Description

Title: Method for installing a drive assembly for a pump of an offloading tower for a tank of a floating structure employing an adjusting device

The invention relates to the field of the storage and/or transport of a cargo of liquefied gas, such as liquefied natural gas or even liquefied petroleum gas.

It relates more particularly to an offloading tower for a sealed and thermally insulated tank of a floating structure intended to contain this liquefied gas.

Liquefied natural gas, commonly known by the acronym "LNG", is an important source of energy, and consists of approximately 95% methane. More particularly, LNG is stored in the liquid state in a thermally insulated tank at a temperature close to -160°C, the LNG then occupying 1/600 of the volume that it would occupy in the gaseous state, thus making it easier to transport from one site to another.

LNG can also be used as fuel for the floating structure, such as a floating structure for the transport of goods, for example an oil tanker, a methane carrier, an ethane carrier or even a container ship. For environmental and economic reasons, the use of LNG as a fuel has an advantage over conventional fuels, in particular those derived from petroleum.

Conventionally, the tank comprises an offloading tower suspended from a cover allowing the tank to be closed. The tank offloading tower may have a tripod-type structure, that is to say comprising three vertical masts connected to each other by crossmembers forming a truss structure.

The offloading tower supports at least one pump whose purpose is to offload the cargo. It is in particular known to have a suction element and a pump drive motor at a lower end of the offloading tower, near the bottom of the tank, the drive motor and the suction element being both submerged in the liquefied gas.

In other fields, it is known to separate the drive motor and the suction element and to connect these elements by a shaft.

In order to facilitate maintenance operations and/or interventions in the event of a malfunction of the drive motor, it is known practice to place the latter outside the storage tank while the suction element remains submerged in this same tank. The drive motor and the suction element of the same pump are thus arranged at opposite

ends of the tank and are separated by a distance substantially equal to the height thereof.

A pump of this type, when it is suitable for transporting liquefied gas, requires that the drive motor be arranged outside the tank, for example on the cover, and that the suction element be arranged at an opposite end of the offloading tower, about 30 m lower down. In operation, the drive motor drives the suction element which pushes the liquefied gas and leads it into an offloading line carrying the liquefied gas out of the tank. To that end, the drive motor and the suction element are mechanically connected by a drive shaft which extends essentially over the height of the offloading tower, one of the masts of said tower housing the drive shaft and the offloading line.

This relative positioning of the drive motor and suction member of the pump at opposite ends of the offloading tower can lead to installation difficulties. Indeed, such a configuration requires, in succession, the installation of the drive motor and of the drive shaft of the pump, these being secured to one another, then the separate installation of the suction element, and finally the fixing of the suction element on the drive shaft.

Due to the distance between the suction element and the drive motor of the pump, the positioning of the drive shaft relative to the suction element may be long and complex, and the result is a significant additional operating cost, in particular due to the downtime of the floating structure. In order to optimize the installation of the pump on the offloading tower, it is therefore essential to precisely adjust the spatial position of the pump drive motor, which carries the drive shaft, relative to the bottom of the tank, so as to allow correct and simplified assembly of the pump.

The present invention falls within this context and aims to solve the aforementioned drawbacks by proposing a method for installing a pump drive assembly, comprising a motor, in the offloading tower of the tank, which implements a device for adjusting the position of said drive assembly.

The present invention proposes a method for installing at least one drive assembly for a pump for a tank of a floating structure intended to contain a liquefied gas, the tank comprising a tower for offloading the liquefied gas equipped with at least one mast, the drive assembly being arranged outside the tank, at a first end of the mast, by means of an adjusting device which comprises at least one sleeve and a platform, the

pump comprising a suction element arranged in the tank at a second end of the mast, opposite the first end, the installation method comprising:

- a first step of positioning the sleeve on the first end of the mast,
- a second step of adjusting the position of the adjusting device to a determined height relative to a bottom wall of the tank,
- a third step of securing the adjusting device to the first end of the mast,
- and a fourth step of mounting the drive assembly for the pump on the platform of the adjusting device.

The tank of the floating structure consists of at least four side walls joined together by a bottom wall and at least one top wall, thus delimiting an internal volume for storing the liquefied gas. The top wall includes at least one opening configured to receive the liquefied gas offloading tower.

The offloading tower consists of at least the mast which extends over all or part of the height of the tank, that is to say between the top wall and the bottom wall of the tank, said mast being fixed relative to the tank. The offloading tower comprises a cover, intended to close the opening of the upper wall so as to make the tank sealed and thermally insulating. The cover is configured to keep the offloading tower suspended in the tank, the cover being secured to at least the mast. It comprises at least one through-orifice intended to receive and hold the mast so that the first end of said mast extends outside the tank while the second end of the mast extends near the bottom wall.

The pump includes at least the drive assembly, the suction element and a drive shaft that connects them mechanically in order to transmit rotational movement from the drive assembly to the suction element.

The drive assembly may, by way of example, consist of a geared motor assembly comprising at least one pump motor and a speed reduction device. The drive assembly is arranged outside the tank, near the cover of the offloading tower. It is carried by the first end of the mast via the adjusting device. Advantageously, the drive assembly may be electric. Alternatively it may be pneumatic or hydraulic.

The suction element includes at least one main body which surrounds one or more propellers. The suction element is arranged at the second end of the mast, opposite

the first end, so that the suction element extends close to the bottom wall of the tank and is submerged in the liquefied gas.

It is understood here that, during the installation of the pump on the offloading tower, the drive assembly is arranged on the adjusting device, which is itself fixed on the first end of the mast, outside the tank.

The adjusting device comprises at least two components: the platform, intended to carry at least the drive assembly for the pump, and the sleeve, which ensures cooperation between the adjusting device and the first end of the mast.

The platform comprises at least a first, flat surface configured to ensure that the drive assembly be held stably on the adjusting device. Also, the platform may be configured to cooperate with at least one fixing member intended to attach at least the drive assembly on the platform.

The sleeve has a cylindrical structure complementary to a section of the first end of the mast. Thus, the movement of the sleeve of the adjusting device relative to the mast allows the position of the platform, as well as that of the drive assembly that it is intended to carry, to be adjusted relative to the bottom wall of the tank, close to which the suction element is arranged.

In particular, such a movement allows an adjustment of the height difference between the first surface of the platform and the bottom wall of the tank, along a main axis on which the mast is centered, thus subsequently allowing an optimized and simplified assembly of the drive shaft and the suction element of the pump.

According to the installation method of the present invention, the second step can also allow adjustment of the attitude of the adjusting device relative to the bottom wall of the tank.

The term “attitude” is understood to mean an adjustment of the inclination of a first plane, in which the first surface of the platform mainly lies, relative to the main axis on which the mast is centered. The adjustment of the attitude by the adjusting device thus ensures the alignment of the drive shaft carried by the drive assembly, on one hand within the mast and on the other hand relative to the suction element.

According to the invention, the second step of the installation method may be carried out by means of an optical tool configured to assess at least the height of the first surface of the platform relative to a point on the bottom wall of the tank.

Specifically, the optical tool may be configured to assess the height and/or attitude extending between the first surface of the platform and the point on the bottom wall of the tank. To that end, the optical tool comprises at least one measuring member and/or a pointer, for example of the laser type, the latter marking on the bottom wall the direction of extension of the drive shaft.

By way of example, a projection of the section of the mast may be produced on the bottom wall of the tank. The optical tool, placed on the platform of the adjusting device, marks on this same wall the direction of extension of the drive shaft by means of the pointer. When the attitude of the adjusting device is changed, the same applies to the inclination of the platform relative to the main axis. This results in a change in the position of the pointer of the optical tool relative to the projection of the section of the mast on the bottom wall of the tank. The attitude of the adjusting device can then be adjusted until a suitable position is obtained, for example until the pointer is directed towards a central zone of the projection.

It is understood that this is only an exemplary implementation of the present invention, and that the invention is not limited thereby. Plans can thus be made to use other tools to evaluate the height and/or the attitude of the first surface of the platform of the adjusting device relative to the bottom wall of the tank. According to another non-limiting exemplary implementation of the present invention, this tool can for example be a tape measure.

According to the invention, the adjustment of the position of the adjusting device in the second step may be effected by sliding of the sleeve relative to the first end of the mast.

Alternatively, the adjusting device and the first end of the mast can each comprise guide members that are complementary to each other, for example threads, in particular to allow the height of the adjusting device to be adjusted by screwing.

According to the invention, the third step, consisting in securing the adjusting device to the first end of the mast, is carried out by welding the sleeve to at least an outer face and/or an upper portion of the first end of the mast.

It should be noted that such welds are advantageously made at the level of the sleeve of the adjusting device and not directly at the level of the platform. Indeed, the welding being likely to cause a substantial deformation of the part in question and the platform being intended to carry at least the pump drive assembly, it is preferable to limit any operation likely to alter the flatness of the platform once the adjusting device is properly positioned on the first end of the mast.

Advantageously, the adjusting device may comprise at least one primary reinforcement, intended to consolidate the assembly of the sleeve and of the platform of the adjusting device. The primary reinforcement may for example consist of a plate configured to bear against an outer wall of the sleeve and to support the platform.

According to the invention, prior to the first step, the sleeve, the platform and at least the primary reinforcement may be secured together.

In other words, the adjusting device may be assembled prior to being positioned on the first end of the mast. As previously explained, since the operations of assembly, and in particular of joining by welding, may be accompanied by deformation of the components, it is preferable to limit the use of such operations after the adjustment of the sleeve on the first end of the mast.

In particular, the adjusting device can comprise a plurality of primary reinforcements, regularly arranged on at least the outer wall of the sleeve. The adjusting device can thus be fully assembled, then the flatness of the platform is adjusted, for example by milling the first surface, prior to the positioning of the adjusting device on the first end of the mast.

According to the invention, the method for installing the drive assembly may comprise, between the third step and the fourth step, an optional step of reinforcing the adjusting device by securing at least one secondary reinforcement which connects the mast to the adjusting device.

The secondary reinforcement consolidates the fixing of the adjusting device on the first end of the mast, once the latter has been arranged and fixed in the appropriate position.

By way of example, the secondary reinforcement may be in the shape of a plate or a substantially planar L-shaped part. The secondary reinforcement may be configured so as to be, at least in part, resting on the outer face of the mast. Additionally, the

secondary reinforcement may be configured so as to be carried by at least one member secured to the mast, for example a ring.

Alternatively, the secondary reinforcement may have a flat shape and a rectangular outline.

Advantageously, the secondary reinforcement may be configured to cooperate with at least the primary reinforcement of the adjusting device, so as to limit interventions at the level of the platform of the adjusting device. In particular, the fixing of the secondary reinforcement may be carried out by welding or, alternatively, by means of a fixing member such as a screw.

According to an exemplary embodiment of the invention, prior to the reinforcing step, the method may comprise a step of adjusting the position of at least the secondary reinforcement relative to the adjusting device.

According to another exemplary embodiment of the method of the invention, prior to the first step, at least one secondary reinforcement is secured to the first end of the mast, the method comprising at least one additional step during which the at least one primary reinforcement is secured to the at least one secondary reinforcement. The additional step during which the at least one primary reinforcement is secured to the at least one secondary reinforcement may be carried out between the second step and the third step or between the third step and the fourth step of the method. For example, the at least one primary reinforcement may be secured to the at least one secondary reinforcement by welding. The present invention also relates to a device for adjusting the position of at least one drive assembly for a pump of an offloading tower arranged in a tank of a floating structure intended to contain a liquefied gas, the adjusting device extending outside the tank, the adjusting device comprising at least one sleeve and a platform, the sleeve being configured to cooperate with a first end of a mast of the offloading tower and the platform being configured to carry the drive assembly.

In other words, the invention proposes an adjusting device suitable for use in the method for installing the pump drive assembly as explained above, the adjusting device making it possible to adjust the spatial position, that is to say the height and/or the attitude of the drive assembly that it carries, relative to a point on the bottom wall of the tank.

The platform consists of a substantially planar part, which may be circular or square, a first surface of which is configured to carry at least the pump drive assembly. In particular, the platform comprises at least one hole which allows on one hand the insertion of the sleeve, during the assembly of the adjusting device, and on the other hand the passage of at least one offloading tube for the liquefied gas. The hole may be arranged so that the sleeve and the platform are centered on the same axis of extension of the adjusting device, the platform lying in a first plane which is substantially orthogonal to said axis of extension.

Additionally, the platform may include at least one fixing hole configured to cooperate with a fixing member of the drive assembly on the platform.

The sleeve has a cylindrical structure of complementary shape to that of the first end of the mast, the sleeve and the first end being configurable so that the sleeve of the adjusting device surrounds the mast or, alternatively, so that the mast surrounds the sleeve.

In particular, the sleeve and the mast are dimensioned in order to have a clearance of between 1 and 2 mm. The adjustment of the position of the adjusting device can then be done by moving the sleeve relative to the first end in a sliding movement.

Alternatively, the sleeve and the first end may comprise, respectively, at least one guide member, the guide member of the sleeve and the guide member of the first end of the mast being complementary to each other in order to cause the sleeve to move along the first end of the mast. For example, each of these guide members can include a thread, allowing the sleeve to be moved by screwing. Once in the desired position, the sleeve and the first end of the mast are secured together in order to maintain said position. For example, the sleeve and the first end of the mast may be welded. In other words, this alternative constitutes another means of adjusting the position of the adjusting device.

According to an exemplary embodiment of the present invention, at least one weld bead is formed between an internal wall of the sleeve and the first end of the mast, and the primary reinforcement is secured to at least one secondary reinforcement connecting the mast to the adjusting device. For example, the primary reinforcement and the secondary reinforcement may be secured together by welding.

According to a first variant of this exemplary embodiment, the at least one weld bead is a single weld bead, which is then produced inside the sleeve. More particularly, according to this first variant, the weld bead joins the internal wall of the sleeve, that is to say a wall of this sleeve facing the mast, to the upper portion of the first end of the mast. Such a variant is advantageously combined with the exemplary embodiment of the method in which, prior to the first step, at least one secondary reinforcement is secured to the first end of the mast, the method comprising at least one additional step during which the at least one primary reinforcement is secured to the at least one secondary reinforcement. The additional step during which the at least one primary reinforcement is secured to the at least one secondary reinforcement may be carried out between the second step and the third step.

According to a second variant of this exemplary embodiment, the at least one weld bead is a first weld bead which joins the internal wall of the sleeve to the upper portion of the first end of the mast and at least one second weld bead is produced between a lower edge of the sleeve and an outer face of the first end of the mast, that is to say a face of this first end of the mast facing the sleeve.

According to one feature of the invention, the sleeve has a height of at least 100 mm. Advantageously, the sleeve can have a height of between 180 and 240 mm, for example 200 mm. Indeed, since the height of the storage tanks produced according to the same model can vary in the order of 40 to 50 mm, the adjusting device must be configured to tolerate such a variation while allowing the fixing of the device of the adjustment on the mast, for example by welding.

According to one feature of the invention, the adjusting device comprises at least one primary reinforcement bearing on an outer wall of the sleeve and/or a second surface of the platform of the adjusting device.

As set out previously, the primary reinforcement is intended to consolidate the adjusting device and to ensure the flatness of the platform, in particular to allow it to withstand the physical stresses exerted by the pump drive assembly, such as vibrations generated by its operation.

The primary reinforcement may for example consist of a plate configured to bear against the outer wall of the sleeve and to support the platform.

In particular, the adjusting device can comprise a plurality of primary reinforcements, which may be regularly arranged against the outer wall of the sleeve and/or the second surface of the platform.

According to one feature of the invention, the sleeve, the platform and at least the primary reinforcement are secured to one another.

The fixing of the sleeve on the platform and the fixing of at least the primary reinforcement on the sleeve and/or the platform can, by way of example, be carried out by welding.

The present invention also relates to an offloading tower for a tank of a floating structure intended to contain a liquefied gas, the offloading tower comprising at least the mast, intended to extend into the tank, and at least the pump for the liquefied gas, which comprises at least the drive assembly and the suction element, the offloading tower being configured so that the drive assembly is arranged outside the tank, at the first end of the mast, and so that the suction element is arranged in the tank, at a second end of the mast, opposite the first end, the drive assembly being mechanically connected to the suction element by means of a drive shaft extending at least into the mast, the offloading tower comprising at least the adjusting device as set out previously, interposed between the drive assembly and the first end of the mast.

According to the invention, the offloading tower comprises at least one secondary reinforcement configured to bear on the adjusting device.

As previously described, the secondary reinforcement is configured to consolidate the fixing of the adjusting device on the first end of the mast, when the latter is placed in the appropriate position. The secondary reinforcement is placed in abutment, then fixed, against the adjusting device, for example by welding. In order to limit the deformation of the platform during such fixing, the secondary reinforcement can in particular be configured to cooperate with the sleeve and/or with the primary reinforcement of the adjusting device.

According to the invention, at least the secondary reinforcement may be configured to cooperate with at least one ring, secured to the mast of the offloading tower.

The ring may consist of an annular part, surrounding the first end of the mast. In particular, the mast of the offloading tower can comprise a plurality of rings extending parallel to one another.

The invention also relates to a tank of a floating structure intended to contain a liquefied gas, comprising an offloading tower as described above.

The invention also relates to a system for loading or offloading a liquefied gas, which combines at least one means on land and at least one floating structure for transporting liquefied gas comprising at least one tank as set out previously.

Finally, the invention relates to a method of loading or offloading a liquefied gas from a tank, as set out previously, of a floating structure for transporting liquefied gas.

Other features, details and advantages of the invention will emerge more clearly on reading the following description on one hand, and several embodiments given by way of non-limiting indication, with reference to the appended schematic drawings on the other hand, in which:

[Fig 1] is a schematic view of a floating structure comprising a tank housing an offloading tower according to one aspect of the invention;

[Fig 2] is a schematic view of an offloading tower arranged in one of the tanks of the floating structure containing a liquefied gas;

[Fig 3] is a schematic perspective view of the offloading tower comprising a device for adjusting the position of at least one drive assembly of a pump included in the offloading tower;

[Fig 4] is a schematic perspective view of the adjusting device according to one aspect of the invention;

[Fig 5] is a schematic top view of the adjusting device positioned on a first end of a mast of the offloading tower according to a first step of an installation method of the invention;

[Fig 6] is a schematic perspective view of the positioning and adjustment of the position of the adjusting device on the first end of the mast of the offloading tower;

[Fig 7] is a cross-sectional schematic view of the adjusting device, mounted on the mast of the offloading tower and carrying the pump drive assembly, illustrating the third step and the fourth step of the method of the invention.

The features, variants and the various embodiments of the invention may be associated with each other, in various combinations, as long as they are not incompatible or exclusive to each other. It is in particular possible to imagine variants

of the invention comprising only a selection of features described below in isolation from the other features described, if this selection of features is sufficient to confer a technical advantage or to differentiate the invention from the prior art.

Figure 1 depicts a floating structure 1, for example a methane carrier or an ethane carrier, which comprises four tanks 2 intended for the storage of gas in the liquid state, in particular liquefied natural gas (abbreviated as LNG), liquefied petroleum gas (LPG), ethane or any other liquid gas at cryogenic temperatures, as it is transported from one site to another.

Each tank 2 is formed by stacking at least a primary insulation layer and a secondary insulation layer, respectively referred to as the primary membrane and the secondary membrane, the various tanks 2 being separated from each other by double transverse partitions, also called cofferdams.

Also, each tank 2 is associated with an offloading tower 3 which allows at least the extraction of the liquefied gas 4 from the tank. As illustrated in figure 2, the offloading tower 3 is arranged in the tank 2 containing the liquefied gas 4.

In order to keep the gas in the liquid state, the tank 2 is sealed and thermally insulated. The tank 2 consists of four side walls 21 forming a parallelepiped and each cooperating, at a first termination, with an upper wall 22 of the tank. A second termination of the side walls 21 cooperates with a bottom wall 23 which extends parallel to the top wall 22, so that the top wall 22 and the bottom wall 23 both extend perpendicular to the side walls 21 of the tank 2. The side walls 21, the bottom wall 23 and the top wall 22 thus define an internal volume 200 of the tank 2 where the liquefied gas 4 extends.

The tank 2 comprises an opening 24, formed in the upper wall 22. Such an opening 24 allows the passage of the offloading tower 3 in the enclosure of the tank 2, in particular during its installation. The opening 24 is configured to cooperate with a cover 31 of the offloading tower 3, which, when the offloading tower 3 is installed, extends parallel to the upper wall 22 of the tank 2 and closes the opening 24 to make the tank 2 sealed and thermally insulated.

Figure 3 further illustrates the offloading tower 3 comprising said cover 31. The offloading tower 3 comprises a plurality of masts 32 extending from the cover 31 of the tank 2 to its bottom wall, in line with the opening, and which each define a duct of

a pump 5 of the offloading tower 3. In particular, the masts 32 are fixed in the tank 2, the various masts 32 being secured to the cover 31.

Each mast 32 consists of a hollow stem, of circular section, and may for example be made of stainless steel. The mast 32 consists of a plurality of tube segments welded to each other, a first end 33 of the mast 32 extending close to the upper wall of the tank while a second end 34 of the mast 32, opposite the first end 33, extends close to the bottom wall.

The masts 32 of the offloading tower 3 are joined to each other by means of truss structures 35. Each truss structure 35 consists of a plurality of arms extending between two masts 32 of the offloading tower 3, over all or part of its height. Advantageously, the truss structures 35 can extend from the cover 31 of the offloading tower 3 to the second ends 34 of the masts 32.

The pump 5 of the offloading tower 3 comprises at least a drive assembly 51, a drive shaft 52 and a suction element 53, the drive shaft 52 mechanically connecting the drive assembly 51 to the suction element 53.

The drive assembly 51 may, in particular, be a geared motor assembly comprising at least one motor for the pump 5 and a speed reduction device for said pump 5. The drive assembly 51 is arranged at the first end 33 of the mast 32, in an environment outside the tank 2. The drive assembly 51 is particularly arranged on an adjusting device 6, provided on the first end 33 of the mast 32 in order to adjust the position of the drive assembly 51 relative to the bottom wall of the tank. According to the example shown, the drive assembly 51 is electric. Alternatively, it could also be a hydraulic or pneumatic system.

The suction element 53 includes at least one main body which surrounds one or more propellers. The suction element 53 is arranged in the tank, near the bottom wall, at the level of the second end 34 of the mast 32. The drive assembly 51, the mast 32 and the suction element 53 extend along a main axis 300 that is perpendicular to the bottom wall 23 of the tank, on which the mast 32 is centered.

The mast 32 houses an offloading tube, configured to convey the liquefied gas 4, and the drive shaft 52, with the offloading tube surrounding the drive shaft 52. The drive shaft 52 transmits to the suction element 53 the rotational movement of the drive

assembly 51. Such a movement then causes the liquefied gas to be pumped and extracted from the tank via the offloading tube.

The cover 31 consists of a flat plate secured to the upper wall 22 of the tank 2 by welding and/or by means of fasteners, such as a screw/nut system. The dimensions of the cover 31 are advantageously greater than those of the opening of the upper wall 22. Thus, the cover 31 can extend over an inner face of the upper wall 22 facing the enclosure of the tank 2, or over an outer face of this upper wall 22.

The cover 31 consists of a set of metal parts giving it mechanical strength. The latter may also include thermal insulation consisting of a primary membrane and possibly of a secondary membrane.

The cover 31 has a first face 311 oriented towards the outside of the tank and a second face 312 oriented towards the inside of the tank. The cover 31 is configured to keep the offloading tower 3 suspended in the tank. It comprises at least one through-orifice intended to receive and hold the mast 32 so that the first end 33 extends outside the tank. The through-orifice thus allows the passage of the offloading tube, of the drive shaft 52 as well as of the mast 32 which surrounds them, through the cover 31 so that the offloading tube emerges outside the tank, while the drive shaft 52 is connected to the drive assembly 51 for the pump 5.

The offloading tower 3 shown in figure 3 comprises two pumps 5 as previously described, each associated with one of the masts 32, respectively a first mast 321 and a second mast 322, while a third mast 323 corresponds to the backup mast of the offloading tower 3.

When installing each pump 5 of the offloading tower 3 in the tank 2, the drive assembly 51 and the drive shaft 52 on one hand, and the suction element 53 on the other hand, are installed separately. In order to ensure the correct positioning of the drive assembly 51 and of the drive shaft 52, which is secured thereto relative to the bottom wall 23 of the tank 2, and therefore relative to the corresponding suction element 53, the adjusting devices 6 are interposed between the drive assembly 51 of each pump 5 and the first end 33 of the mast 32. The adjusting device 6 thus cooperates with the first end 33 of the mast 32 of the offloading tower 3 and carries the drive assembly 51 for the pump 5.

Figure 4 illustrates an exemplary embodiment of the adjusting device 6. The adjusting device 6 may include a sleeve 61, a platform 62 and a plurality of primary reinforcements 63.

The sleeve 61 has a cylindrical shape configured to cooperate with the first end of the mast. The sleeve 61 has a height of at least 100 mm, so that it can tolerate a variation in the height of the tank of the order of 40 to 50 mm, which may be observed between two tanks made according to the same tank model. By way of example, the illustrated sleeve 61 extends over a height of 200 mm, measured along an axis of extension 600 of the adjusting device 6, on which the sleeve 61 is centered.

The platform 62 consists of a flat part which extends perpendicularly to the axis of extension 600 and to the sleeve 61. The illustrated platform 62 has a circular shape but may alternatively be square. The platform 62 includes a hole 64, centered on the axis of extension 60, allowing the sleeve 61 to be inserted into the platform 62 during assembly of the adjusting device 6.

A first surface 621 of the platform 62, which is planar and configured to carry the pump drive assembly, lies in a first plane 610 that is orthogonal to the axis of extension 60. In order to ensure the fixing of said drive assembly, the platform 62 comprises a plurality of fixing holes 65, configured to cooperate with a plurality of fixing members of the pump.

The primary reinforcements 63 consist of substantially rectangular plates reinforcing the structure of the adjusting device 6, in particular in order to preserve the flatness of the first surface 621 of the platform 62. A plurality of primary reinforcements 63 are regularly arranged on an outer wall 611 of the sleeve 61, each primary reinforcement 63 extending radially relative to the axis of extension 600 of the adjusting device 6.

The primary reinforcements 63 are arranged so as to bear on the outer wall 611 of the sleeve 61 and/or on the platform 62. As illustrated, a lateral edge 631 of the primary reinforcement 63 bears against the outer wall 611 of the sleeve 61, while an upper edge 632 is in contact with a second surface 622 of the platform 62, opposite the first surface 621.

According to an optional step of the method for installing the pump drive assembly on the offloading tower, the sleeve 61, the platform 62 and at least one of the primary

reinforcements 63 can advantageously be secured prior to the positioning of the sleeve 61 on the first end of the mast so that the adjusting device 6, when it is positioned on the first end of the mast, has the configuration as illustrated in figure 4.

Indeed, the platform 62 being surfaced so that the first surface 621 is flat, it is necessary to prevent any subsequent deformation of the platform 62 which may, for example, accompany the fixing by welding of the primary reinforcements 63 on the sleeve 61 and/or the platform 62 of the adjusting device 6. The sleeve 61, the platform 62 and the primary reinforcements 63 can thus, first of all, be joined together by welding, then the first surface 621 of the platform 62 is surfaced before the positioning of the adjusting device 6 on the mast.

The method for installing at least the drive assembly 51 of the pump 5 at the level of the first end 33 of the mast 32 by means of the adjusting device 6 comprises, as shown in figures 5 and 6, a first step of positioning the adjusting device 6, and more particularly the sleeve 61, on the first end 33 of the mast 32.

In the example illustrated, the sleeve 61 is characterized by a first diameter 6120, measured at an internal wall 612 of the sleeve 61. The first diameter 6120 is greater than a second diameter 3300 of the first end 33 of the mast 32, measured at an outer face 331 of said mast 32, so that the sleeve 61 closely surrounds the first end 33 of the mast 32. The first diameter 6120 and the second diameter 3300 are particularly defined in order to have a clearance of the order of 1-2 mm between the sleeve 61 and the outer face 331 of the first end 33 of the mast 32. Additionally, the mast 32 is configured to accommodate the offloading tube 36 of the pump.

The hole 64 of the platform 62 is characterized by a third diameter 6400, allowing the insertion of the sleeve 61 into said hole 64.

Alternatively, the sleeve 61 may be configured so that its first diameter 6110 is smaller than the second diameter 3300 of the mast 32, the mast 32 then surrounding the sleeve 61.

According to a second step of the method for installing the drive assembly 51 of the pump 5, the position of the adjusting device 6 is adjusted to a determined height relative to the bottom wall 23 of the tank 2, said height evaluating the distance between the first surface 621 of the platform 62 and a point of the bottom wall of the tank along the main axis 300 of the mast, here shown so as to coincide with the axis

of extension 600 of the adjusting device 6. The height adjustment is carried out by a translational movement T1 along the main axis 300 on which the mast 32 is centered.

Optionally, the second step of the method for installing the drive assembly 51 for the pump 5 can allow the height and the attitude of the adjusting device 6 to be adjusted relative to the bottom wall 23 of the tank. The adjusting of the attitude consists of an adjustment of the inclination of the first surface 621 of the platform 62 relative to the main axis 600 of the mast 32, and therefore relative to the bottom wall of the tank, according to a tilting movement M1.

In particular, in the second step, the adjustment of the position of the adjusting device 6 may be operated by sliding the sleeve 61 relative to the first end 33 of the mast 32, the sliding movement of the sleeve 61 thus making it possible to adjust the height and/or the attitude of the adjusting device 6, and therefore of the drive assembly and of the drive shaft for the pump, which it carries relative to the bottom wall of the tank.

In particular, during the second step of the installation method, the adjusting of the position of the adjusting device 6 may be carried out by means of an optical tool (not shown) placed on the platform 32 of the adjusting device 6.

The optical tool may be configured to assess the height and/or attitude extending between the first surface 621 of the platform 62 and a point on the bottom wall of the tank. In particular, the optical tool may comprise at least one measuring member and a laser pointer, the latter marking on the bottom wall the direction of extension of the drive shaft. By way of example, the projection of an image of a section of the mast 32 may be carried out on the bottom wall of the tank and the optical tool is used to materialize and apprehend the position of the drive shaft relative to said projection. The modification of the attitude of the adjusting device 6 moves the optical tool and therefore the pointer relative to the projection of the section of the mast 32 which serves as a reference. The attitude of the adjusting device 6 can then be adjusted until a suitable position is obtained, for example until the pointer is centered in the projection of the mast 32.

It is understood that this is only an exemplary implementation of the present invention which does not limit said invention. For example, the optical tool may be

replaced with a tape measure without departing from the scope of the present invention.

When the desired position of the adjusting device 6 is obtained, a third step of the method for installing the drive assembly 51 of the pump 5, visible in figure 6 and more particularly in figure 7, consists in securing the adjusting device 6 on the first end 33 of the mast 32. Such securing may be achieved by welding the sleeve 61 to at least the outer face 331 and/or an upper portion 332 of the first end 33 of the mast 32.

The adjusting device 6 is secured to the first end 33 of the mast 32 by means of a first weld bead 66 and/or a second weld bead 67. The first weld bead 66 is made inside the sleeve 61 and joins the internal wall 612 of the sleeve 61 with the upper portion 332 of the first end 33 of the mast 32. The second weld bead 67 extends between a lower edge 613 of the sleeve 61 and the outer face 331 of the first end 33 of the mast 32.

Advantageously, the joining by welding of the adjusting device 6 on the mast 32 is not directly carried out at the level of the platform 62 of the adjusting device 6, thus preventing possible deformations of said platform 62, more particularly of the first, flat surface 621.

In particular, the mast 32 comprises at least one through-perforation 324 which extends from the outer face 331 and opens out inside the mast 32, the perforation 324 being arranged facing the sleeve 61. Such a perforation 324 makes it possible to evacuate, towards the inside of the mast 32, any gases that may have accumulated between the internal wall 612 of the sleeve 61, the outer face 331 of the mast 32, the first weld bead 66 and the second weld bead 67 during the welding operation, thus guaranteeing the leaktightness of the resulting welds.

Optionally, the method for installing the drive assembly 51 for the pump 5 may comprise, after the third step, a step of reinforcing the adjusting device 6 by securing at least one secondary reinforcement 37 which connects the mast 32 to the adjusting device 6.

Alternatively, the method for installing the drive assembly 51 for the pump 5 may comprise, prior to the first step, a step of securing at least one secondary reinforcement 37 which connects the mast 32 to the adjusting device 6. According to this alternative, the method then comprises an additional step of securing at least one

primary reinforcement 63 on the at least one secondary reinforcement 37 previously secured to the mast 32. This additional step may be carried out without distinction before or after the third step of the method described above.

The secondary reinforcement 37 can consist of a rectangular plate, for example similar to the primary reinforcement 63 of the adjusting device 6, or, as shown in figures 5 to 7, the secondary reinforcement 37 can have a so-called “L” shape, a base 371 of the secondary reinforcement 37 bearing in part on the outer face 331 of the mast 32 while an arm 372 of the secondary reinforcement 37 is in contact with the adjusting device 6, here with one of the primary reinforcements 63 of said device. The securing of the secondary reinforcement 37 on the adjusting device 6 may be achieved by welding, with the fact that it is fixed on at least the primary reinforcement 63, that is to say at a distance from the platform 62, preventing, as set out above, possible deformations of the platform 62.

In particular, the arm 372 of the secondary reinforcement 37 and the outer face 331 of the first end 33 of the mast 32 define a hook 373 allowing the sleeve 61 of the adjusting device 6 to pass through, which allows the position of the secondary reinforcement 37 to be adjusted relative to the adjusting device 6.

The offloading tower 3 can thus comprise the same number of primary reinforcements 63 and secondary reinforcements 37, so that each secondary reinforcement 37 is placed against one of the primary reinforcements 63. According to an alternative configuration, which is not shown, the offloading tower 3 can comprise a greater number of secondary reinforcements 37, for example in order to fix a secondary reinforcement 37 on either side of each of the primary reinforcements 63.

The offloading tower 3 is configured so that the mast 32 has at least one ring 38, implemented between the adjusting device 6 and the cylindrical ring 314 of the cover 31 of the offloading tower 3. The ring 38 consists of an annular part secured to the outer face 331 of the mast 32 which extends perpendicularly to the main axis 300 of the mast 32, the ring 38 being intended to carry, at least in part, at least one of the secondary reinforcements 37.

As illustrated, the offloading tower 3 can also include additional reinforcement members, for example tertiary reinforcements 39, intended to be interposed between

two adjacent rings 38 in order to consolidate the position of the adjusting device 6 on the first end 33 of the mast 32.

In the configuration of the offloading tower 3 shown, the mast 32 comprises a first ring 381 and a second ring 382 which extend parallel to each other between the adjusting device 6 and the cylindrical ring 314 of the cover 31. The first ring 381 carries the secondary reinforcements 37 of the offloading tower 3, while the second ring 382 is arranged in abutment against the cylindrical ring 314 of the cover 31. A plurality of tertiary reinforcements 39 extend between the first ring 38 and the second ring 38, the tertiary reinforcements 39 reinforcing the fixing of the adjusting device 6 on the mast 32 in the desired position.

According to a fourth step of the installation method, as illustrated in figures 6 and 7, at least the drive assembly 51 of the pump 5, which is secured to the drive shaft 52, is mounted on the platform 62 of the adjusting device 6. A body 54 of the drive assembly 51 is arranged on the first surface 621, the drive assembly 51 being carried by the adjusting device 6 so that the drive shaft 52 extends from the drive assembly 51, through the through-orifice 313 of the cover 31 and then into the tank 2, towards the suction element of the pump 5. The drive shaft is thus mainly surrounded by the offloading tube 36 which is itself surrounded by the mast 32.

The body 54 of the pump 5 can then be fixed in position on the adjusting device 6, for example by means of a plurality of fixing members keeping the platform 62 of the adjusting device 6 secured to the body 54 of the pump 5.

It will be understood from reading the foregoing that the present invention proposes a method for installing at least one drive assembly for a pump of an offloading tower, contained in a liquefied gas storage tank of a floating structure, by means of a device for adjusting the position of the drive assembly intended to carry said assembly. The present invention also proposes an adjusting device capable of being used during the implementation of the installation method which is the subject of the invention. The adjusting device comprises at least a platform and a sleeve, configured to be arranged and moved on a first end of a mast of the offloading tower.

The invention should not however be limited to the means and configurations that are described and illustrated here, and it also extends to any equivalent means or configuration and to any technical combination using such means. In particular, the

number, dimensions, shape and arrangement of the primary reinforcements, secondary reinforcements or tertiary reinforcements may be modified without harming the invention, insofar as the adjusting device ultimately fulfills the same functionalities as those described in this document.

Claims

1. A method for installing at least one drive assembly (51) for a pump (5) for a tank (2) of a floating structure (1) intended to contain a liquefied gas (4), the tank (2) comprising a tower (3) for offloading the liquefied gas (4) equipped with at least one mast (32), the drive assembly (51) being arranged outside the tank (2), at a first end (33) of the mast (32), by means of an adjusting device (6) which comprises at least one sleeve (61) and a platform (62), the pump (5) comprising a suction element (53) arranged in the tank (2) at a second end (34) of the mast (32), opposite the first end (33), the installation method comprising:

- a first step of positioning the sleeve (61) on the first end (33) of the mast (32),

- a second step of adjusting the position of the adjusting device (6) to a determined height relative to a bottom wall (23) of the tank (2),

- a third step of securing the adjusting device (6) to the first end (33) of the mast (32),

- and a fourth step of mounting the drive assembly (51) for the pump (5) on the platform (62) of the adjusting device (6).

2. The installation method as claimed in claim 1, during which the second step allows adjustment of the attitude of the adjusting device (6) relative to the bottom wall (23) of the tank (2).

3. The installation method as claimed in claim 1 or 2, during which the adjustment of the position of the adjusting device (6) in the second step is effected by sliding of the sleeve (61) relative to the first end (33) of the mast (32).

4. The installation method as claimed in any one of claims 1 to 3, during which the third step is carried out by welding the sleeve (61) to at least an outer face (331) and/or an upper portion (332) of the first end (33) of the mast (32).

5. The installation method as claimed in any one of claims 1 to 4, during which, prior to the first step, the sleeve (61), the platform (62) and at least one primary reinforcement (63) are secured together.

6. The installation method as claimed in any one of claims 1 to 5, comprising, between the third step and the fourth step, a step of reinforcing the adjusting device (6) by securing at least one secondary reinforcement (37) which connects the mast (32) to the adjusting device (6).

7. The installation method as claimed in claim 6, comprising, prior to the reinforcing step, a step of adjusting the position of at least the secondary reinforcement relative to the adjusting device.

8. The installation method as claimed in claim 5, during which, prior to the first step, at least one secondary reinforcement (37) is secured to the first end (33) of the mast (32), the method comprising at least one additional step during which the at least one primary reinforcement (63) is secured to the at least one secondary reinforcement (37).

9. A device (6) for adjusting the position of at least one drive assembly (51) for a pump (5) of an offloading tower (3) arranged in a tank (2) of a floating structure (1) intended to contain a liquefied gas (4), the adjusting device (6) extending outside the tank (2), characterized in that the adjusting device (6) comprises at least one sleeve (61) and a platform (62), the sleeve (61) being configured to cooperate with a first end (33) of a mast (32) of the offloading tower (3) and the platform (62) being configured to carry the drive assembly (51).

10. The adjusting device (6) as claimed in claim 9, wherein the sleeve (61) has a height of at least 100 mm.

11. The adjusting device (6) as claimed in claim 9 or 10, comprising at least one primary reinforcement (63) bearing on an outer wall (611) of the sleeve (61) and/or a second surface (622) of the platform (62) of the adjusting device (6).

12. The adjusting device (6) as claimed in the preceding claim, wherein the sleeve (61), the platform (62) and at least the primary reinforcement (63) are secured to one another.

13. Assembly of a mast (32) and of an adjusting device (6) as claimed in any one of claims 11 or 12, the at least one sleeve (61) of the adjusting device (6) cooperating with a first end (33) of the mast (32), wherein at least one weld bead (66) is formed between an internal wall (612) of the sleeve (61) and the first end (33) of the mast (32), and wherein the assembly comprises at least one secondary reinforcement (37) connecting the mast (32) to the adjusting device (6), the primary reinforcement (63) being secured to the at least one secondary reinforcement (37).

14. Assembly of a mast (32) and of an adjusting device (6) as claimed in any one of claims 9 to 12, the at least one sleeve (61) of the adjusting device (6) cooperating with a first end (33) of the mast (32), wherein the sleeve (61) and the first end (33) of the mast (32) comprise, respectively, a guide member, the guide member of the sleeve (61) and the guide member of the first end (33) of the mast (32) being complementary to each other in order to cause the sleeve (61) to move along the first end (33) of the mast (32).

15. An offloading tower (3) for a tank (2) of a floating structure (1) intended to contain a liquefied gas (4), the offloading tower (3) comprising at least a mast (32), intended to extend into the tank (2), and at least a pump (5) which comprises at least a drive assembly (51) and a suction element (53), the offloading tower (3) being configured so that the drive assembly (51) is arranged outside the tank, at a first end (33) of the mast (32), and so that the suction element (53) is arranged in the tank (2), at a second end (34) of the mast (32), opposite the first end (33), the drive assembly (51) being mechanically connected to the suction element (53) by means of a drive shaft (52) extending at least into the mast (32), the offloading tower (3) comprising at least the adjusting device (6) as claimed in any one of the claims 9 to 12, interposed between the drive assembly (51) and the first end (33) of the mast (32).

16. The offloading tower (3) as claimed in the preceding claim, comprising at least one secondary reinforcement (37) configured to bear on the adjusting device (6).

17. The offloading tower (3) as claimed in the preceding claim, wherein at least the secondary reinforcement (37) is configured to cooperate with at least one ring (38), secured to the mast (32) of the offloading tower (3).

18. A tank (2) for a floating structure (1), this tank being intended to contain a liquefied gas (4) and comprising an offloading tower (3) as claimed in any one of claims 15 to 17.

19. A system for loading or offloading a liquefied gas, which combines at least one means on land and at least one floating structure (1) for transporting liquefied gas comprising at least one tank (2) as claimed in the preceding claim.

20. A method of loading or offloading a liquefied gas from a tank (2), as claimed in claim 18, of a floating structure (1) for transporting liquefied gas.