

Protective panel for low-temperature fluid processing equipment, and related assembly, equipment, and method

The present invention relates to a protective panel designed to be placed on a surface of low-temperature fluid processing equipment, comprising:

- a planar body;
- at least one element for detecting the presence of fluid in gas or liquid form, received in the body.

Such a panel is for example designed to be mounted on fluid processing equipment situated on an expanse of water, such as a ship, platform, barge or floating plant, for example an FPSO.

The low-temperature fluid is for example a liquid with a temperature below -100°C , in particular a liquefied natural gas (LNG), available at a temperature of approximately -161°C .

Low-temperature liquid storage vessels can be subject to liquid leaks occurring on the deck of the vessels. These leaks of low-temperature liquid can cause structural damage to the equipment provided on the deck.

Abrupt cooling of part of the deck adjacent to the leak and excessively long exposure to those negative temperatures is particularly damaging for the metal structures supporting the gas treatment stations located on the deck of the storage vessel. This damage may cause a mechanical break resulting from the fragility of the metal structure at low temperatures.

In a tank for storing liquid at a very low temperature, described in application FR 2,220,039, it is known to place detection devices that include an layer impermeable to the liquid fastened on the inner surface of the wall of the tank via a thermally insulating layer.

A second screen is formed on the thermally insulating layer and temperature detection elements are provided along the second screen to electrically or electromagnetically detect low temperatures. The device is thus able to detect breaks of the liquid-impermeable layer. The electrical or electronic means for detecting those leaks are advantageously thermocouples (temperature measuring resistances).

Also known is a temperature measuring system that is suitable for reliably and precisely detecting a temperature anomaly caused by an accidental leak of very low-temperature liquid. The system determines a continuous temperature profile over the entire length of the optical fiber, thus offering a multitude of data points for single measurement.

In order to isolate the metal structures exposed to potential low-temperature liquid leaks, these structures are covered beforehand with at least one layer of low-temperature insulating paint that preserves the structural integrity.

In the case of very low-temperature liquid storage vessels, other systems are also used to isolate the deck equipment with respect to any liquid leaks from the storage tanks, such as wood floors.

Such isolating systems are difficult to implement due to their complexity during manufacturing of the equipment, their implementation time, and their cost.

Embodiments of the invention seek to provide an isolating system making it possible to simply, inexpensively and very effectively protect a surface of a piece of low-temperature fluid storage equipment, able to be placed in contact with the fluid.

According to a first aspect of the present invention, there is provided a protective panel designed to be placed on a surface of low-temperature fluid processing equipment at a temperature below -100°C , comprising: a planar body; at least one element for detecting the presence of fluid in gas or liquid form, received in the body; the panel including at least one element for heating the body, received in the body, wherein the body is manually deformable so as to be able to be wound and unwound.

The panel according to embodiments of the invention may comprise one or more of the following features, considered alone or according to any technically possible combination:

- it includes a control unit, received in the body, the control unit being connected to the detection element to measure a parameter for detecting the presence of a low-temperature fluid in gas or liquid form, the control unit being connected to the heating element, to activate the heating element;

- the control unit includes a communication assembly with an outside command unit, advantageously a wireless communication assembly of the Wi-Fi or Bluetooth type;

- it defines a lower face, designed to be pressed on the surface of the fluid processing equipment, and an upper face, situated opposite the lower face, the detection element being situated near or flush with the upper face, the heating element being situated near or flush with the lower face;

- the detection element is chosen from among a thermocouple or an optical fiber, the heating element being chosen from among a heating cable and/or heating resistance;

- as shown in the first aspect, the body is manually deformable, advantageously being able to be wound and unwound;

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- the planar body is rigid.

According to a second aspect of the present invention, there is provided a protective assembly for low-temperature fluid processing equipment at a temperature below -100°C , wherein it includes:

- 5 - at least one panel according to the first aspect, designed to be pressed on a surface of the equipment;

- a control unit, positioned away from the panel, the control unit being connected to the panel, the control unit being able to collect at least one leak detection parameter measured by the detecting assembly, and being able to activate the heating element.

The assembly according to embodiments of the invention may include one or more of the following features, considered alone or according to any technically possible combination(s):

- it includes a plurality of panels designed to be applied on a surface of the fluid processing equipment, each panel being connected to the command unit.

According to a third aspect of the present invention, there is provided an equipment for fluid processing at a temperature below -100°C , wherein it includes:

- a surface able to come in contact with the low-temperature fluid;
- a protective assembly according to the second aspect, the panel being applied on the surface.

According to a fourth aspect of the present invention, there is provided a protective method for equipment for fluid processing at a temperature below -100°C , including the following steps: a protective assembly according to the second aspect, the panel being applied on a surface of the equipment that may come into contact with fluid at a temperature below -100°C ; verifying, at regular intervals, the presence of fluid in gas or liquid form on the panel by means of the detection assembly.

The method according to embodiments of the invention may include one or more of the following features, considered alone or according to any technically possible combination(s):

- detecting low-temperature fluid in gas or liquid form on the panel using the detection assembly;

- activating the heating assembly to heat the panel.

The invention will be better understood upon reading the following description, provided solely as an example and done in reference to the appended drawings, in which:

- figure 1 is a diagrammatic side view of first low-temperature fluid processing equipment, provided with a plurality of protective panels according to the invention;

- figure 2 is a three-quarters front perspective view of a protective panel according to the invention; and

- figure 3 is a sectional view along plane III-III in figure 2.

5 The first piece of low-temperature fluid processing equipment 10 according to the invention is diagrammatically illustrated by figure 1.

The equipment 10 is designed for the storage, transfer, and optionally treatment of the fluid. It advantageously includes at least one fluid tank 12.

The fluid is preferably kept in liquid form, at a low temperature, in particular at a temperature below -100°C .

The fluid is for example hydrocarbon such as liquefied natural gas (LNG). Its temperature is for example below -160°C .

In the example illustrated in figure 1, the equipment 10 is situated at the surface of the expanse of water 14. The expanse of water 14 may for example be a sea, ocean, lake or river.

In this example, the equipment 10 floats on the expanse of water 14. It includes at least one substantially horizontal surface 16 forming a deck of the equipment 10. The surface 16 is generally made from metal.

The equipment 10 is for example a vessel comprising a floating hull 18. Alternatively, the equipment 10 is a barge, platform or floating plant.

In still another alternative (not shown), the equipment 10 is situated on land.

According to the invention, the equipment 10 includes a protective assembly 20, able to protect the surface 16 when a low-temperature fluid leak occurs.

The assembly 20 includes a control unit 22, shown in figure 1, and at least one protective panel 24 according to the invention, shown in more detail in figures 2 and 3.

In the example shown in figure 1, the assembly 20 includes a plurality of separate and adjacent panels 24 substantially covering the entire surface 16.

As illustrated by figures 2 and 3, each panel 24 includes a planar body 26 made from a flexible material, applied on the surface 16, at least one element 28 for detecting the presence of fluid, embedded in or flush with the body 26, and at least one heating element 30, situated below the detecting element 28 in the body 26.

Each panel 24 further includes a control unit 32 received in the body 26.

The thickness of the planar body 26 is for example comprised between 10 mm and 15 mm.

In this example, it defines a polygonal contour, in particular rectangular. Alternatively, the contour of the planar body 26 has a different shape.

The planar body 26 is flexible to be manually deformable by a placement operator. It is for example able to be wound in the form of a roll and unwound when it is applied on the surface 16, to adapt to the configuration of the surface 16, in particular the raised portions present on that surface 16.

It has good heat conductivity and is robust enough to accommodate the components positioned inside the planar body 26.

The body 26 has a lower face 34 designed to be applied on the surface 16, and an upper face 36, extending opposite the lower face 34 and designed to be placed in a volume of ambient air.

The area of each panel, considered at the upper face 34, is for example less than 1 m^2 and is in particular comprised between 0.1 m^2 and 0.5 m^2 .

In this example, the panel 24 includes a plurality of leak detecting elements 28 distributed on the panel 24 near the upper face 36, or on that face 36.

Each leak detecting element 28 is advantageously flush with the upper face 36, while being partially embedded in the body 26.

In that case, when the low-temperature fluid, in gas or liquid form, comes into contact with the upper face 36 of the planar body 26, the leak detecting element 28 is in contact with the fluid.

Alternatively, each leak detecting element 28 is completely embedded in the body 26, while being situated near the upper face 36.

In this example, each leak detecting element 28 is filiform. It is for example chosen from among a thermocouple or an optical fiber. It is able to detect a temperature variation on the upper face 36, in particular a temperature decrease due to the presence of fluid on that face 36.

Each detecting element 28 is connected to the control unit 32.

Each heating element 30 is advantageously situated near the lower face 34, below each leak detecting element 28.

Each heating element 30 has a filiform shape. It is for example formed by a heating cable, or by a heating resistance.

In the example shown in figure 1, each heating element 30 is wound in a serpentine form.

Each heating element 30 is connected to the control unit 32.

The control unit 32 is embedded in the planar body 26. It preferably includes an electricity storage assembly 38, such as a battery, and a communication assembly 40, able to communicate with the command unit 22.

The control unit 32 is able to activate each detecting element 28 periodically to determine the variation in a parameter representative of the temperature on that element 28, signifying the presence of low-temperature fluid on the upper surface 36. This activation is for example done at time intervals comprised between one second and 50 seconds, for example every 15 seconds.

The control unit 32 is further able to transmit the measured representative parameter to the control unit 22 via the communication assembly 40.

When the detected temperature variation is deemed significant by the command unit 22, the control unit 32 is able to receive an order to activate each heating element 30 via the communication assembly 40.

The control unit 32 then activates each heating element 30 by providing it with electricity from the storage assembly 38.

The operation of the protective assembly 20 will now be described.

Initially, the protective assembly 20 is placed on the equipment 10, deploying each panel 24 to apply it on the surface 16 and cover the surface 16.

The lower face 34 of each panel 24 is applied against the surface 16. Each control unit 32 is paired with the command unit 22 by means of the transmission assembly 40.

During normal operation of the equipment 10, the low-temperature fluid is confined in each tank 12.

No low-temperature fluid is present in the upper face 36 of each panel 24.

At regular intervals, for example comprised between one second and 50 seconds, in particular equal to 15 seconds, the command unit 32 activates each leak detecting element 28.

The parameter representative of the temperature of each element 28 is advantageously measured, then is sent to the command unit 22 via the transmission assembly 40.

When the difference between the temperature measured by each element 28 and the temperature of the ambient air situated above the element 28 remains below a given threshold, for example below 10°C, the command unit 22 determines that no low-temperature fluid is present on the upper face 36 of the panel 24.

The control unit 22 then keeps each heating element 30 inactive.

When low-temperature fluid in gas or liquid form comes into contact with the upper face 36, for example in case of a leak coming from one of the tanks 12, the temperature measured by each element 28 in contact with the fluid, or situated across from the fluid, decreases significantly.

The difference between the temperature measured by the element 28 and the temperature of the ambient air situated above the element 28 becomes higher than the given threshold.

The command unit 22 then determines that a low-temperature fluid is present on the upper face 36 and the panel 24.

Immediately, the command unit 22 sends an activation order for the heating element 30 to the control unit 32 of the panel 24.

The control unit 32 then provides electricity to each heating element 30 via the electricity storage assembly 38.

Each heating element 30 present in the body 26 then heats the panel 24 and the surface 16.

The surface 16 stays at a same temperature, despite the presence of low-temperature fluid. The panel 24 thus provides effective thermal isolation adapted to the surface 16 relative to the low-temperature fluid.

Thus, the protective assembly 20 has the advantage of being extremely reactive, since the control unit 22 is informed practically instantaneously of the presence and location of a low-temperature fluid in gas or liquid form in a given region of the equipment 10.

The presence of an off-board control unit 32 on each panel 24 makes it possible to activate at least one heating element 30 very quickly, in order to thoroughly isolate the surface 16 and prevent it from cooling significantly.

The protective assembly 20 therefore constitutes a very effective and very reactive protection and monitoring tool.

The heating elements 30 make each panel 24 particularly effective in terms of thermal protection, which reduces the thickness necessary for the body 26, and which lightens the overall mass of the protective assembly 20.

Alternatively, the planar body 26 is rigid and is in particular not deformable to the touch. Such a planar body 26 is for example appropriate when the surface 16 has a predefined configuration, in particular planar.

In general, as stated above, the low-temperature fluid is a fluid at a temperature below -100°C , in particular a cryogenic fluid at a temperature below -150°C .

In the embodiment described in figure 3, the planar body 26 is solid. It contains the detecting element 28, the heating element 30, the control unit 32 and the electricity storage assembly 38.

In one alternative, the planar body 26 is hollow. It contains a peripheral enclosure defining an insertion cavity receiving the heating element 30, the command unit 32, and optionally the detecting element 28. The elements received in the insertion cavity are fixed using a filler material. The filler material is for example a hardenable material such as a resin or an expandable material such as a foam, for example polyurethane.

CLAIMS

1.- A protective panel designed to be placed on a surface of low-temperature fluid processing equipment at a temperature below -100°C , comprising:

- a planar body;
- at least one element for detecting the presence of fluid in gas or liquid form, received in the body;

the panel including at least one element for heating the body, received in the body, wherein the body is manually deformable so as to be able to be wound and unwound.

2.- The panel according to claim 1, wherein it includes a control unit, received in the body, the control unit being connected to the detection element to measure a parameter for detecting the presence of a fluid in gas or liquid form at a temperature below -100°C , the control unit being connected to the heating element, to activate the heating element.

3.- The panel according to claim 2, wherein the control unit includes a communication assembly with an outside command unit, advantageously a wireless communication assembly of the Wi-Fi or Bluetooth type.

4.- The panel according to any one of claims 1 to 3, wherein it defines a lower face, designed to be pressed on the surface of the fluid processing equipment, and an upper face, situated opposite the lower face, the detection element being situated near or flush with the upper face, the heating element being situated near or flush with the lower face.

5.- The panel according to any one of claims 1 to 3, wherein the detection element is chosen from among a thermocouple or an optical fiber, the heating element being chosen from among a heating cable and/or heating resistance.

6.- The panel according to any one of claims 1 to 3, wherein the body includes an enclosure delimiting a cavity receiving the heating element and a filler material fixing the heating element in the cavity.

7.- A protective assembly for low-temperature fluid processing equipment at a temperature below -100°C , wherein it includes:

- at least one panel according to any one of claims 1 to 3, designed to be pressed on a surface of the equipment;

- a control unit, positioned away from the panel, the control unit being connected to the panel, the control unit being able to collect at least one leak detection parameter measured by the detecting assembly, and being able to activate the heating element.

8.- The assembly according to claim 7, wherein it includes a plurality of panels designed to be applied on a surface of the fluid processing equipment, each panel being connected to the command unit.

9.- Equipment for fluid processing at a temperature below -100°C , wherein it includes:

- a surface able to come in contact with the low-temperature fluid;
- a protective assembly according to claim 7, the panel being applied on the surface.

10.- A protective method for equipment for fluid processing at a temperature below -100°C , including the following steps:

- a protective assembly according to claim 7, the panel being applied on a surface of the equipment that may come into contact with fluid at a temperature below -100°C ;
- verifying, at regular intervals, the presence of fluid in gas or liquid form on the panel by means of the detection assembly.

11.- The method according to claim 10, wherein it comprises the following steps:

- *detecting fluid in gas or liquid form at a temperature below -100°C on the panel using the detection assembly;*
- activating the heating assembly to heat the panel.