

DESCRIPTION

Title of Invention

CARGO TANK UNIT AND SHIP

Technical Field

[0001]

The present disclosure relates to a cargo tank unit and a ship.

The present application claims priority with respect to Japanese Patent Application No. 2019-238408 filed in Japan on December 27, 2019, the contents of which are incorporated herein by reference.

Background Art

[0002]

A ship carrying liquefied gas such as natural gas is equipped with a cargo tank accommodating the liquefied gas. For example, Patent Document 1 discloses a configuration in which a cargo tank is supported by a hull via a cylindrical skirt. The upper end portion of the skirt described in Patent Document 1 is disposed at the equatorial position of the cargo tank. The upper end portion of this skirt is fixed by welding to the equatorial part of the cargo tank.

[0003]

Such cargo tanks are designed in accordance with the International Maritime Organization (IMO) Tank Type B requirements specified in the International Gas Carrier (IGC) Code, which is the IMO safety rules for liquefied gas ships.

Citation List

Patent Literature

[0004]

[PTL 1] Japanese Patent No. 6342358

Summary of Invention

Technical Problem

[0005]

An IMO Tank Type B cargo tank is one in which the stress of each part of the structure is precisely grasped using, for example, a model test and a detailed analysis method, and fatigue analysis and fracture mechanism analysis are accurately performed. Accordingly, the welded portion between the cargo tank and a skirt needs to meet the same fatigue strength requirements as the tank. For this reason, a ring-shaped member formed by machining is generally used for the welded portion between the equatorial part of the cargo tank and the skirt. This ring-shaped member is joined between the upper half portion and the lower half portion of the cargo tank. The upper end of the lower half portion of the cargo tank and the upper end portion of the skirt disposed on the radially outer side of the cargo tank are

welded to the lower end portion of the ring-shaped member. Accordingly, the thickness of the lower end portion of the ring-shaped member is the sum of the wall thickness of the lower half portion of the cargo tank and the wall thickness of the upper end portion of the skirt.

[0006]

In the IMO Tank Type B cargo tank, the upper limit of the wall thickness of each part including the ring-shaped member is 40 mm unless the material is an aluminum alloy. The wall thickness of the lower half portion of the cargo tank is the thickness of the welded ring-shaped member (up to 40 mm) minus the wall thickness of the upper end portion of the skirt. In other words, at least in the lower half portion of the cargo tank, an increase in wall thickness is limited to a certain level. This hinders an increase in the size of the cargo tank required to have pressure resistance.

[0007]

The present disclosure has been made in view of the above, and an object of the present disclosure is to provide a cargo tank unit and a ship enabling an increase in the wall thickness of a cargo tank and, by extension, an increase in the size of the cargo tank.

Solution to Problem

[0008]

In order to achieve the above object, the cargo tank unit according to the present disclosure includes a cargo tank, a skirt, and a welded portion. The cargo tank is of IMO IGC Code Tank Type C. The skirt has an upper end connected to a lower half portion of the cargo tank over a circumferential direction. The skirt extends downward to be fixed to a hull. The welded portion fixes the upper end of the skirt to the cargo tank over the circumferential direction.

Advantageous Effects of Invention

[0009]

According to the ship of the present disclosure, it is possible to increase the wall thickness of a cargo tank and, by extension, increase the size of the cargo tank.

Brief Description of Drawings

[0010]

Fig. 1 is a plan view illustrating an overall configuration of a ship according to an embodiment of the present disclosure.

Fig. 2 is a half cross-sectional view in which a cargo tank provided on the ship according to the embodiment of the present disclosure is viewed from the ship stern direction.

Fig. 3 is an enlarged cross-sectional view illustrating the configuration of a cargo tank-skirt joint according to the embodiment of the present disclosure.

Description of Embodiments

[0011]

Fig. 1 is a plan view illustrating an overall configuration of a ship according to an embodiment of the present disclosure. Fig. 2 is a half cross-sectional view in which a cargo tank provided on the ship is viewed from the ship stern direction.

As illustrated in Figs. 1 and 2, a ship 1 of the embodiment of the present disclosure, for example, stores and carries liquefied gas such as liquefied natural gas. The ship 1 includes at least a hull 2, a cargo tank 20, a skirt 30, and a welded portion 40.

For convenience, the cargo tank 20, the skirt 30, and the welded portion 40 are collectively referred to as a cargo tank unit.

[0012]

The hull 2 has a pair of broadsides 3A and 3B, a ship bottom 4, and an upper deck 5, which form the outer shell of the hull 2. The broadsides 3A and 3B are provided with a pair of broadside skins respectively forming the left and right broadsides. The ship bottom 4 is provided with a ship bottom skin connecting the broadsides 3A and 3B. By the

pair of broadsides 3A and 3B and the ship bottom 4, the outer shell of the hull 2 has a U shape in a cross section orthogonal to a ship stern direction Da. The upper deck 5 is a whole deck exposed to the outside. In the hull 2, an upper structure 7 having a living quarter is formed on the upper deck 5 on a stern 2b side.

[0013]

In the hull 2, a cargo loading section (hold) 8 is formed closer to a bow 2a side than the upper structure 7. The cargo loading section 8 is recessed toward the ship bottom 4 below the upper deck 5 and is open upward.

[0014]

A plurality of the cargo tanks 20 are provided in the cargo loading section 8. The plurality of cargo tanks 20 are disposed side by side in the ship stern direction Da. An upper portion 20a of each cargo tank 20 protrudes upward beyond the upper deck 5 of the hull 2. The upper portions 20a of the plurality of cargo tanks 20 are covered with tank covers 25 provided on the upper deck 5. A heat insulating material (not illustrated) that suppresses heat input from the outside is provided on the outer surface of each of the plurality of cargo tanks 20.

[0015]

The cargo tank 20 has a spherical shape. Liquefied gas to be carried is accommodated in the cargo tank 20. In

the embodiment of the present disclosure, the liquefied gas accommodated in the cargo tank 20 is, for example, a high-pressure low-temperature gas of approximately 9 to 20 (BarG). The cargo tank 20 is an IMO Tank Type C tank specified in the IMO IGC Code.

[0016]

Each cargo tank 20 includes a lower half portion 21 and an upper half portion 22.

The lower half portion 21 is hemispherical in the lower portion of the cargo tank 20. The diameter dimension of the lower half portion 21 gradually increases upward from below. The lower half portion 21 may, for example, have a semi-true sphere shape having a constant radius of curvature or be formed so as to have a radius of curvature increasing in stages upward from below in the cross section illustrated in Fig. 2.

[0017]

The upper half portion 22 is provided above the lower half portion 21. The upper half portion 22 is hemispherical in the upper portion of the cargo tank 20. The diameter dimension of the upper half portion 22 gradually decreases upward from below. In the embodiment of the present disclosure, the upper half portion 22 may have a semi-true sphere shape having a constant radius of curvature or be

formed so as to have a radius of curvature increasing in stages upward from below.

The cargo tank 20 is not limited to the above shape. The cargo tank 20 may be configured to include a cylindrical portion (not illustrated) or the like between the upper half portion 22 and the lower half portion 21.

[0018]

Each cargo tank 20 is supported on the hull 2 by the skirt 30. Each cargo tank 20 has a tank structure independent of the hull 2. The cargo tank 20 has a liquid-tight structure and self-supports the load of the liquefied gas accommodated in the cargo tank 20.

[0019]

Fig. 3 is an enlarged cross-sectional view illustrating the configuration of the joint between the cargo tank and the skirt.

The skirt 30 supports the cargo tank 20. The skirt 30 has a cylindrical shape extending in an up-down direction Dv as a whole. The lower end portion of the skirt 30 is fixed on a foundation deck portion 9 provided in the bottom portion of the cargo loading section 8. An upper end 30t of the skirt 30 is connected to an outer peripheral surface 21f of the lower half portion 21 of the cargo tank 20.

[0020]

The skirt 30 includes a tubular portion 31 and a tank support portion 32.

The tubular portion 31 has a cylindrical shape extending in the up-down direction D_v and has a constant diameter dimension over the up-down direction D_v . The tubular portion 31 in this embodiment has a cylindrical shape centered on an axis a passing through the center of the cargo tank 20 in the ship width direction.

[0021]

The tank support portion 32 is provided in the upper end portion of the skirt 30. The tank support portion 32 is continuously provided on the upper portion of the tubular portion 31. The tank support portion 32 extends upward and toward the inside in a radial direction D_r . In other words, the tank support portion 32 extends toward the outside in the radial direction D_r and downward from a tip 32t. In this embodiment, the tank support portion 32 includes a curved portion 32w that curves upward and to the inside in the radial direction D_r . The curved portion 32w is formed such that the angle formed by the curved portion 32w and the central axis of the tubular portion 31 gradually increases upward. In this embodiment, the tip 32t of the curved portion 32w on the inside in the radial direction D_r is the upper end 30t of the skirt 30. The tip 32t of the curved portion 32w abuts against the outer peripheral

surface 21f of the lower half portion 21 of the cargo tank 20. Here, the radial direction D_r means the radial direction centered on the axis a described above. In addition, the circumferential direction in the following description means the circumferential direction centered on the axis a .

[0022]

A crossing angle θ of the tip 32t of the curved portion 32w with respect to the outer peripheral surface of the cargo tank 20 can be, for example, approximately 30 degrees to 90 degrees. Here, the crossing angle θ is the angle that is formed by the innermost part of an inner surface 30f of the upper end 30t in the radial direction D_r (that is, the tip 32t) and a tangent $ta1$ of the outer peripheral surface 21f (circular arc shape in Fig. 3) of the cargo tank 20 at the position intersecting the inner surface 30f in a cross section including the axis a (see Fig. 3). In this embodiment, the curved portion 32w is provided and the tip 32t of the inner surface 30f is also curved. Accordingly, the crossing angle θ is the angle that is formed by a tangent $ta2$ at the tip 32t of the inner surface 30f (curved in Fig. 3) and the tangent $ta1$ on the outer peripheral surface 21f in a cross-sectional view including the axis a .

[0023]

As illustrated in Fig. 2, an inner diameter D1 of the upper end 30t of the skirt 30 (the tip 32t of the curved portion 32w) is smaller than an outer diameter D2 at the equatorial part of the cargo tank 20. In Fig. 2, the inner diameter D1 and the outer diameter D2 are illustrated in half for convenience.

As a result, the cargo tank 20 is supported from below by the upper end 30t of the skirt 30.

[0024]

As illustrated in Fig. 3, the cargo tank 20 and the skirt 30 are joined by welding. As a result, the welded portion 40 is formed at the joint between the cargo tank 20 and the skirt 30. A high-strength welding material such as 9% Ni steel can be used as the welding material that is used in welding the cargo tank 20 and the skirt 30. By using such a high-strength welding material, the strength of the welded portion 40 can be enhanced, and thus the reliability of the welded portion 40 can be improved.

[0025]

The welded portion 40 fixes the upper end 30t of the skirt 30 to the cargo tank 20. In the welded portion 40 exemplified in this embodiment, the upper end 30t of the skirt 30 is continuously fixed to the outer peripheral surface 21f of the cargo tank 20 over the entire circumference in the circumferential direction. Although a

case where the welded portion 40 is continuously formed over the entire circumference in the circumferential direction has been described, the present disclosure is not limited to this configuration. For example, the welded portion 40 may be formed at a part in the circumferential direction. In this case, the upper end 30t of the skirt 30 is fixed to the cargo tank 20 at a part in the circumferential direction. In this case, the welded portion 40 may be intermittently provided in the circumferential direction of the cargo tank 20, that is, at a plurality of locations.

[0026]

A joining member 50 is provided between the outer peripheral surface 21f of the lower half portion 21 of the cargo tank 20 and the inner surface 30f of the skirt 30 facing the inside in the radial direction Dr. The joining member 50 is provided at a plurality of locations at intervals in the circumferential direction of the lower half portion 21 of the cargo tank 20. The joining member 50 exemplified in this embodiment is formed in a flat plate shape along a vertical plane orthogonal to the circumferential direction (that is, a virtual plane including the axis a). The joining member 50 has an inside edge portion 50a welded along the outer peripheral surface 21f of the lower half portion 21 of the cargo tank 20 on the inside in the radial direction Dr and an outside edge

portion 50b welded along the inner surface 30f of the skirt 30 on the outside in the radial direction Dr. Welding may be performed on only one of the inside edge portion 50a and the outside edge portion 50b. A lower edge portion 50c of the joining member 50 exemplified in this embodiment is formed in a circular arc shape that is recessed upward in the central portion in radial direction Dr. The shape of the lower edge portion 50c is not limited to the circular arc shape in which the central portion in the radial direction Dr is recessed upward.

[0027]

The ship of the above embodiment further includes the joining member 50 provided at a plurality of locations at intervals in the circumferential direction of the lower half portion 21 of the cargo tank 20 and joining the lower half portion 21 of the cargo tank 20 and the inner surface of the skirt 30.

Accordingly, the spherical lower half portion 21 and the inner surface 30f of the skirt 30 can be more firmly joined by the plurality of joining members 50 provided in the circumferential direction. As a result, it is possible to further enhance the strength with which the skirt 30 supports the cargo tank 20.

[0028]

In the ship of the above embodiment, the upper end portion of the skirt 30 extends downward and toward the outside in the radial direction Dr of the cargo tank 20. The upper end 30t of the skirt 30 supporting the cargo tank 20 is connected to the lower half portion 21 of the cargo tank 20. In addition, the upper end 30t of the skirt 30 is connected by the welded portion 40 to the outer peripheral surface 21f of the lower half portion 21 of the cargo tank 20 so as to abut from the outside in the radial direction Dr.

Accordingly, the upper end 30t of the skirt 30 and the outer peripheral surface 21f of the lower half portion 21 of the cargo tank 20 are reliably welded, and the joining strength of the welded portion 40 can be effectively enhanced.

[0029]

In the ship of the above embodiment, the upper end portion of the skirt 30 has the curved portion 32w that curves upward and to the inside in the radial direction Dr, and the tip 32t of the curved portion 32w is welded to the outer peripheral surface 21f of the cargo tank 20.

By forming the curved portion 32w in the upper end portion of the skirt 30 in this manner, the lower end of the curved portion 32w and the upper end of the tubular portion 31 can be formed smoothly and continuously.

Accordingly, in the skirt 30 where the tip 32t of the curved portion 32w is welded to the outer peripheral surface 21f of the cargo tank 20, stress attributable to the load of the cargo tank 20 being locally concentrated is suppressed.

[0030]

Although an embodiment of the present disclosure has been described in detail with reference to the drawings, the specific configuration is not limited to this embodiment and also includes, for example, design changes within the gist of the present disclosure.

Although the curved portion 32w is provided in the upper end portion of the skirt 30 in the above embodiment, the present disclosure is not limited thereto. The upper end portion of the skirt 30 may extend downward and toward the outside in the radial direction D_r of the cargo tank 20 and may have a conical tube shape as an example. In this case, a corner portion is formed at the joint part between the lower end of the conical tube-shaped part and the upper end of the tubular portion 31 in the upper end portion of the skirt 30. Accordingly, in a case where stress attributable to the load of the cargo tank 20 may be locally concentrated on the corner portion between the lower end of the conical tube-shaped part and the tubular portion 31, the corner portion may be reinforced or the like so that sufficient strength is ensured.

[0031]

In addition, although the upper end portion of the skirt 30 in the above embodiment is provided so as to extend downward and toward the outside in the radial direction Dr of the cargo tank 20, the present disclosure is not limited thereto. For example, the upper end portion of the skirt 30 may have a cylindrical shape having a constant diameter along the up-down direction Dv.

[0032]

Although the joining member 50 is provided in the above embodiment, the shape of the joining member 50 is not limited at all. The joining member 50 may have another shape as appropriate insofar as the joining member 50 joins the lower half portion 21 of the cargo tank 20 and the inner surface 30f of the skirt 30. In addition, the circumferential installation interval, count, and the like of the joining member 50 can be appropriately changed. Further, a configuration without the joining member 50 is also possible.

[0033]

Although the cargo tank 20 and the skirt 30 in the above embodiment are provided in the cargo loading section 8 formed in the hull 2, the present disclosure is not limited thereto. For example, the cargo tank 20 and the skirt 30 may be provided on, for example, the upper deck 5.

In addition, although the above embodiment assumes installation on the hull 2, the present disclosure is not limited thereto. For example, providing on a floating body (not illustrated) may be performed instead.

[0034]

<Additional Notes>

The ship 1 described in the embodiment is, for example, grasped as follows.

[0035]

(1) A cargo tank unit according to a first aspect includes: a cargo tank 20 of IMO IGC Code Tank Type C; a skirt 30 having an upper end 30t connected to a lower half portion 21 of the cargo tank 20 over a circumferential direction and extending downward to be fixed to a hull 2; and a welded portion 40 fixing the upper end 30t of the skirt 30 to the cargo tank 20 over the circumferential direction.

[0036]

The IMO Tank Type C cargo tank 20 is designed based on pressure vessel standards to be capable of withstanding the temperature and pressure of the liquefied gas accommodated therein. In the IMO IGC Code Tank Type C, fatigue strength requirements are not required up to the joint with the skirt 30 as in the IMO IGC Code Tank Type B. Accordingly, the cargo tank 20 has excellent strength characteristics because

it is spherical, it can be designed to be increased in wall thickness, and an increase in diameter and an increase in capacity can be achieved with strength ensured.

[0037]

(2) The cargo tank unit according to a second aspect, which is the cargo tank unit of (1), further includes a joining member 50 provided at a plurality of locations of the lower half portion 21 of the cargo tank 20 at intervals in the circumferential direction and joining the lower half portion 21 of the cargo tank 20 and an inner surface 30f of the skirt 30.

[0038]

As a result, the spherical lower half portion 21 and the inner surface 30f of the skirt 30 can be more firmly joined by the plurality of joining members 50 provided in the circumferential direction. As a result, it is possible to further enhance the strength with which the skirt 30 supports the cargo tank 20.

[0039]

(3) In the cargo tank unit according to a third aspect, which is the cargo tank unit of (1) or (2), the skirt 30 includes a tubular portion 31 and a tank support portion 32, the tubular portion 31 has a cylindrical shape extending in an up-down direction, and the tank support portion 32 is continuously provided on an upper portion of the tubular

portion 31 and extends downward and outward in a radial direction Dr of the cargo tank 20.

[0040]

As a result, the tank support portion 32 is connected to the outer peripheral surface 21f of the lower half portion 21 of the cargo tank 20 so as to abut from the outside in the radial direction Dr. As a result, the tank support portion 32 and the outer peripheral surface 21f of the lower half portion 21 of the cargo tank 20 are reliably welded, and the joining strength of the welded portion 40 is effectively enhanced.

[0041]

(4) In the cargo tank unit according to a fourth aspect, which is the cargo tank unit of (3), an angle formed by the tank support portion 32 and a central axis of the tubular portion 31 is formed so as to gradually increase upward.

[0042]

In this manner, corner portion formation at the joint part between the tank support portion 32 and the tubular portion 31 is suppressed. As a result, in the skirt 30 welded to the outer peripheral surface 21f of the cargo tank 20, stress attributable to the load of the cargo tank 20 being locally concentrated is suppressed.

[0043]

(5) A ship according to a fifth aspect includes the cargo tank unit according to any one of (1) to (4).

[0044]

On condition that the capacity of the cargo tank 20 is increased, the number of the cargo tanks 20 on the hull 2 can be reduced and the manufacturing cost of the ship 1 can be reduced.

Industrial Applicability

[0045]

According to the present disclosure, it is possible to increase the wall thickness of a cargo tank and, by extension, increase the size of the cargo tank.

Reference Signs List

[0046]

1: ship

2: hull

2a: bow

2b: stern

3A, 3B: broadside

4: ship bottom

5: upper deck

7: upper structure

8: cargo loading section

9: foundation deck portion

20: cargo tank

20a: upper portion
21: lower half portion
21f: outer peripheral surface
22: upper half portion
25: tank cover
30: skirt
30f: inner surface
30t: upper end
31: tubular portion
32: tank support portion
32t: tip
32w: curved portion
40: welded portion
50: joining member
50a: inside edge portion
50b: outside edge portion
50c: lower edge portion
D1: inner diameter
D2: outer diameter
Da: ship stern direction
Dr: radial direction
Dv: up-down direction
 θ : crossing angle

Claims

[Claim 1]

A cargo tank unit comprising:

a cargo tank of IMO IGC Code Tank Type C;

a skirt having an upper end connected to a lower half portion of the cargo tank over a circumferential direction and extending downward to be fixed to a hull; and

a welded portion fixing the upper end of the skirt to the cargo tank over the circumferential direction.

[Claim 2]

The cargo tank unit according to Claim 1, further comprising joining members provided at a plurality of locations of the lower half portion of the cargo tank at intervals in the circumferential direction and joining the lower half portion of the cargo tank and an inner surface of the skirt.

[Claim 3]

The cargo tank unit according to Claim 1 or 2, wherein the skirt includes a tubular portion and a tank support portion,

the tubular portion has a cylindrical shape extending in an up-down direction, and

the tank support portion is continuously provided on an upper portion of the tubular portion and extends downward and outward in a radial direction of the cargo tank.

[Claim 4]

The cargo tank unit according to Claim 3, wherein an angle formed by the tank support portion and a central axis of the tubular portion is formed so as to gradually increase upward.

[Claim 5]

A ship comprising the cargo tank unit according to any one of Claims 1 to 4.