible insulating sealing material is inserted in a remaining part of the intermediate space (35) so as to limit heat transfers by convection.

14. The tank according to any one of claims 2 to 13, in which the projecting flange is interrupted at the drain hole (11) to allow the flow of liquid to pass towards the drain hole.

15. The tank according to claim 14, in which the edges of the bottom supporting wall (2) are located on an outer side of the projecting flange (10) and the drain hole (11) is located on an inner side of the projecting flange (10) opposite the outer side,

in which the thermally insulating barrier of the tank wall comprises flat insulating blocks (43) attached on the bottom supporting wall on the inner side of the projecting flange,

and in which a flat insulating block (50) located between a break in the projecting flange (10) and the drain hole (11) comprises a recess defining a flow channel (51) in a lower surface of the flat insulating block (50), the flow channel extending transversely to the projecting flange.

16. The tank according to claim 14, in which the drain hole (11) is located in line with the projecting flange (10), the projecting flange being interrupted at the edge of the drain hole.

17. The tank according to any one of claims 1 to 16, in which the supporting structure is the hull of a ship (70), the drain hole being located near an edge of the bottom supporting wall (2) located towards the rear (5) of the ship.

18. The tank according to any one of claims 1 to 17, in which the projecting flange (10) is at a distance from the edge of the bottom supporting wall (2) which is less than one tenth of the dimension of the bottom supporting wall in a direction perpendicular to said edge of the bottom supporting wall.

19. The tank according to any one of claims 1 to 18, in which the drain hole is equipped with a water presence sensor.

20. A ship (70) for transport of a cold liquid product, the ship comprising a hull (72) and a tank according to one of claims 1 to 19, in which the supporting structure consists of the hull (72) of the ship.

21. A process of loading or unloading of a ship (70) according to claim 20, in which a cold liquid product is routed through the insulated pipes (73, 79, 76, 81) from or to a floating or shore-based storage facility (77) to or from the tank (71) of the ship according to claim 20.

22. A transfer system for a cold liquid product, the system comprising a ship (70) according to claim 20, insulated pipes (73, 79, 76, 81) fitted so as to connect the tank (71) installed in the hull of the ship to a floating or shore-based storage facility (77) and a pump to cause a flow of cold liquid product through the insulated pipes from or to the floating or shore-based storage facility to or from the tank of the ship.