

INSULATION STRUCTURE OF CRYOGENIC STORAGE TANK

BACKGROUND OF THE INVENTION

5 1. Field of the invention

The present disclosure relates to an insulation structure of a cryogenic storage tank, and more particularly to an insulation structure of a cryogenic storage tank, in which thin long grooves for absorbing
10 thermal shrinkage displacement of insulation pads caused by a cryogenic temperature are formed in the insulation pads, and to which spray foam is applied between the insulation pads to prevent a cryogenic fluid leaking out of a tank body from flowing out to the outside.

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2. Description of the Prior Art

In general, liquid oxygen (-183°C), liquid nitrogen (-196°C), liquid argon (-186°C), LNG (-162°C), or the like having respective boiling points may be stored in a
20 cryogenic storage tank in view of characteristics thereof.

The cryogenic storage tank largely has a structure that prevents heat penetration from the outside and prevents evaporation of a cryogenic liquid.

The conventional cryogenic storage tank is made up of
25 a tank body in which a cryogenic liquid is stored and which

is formed of a metal, and an insulation structure that is joined to an outside of the tank body and secures insulation performance.

The conventional insulation structure is made up of a plurality of insulation pads that are adhered to an outer surface of the tank body, an insulator that is joined to a gap between the insulation pads, a fastening member that joins the insulation pads to the outside of the tank body, and so on. For example, a cryogenic tank insulation panel comprising an upper insulation layer at a higher temperature, a reinforced mesh on and a lower insulation layer at a lower temperature is disclosed in Japanese Unexamined Patent Application Publication No. H07-61493 (published on March 07, 1995). In addition, a cryogenic liquid storage tank comprising an inner insulation panel and an outer insulation panel is disclosed in Korean Patent No. 10-1180742 (issued on No. September 07, 2012) is disclosed.

However, in the conventional insulation structure, thermal shrinkage displacement of the insulation pads is caused by an influence of a temperature of the cryogenic liquid stored in the tank body, so that there is a fear that the gap between the insulation pads may be deformed and the cryogenic liquid leaking out of the tank body may flow out to the outside through the gap between the

insulation pads.

SUMMARY OF THE INVENTION

5 An aspect of the present disclosure is to provide an insulation structure of a cryogenic storage tank, capable of improving absorption of thermal shrinkage displacement of insulation pads caused by a cryogenic temperature and preventing a cryogenic liquid leaking out of a tank body
10 from flowing out to the outside.

Further, another aspect of the present disclosure is to provide an insulation structure of a cryogenic storage tank, capable of reducing a time and expenses required for construction and improving efficiency of work.

15 In accordance with an aspect of the present disclosure, an insulation structure of a cryogenic storage tank comprises: a plurality of insulation pads in which an area of a lower insulation pad adjacent to a tank body is larger than that of an upper insulation pad, in which
20 grooves are formed to extend from the lower insulation pad to the upper insulation pad, and in which a first crack stopper is provided at points at which the grooves are terminated across the upper insulation pad; a second crack stopper that is joined to a bottom of the lower insulation
25 pad; and a protection sheet that is joined along an outer

surface of the upper insulation pad, wherein at least one or more gap pads for forming a fluid passage are located between the second crack stopper and the tank body, and are adhered to an outer surface of the tank body, the plurality
5 of insulation pads are joined to form an empty space in the upper insulation pad, and spray foam is located in the empty space.

Further, the grooves of the insulation pads are preferably configured such that lengthwise grooves crossing
10 the insulation pads in a lengthwise direction and widthwise grooves crossing the insulation pads intersect each other.

Further, a material of the first crack stopper is preferably a glass mesh.

Further, a material of the second crack stopper is
15 preferably a glass mesh.

Further, grooves corresponding to the grooves of the insulation pads are preferably formed in the second crack stopper.

Further, the insulation pads are formed of
20 polyurethane foam (PUF).

Further, the protection sheet is preferably an aluminum material, and is preferably adhered by an adhesive.

Further, a lengthwise groove is preferably formed in
25 the spray foam.

Further, the spray foam is preferably formed of polyurethane foam (PUF).

Further, a joint filler is preferably further joined to an edge of the insulation pad at a fixed thickness, and
5 is preferably disposed between the insulation pad and the spray foam.

Further, an anchoring pad is preferably further adhered to one side of the insulation pad.

Further, the plurality of insulation pads are
10 preferably supported on the outer surface of the tank body by a fastener.

Further, the fastener preferably a stud bolt.

In the insulation structure of a cryogenic storage tank according to the present disclosure, thin long grooves
15 absorbing thermal shrinkage displacement of insulation pads caused by a cryogenic temperature are formed in the insulation pads, and thereby the thermal shrinkage displacement of the insulation pads caused by the cryogenic temperature can be absorbed. Further, spray foam is applied
20 to a gap between the insulation pads, and thereby a cryogenic fluid leaking out of a tank body can be prevented from flowing out to the outside, and damage to a hull caused by possible leakage of a tank is prevented, and thus safety of a ship can be improved.

25 Further, an external insulation layer is formed by

spraying spray foam to the outside of the tank body, and thereby a time and expenses required for construction can be reduced, and efficiency of work can be improved.

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BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features and advantages of the present present disclosure will be more apparent from the following detailed description taken in
10 conjunction with the accompanying drawings, in which:

FIG. 1 is an exploded perspective view illustrating an insulation structure of a cryogenic storage tank according to an embodiment of the present disclosure;

FIG. 2 is a joined perspective view (an upper view)
15 illustrating grooves 120 and 130 for absorbing thermal shrinkage displacement of the insulation structure of a cryogenic storage tank according to the embodiment of the present disclosure, a joined sectional view (a middle view) illustrating a crack stopper 30 of the insulation structure
20 of a cryogenic storage tank, and a sectional view (a lower view) schematically illustrating a disposed state of the grooves 120 and 130 for absorbing thermal shrinkage displacement of the insulation structure of a cryogenic storage tank;

25 FIG. 3 is joined sectional views illustrating a

process in which insulation pads of the insulation structure of a cryogenic storage tank according to the embodiment of the present disclosure are supported by a stud bolt 220 and a process in which sealing between the
5 insulation pads is formed by spray foam 141; and

FIG. 4 is a joined sectional view illustrating an adhered shape and effects of a joint tape 231 of the insulation structure of a cryogenic storage tank according to the embodiment of the present disclosure.

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DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Hereinafter, an exemplary embodiment of the present disclosure will be described in detail with reference to
15 the accompanying drawings.

The above features and advantages of the present disclosure and methods of achieving the same will be apparent from the following detailed embodiments in conjunction with the accompanying drawings.

20 However, the present disclosure should not be construed as being limited to the embodiments set forth herein and may be embodied in many different forms; rather, these embodiments are provided so that the present disclosure will be thorough and complete, and will fully
25 convey the scope of the present disclosure to those skilled

in the art. The scope of the present disclosure is merely defined by the claims.

Further, in the description of the present disclosure, when it is determined that the related art would obscure
5 the gist of the present disclosure, the detailed description thereof will be omitted.

Referring to FIG. 1, an insulation structure of a cryogenic storage tank according to the present embodiment is configured to include an upper insulation pad 10, a
10 lower insulation pad 12, a first crack stopper 30, a second crack stopper 50, a protection sheet 70, a gap pad 110, a joint filler 200, and an anchoring pad 210, and may be constructed along with a hull, or be manufactured separately from the hull and be mounted in the hull.

15 A hull for transporting a liquefied gas may be made up of a double hull of an outer hull and an inner hull, and a cryogenic storage tank for storing the liquefied gas is located inside the inner hull of the hull.

The liquefied gas storage tank may be roughly
20 classified into an independent type and a membrane type according to a shape. Here, the independent type is a type in which the storage tank is not formed integrally with the hull and a support unit of the hull independently supports the storage tank, and is divided into types A, B, and C.

25 Among them, the cryogenic storage tank of the present

disclosure is the storage tank of the independent type B. In FIG. 1, a self-supporting prismatic shape IMO type B (SPB) in which the shape of the storage tank is a prismatic type will be described by way of example.

5 The insulation structure of a cryogenic storage tank according to the present embodiment is configured to include the upper insulation pad 10, the lower insulation pad 12, the first crack stopper 30, the second crack stopper 50, the protection sheet 70, the gap pad 110, the
10 joint filler 200, and the anchoring pad 210.

A tank body is provided with a sealed container for maintaining airtightness of the liquefied gas storage tank, and an internal space is formed inside the tank body such that the liquefied gas is sealed and stored.

15 Insulation pads are joined along an outer surface of the tank body, form an insulation layer, and serve to prevent heat penetration into a cryogenic liquid by securing insulation performance.

A hard insulator such as polyurethane foam (PUF) is
20 preferably used as the insulation pads.

The insulation pads may be joined to the outer surface of the tank body in a polyhedral shape having a fixed width. For example, the shapes of the insulation pads can be variously applied according to a needs of the tank body.

25 As illustrated in FIGS. 1 to 4, the insulation pads

are configured such that an area of the lower insulation pad 12 adjacent to the tank body is larger than that of the upper insulation pad 10.

Further, a thickness of the upper insulation pad 10 is preferably thicker than that of the lower insulation pad 12. As an example, the thickness of the upper insulation pad 10 may be twice that of the lower insulation pad 12.

The insulation pads have thin long grooves 120 and 130 formed to extend from the lower insulation pad 12 to the upper insulation pad 10.

The thin long grooves function to absorb thermal deformation displacement generated when the insulation pads shrink in a cryogenic environment. In the present disclosure, when the thin long grooves are formed in the insulation pads and the tank shrinks at a cryogenic temperature, the insulation pads are also exposed to the cryogenic temperature, and thereby the thin long grooves absorb the displacement generated when the insulation pads shrink.

The grooves are preferably configured such that the lengthwise grooves 130 crossing the insulation pad in a lengthwise direction intersect the widthwise grooves 120 crossing the insulation pad in a widthwise direction.

In this case, the widthwise grooves 120 and the lengthwise grooves 130 preferably extend from the lower

insulation pad 12 to the upper insulation pad 10 by a thickness of the lower insulation pad 12.

According to an embodiment of the present disclosure, the first crack stopper 30 is formed at the upper
5 insulation pad 10 at points at which the widthwise grooves 120 and the lengthwise grooves 130 are terminated.

A material of the first crack stopper 30 is preferably a glass mesh.

The first crack stopper 30 is located at an
10 intermediate portion of the upper insulation pad 10, and preferably at the points at which the widthwise grooves 120 and the lengthwise grooves 130 are terminated, and functions to prevent possible cracks of the insulation pad from propagating.

15 Further, the second crack stopper 50 in which grooves corresponding to the grooves of the insulation pad are formed is provided on the bottom of the insulation pad.

Preferably, widthwise grooves 120' and lengthwise grooves 130' that correspond to the widthwise grooves 120
20 and the lengthwise grooves 130, respectively, of the insulation pad are formed in the second crack stopper 50.

The second crack stopper 50 may be formed of a glass mesh. The second crack stopper 50 is adhered to the bottom of the lower insulation pad by an adhesive.

25 In this way, the insulation pads of the present

disclosure include the first crack stopper 30 and the second crack stopper 50, and thereby even if damage occurs at the grooves of the insulation pad, the damage does not propagate any more, and the damage to the insulation pads
5 can be minimized.

Meanwhile, at least one or more gap pads 110 for forming a fixed gap between the insulation pads and the outer surface of the tank body may be adhered.

The gap pads have fixed lengths as in FIG. 1, and a
10 fluid passage having a fixed length is formed between the gap pads such that a fluid w can be discharged to the outside.

In the case where damage or cracks occur at the tank body and the liquefied gas contained in the liquefied gas
15 storage tank leaks out through the spaced space formed between the insulation structure and the tank body in this way, the leaking liquefied gas flows down along the surface of the tank body, and is collected at a certain position below the liquefied gas storage tank, and thereby direct
20 damage to the hull can be prevented.

To capture the liquefied gas flowing down to a lower portion of the liquefied gas storage tank in this way, a drip tray may be installed below the storage tank.

The gap pad 110 is preferably made of melamine foam.

25 The protection sheet 70 is adhered to a surface of the

upper insulation pad 10 in order to absorb external impacts. The protection sheet 70 is continuously adhered to the upper insulation pad 10 to completely cover the upper insulation pad 10 such that the insulation pad is not
5 exposed to the outside. The protection sheet 70 serves to prevent an outflow of the cryogenic fluid from the tank body and to prevent the insulation pad from being damaged by external impacts.

To this end, the protection sheet 70 is preferably
10 made of aluminum or a material equivalent thereto, and is adhered to the outer surface of the upper insulation pad 10 using an adhesive. The adhesive may be, but is not limited to, a urethane adhesive.

As illustrated in FIG. 3, the insulation pad has a
15 structure in which the area of the lower insulation pad 12 adjacent to the tank body is larger than that of the upper insulation pad 10, and thus an empty space 140 is formed in the upper insulation pad when the insulation pad is joined with another insulation pad. In the present disclosure,
20 spray foam 141 is located in the empty space 140. The spray foam 141 may be formed by injecting and filling with a spray method, but is not limited thereto. By introducing the spray foam 141, bonding between the insulation pads is made, and sealing between panels is made. In this case, a
25 thin and long lengthwise groove 150 is formed in the spray

foam 141 like the grooves formed in the insulation pad. The lengthwise groove 150 functions to absorb thermal shrinkage displacement generated when the insulation pad shrinks in the cryogenic environment. The spray foam is
5 preferably polyurethane foam (PUF).

Because the spray foam 141 is deformed in a shape corresponding to a shape of the empty space 140 of the insulation pad, installation thereof is easy, so that a period and expenses of construction can be reduced, and
10 work efficiency can be improved.

As illustrated in FIGS. 3 and 4, a soft insulation material layer 230 is formed at an upper portion of the injected spray foam 141, and a joint tape 231 having a curved corrugation shape is adhered to an upper portion of
15 the soft insulation material layer 230. The curved corrugation shape is obtained by locating the soft insulation material layer 230 between the joint tape 231 and the spray foam 141. The joint tape 231 has the curved corrugation shape, and thereby when the insulation pads
20 thermally shrink at a cryogenic temperature, curved corrugations of the joint tape 231 can absorb the thermal shrinkage displacement of the insulation pad while being flattened or extended.

Further, the insulation structure of a cryogenic
25 storage tank according to the present disclosure may

further include the joint filler 200 and the anchoring pad 210.

The joint filler 200 is joined along an edge of the insulation pad at a fixed thickness.

5 In this case, the joint filler 200 is disposed between the insulation pad and the spray foam 141 (to be described below).

The joint filler 200 may be formed of a soft material such as a sponge or a soft insulator. The joint filler 200
10 may be preferably a polyurethane (PU) material.

In the present disclosure, the joint filler fills a gap formed in an edge of the insulation pad, thereby serving to prevent external heat penetration and absorb thermal displacement of the gap caused by shrinkage of the
15 insulation pads exposed to the cryogenic temperature.

The anchoring pad is adhered to an upper side of the insulation pads in a lengthwise direction, and thereby serving to anchor the panel and prevent the panel from being damaged by a tightening force of a nut.

20 The anchoring pad is preferably made using a plywood material.

As illustrated in FIGS. 3 and 4, a fastener 240 may be provided to join the outer surface of the tank body and the insulation pad.

25 The fastener 240 may include a stud bolt 220 or a

connecting member 220 having a function equivalent thereto. To be specific, the fastener may be made up of a stud bolt, a holding member, an inserting member, a fixing plate, and a nut. As an example, after the stud bolt 220 is welded to
5 a surface of the tank, the insulation pad is positioned, a washer and a nut are joined and fastened to the stud bolt in turn, and the insulation pad is firmly fixed.

As an example, the stud bolt 220 may be formed to protrude from the outer surface of the tank body, and one
10 end of the stud bolt 220 may be joined to the outer surface of the tank body by a method such as welding.

It is apparent that the concrete embodiment of the insulation structure of a cryogenic storage tank according to the present disclosure has been described so far, but it
15 may be modified in various ways without departing from the scope of the present disclosure.

Therefore, the scope of the present disclosure is not limited to the aforementioned embodiment, and should be defined by the claims to be described below as well as
20 equivalents thereof.

It should be considered that the embodiment disclosed herein is illustrative and non-restrictive in every respect. The scope of the present disclosure is defined not by the above description but by the claims to be
25 described below, and is intended to include all the

modifications and alternations derived from the meanings and the scope of the claims and the equivalent concept of the claims.

WHAT IS CLAIMED IS:

1. An insulation structure of a cryogenic storage tank comprising:

5 a plurality of insulation pads in which an area of a lower insulation pad adjacent to a tank body is larger than that of an upper insulation pad, in which grooves are formed to extend from the lower insulation pad to the upper insulation pad, and in which a first crack stopper is
10 provided at points at which the grooves are terminated across the upper insulation pad;

a second crack stopper that is joined to a bottom of the lower insulation pad; and

a protection sheet that is joined along an outer
15 surface of the upper insulation pad,

wherein at least one or more gap pads for forming a fluid passage are located between the second crack stopper and the tank body, and are adhered to an outer surface of the tank body,

20 the plurality of insulation pads are joined to form an empty space in the upper insulation pad, and

spray foam is located in the empty space.

2. The insulation structure of claim 1, wherein
25 lengthwise grooves crossing the insulation pads in a

lengthwise direction and widthwise grooves crossing the insulation pads intersect each other at the insulation pads.

5 3. The insulation structure of claim 1, wherein the first crack stopper is formed of a glass mesh.

 4. The insulation structure of claim 1, wherein the second crack stopper is formed of a glass mesh.

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 5. The insulation structure of claim 1, wherein grooves corresponding to the grooves of the insulation pads are formed in the second crack stopper.

15 6. The insulation structure of claim 1, wherein the insulation pads are formed of polyurethane foam (PUF).

 7. The insulation structure of claim 1, wherein the protection sheet is formed of an aluminum material, and is
20 adhered by an adhesive.

 8. The insulation structure of claim 1, wherein a lengthwise groove is formed in the spray foam.

25 9. The insulation structure of claim 1, wherein the

spray foam is formed of a polyurethane foam (PUF).

10. The insulation structure of claim 1, wherein a joint filler is further joined to an edge of the insulation pad at a fixed thickness, and is disposed between the insulation pad and the spray foam.

11. The insulation structure of claim 1, wherein an anchoring pad is further adhered to an upper side of the insulation pad.

12. The insulation structure of claim 1, wherein the plurality of insulation pads are supported on the outer surface of the tank body by a fastener.

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13. The insulation structure of claim 12, wherein the fastener comprises a stud bolt.