METHOD FOR ASSEMBLING A SEALED AND THERMALLY INSULATING TANK

Technical field

The invention relates to the field of sealed and thermally insulating tanks for storing and/or transporting a fluid such as a cryogenic fluid. Sealed and thermally insulating tanks are in particular employed for storing liquefied natural gas (LNG), which is stored, at atmospheric pressure, at approximately -162°C.

The invention more particularly concerns a method of assembling a sealed and thermally insulating tank of this kind.

Technological background

The document FR2785034 discloses a sealed and thermally insulating tank for storing liquefied natural gas that is installed in the double hull of a ship.

The sealed and thermally insulating tank includes walls that feature a multilayer structure successively consisting of a secondary thermally insulating barrier resting against the internal hull of the ship, a secondary sealing membrane resting against the secondary thermally insulating barrier, a primary thermally insulating barrier resting against the secondary sealing membrane, and a primary sealing membrane intended to be in contact with the liquefied gas contained in the tank.

The tank is equipped with a loading/offloading tower for loading the cargo into the tank before its transportation and for offloading the cargo after its transportation.

During the assembly of a tank of this kind the secondary and primary thermally insulating barriers and the secondary and primary sealing membranes are mounted in the double hull of the ship and anchored to the latter, after which the loading/offloading tower is mounted in the tank and fixed to the double hull of the ship.

The method of assembling a tank of this kind is not entirely satisfactory, in particular because it is particularly lengthy.

The known document JP S56146485 describes a method for assembling a prior art sealed and thermally insulating tank.

Summary

An idea on which the invention is based is to propose a method for assembling a sealed and thermally insulating tank that enables reduction of the assembly time.

In accordance with one embodiment the invention provides a method for assembling a sealed and thermally insulating tank for storing a fluid inside a support structure, said support structure having a polyhedral general shape defined by a plurality of walls, said plurality of walls including an upper wall, a lower wall and a first transverse wall that extends vertically between the upper wall and the lower wall; the assembly method including the following steps:

- mounting a scaffold inside the support structure, said scaffold including a support frame resting against the lower wall and a plurality of horizontal platforms fixed to the support frame; each of the platforms featuring an opening; the openings of the platforms being disposed one above the other in such a manner as to form through the platforms a vertical passage;
- lowering a loading/offloading tower inside the support structure by inserting said loading/offloading tower, on the one hand, through an opening formed in the upper wall of the support structure and, on the other hand, through openings of the platforms;
- fixing said loading/offloading tower to the upper wall of the support structure;
- anchoring to each of the walls of the support structure at least one thermally insulating barrier and one sealing membrane resting against said thermally insulating barrier; the sealing membrane of the first transverse wall being anchored to said first transverse wall after lowering the loading/offloading tower inside the support structure.

Compared to the prior art assembly methods, an assembly method of this kind therefore enables a considerable reduction in assembly time because the fixing of the loading/offloading tower onto the support structure and/or the sealing tests on the tank wall in the zone of the support structure from which the loading/offloading tower is suspended may be carried out at the same time as anchoring to the support structure at least a part of the multilayer structure of at least one of the walls of the tank, such as the primary sealing membrane of the first transverse wall.

According to one embodiment the platforms each further feature a catwalk between the opening of said scaffold and the first transverse wall. These catwalks enable access to the zones of the first transverse wall situated between the loading/offloading tower and said first transverse wall in order to anchor thereto at least the sealing membrane, while said loading/offloading tower extends inside the support structure.

According to another embodiment the scaffold includes an elevator able to move vertically through the portion of the openings adjacent the first transverse wall. An elevator of this kind is therefore able to move between the loading/offloading tower and the first transverse wall when said loading/offloading tower extends inside the support structure, which allows operatives access to the zones of the support structure situated behind the loading/offloading tower.

According to other advantageous embodiments a method of this kind may feature one or more of the following features.

According to one embodiment the openings of the platforms are formed near the first transverse wall.

According to one embodiment the first transverse wall is the wall of the support structure closest to the openings.

According to one embodiment the catwalks close the contour of the openings of the platforms.

According to one embodiment the distance L between the loading/offloading tower and the sealing membrane of the first transverse wall is greater than 0.80 m, advantageously greater than 1 m and preferably greater than or equal to 1.50 m.

According to one embodiment the distance L between the loading/offloading tower and the sealing membrane of the first transverse wall is less than 10 meters, advantageously less than 5 meters and preferably less than 3 meters. This enables optimization of the quantity of cargo that can be offloaded, in particular when the tank is on board a ship and the first transverse wall is a rear wall.

According to one embodiment the loading/offloading tower includes three pylons that are fixed to one another by crossmembers and each of which extends

vertically along a central axis; the three central axes of the pylons define in projection in a horizontal plane the vertices of a triangle; said triangle being oriented relative to the first transverse wall so that one of the three vertices of the triangle is disposed closer to the first transverse wall than the other two vertices. This enables access to the zones of the first transverse wall behind the loading/offloading tower to be facilitated.

According to one embodiment the triangle is equilateral.

According to one embodiment the triangle is oriented so that a bisector of a corner of the triangle defined by two sides of the triangle join at the level of the vertex of the triangle that is disposed closest to the first transverse wall forms with said first transverse wall an angle α between 45° and 135° inclusive. According to one embodiment the angle α is between 70 and 110° inclusive. According to one embodiment the angle α is equal to 90°. This enables further facilitation of access to the zones of the first transverse wall behind the loading/offloading tower.

According to one embodiment the upper wall includes a liquid dome projecting upwardly from the upper wall of the support structure, the opening formed in the upper wall through which the loading/offloading tower is lowered being formed in the liquid dome, and fixing the loading/offloading tower to the upper wall of the support structure includes the steps of fixing a cover onto the liquid dome in such a manner as to cover the opening formed in the liquid dome and to fix said loading/offloading tower to said cover.

According to one embodiment the loading/offloading tower includes three hollow pylons and the interior of the support structure is aerated via at least one of the pylons, thus forming an aeration duct when the cover is fixed to the liquid dome.

According to one embodiment the liquid dome is positioned at a distance from the first transverse wall, the upper wall of the support structure including a horizontal portion connecting the first transverse wall of the support structure to a vertical transverse wall of the liquid dome. This enables the loading/offloading tower to be disposed at a distance from the first transverse wall sufficient to enable access between the loading/offloading tower and the first transverse wall without

consequently increasing the size of the liquid dome in the longitudinal direction of the ship.

According to another embodiment the liquid dome includes a vertical transverse wall that extends in line with the first transverse wall.

According to one embodiment the liquid dome includes two transverse walls and two lateral walls that extend vertically.

According to one embodiment, after fixing the cover over the opening of the liquid dome:

- insulating elements of the thermally insulating barrier are anchored against a central part of the cover;
- insulating elements of the thermally insulating barrier are anchored against the transverse walls and lateral walls of the liquid dome; and
- after anchoring insulating elements of the thermally insulating barrier against the central part of the cover and against the transverse and lateral walls of the liquid dome insulating elements of the thermally insulating barrier are disposed against a peripheral portion of the cover disposed around the central part of the cover. It is therefore possible to assemble the tank wall in the zone of the liquid dome from which the loading/offloading tower is suspended in parallel with assembling the rest of the upper wall of the tank.

According to one embodiment when lowering the loading/offloading tower inside the support structure, temporary support means are disposed between the loading/offloading tower and the lower wall of the support structure in such a manner as to support said loading/offloading tower; the temporary support means being removed after fixing the loading/offloading tower to the upper wall of the support structure.

According to one embodiment the temporary support means are equipped with lifting means such as jacks.

According to one embodiment the support frame of the scaffold is equipped with feet that are vertically retractable and by means of which said support frame rests against the lower wall of the support structure and said feet are retracted successively when anchoring the thermally insulating barrier and the sealing membrane onto the

lower wall of the support structure in such a manner as to cause them successively to rest against the thermally insulating barrier and against the sealing membrane.

According to one embodiment there is further anchored to each of the walls of the support structure a secondary thermally insulating barrier resting against the support structure and a secondary sealing membrane resting against the secondary thermally insulating barrier; the primary thermally insulating barrier resting against the secondary sealing membrane and the feet are successively retracted when anchoring the secondary thermally insulating barrier and the secondary sealing membrane onto the lower wall of the support structure.

According to one embodiment the platforms feature retractable edges and each of said edges is retracted as and when the thermally insulating barrier and the sealing membrane are anchored to the wall of the support structure facing said edge.

According to one embodiment the catwalks feature an edge facing the first transverse wall that is retractable horizontally and said edge is retracted as and when the thermally insulating barrier and the sealing membrane are anchored to the first transverse wall.

According to one embodiment there are further anchored to each of the walls of the support structure a secondary thermally insulating barrier resting against the support structure and a secondary sealing membrane resting against the secondary thermally insulating barrier; the thermally insulating barrier resting against the secondary sealing membrane.

In other words, each wall of the tank features successively, from the exterior to the interior, in the direction of the thickness of the wall, a secondary thermally insulating barrier, a secondary sealing membrane anchored to the secondary thermally insulating barrier, a primary thermally insulating barrier resting against the secondary sealing membrane, and a primary sealing membrane anchored to the primary thermally insulating barrier and intended to be in contact with the liquid contained in the tank.

According to one embodiment the support structure is on board a ship and the first transverse wall is a rear wall.

According to one embodiment at least the primary sealing membrane is anchored to the first transverse wall after lowering the loading/offloading tower. According to one embodiment at least the primary sealing membrane and the primary thermally insulating barrier are anchored to the first transverse wall after lowering the loading/offloading tower. According to one embodiment at least the primary sealing membrane, the primary thermally insulating barrier and the secondary sealing membrane are anchored to the first transverse wall after lowering the loading/offloading tower. According to one embodiment at least the primary sealing membrane, the primary thermally insulating barrier, the secondary sealing membrane and the secondary thermally insulating barrier are anchored to the first transverse wall after lowering the loading/offloading tower.

According to one embodiment the support structure consists of the double hull of a ship.

Brief description of the figures

The invention will be better understood and other aims, details, features and advantages thereof will become more clearly apparent in the course of the following description of a plurality of particular embodiments of the invention given by way of nonlimiting illustration only and with reference to the appended drawings.

- Figure 1 is a partial schematic view of a support structure intended to receive the walls of a sealed and thermally insulating tank.

- Figure 2 is a schematic view of the multilayer structure of the walls of the tank.

- Figure 3 is a schematic view illustrating a loading/offloading tower and partly illustrating the support structure inside which it is mounted.

- Figure 4 is a schematic illustration representing the disposition of the pylons of the loading/offloading tower relative to the rear wall of the support structure in accordance with one embodiment.

- Figure 5 is a schematic illustration representing the disposition of the pylons of the loading/offloading tower relative to the rear wall of the support structure in accordance with another embodiment.

- Figure 6 is a partial view in longitudinal section of the sealed and thermally insulating tank at the level of the liquid dome and of the loading/offloading tower in accordance with one embodiment.

- Figure 7 is a partial view in longitudinal section of the sealed and thermally insulating tank at the level of the liquid dome and of the loading/offloading tower in accordance with another embodiment.

- Figure 8 is a schematic perspective view partly illustrating the support structure and the scaffold assembled inside the support structure in order to assemble the sealed and thermally insulating tank; the platforms not being equipped with catwalks disposed between the openings formed in the platforms and the rear wall of the support structure.

- Figure 9 is a diagrammatic perspective view partly illustrating the support structure and the scaffold installed inside the support structure, the platforms being equipped with catwalks disposed between the openings formed in the platforms and the rear wall of the support structure.

- Figure 10 is a view from above of one of the platforms of the scaffold as represented in figure 8.

- Figure 11 is a view from above of one of the platforms of the scaffold as represented in figure 9.

- Figure 12 is a schematic view of a support foot intended to cooperate with the base of the loading/offloading tower.

- Figure 13 is a diagrammatic illustration of temporary support means supporting the loading/offloading tower on the lower wall of the support structure.

- Figure 14 is a schematic illustration of temporary support means supporting the loading/offloading tower on insulating elements of the secondary thermally insulating barrier that are anchored against the lower wall of the support structure.

- **Figures 15 and 16** illustrate a sequence of assembling the wall of the tank at the level of the liquid dome in accordance with one embodiment.

Detailed description of embodiments

Referring to figure 1, there is seen the rear part of a support structure 1 intended to receive the walls of a sealed and thermally insulating tank. The support structure 1 is formed by the double hull of a ship. The support structure 1 has a polyhedral general shape. The support structure 1 has a front wall 2 and a rear wall 3, here of octagonal shape. In figure 1 only part of the front wall 2 is shown in order to enable the internal space of the support structure 1 to be visualized. The front wall 2 and the rear wall 3 are cofferdam walls of the ship and extend transverse to the longitudinal direction of the ship. The support structure 1 also includes an upper wall 4, a lower wall 5 and lateral walls 6, 7, 8, 9, 10, 11. The upper wall 4, the lower wall 5 and the lateral walls 6, 7, 8, 9, 10, 11 extend in the longitudinal direction of the ship and connect the front wall 2 and the rear wall 3.

The upper wall 4 includes near the rear wall 3 of the support structure 1 a space of rectangular parallelepiped shape projecting upward, called the liquid dome 12. The liquid dome 12 is defined by a front transverse wall 13 and a rear transverse wall 14 and by two lateral walls 15, 16 that extend vertically and project upward from the upper wall 4. The liquid dome 12 further includes a horizontal cover, not represented in figure 1, that is intended to cover in sealed manner the opening formed between the front wall 13, rear wall 14 and lateral walls 15, 16 of the liquid dome 12.

The tank the assembly method of which will be described hereinafter is a membrane type tank having a multilayer structure. As represented schematically in figure 2, each wall of the tank therefore features successively, from the exterior toward the interior, in the direction of thickness of the wall, a secondary thermally insulating barrier 17 including insulating elements resting against the support structure 1, a secondary sealing membrane 18 anchored to the insulating elements of the secondary thermally insulating barrier 17, a primary thermally insulating barrier 19 including insulating elements resting against the secondary sealing membrane 17, and a primary sealing membrane 20 anchored to the insulating elements of the primary thermally insulating barrier 19 and intended to be in contact with the fluid

contained in the tank. This multilayer structure of the tank is disposed on each of the walls 4, 5, 6, 7, 8, 9, 10 of the support structure 1. This multilayer structure is also present on the walls of the liquid dome 12 except at the level of the cover where it is liable to be different.

By way of example, each wall of the tank may in particular be of the Mark III type as described for example in FR2691520, of NO96 type as described for example in FR2877638, or of Mark V type as described for example in WO14057221.

Each wall of the tank is anchored to the respective wall of the support structure 1, proceeding from the exterior toward the interior of the tank, that is to say:
- by anchoring the insulating elements of the secondary thermally insulating barrier 17 onto the respective wall of the support structure 1;
- by anchoring the secondary sealing member 18 onto the insulating elements of the secondary thermally insulating barrier 17;
- by anchoring the insulating elements of the primary thermally insulating barrier 19 onto the insulating elements of the secondary thermally insulating barrier 17 or onto the support structure 1 through the secondary sealing membrane 18; and then
- by anchoring the primary sealing membrane 20 to the insulating elements of the primary thermally insulating barrier 19.

Moreover, the tank includes a loading/offloading tower 21, illustrated in figure 3, in particular enabling the cargo to be loaded into the tank before its transportation and/or the cargo to be offloaded after its transportation. The loading/offloading tower 21 is installed near the rear wall 3 of the support structure 1 because when offloading the cargo the ship is tilted backwards, which enables optimization of the quantity of cargo that can be offloaded by the loading/offloading tower 21.

The loading/offloading tower 21 is suspended from the upper wall 4 of the support structure 1 and more particularly from the cover of the liquid dome 12. The loading/offloading tower 21 extends over substantially all the height of the tank. The loading/offloading tower 21 supports at its lower end one or more pumps for offloading the cargo.

The base of the loading/offloading tower 21 cooperates with a support foot 36, illustrated in figure 12, that is fixed to the lower wall 5 of the support structure 1

and which aims to maintain the loading/offloading tower 21 in a vertical position. When the tank is assembled the support foot 36 projects inside the tank and through the primary thermally insulating barrier 19 and the secondary thermally insulating barrier 17 and the primary sealing membrane 20 and the secondary sealing membrane 18 of the lower wall of the tank. A support foot 36 of this kind is described for example in the applications FR3035475 and WO2011157915.

Returning to figure 3, it is seen that the loading/offloading tower 21 has a tripod structure, that is to say that it includes three vertical pylons 22, 23, 24 fixed to one another by crossmembers 25. Each of the pylons 22, 23, 24 is hollow and passes through the cover of the liquid dome 12. Each of the pylons 22, 23, 24 therefore forms either a loading and/or offloading line enabling loading or offloading of the fluid to or from the tank or an emergency well enabling lowering of an emergency pump and an offloading line in the event of failure of the other offloading pumps. In a represented embodiment two of the pylons 22, 23 form a line for offloading the tank and to this end each of them is associated with an offloading pump 26, 27 fixed to the lower end of the loading/offloading tower 21 whereas the third pylon 25 forms an emergency well. In an embodiment of this kind the loading/offloading tower 21 carries one or more loading lines, not represented, that do not constitute one of the pylons 22, 23, 24 of the tripod structure.

As will be described in detail hereinafter, the loading/offloading tower 21 is advantageously lowered inside the support structure 1 before all of the walls of the tank are assembled and fixed to the support structure 1 and in particular before the primary sealing membrane of the rear wall is assembled and anchored to the rear wall 3 of the support structure 1.

Figures 4 and 5 illustrate schematically the tripod structure of the pylons 22, 23, 24 of the loading/offloading tower 21 in accordance with two different arrangements relative to the rear wall 3 of the support structure 1. The three pylons 22, 23, 24 extend vertically. The central axes of the three pylons 22, 23, 24 therefore define, in projection in a horizontal plane, the vertices ABC of a triangle. The three pylons 22, 23, 24 are advantageously disposed equidistantly from one another so that the triangle ABC is an equilateral triangle.

In the embodiment represented in figure 4 the side AC of the triangle that is nearest the rear wall 3 of the support structure 1 is parallel to said rear wall 3. In other words, two vertices A and C of the triangle are placed at an equal distance from the rear wall 3 of the support structure 1.

In figure 5 the orientation of the angle ABC defined by the central axis of the pylons 22, 23, 24 of the loading/offloading tower 21 relative to the rear wall 3 of the support structure 1 is optimized in order to facilitate access to the zones of the rear walls 3 situated behind the loading/offloading tower 21. A disposition of this kind is therefore advantageous in that it facilitates mounting the wall of the tank against the rear wall 3 of the support structure 1 when the loading/offloading tower 21 is already present inside the support structure 1. In this embodiment the triangle ABC is oriented so that one vertex A of the triangle defined by the central axes of the three pylons 23, 24, 25 is placed closer to the rear wall 3 than the other two vertices B and C of the triangle. Moreover, the bisector 28 of the corner BAC of the triangle that is defined by the two sides BA and AC of the triangle joining at the vertex A nearest the rear wall 3 forms with said rear wall 3 an angle α between 45° and 135° inclusive, advantageously between 70° and 110° inclusive, and preferably of the order of 90°.

Whatever the disposition of the loading/offloading tower 21, the latter is advantageously placed at a distance L from the destination location of the primary sealing membrane 21 of the rear wall, represented in dashed line in figures 4 and 5, that is sufficient to enable installation of said rear wall of the tank in the zones situated behind the loading/offloading station 21. The distance L is preferably greater than 0.80 meter, advantageously greater than 1 meter and preferably greater than or equal to 1.50 meter.

In order to optimize the quantity of cargo that can be offloaded via the loading/offloading tower 21 the distance L between the loading/offloading tower 21 and the destination location of the primary sealing membrane 21 of the rear wall is advantageously less than 10 meters, advantageously less than 5 meters and preferably less than 3 meters.

Moreover, in accordance with one embodiment, in order to enable installation of the lower wall of the tank after installation of the loading/offloading tower 21 inside

the support structure 1, the lower end of the loading/offloading tower 21 is disposed at a vertical distance greater than 0.4 m and preferably greater than 0.5 m from the destination location of the primary sealing membrane of the lower wall of the tank.

Figures 6 and 7 represent in detail the liquid dome 12 and the upper part of a loading/offloading tower 21 in accordance with two variant embodiments.

In the variant embodiment represented in figure 6 the liquid dome 12 is offset toward the front of the ship relative to the rear wall 3 of the support structure 1. In other words, the rear wall 14 of the liquid dome 12 does not extend in the same horizontal plane as the rear wall 3 of the support structure 1, that is to say in line with it, and is positioned toward the front of the ship relative to the rear wall 3. The upper wall 4 of the support structure 1 then includes a horizontal portion 29 that connects the rear wall 3 of the support structure 1 to the rear wall 14 of the liquid dome 12. This enables the loading/offloading tower 21 to be disposed at a distance from the rear wall 3 of the support structure 1 sufficient to enable access between the loading/offloading tower 21 and the rear wall 3 of the support structure 1 enabling assembly of the rear wall of the tank without consequently increasing the size of the liquid dome 12 in the longitudinal direction of the ship.

To the contrary, in another variant embodiment represented in figure 7 the rear wall 14 of the liquid dome 12 extends in line with the rear wall 3 of the support structure 1 and the length of the liquid dome 12 along the longitudinal axis of the ship is sized accordingly, that is to say so that the loading/offloading tower 21 can be disposed at a distance from the rear wall 3 of the support structure 1 sufficient to allow assembly of the rear wall of the tank. Accordingly, in an embodiment of this kind the loading/offloading tower 21 is placed at a distance from the destination location of the primary sealing membrane intended to cover the rear wall 14 of the liquid dome that is preferably greater than 0.80 meter, advantageously greater than 1 meter and preferably greater than or equal to 1.50 meter.

Figures 8 to 11 illustrate a scaffold 30 intended to be used for assembling the tank.

The scaffold 30 includes a support frame 31 and a plurality of platforms 32a, 32b, 32c that are fixed to the support frame 31. The platforms 32a, 32b, 32c are

regularly spaced in the vertical direction and enable operatives to access the various zones of the support structure 1 in order to anchor thereto the tank walls. The platforms 32a, 32b, 32c are associated with one another by at least one staircase 42 enabling operatives to pass from one platform 32a, 32b, 32c to another.

Moreover, each of the platforms 32a, 32b, 32c includes an opening 34 formed near the rear wall 3 of the support structure 1. The openings 34 are disposed one below the other, below the liquid dome 12 formed in the upper wall 4 of the support structure 1. The openings 34 therefore define a vertical passage that allows the loading/offloading tower 21 to pass through the platforms 32a, 32b, 32c.

Moreover, as represented in figures 9 and 11, each of the platforms 32a, 32b, 32c is advantageously equipped with a catwalk 33 that is disposed between the opening 34 and the rear wall 3 of the support structure 1 and therefore closes the contour of one of the openings 34. In accordance with one embodiment the catwalks 33 are removably fixed to the platforms 32a, 32b, 32c and can be removed as represented in particular in figures 8 and 10, for example in order to facilitate lowering the loading/offloading tower 21 inside the support structure 1. Catwalks 33 of this kind enable access to the zones of the support structure 1 situated behind the loading/offloading tower 21 when the loading/offloading tower 21 is inside the support structure 1 and extends through the openings 34 formed in the platforms 32a, 32b, 32c.

In accordance with an embodiment that is not represented the platforms 32a, 32b, 32c have no catwalks 33 as described hereinbelow. The scaffold 30 then includes one or more elevators able to move vertically through the portion of the openings 34 adjacent the rear wall 3 of the support structure 1. An elevator of this kind is therefore able to move between the loading/offloading tower 21 and the rear wall 3 of the support structure 1 when said loading/offloading tower 21 extends inside the support structure 1, which allows operatives to access the zones of the support structure 1 situated behind the loading/offloading tower 21.

The support frame 31 of the scaffold 30 includes a plurality of feet 35. The feet 35 are advantageously vertically retractable feet. The feet 35 are therefore adapted to be disposed resting against the lower wall 5 of the support structure 1 when mounting the scaffold 30 inside the support structure 1 and then to be disposed

resting against the secondary thermally insulative barrier 17 and the primary thermally insulating barrier 19 and against the secondary sealing membrane 18 and the primary sealing membrane 20 as and when they are assembled and when anchoring the support structure 1 against the lower wall 5. Also, the feet 35 are advantageously retractable over a length greater than or equal to the thickness of the multilayer structure of the lower wall of the tank. Moreover, the lower platform 32a of the scaffold 30 is disposed at a vertical distance from the lower wall 5 of the support structure 1 that is greater than the thickness of the multilayer structure of the lower wall of the tank.

The number and positions of the feet 35 are determined so that the pressure due to the weight of the scaffold remains less than 2 bar at the level of each of the feet 35, which enables deformation of the secondary thermally insulating barrier 17 and the primary thermally insulating barrier 19 and the secondary sealing membrane 18 and the primary sealing membrane 20 to be prevented.

Moreover, the edges of each of the platforms 32a, 32b, 32c are advantageously retractable, for example horizontally, and are therefore adapted to be retracted as and when assembling the tank wall onto the facing wall of the support structure 1. The edge of the catwalks 33 is also retractable.

A method of assembling a sealed and thermally insulating tank will be described hereinafter.

The scaffold 30 is mounted inside the support structure 1 before anchoring any of the tank walls to the support structure 1 commences.

As illustrated in figure 12, a support foot 36 is then assembled and fixed against the lower wall 5 of the support structure 1.

Thereafter the loading/offloading tower 21 is lowered inside the support structure before the cover of the liquid dome 12 has been installed. The loading/offloading tower 21 is inserted through the opening formed between the front wall 13, rear wall 14 and lateral walls 15, 16 of the liquid dome 12. The loading/offloading tower 21 is then lowered inside the support structure 1 through the openings 24 formed in the platforms 32a, 32b, 32c of the scaffold 30.

As represented in figure 13 the base of the loading/offloading tower 21 is guided by the support foot 36 so that said support foot 36 accurately positions the loading/offloading tower 21 and retains it in a vertical position.

The loading/offloading tower 21 is then supported on the lower wall of the support structure by temporary support means 38 represented schematically in figure 13. The temporary support means 38 are advantageously provided with lifting means, such as jacks, enabling adjustment of the vertical position of the loading/offloading tower 21.

In the embodiment represented in figure 13 the loading/offloading tower 21 has been lowered inside the support structure 1 before the secondary thermally insulating barrier 17 is anchored to the lower wall 5 of the support structure 1 in the zone facing said loading/offloading tower 21. Also, in a situation of this kind, the temporary support means 38 rest directly against the lower wall 5 of the support structure 1.

In the variant embodiment illustrated in figure 14 the secondary thermally insulating barrier is anchored to the lower wall 5 of the support structure 1 at least in the zone facing the loading/offloading tower 21. Also, in this variant embodiment the temporary support means 38 rest against insulating elements of the secondary thermally insulating barrier 17 that are anchored against the lower wall 5 of the support structure 1.

Thereafter the cover of the liquid dome 12 is fitted and then welded to the front wall 13, rear wall 14 and lateral walls 15, 16 of the liquid dome 12 in such a manner as to cover the opening formed between the latter.

The loading/offloading tower 21 may then be suspended from the cover, the pylons 22, 23, 24 of the loading/offloading tower 21 passing through orifices formed in said cover. The temporary support means 38 may then be removed.

In accordance with one embodiment, when the cover of the liquid dome has been welded to the front walls 13, rear wall 14 and lateral walls 15, 16 of the liquid dome 12 in such a manner as to cover the opening formed between the latter, the interior space of the tank is aerated via one or more of the hollow pylons 22, 23, 24 of the loading/offloading tower 21, which then serve as aeration ducts.

At least part of the multilayer structure of at least one wall of the tank is advantageously assembled and anchored in parallel with the aforementioned operations of welding the cover of the liquid dome 12 and fixing the loading/offloading tower 21 onto the cover of the liquid dome 12. Compared to the prior art assembly methods in which the loading/offloading tower 21 was lowered inside the support structure 1 and fixed to the latter only after anchoring all the walls of the tank, an assembly method of this kind therefore enables the tank assembly time to be reduced.

In particular, at least the primary sealing membrane of the rear wall of the tank and advantageously all the multilayer structure of the rear wall of the tank are mounted on and anchored to the rear wall 3 of the support structure 1 after the operation of lowering the loading/offloading tower 21 inside the support structure 1. This is in particular made possible by the presence of the catwalks 33 that are disposed between the rear wall 3 of the support structure 1 and the loading/offloading tower 21 when said loading/offloading tower 21 extends inside the support structure 1.

The scaffold 30 can then be dismantled when all the walls of the tank have been assembled and anchored to the support structure 1.

Referring to figures 15 and 16 there is described hereinafter a sequence of assembling the tank inside the liquid dome 12 in accordance with one embodiment.

In this embodiment, after the cover 39 of the liquid dome 12 has been fitted and then welded to the front wall 13, rear wall 14 and lateral walls 15, 16 of the liquid dome 12 and the loading/offloading tower 21 has been fixed to said cover 39, a part 40 of the upper wall of the tank including insulating elements and optionally including one or more sealing membranes is fixed in a central portion of the cover 39. At this stage a peripheral portion 41 of the cover 39 extending around the part of the wall 40 of the upper wall is not covered by insulating elements.

The transverse walls 13, 14 and lateral walls 15, 16 of the liquid dome 12 and advantageously the rest of the upper wall 4 and the rear wall 3 are covered with a multilayer tank wall structure. The multilayer structure is advantageously anchored in some or all of these zones of the support structure at the same time as anchoring the part 40 of the upper wall of the tank that is fixed against the central portion of the cover 39.

Finally, as represented in figure 16, in a later step insulating elements and optionally sealing membranes are positioned against the peripheral portion 41 of the cover 39 in order to ensure continuity of thermal insulation. Mounting, assembling and testing the loading/offloading tower and assembling at least a part of the multilayer structure of the tank walls can therefore be carried out simultaneously.

Although the invention has been described with reference to a plurality of particular embodiments it is obvious that it is in no way limited to them and that it encompasses all of the technical equivalents of the means described and their combinations if the latter fall within the scope of the invention.

The use of the verb "include" or "comprise" and its conjugate forms does not exclude the presence of elements or steps other than those stated in a claim.

In the claims any reference sign between parentheses should not be interpreted as a limitation of the claim.

CLAIMS

1. A method for assembling a sealed and thermally insulating tank for storing a fluid inside a support structure (1), said support structure (1) having a polyhedral general shape defined by a plurality of walls, said plurality of walls including an upper wall (4), a lower wall (5) and a first transverse wall (3) that extends vertically between the upper wall (4) and the lower wall (5); the assembly method including the following steps:

- mounting a scaffold (30) inside the support structure (30), said scaffold (30) including a support frame (31) resting against the lower wall (5) and a plurality of horizontal platforms (32a, 32b, 32c) fixed to the support frame (31); each of the platforms (32a, 32b, 32c) featuring an opening (34); the openings (34) of the platforms (32a, 32b, 32c) being disposed one above the other in such a manner as to form through the platforms (32a, 32b, 32c) a vertical passage, the platforms (32a, 32b, 32c) each further featuring a catwalk (33) between the opening of said scaffold (30) and the first transverse wall (3);
- lowering a loading/offloading tower (21) inside the support structure (1) by inserting said loading/offloading tower (21), on the one hand, through an opening formed in the upper wall (4) of the support structure (1) and, on the other hand, through openings (34) of the platforms (32a, 32b, 32c);
- fixing said loading/offloading tower (21) to the upper wall (4) of the support structure (1);
- anchoring to each of the walls of the support structure (1) at least one thermally insulating barrier (19) and one sealing membrane (20) resting against said thermally insulating barrier (19); the sealing membrane (20) of the first transverse wall (3) being anchored to said first transverse wall (3) after lowering the loading/offloading tower (21) inside the support structure (1).

2. The assembly method as claimed in claim 1, in which the distance L between the loading/offloading tower (21) and the sealing membrane (20) of the first transverse wall (3) is greater than 0.80 m.

3. The assembly method as claimed in claim 1 or 2, in which the distance L between the loading/offloading tower (21) and the sealing membrane (20) of the first transverse wall (3) is less than 5 m.

4. The assembly method as claimed in any one of claims 1 to 3, in which the loading/offloading tower (21) includes three pylons (22, 23, 24) that are fixed to one another by crossmembers (25) and each of which extends vertically along a central axis; the three central axes (A, B, C) of the pylons (22, 23, 24) define in projection in a horizontal plane the vertices of a triangle (ABC); said triangle (ABC) being oriented relative to the first transverse wall (3) so that one of the three vertices (A) of the triangle (ABC) is disposed closer to the first transverse wall (3) than the other two vertices (B, C).

5. The assembly method as claimed in claim 4, in which the triangle (ABC) is oriented so that a bisector (28) of a corner of the triangle (ABC) defined by the two sides AB, AC) of the triangle (ABC) join at the level of the vertex (A) of the triangle (ABC) that is disposed closest to the first transverse wall (3) forms with the first transverse wall (3) an angle α between 45° and 135° inclusive.

6. The assembly method as claimed in claim 5, in which the angle α is equal to 90°.

7. The assembly method as claimed in any one of claims 1 to 6, in which the upper wall includes a liquid dome (12) projecting upwardly from the upper wall (4) of the support structure (1), in which the opening formed in the upper wall (4) through which the loading/offloading tower (21) is lowered is formed in the liquid dome (12), and in which fixing the loading/offloading tower (21) to the upper wall (4) of the support structure (1) includes the steps of fixing a cover (39) onto the liquid dome (12) in such a manner as to cover the opening formed in the liquid dome (12) and to fix said loading/offloading tower (21) to said cover (39).

8. The assembly method as claimed in claim 7, in which the loading/offloading tower (21) includes three hollow pylons (22, 23, 24) and in which the interior of the support structure is aerated via at least one of the pylons (22, 23, 24), thus forming an aeration duct when the cover (39) is fixed to the liquid dome (12).

9. The assembly method as claimed in claim 7 or 8, in which the liquid dome (12) is positioned at a distance from the first transverse wall (3), the upper wall (4) of the support structure including a horizontal portion (29) connecting the first transverse wall (3) of the support structure (1) to a vertical transverse wall (14) of the liquid dome (12).

10. The assembly method as claimed in claim 7 or 8, in which the liquid dome (12) includes a vertical transverse wall (14) that extends in line with the first transverse wall (3).

11. The assembly method as claimed in any one of claims 7 to 10, in which the liquid dome (12) includes two transverse walls (13, 14) and two lateral walls (15, 16) that extend vertically and in which after fixing the cover (39) over the opening of the liquid dome:

- insulating elements of the thermally insulating barrier are anchored against a central part of the cover (39);
- insulating elements of the thermally insulating barrier are anchored against the transverse walls (13, 14) and lateral walls (15, 16) of the liquid dome (12); and
- after anchoring insulating elements of the thermally insulating barrier against the central part of the cover (39) and against the transverse and lateral walls of the liquid dome insulating elements of the thermally insulating barrier are disposed against a peripheral portion of the cover (39) disposed around the central part of the cover (39).

12. The assembly method as claimed in any one of claims 1 to 11, in which, when lowering the loading/offloading tower (21) inside the support structure (1), temporary support means (38) are disposed between the loading/offloading tower (21) and the lower wall (5) of the support structure in such a manner as to support said loading/offloading tower (21) and in which the temporary support means (38) are removed after fixing the loading/offloading tower (21) to the upper wall (4) of the support structure (1).

13. The assembly method as claimed in any one of claims 1 to 12, in which the support frame (31) of the scaffold (30) is equipped with feet (35) that are vertically retractable and by means of which said support frame (31) rests against the lower wall (5) of the support structure (1) and in which said feet (35) are retracted

successively when anchoring the thermally insulating barrier (19) and the sealing membrane (20) onto the lower wall (5) of the support structure (1) in such a manner as to cause them successively to rest against the thermally insulating barrier (19) and against the sealing membrane (20).

14. The assembly method as claimed in any one of claims 1 to 13, in which the platforms (32a, 32b, 32c) feature retractable edges and in which each of said edges is retracted as and when the thermally insulating barrier (19) and the sealing membrane (20) are anchored to the wall of the support structure (1) facing said edge.

15. The assembly method as claimed in any one of claims 1 to 14, in which the catwalks feature an edge facing the first transverse wall (3) that is retractable horizontally and in which said edge is retracted as and when the thermally insulating barrier (19) and the sealing membrane (20) are anchored to the first transverse wall (3).

16. The assembly method as claimed in any one of claims 1 to 15, in which there are further anchored to each of the walls of the support structure (1) a secondary thermally insulating barrier (17) resting against the support structure and a secondary sealing membrane (18) resting against the secondary thermally insulating barrier (17); the thermally insulating barrier (19) resting against the secondary sealing membrane (18).

17. The assembly method as claimed in any one of claims 1 to 16, in which the support structure (1) is on board a ship and in which the first transverse wall (3) is a rear wall.

18. The assembly method as claimed in claim 17 in which the support structure (1) consists of the double hull of a ship.