

Description

Title of the invention: Method for manufacturing a thermally insulating barrier for a tank

Technical field

[0001] The invention relates to the field of sealed and thermally insulating tanks for storing and/or transporting a liquefied gas, such as tanks for transporting liquefied petroleum gas (also referred to as LPG) having for example a temperature of between -50°C and 0°C , or for transporting liquefied natural gas (LNG) at approximately -162°C and atmospheric pressure.

[0002] These tanks may be installed on land or on a floating structure. In the case of a floating structure, the tank may be intended to transport liquefied gas or accommodate liquefied gas serving as fuel for propulsion of the floating structure.

Technological background

[0003] The document WO19092384 discloses a method for manufacturing a thermally insulating barrier for a wall of a sealed and thermally insulating tank. The wall of the tank has a multilayer structure successively having, in the thickness direction, from the outside to the inside of the tank, a secondary thermally insulating barrier having insulating panels retained on a supporting structure, a secondary sealing membrane resting against the secondary thermally insulating barrier, a primary thermally insulating barrier having insulating panels resting against the secondary sealing membrane, and a primary sealing membrane resting against the primary thermally insulating barrier and intended to be in contact with the liquefied natural gas contained in the tank. Each insulating panel of the primary thermally insulating barrier has cutouts along its edges and at its corners. These cutouts define recesses forming receiving portions in which are received anchoring devices that fix the insulating panels of the primary thermally insulating barrier on the insulating panels of the secondary thermally insulating barrier. Insulating stoppers having an insulating polymer foam layer are received in the receiving portions made in the primary thermally insulating barrier in order to ensure continuity of the thermal insulation. To do this, said document provides for inserting each insulating stopper into a respective receiving portion and pushing it in the direction of the supporting structure until the insulating stopper is irreversibly damaged where said insulating stopper bears against a bearing member received inside the receiving portion. Each insulating stopper is pushed until the internal end of the insulating stopper reaches a predetermined position inside said receiving portion.

[0004] This makes it possible to prevent the insulating stoppers from locally causing differences in level which adversely affect the flatness of the support surface of the primary sealing membrane, even when the dimensional manufacturing tolerances of the insulating stoppers are great.

[0005] However, this method is not completely satisfactory. In particular, pushing the insulating stoppers until they irreversibly deform requires considerable forces on the part of operators, thereby lengthening the manufacturing time of the thermally insulating barrier and impairing the working conditions of the operators, this being all the more the case when the polymer foam of the insulating stoppers has a high density.

Summary

[0006] An idea on which the invention is based is to provide a method for manufacturing a thermally insulating barrier, intended to define an internal support surface for a sealing membrane and having receiving portions and also insulating stoppers received in said receiving portions, which method is simple to implement and limits the presence of differences in level in the internal support surface of the sealing membrane in line with the receiving portions.

[0007] According to one embodiment, the invention provides a method for manufacturing a thermally insulating barrier for a wall of a sealed and thermally insulating tank fixed to a supporting structure, said method comprising the following steps:

- anchoring a plurality of insulating panels directly or indirectly to the supporting structure by means of at least one anchoring device, said plurality of insulating panels defining an internal surface intended to support a sealing membrane and having a receiving portion that opens out at the internal surface and in which the anchoring device is received;
- providing an insulating stopper intended to ensure continuity of the thermal insulation at said receiving portion, said insulating stopper having an internal end and an external end and having a dimension d_1 between the internal end and the external end, the insulating stopper having an insulating polymer foam layer and an internal rigid sheet fixed to the insulating polymer foam layer and forming the internal end of the insulating stopper;
- inserting the insulating stopper into the receiving portion and pushing it in the direction of the supporting structure until the external end of the insulating stopper bears in the direction of the supporting structure against a bearing surface which is spaced apart from the internal surface of the plurality of insulating panels by a distance d_2 that is less than d_1 ;
- trimming the internal rigid sheet of the insulating stopper such that the internal end of the insulating stopper is flush with the internal surface of the plurality of insulating panels.

[0008] Thus, such a method is particularly simple since it does not require the application of significant pushing forces in order to deform the insulating stoppers and allows the dimensional tolerances of the stopper to be increased since they are not critical in the proposed method. Moreover, this method makes it possible to prevent the insulating stoppers from locally causing differences in level at the support surface of the sealing membrane.

[0009] According to embodiments, such a method may have one or more of the following features.

[0010] According to one embodiment, the internal rigid sheet is made of plywood.

[0011] According to one variant embodiment, the internal rigid sheet is adhesively bonded to the insulating polymer foam layer, for example by means of a polyurethane glue or an epoxy glue.

[0012] According to another variant embodiment, the internal rigid sheet is stapled on the insulating polymer foam layer.

[0013] According to one embodiment, the anchoring device received inside said receiving portion has a pin fixed directly or indirectly to the supporting structure. When anchoring the plurality of insulating panels, a retaining member is mounted on the pin so that said retaining member cooperates with a retaining zone of at least one of the insulating panels so as to retain said insulating panel toward the supporting structure, and a nut is screwed on the pin so as to fix the retaining member on the pin.

[0014] According to one embodiment, the retaining member forms the bearing surface against which the external end of the insulating stopper is pushed.

[0015] According to one embodiment, the insulating stopper has an external rigid sheet having an external face that forms the external end of said insulating stopper and an internal face in contact with the insulating polymer foam layer of the insulating stopper, the external rigid sheet having a recess made in the external face of the external rigid sheet and in which the nut of the anchoring device is received. This allows the insulating polymer foam layer to better take up compressive forces.

[0016] According to one embodiment, the internal face of the external rigid sheet at least partially covers the recess.

[0017] According to one embodiment, the external rigid sheet has a hole which opens into the recess and in which one end of the pin is received, the hole having a diameter less than that of the recess.

- [0018] According to one embodiment, the hole is a blind hole.
- [0019] According to one embodiment, the external rigid sheet is fixed to the insulating polymer foam layer.
- [0020] According to one variant embodiment, the external rigid sheet is adhesively bonded to the insulating polymer foam layer, for example by means of a polyurethane glue or an epoxy glue.
- [0021] According to another variant embodiment, the external rigid sheet is stapled to the insulating polymer foam layer.
- [0022] According to another embodiment, the external rigid sheet is free with respect to the insulating polymer foam layer, the insertion of the insulating stopper into the receiving portion including a phase of inserting the external rigid sheet in said receiving portion, then a phase of inserting the insulating polymer foam layer in said receiving portion.
- [0023] According to another embodiment, the external rigid sheet is selected from among multiple external rigid sheets having different thicknesses so as to limit the thickness $\Delta = d_1 - d_2$ of the internal rigid sheet to be trimmed.
- [0024] According to one embodiment, the insulating polymer foam layer has a density of between 100 and 260 kg/m³.
- [0025] According to one embodiment, the external rigid sheet is stapled to one of the insulating panels.
- [0026] According to another aspect, the invention also provides a thermally insulating barrier for a wall of a sealed and thermally insulating tank fixed to a supporting structure, said thermally insulating barrier having:
- a plurality of insulating panels anchored directly or indirectly to the supporting structure by means of at least one anchoring device, said plurality of insulating panels defining an internal surface intended to support a sealing membrane and having a receiving portion that opens out at the internal surface and in which the anchoring device is received,
 - the anchoring device received inside said receiving portion having a pin fixed directly or indirectly to the supporting structure, a retaining member mounted on the pin so that it cooperates with a retaining zone of at least one of the insulating panels, and a nut screwed on the pin so as to fix the retaining member on the pin;
 - an insulating stopper received inside the receiving portion so as to ensure continuity of the thermal insulation at said receiving portion, the insulating stopper having an insulating polymer foam layer, an internal rigid sheet fixed to the insulating polymer foam layer and forming the internal end of the insulating stopper, and an external rigid sheet, said external

rigid sheet having an internal face in contact with the insulating polymer foam layer of the insulating stopper, and an external face forming the external end of said insulating stopper and bearing in the direction of the supporting structure against the retaining member, the external rigid sheet having a recess made in the external face of the external rigid sheet and in which the nut of the anchoring device is received, the internal face of the external rigid sheet at least partially covering the recess.

[0027] Thus, by virtue of such an arrangement, the support zone of the insulating polymer foam layer, that is to say the zone through which the compressive forces pass under the effect of dynamic and hydrostatic pressures exerted by the liquid contained in the tank, is larger. This allows the insulating polymer foam layer to better take up compressive forces without the insulating polymer foam layer having a greater density.

[0028] According to one embodiment, the invention concerns a tank wall having an abovementioned thermally insulating barrier and a sealing membrane which rests against the thermally insulating barrier and is intended to be in contact with the fluid stored in the tank.

[0029] According to one embodiment, the invention concerns a sealed and thermally insulating tank having an abovementioned wall.

[0030] A tank according to one of the abovementioned embodiments may form part of an onshore storage facility, for example for storing LNG, or may be installed in an onshore or offshore floating structure, in particular an ethane or methane tanker, a floating storage and regasification unit (FSRU), a floating production storage and offloading (FPSO) unit and the like. In the case of a floating structure, the tank may be intended to accommodate liquefied natural gas serving as fuel for propulsion of the floating structure.

[0031] According to one embodiment, the abovementioned thermally insulating barrier is a primary thermally insulating barrier, the tank wall moreover having a secondary thermally insulating barrier and a secondary sealing membrane disposed between the primary thermally insulating barrier and the secondary thermally insulating barrier.

[0032] According to one embodiment, a ship for transporting a fluid has a hull, such as a double hull, and an abovementioned tank disposed in the hull.

[0033] According to one embodiment, the invention also provides a method for loading or offloading such a ship, wherein a fluid is conducted through insulated pipelines from or to a floating or onshore storage facility to or from the tank of the ship.

[0034] According to one embodiment, the invention also provides a transfer system for a fluid, the system having the abovementioned ship, insulated pipelines arranged so as to connect

the tank installed in the hull of the ship to a floating or onshore storage facility, and a pump for driving a flow of fluid through the insulated pipelines from or to the floating or onshore storage facility to or from the tank of the ship.

Brief description of the figures

[0035] The invention will be better understood, and further aims, details, features and advantages thereof will become more clearly apparent from the following description of several particular embodiments of the invention, which are given solely by way of nonlimiting illustration, with reference to the appended drawings.

[0036] [fig.1] Figure 1 is a cutaway perspective representation of a wall of a sealed and thermally insulating tank.

[0037] [fig.2] Figure 2 is a sectional view of a thermally insulating barrier, which sectional view passes through an insulating stopper according to a first embodiment.

[0038] [fig.3] Figure 3 is a sectional view of a thermally insulating barrier, which sectional view passes through an insulating stopper according to a second embodiment.

[0039] [fig.4] Figure 4 is a cutaway schematic representation of a ship having a tank for storing liquefied natural gas and a terminal for loading/offloading from this tank.

[0040] [fig.5] Figure 5 is a cutaway perspective representation of a wall of a sealed and thermally insulating tank according to another embodiment.

Description of the embodiments

[0041] By convention, the terms “external” and “internal” are used to define the relative position of one element with respect to another, with reference to the outside and the inside of the tank.

[0042] Figure 1 shows the multilayer structure of a wall 1 of a sealed and thermally insulating tank for storing a fluid, such as liquefied natural gas (LNG). Each wall 1 of the tank successively has, in the thickness direction, from the outside to the inside of the tank, a secondary thermally insulating barrier 3 retained on the supporting structure 2, a secondary sealing membrane 4 resting against the secondary thermally insulating barrier 3, a primary thermally insulating barrier 5 resting against the secondary sealing membrane 4, and a primary sealing membrane 6 intended to be in contact with the liquefied natural gas contained in the tank.

[0043] The supporting structure 2 may in particular comprise self-supporting metal sheetings or, more generally, any type of rigid bulkheads having suitable mechanical properties. The supporting structure 2 may in particular be formed by the hull or double hull of a ship. The

supporting structure 2 has a plurality of walls defining the general shape of the tank, which is usually a polyhedral shape.

[0044] The secondary thermally insulating barrier 3 has a plurality of secondary insulating panels 7 anchored to the supporting structure 2 by means of resin beads and pins welded to the supporting structure 2. The secondary insulating panels 7 are substantially in the shape of a rectangular parallelepiped and are juxtaposed in parallel rows separated from one another by gaps ensuring a functional mounting clearance. The gaps are filled with a thermally insulating filling, such as glass wool, rock wool or open-cell flexible synthetic foam, for example. The secondary insulating panels 7 each have a polymer foam layer 8 sandwiched between an internal sheet 9 and an external sheet 10. The internal sheet 9 and external sheet 10 are, for example, sheets of plywood adhesively bonded to said polymer foam layer 8. The polymer foam 8 may in particular be a polyurethane-based foam, optionally reinforced by fibers, such as glass fibers for example.

[0045] In the embodiment shown, the secondary sealing membrane 4 has a continuous ply of metal strakes with raised edges. The strakes are welded by their raised edges on parallel welding supports which are fixed in the grooves made in the internal sheets 9 of the secondary insulating panels 7. The strakes are for example made of Invar®: i.e. an alloy of iron and nickel, the coefficient of expansion of which is typically between $1.2 \cdot 10^{-6}$ and $2 \cdot 10^{-6} \text{ K}^{-1}$.

[0046] According to another embodiment (not shown), the secondary sealing membrane 4 has a plurality of corrugated metal sheetings, each of which has a substantially rectangular shape and which are lap-welded to one another. Moreover, the corrugated metal sheetings are welded on metal plates which are fixed on the internal sheet 9 of the secondary insulating panels 7. The corrugations, for example, protrude toward the outside of the tank and are received in grooves made in the internal sheet 9 of the secondary insulating panels 7.

[0047] Furthermore, the primary thermally insulating barrier 5 has a plurality of primary insulating panels 11 of substantially rectangular parallelepiped shape. In this case, the primary insulating panels 11 are offset with respect to the secondary insulating panels 7 of the secondary thermally insulating barrier 3 such that each primary insulating panel 11 is disposed in a staggered manner on four secondary insulating panels 7. The primary insulating panels 11 are fixed on the secondary insulating panels 7 by means of anchoring devices 12, which will be described below.

[0048] In the embodiment illustrated, each primary insulating panel 11 has a polymer foam layer 13 sandwiched between two rigid sheets, specifically an external sheet 15 and an

internal sheet 14. The external sheet 15 and internal sheet 14 are made of plywood, for example. The polymer foam layer 13 is, for example, polyurethane foam, optionally reinforced by fibers, such as glass fibers.

[0049] The primary sealing membrane 6 is obtained by assembling a plurality of corrugated metal sheetings. The corrugated metal sheetings are each of substantially rectangular shape. The corrugations protrude toward the inside of the tank. The corrugated metal sheetings of the primary sealing membrane 6 are disposed in an offset manner with respect to the primary insulating panels 11 such that each of said corrugated metal sheetings extends jointly over four adjacent primary insulating panels 11. The corrugated metal sheetings are lap-welded together and are also welded along their edges on metal plates which are fixed on the primary insulating panels 11 and more particularly on their internal sheet 14. The internal sheets 14 of the primary insulating panels 11 define the internal support surface of the primary sealing membrane 6.

[0050] As is shown in figure 1, each primary insulating panel 11 has a recess 16 at each of its corners. Each recess 16 passes through the internal sheet 14 and extends over the entire thickness of the polymer foam layer 13.

[0051] Thus, as is illustrated in figure 2, at each of the recesses 16, the external sheet 15 protrudes beyond the polymer foam layer 13 and beyond the internal sheet 14 so as to form a bearing zone 17 cooperating with an anchoring device 12. Each recess 16 formed in the corner of one of the primary insulating panels 11 is disposed facing recesses 16 formed in the corner of the three adjacent primary insulating panels 11 so that the four recesses 16 together define a receiving portion 18 in the primary thermally insulating barrier 5. Thus, a single anchoring device 12 disposed in said receiving portion 18 can cooperate with four bearing zones 17 belonging respectively to four adjacent primary insulating panels 11.

[0052] In the embodiment shown, a cleat 19, for example made of plywood, is fixed on the bearing zone 17 of each primary insulating panel 11 so as to reinforce it.

[0053] In the embodiment shown, each receiving portion 18 is formed by multiple recesses 16 made at the corners of the primary insulating panels 11. However, in other embodiments that are not shown, each receiving portion 18 is made neither at an edge of a primary insulating panel 11 nor at one of its corners, but instead is made through the polymer foam layer 13 of a single primary insulating panel 11.

[0054] In the embodiment shown, each anchoring device 12 has a pin 20 which protrudes from a metal plate (not illustrated), which is fixed on the internal sheet 9 of one of the

secondary insulating panels 7. The pins 20 each pass through an orifice made in the secondary sealing membrane 4. Moreover, the secondary sealing membrane 4 is welded in a sealed manner to the metal plate all around the orifice so as to seal the passage of the pins 20 through the secondary sealing membrane 4.

[0055] As is shown in figure 2, each anchoring device 12 has a retaining member 21 which is fixed on each of the pins 20 and which bears against the bearing zones 17 of each of the four adjacent primary insulating panels 11, in this case via cleats 19. Furthermore, a fixing member, such as a nut 22, cooperates with a thread of the pin 20 and bears against the internal face of the retaining member 21 so that the retaining member 21 is fixed on the pin 20 and thus exerts a retaining force against the bearing zones 17. By way of example, the nut 22 is a split nut and has the advantage of not coming loose during operation.

[0056] In the embodiment of figure 2, the retaining member 21 is an annular plate which has an orifice threaded on the pin 20.

[0057] Moreover, in embodiments that are not shown, one or more elastic washers, such as Belleville washers, are threaded on the pin 20, between the nut 22 and the retaining member 21, thereby elastically anchoring the primary insulating panels 11 on the secondary insulating panels 7.

[0058] The primary thermally insulating barrier 5 has an insulating stopper 25 which is intended to be inserted in the receiving portion 18 so as to ensure continuity of the thermal insulation. The insulating stopper 25 has an insulating polymer foam layer 23. The insulating polymer foam layer 23 is, for example, a polyurethane foam, optionally reinforced by fibers, such as glass fibers. The insulating polymer foam layer 23 has a density of between 100 and 260 kg/m³ and advantageously between 110 and 150 kg/m³, for example about 130 kg/m³.

[0059] The insulating stopper 25 moreover has an internal rigid sheet 24, for example made of plywood, forming the internal end of the insulating stopper 25. The internal rigid sheet 24 is advantageously adhesively bonded to the insulating polymer foam layer 23, for example by means of a polyurethane glue or an epoxy glue. According to another variant embodiment, the internal rigid sheet 24 is stapled on the insulating polymer foam layer 23. In such a case, the staples are advantageously placed spaced apart from the internal face of the internal rigid sheet 24, for example by being disposed in cavities made in the internal face of the internal rigid sheet 24, in order to not impair the subsequent sanding operations described below.

[0060] The insulating stopper 25 has an external end which bears in the direction of the supporting structure 2 against a bearing surface received in the receiving portion 18. In the embodiment shown, the bearing surface is formed by the retaining member 21. The bearing surface is placed at a distance d_2 from the internal support surface of the primary sealing membrane 6.

[0061] In the embodiment shown in figure 2, the insulating stopper 25 has a recess 26 which opens out at the external end of said insulating stopper 25 and in which the nut 22 of the anchoring device 12 is formed. The insulating stopper 25 also has a blind hole 27 which opens into said recess 26 and in which is received the end of the pin 20. In the initial state, the insulating stopper 25 has a dimension d_1 , measured in the thickness direction of the wall 1, between the internal end and the external end of said insulating stopper 25. The dimension d_1 is less than d_2 .

[0062] During the manufacture of the primary thermally insulating barrier 5, the insulating stopper 25 is inserted into the receiving portion 18 and then pushed in the direction of the supporting structure 2 until the external end of the insulating stopper 25 bears against the bearing surface, that is to say against the retaining member 21.

[0063] Subsequently, the internal rigid sheet 24 is trimmed to a thickness $e = d_1 - d_2$ so that the internal face of the internal rigid sheet 24 thus trimmed is flush with the internal support surface of the primary sealing membrane 6. This operation thus makes it possible to bring the internal face of the internal rigid sheet 24 of the insulating stopper 25 level with the internal surface of the primary insulating panels 11. This trimming operation is carried out by means of a plane, for example. A plane is typically fitted with one or more handles, a sole intended to cooperate with the surface to be planed, in this instance the internal face of the internal rigid sheet 24, and a tool, flush with the sole, for machining the surface to be planed. According to one embodiment, the tool is a roller fitted with blades or with a milling cutter and is driven in rotation by a motor.

[0064] Lastly, in order to keep the insulating stopper 25 in position, the internal rigid sheet 24 is fixed to the primary thermally insulating barrier 5. To this end, the internal rigid sheet 24 is, for example, fixed to one of the four primary insulating panels 11 bordering the receiving portion 18 by means of one or more staples disposed in a straddling manner between the internal rigid sheet and one of the primary insulating panels 11.

[0065] Such a method is advantageous in that it makes it possible to prevent the insulating stoppers 25 from locally causing differences in level which adversely affect the flatness of the support surface of the primary sealing membrane 6.

[0066] Figure 3 illustrates an insulating stopper 25 according to another embodiment. As in the previous embodiment, the insulating stopper 25 has an internal rigid sheet 24, which is trimmed in order to bring its internal face level with the internal support surface of the primary sealing membrane 6.

[0067] However, the insulating stopper 25 of the embodiment of figure 3 differs from the embodiment described above in relation to figure 2 in that it moreover comprises an external rigid sheet 28, for example made of plywood. The external rigid sheet 28 has an external face which forms the external end of the insulating stopper 25 and which is, therefore, intended to bear in the direction of the supporting structure 2 against the bearing surface, that is to say against the retaining member 21 in the embodiment shown. The external rigid sheet 28 has an internal face which is in contact with the insulating polymer foam layer 23. According to one embodiment, the external rigid sheet 28 is adhesively bonded to the insulating polymer foam layer, for example by means of a polyurethane glue or an epoxy glue. As an alternative, the external rigid sheet 28 is stapled on the insulating polymer foam layer 23.

[0068] According to another embodiment, the insulating stopper 25 is made in two parts that are free with respect to one another and respectively have the external rigid sheet 28, for the one part, and the insulating polymer foam layer 23 and the internal rigid sheet 24, for the other part. In this case, the insulating stopper 25 is inserted into the receiving portion 18 in two stages. In a first stage, the external rigid sheet 28 is inserted in the receiving portion 18 and pushed in the direction of the supporting structure 2 until it bears against the retaining member 21. In a second stage, the insulating polymer foam layer 23 and the internal rigid sheet 24 are inserted in the receiving portion 18 and then pushed in the direction of the supporting structure 2 until the insulating polymer foam layer 23 bears against the external rigid sheet 28.

[0069] Furthermore, the external rigid sheet 28 has a recess 29 which is made in the external face of the external rigid sheet 28 and in which the nut 22 of the anchoring device 12 is received. In the embodiment shown, the external rigid sheet 28 also has a hole 30 which has a diameter less than the diameter of the recess 29 and in which the end of the pin 20 is received. The hole 30 may be either a through-hole, and thus pass through the internal face of the external rigid sheet 29, or a blind hole, that is to say it does not pass through the internal face of the external rigid sheet 28. In any event, the internal face of the external rigid sheet 28 at least partially covers the recess 29.

[0070] Thus, by virtue of such an arrangement, the support zone of the insulating polymer foam layer 23, that is to say the zone of the insulating polymer foam layer 2 through which

the compressive forces pass under the effect of dynamic and hydrostatic pressures exerted by the liquid contained in the tank, is larger than in the embodiment of figure 2. This makes it possible for there to be no crushing of the insulating polymer foam layer 23, or for the crushing to occur to a lesser extent, and allows said layer to better take up compressive forces without the insulating polymer foam layer 22 having a greater density.

[0071] According to a variant of the embodiment of figure 3, the operator has a set of multiple external rigid sheets 28 having different thicknesses and selects the external rigid sheet 28 with the thickness which makes it possible to limit the thickness $\Delta = d1-d2$ of the internal rigid sheet 24 to be sanded.

[0072] When the external rigid sheet 28 has been selected, according to one embodiment it is then fixed by adhesive bonding, by stapling or by means of one or more screws to the insulating polymer foam layer 22.

[0073]

[0074] Figure 5 shows a tank wall according to another embodiment. This embodiment differs from that described above in relation to figure 1 in that each of the primary insulating panels 11 is placed in line with one of the secondary insulating panels 7, aligned with the latter in the thickness direction of the wall 1.

[0075] Thus, the anchoring devices are placed preferably at the four corners of the secondary insulating panels 7 and primary insulating panels 11. Each stack of a secondary insulating panel 7 and a primary insulating panel 11 is therefore anchored to the supporting structure 2 by means of four anchoring devices. Moreover, each anchoring device cooperates with the corners of four adjacent secondary insulating panels 7 and with the corners of four adjacent primary insulating panels 11.

[0076] Moreover, in this embodiment, the primary sealing membrane 6 has a continuous ply of metal strakes with raised edges. It is also the case that, as in the secondary sealing membrane 4 of the embodiment of figure 1, the metal strakes are welded by their raised edges on parallel welding supports which are fixed in grooves made in the internal sheets of the primary insulating panels 11.

[0077] With reference to figure 4, a cutaway view of a methane tanker 70 shows a sealed and insulated tank 71 that has a generally prismatic shape and is mounted in the double hull 72 of the ship. The wall of the tank 71 has a primary membrane intended to be in contact with the LNG contained in the tank, a secondary membrane arranged between the primary membrane and the double hull 72 of the ship, and two thermally insulating barriers

arranged between the primary membrane and the secondary membrane and between the secondary membrane and the double hull 72, respectively.

[0078] In a way known per se, loading/offloading pipelines 73 disposed on the upper deck of the ship can be connected, by means of appropriate connectors, to a maritime or harbor terminal, in order to transfer a cargo of LNG from or to the tank 71.

[0079] Figure 4 also shows an example of a maritime terminal having a loading and offloading station 75, an underwater pipe 76 and an onshore facility 77. The loading and offloading station 75 is a fixed offshore facility having a mobile arm 74 and a tower 78 that supports the mobile arm 74. The mobile arm 74 carries a bundle of insulated flexible hoses 79 that can be connected to the loading/offloading pipelines 73. The orientable mobile arm 74 can adapt to suit all sizes of methane tanker. A connecting pipe (not shown) extends inside the tower 78. The loading and offloading station 75 allows the methane tanker 70 to be loaded and offloaded from or to the onshore facility 77. The latter has liquefied-gas storage tanks 80 and connecting pipes 81 connected by the underwater pipe 76 to the loading or offloading station 75. The underwater pipe 76 makes it possible to transfer the liquefied gas between the loading or offloading station 75 and the onshore facility 77 over a long distance, for example 5 km, allowing the methane tanker 70 to be kept standing off shore by a long distance during the loading and offloading operations.

[0080] In order to generate the pressure needed for transferring the liquefied gas, use is made of pumps carried on board the ship 70 and/or pumps with which the onshore facility 77 is equipped and/or pumps with which the loading and offloading station 75 is equipped.

[0081] Although the invention has been described in connection with several particular embodiments, it is quite obvious that it is in no way limited thereto and that it comprises all the technical equivalents of the means described and also their combinations, if these come within the scope of the invention.

[0082] In the claims, any reference sign between parentheses should not be interpreted as imposing a limitation on the claim.

[0083] Although the invention has been described in connection with several particular embodiments, it is quite obvious that it is in no way limited thereto and that it comprises all the technical equivalents of the means described and also their combinations, if these come within the scope of the invention, as defined by the claims.

[0084] The use of the verb "to have", "to comprise" or "to include" and the conjugated forms thereof does not exclude the presence of elements or steps other than those mentioned in a claim.

[0085] In the claims, any reference sign between parentheses should not be interpreted as imposing a limitation on the claim.

Claims

[Claim 1] A method for manufacturing a thermally insulating barrier (5) for a wall (1) of a sealed and thermally insulating tank fixed to a supporting structure (2), said method having the following steps:

- anchoring a plurality of insulating panels (11) directly or indirectly to the supporting structure (2) by means of at least one anchoring device (12), said plurality of insulating panels (11) defining an internal surface intended to support a sealing membrane (6) and having a receiving portion (18) that opens out at the internal surface and in which the anchoring device (12) is received;
- providing an insulating stopper (25) intended to ensure continuity of the thermal insulation at said receiving portion (18), said insulating stopper (25) having an internal end and an external end and having a dimension d_1 between the internal end and the external end, the insulating stopper (25) having an insulating polymer foam layer (23) and an internal rigid sheet (24) fixed to the insulating polymer foam layer (23) and forming the internal end of the insulating stopper (25);
- inserting the insulating stopper (25) into the receiving portion (18) and pushing it in the direction of the supporting structure (2) until the external end of the insulating stopper (25) bears in the direction of the supporting structure (2) against a bearing surface which is spaced apart from the internal surface of the plurality of insulating panels (11) by a distance d_2 that is less than d_1 ;
- trimming the internal rigid sheet (24) of the insulating stopper (25) such that the internal end of the insulating stopper (25) is flush with the internal surface of the plurality of insulating panels (11).

[Claim 2] The manufacturing method as claimed in claim 1, wherein the internal rigid sheet (24) is made of plywood.

[Claim 3] The manufacturing method as claimed in claim 1 or 2, wherein the internal rigid sheet (24) is adhesively bonded or stapled to the insulating polymer foam layer (23).

[Claim 4] The manufacturing method as claimed in any one of claims 1 to 3, wherein the anchoring device (12) received inside said receiving portion (18) has a pin (20) fixed directly or indirectly to the supporting structure (2),

wherein, when anchoring the plurality of insulating panels (11), a retaining member (21) is mounted on the pin (20) so that said retaining member cooperates with a retaining zone of at least one of the insulating panels (11) so as to retain said insulating panel toward the supporting structure (2), and wherein a nut (22) is screwed on the pin (20) so as to fix the retaining member (21) on the pin (20).

[Claim 5] The manufacturing method as claimed in claim 4, wherein the retaining member (21) forms the bearing surface against which the external end of the insulating stopper (25) is pushed.

[Claim 6] The manufacturing method as claimed in claim 4 or 5, wherein the insulating stopper (25) has an external rigid sheet (28) having an external face that forms the external end of said insulating stopper (25) and an internal face in contact with the insulating polymer foam layer (23) of the insulating stopper (25), the external rigid sheet (28) having a recess (29) made in the external face of the external rigid sheet (28) and in which the nut (22) of the anchoring device (12) is received.

[Claim 7] The manufacturing method as claimed in claim 6, wherein the internal face of the external rigid sheet (28) at least partially covers the recess (29).

[Claim 8] The manufacturing method as claimed in claim 6 or 7, wherein the external rigid sheet (28) has a hole (30) which opens into the recess (29) and in which one end of the pin (20) is received, the hole (30) having a diameter less than that of the recess (29).

[Claim 9] The manufacturing method as claimed in claim 8, wherein the hole (30) is a blind hole.

[Claim 10] The manufacturing method as claimed in any one of claims 6 to 9, wherein the external rigid sheet (28) is fixed to the insulating polymer foam layer (23).

[Claim 11] The manufacturing method as claimed in any one of claims 6 to 9, wherein the external rigid sheet (28) is free with respect to the insulating polymer foam layer (23), the insertion of the insulating stopper (25) into the receiving portion (18) including a phase of inserting the external rigid sheet (28) in said receiving portion (18) and then a phase of inserting the insulating polymer foam layer (23) in said receiving portion (18).

[Claim 12] The manufacturing method as claimed in claim 11, wherein the external rigid sheet (28) is selected from among multiple external rigid sheets having different thicknesses so as to limit the thickness $\Delta = d1-d2$ of the internal rigid sheet (24) to be trimmed.

[Claim 13] The manufacturing method as claimed in any one of claims 1 to 12, wherein the insulating polymer foam layer (23) has a density of between 100 and 260 kg/m³.

[Claim 14] The manufacturing method as claimed in any one of claims 1 to 13, wherein the internal rigid sheet (24) is stapled to one of the insulating panels (11).