

JUNCTION PARTITION FOR USE IN A FLOATING COVER

FIELD OF INVENTION

5 The present disclosure relates to junction partitions of a floating roof/cover that limit the ingress and migration of liquids between the buoyant panels that make up the floating cover.

BACKGROUND

10 The oil refinery and petrochemical industry are some examples of industries where there exists a need to store large quantities of liquids in storage tanks. Storage tanks serve to isolate the liquid from the environment and reduce loss of the liquid, specifically volatile organic compounds via evaporation that can have both economic as well as environmental consequences.

15 A floating roof tank refers to a particular type storage tank with a cover or roof that sits directly over the surface of the stored liquid which either greatly reduces or eliminates vapour space and in doing so leads to a significant decrease in the loss of the stored liquid due to evaporation.

20 While traditionally made from carbon steel or aluminium, glass fibre reinforced plastic is an increasingly popular alternative. Glass fibre reinforced plastic is particularly advantageous in prefabricated floating covers which consist primarily of panels that are manufactured offsite and assembled at the installation site. Glass fibre reinforced plastic panels are joined by the application and curing of a polymer resin, thus eliminating the need for welding which raises safety concerns especially when the liquid to be stored is flammable. Floating covers assembled from panels also have the added advantage of having higher reparability as damaged panels can easily be removed and replaced during maintenance servicing.

25 WO2004/067408 discloses glass fibre reinforced epoxy panels comprising a lightweight honeycomb structure sandwiched in between upper and lower layered portions of glass fibre reinforced composite and methods of making a floating cover from said panels. The panels have extended lower portions that extend beyond main body of the panel to form canals in between adjacent panels. The canals are subsequently filled by infill sections that are structurally similar to that of the panels. When such a floating cover is damaged in a manner
30 that leads to the ingress of liquid into the panel, it is common for the bottom layered portion to detach from the honeycomb structure which creates a passageway in which the liquid can propagate from one panel to another, thus increasing the number of panels that need to be replaced.

WO2010/093328 partially addresses this problem by extending the upper layered portion around the edges to enveloping the honeycomb structure which has been found to be effective in confining the ingress of liquids to the panel(s) that was damaged. However, this does not address damage that allows liquid to enter the canals between the panels where the honeycomb infill is similarly vulnerable to separation from its lower layered portion.

Accordingly, there exists for a need for a solution that prevents the spread of liquid along the canals without the use of significantly increasing the need to use additional quantities of resin.

SUMMARY OF THE INVENTION

In one aspect of the invention, there is provided a junction partition for adjacent buoyant panels of a floating cover, the partition comprising an inner core and a perimeter wall surrounding the inner core, the perimeter wall having a projection with a height proximate to the adjacent buoyant panels, wherein the projection extends to at least one adjacent buoyant panel. Preferably, the partition further comprises at least one additional projection wherein each projection extends to at least one adjacent buoyant panel. Preferably, each projection has a through hole.

In another aspect of the invention, there is provided a floating cover comprising adjacent buoyant panels, a junction partition disposed between the adjacent buoyant panels, the partition comprising an inner core having substantially vertical surface and a perimeter wall surrounding the inner core, the perimeter wall having a projection with a height proximate to the adjacent buoyant panels, wherein the projection extends to at least one adjacent buoyant panel.

Preferably, the floating cover comprises at least one additional projection wherein each projection extends to at least one adjacent buoyant panel. Preferably, the adjacent buoyant panels comprise a first buoyant panel, a second buoyant panel adjacent to and defining a first passage with the first buoyant panel and a third buoyant panel adjacent to and defining a second passage with the second buoyant panel, wherein the at least one adjacent buoyant panel is the second buoyant panel, and the projection permits a fluid communication between the first passage and the second passage. Preferably, the projection at least partially envelops a vertical surface of the nearest buoyant panel.

Preferably, the inner core is selected from a group of structural foam boards consisting of polyvinyl chloride, polyurethane, polystyrene, styrene acrylonitrile, polyetherimide and polymethacrylimide. More preferably, the inner core is polyvinyl chloride foam board.

Preferably, the perimeter wall is a glass fibre reinforced composite.

In another aspect of the invention, there is provided a method of making a floating roof cover comprising the steps of placing on a working surface a first buoyant panel, placing and securing edge-to-edge a second buoyant panel to the first buoyant panel, placing and securing an inner core at a junction between the first and second buoyant panels, enclosing vertical surfaces of the inner core in a perimeter wall and projecting a projection of the perimeter wall to contact each of the first and second buoyant panels, inserting and securing an infill section between the first buoyant panel and second buoyant panel, and applying an upper structural portion above the infill section.

Preferably, the method further comprises the step of making a through hole in the projection.

10 **BRIEF DESCRIPTION OF DRAWINGS**

Fig. 1 is a front perspective view of the partition disposed at a junction between adjacent buoyant panels. The infill sections that would normally fill the canals are not depicted.

Fig. 2A-2E are plan views depicting the process of making a floating cover comprising four adjacent panels that incorporates the partition at a junction.

15 **DETAILED DESCRIPTION OF THE INVENTION**

In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. The illustrative embodiments described in the detailed description, drawings and claims are not meant to be limiting. Other embodiments can be utilized, and other changes can be made, without departing from the spirit or scope of the subject matter presented herein.

Referring to Fig. 1, a primary embodiment of the invention is a partition **100** placed at a junction **101** between buoyant panels **102** that serve as individual building blocks for a floating cover which comprises a monolayer of buoyant panels **102**. The buoyant panels **102** are multi-layered and have a lightweight honeycomb structure sandwiched in between upper and lower layered portions of glass fibre reinforced composite. The lower layered portions **108** of the buoyant panels **102** extend beyond both the honeycomb and upper layered portion. The buoyant panels **102** are laid adjacent with the extended lower portions coming into contact with each other edge-to-edge, thus forming canals **103** defined by the now continuous extended lower portions and vertical surfaces of adjacent buoyant panels **102**. Methods of fabricating and joining the buoyant panels **102** are known in the art, for example, as disclosed in WO2004/067408 and will not be discussed in further detail.

The partition comprises an inner core **105** of polyvinyl chloride foam board with a density of about 36 kg/m². Polyvinyl chloride foam board, particularly cross-linked foam board is desirable for its relative stiffness and rigidity along with its resistance to styrene, thus permitting their use with laminating polyester and vinyl resins and can be easily cut, thus allowing for easy alterations to its size to compensate for size variations between the panels to be made onsite. Additionally, polyvinyl chloride foam boards have low moisture absorption, are highly resistant to some chemicals and are flame retardant. Alternatively, structural foam boards made from polyurethane, polystyrene, styrene acrylonitrile, polyetherimide and polymethacrylimide may be used.

The inner core **105** is a quadrate block that may be cut to size before being bonded to the junction **101** at a position approximately equidistant to each of the buoyant panels **102**. The vertical surfaces of the inner core **105** are enclosed by a perimeter wall **106** of glass fibre reinforced composite. The glass fibre reinforced composite of the perimeter wall **106** comprises an M-layer directly adjacent to the inner core **105** and a V-layer directly above the M-layer. The resin used is preferably polyester or vinyl ester resin. It would be readily understood that the inner core can assume any shape so long as it substantively occupies the junction.

The V-layers have a surfacing veil glass fibre mat of C-glass reinforcements with a density of about 30g/m² and have carbon that enhances the surface finish along with increased strength, conductivity and provides a corrosion barrier. V-layers are usually about 90 - 95% by weight of resin and approximately 0.5mm thick.

The M-layers have a chopped strand mat of E-glass fibres with a density of about 450g/m² that are of certain lengths but are randomly orientated. M-layers are about 60-70% by weight of resin and approximately 0.8mm thick. The M-layers absorb relatively more resin and give relatively higher resistance to corrosion.

The R-layers have a woven roving mat of glass reinforcements with a density of about 600g/m² that are woven in two perpendicular directions. Typically, R-layers are about 40 - 50% by weight of resin and about 0.8 mm thick. Due to the orientations of the reinforcement, the R-layers provide mechanical strength in two directions.

The perimeter wall **106** has projections **107** that substantially span the entire height of the perimeter wall **106** and with each of the projections extending outward to the nearest buoyant panel **102**, typically from a corner of the perimeter wall **106** to corner of the nearest buoyant panel **102**. In this manner, the projections serve as a barrier that physically isolates a segment of the canals **103** thus preventing or at least hindering the spread of the liquid within the canals

while minimising the amount of material used in constructing the projections **107**. In other words, in instances where penetrating damage extends upward into the canals **103**, the spread of liquid will be contained within the damaged section of the canals **103** by partitions **100**. In an alternative embodiment, each projection may extend to more than one buoyant panel **102** and not strictly the nearest.

The projections **107** may partially envelop the vertical surfaces of the nearest buoyant panel **102** which can confer additional structural rigidity. The barrier/containment effect and enhancements to structural rigidity can be fully realised by placing the partition **100** at every junction **101** within the floating cover.

Each projection **107** may optionally have a through hole **104** located preferably towards the upper extant of each projection. The holes **104** are preferably 10mm in diameter and allow for the passage of air between the isolated sections of canals **103** to allow a pressure test for leaks between the buoyant panels **102** to be performed during commissioning. The pressure test is known in the art and is described in detail in WO2004/067408. Applicants have found that while their presence seems contrary to the primary purpose of the partition, the holes do not significantly impact the ability of the partition to serve as a barrier.

Referring to Fig. 2A, buoyant panels **102** are laid on a working surface such as a purpose for example, a raised platform. The buoyant panels **102** are placed such that the extended lower layered portions **108** of adjacent buoyant panels **102** are in contact edge-to-edge with each other to form a continuous surface that serves as the horizontal lower surface of canals **103** formed between adjacent buoyant panels **102**. After levelling the buoyant panels **102**, a tagging mat having a first M-layer and above it, a second M layer is applied to the interface between the lower layered portions **108** of adjacent buoyant panels **102**. An inner sealing mat **201** having a first M-layer and above it, a second M layer is applied to the interface between the lower layered portions **108** of adjacent buoyant panels **102**. Once cured, the inner sealing mat **201** may be lightly sanded as required to achieve a smooth finish.

Referring to Fig. 2B, a cross-junction layer **202** is applied to the junction **101** between adjacent buoyant panels joined directly together by the inner sealing mat **201**, to provide structural reinforcement for the junction **101**. The cross-junction layer **202** extends outwards from the junction **101** in both the horizontal and vertical directions and extends slightly into the canals **103** to adopt a cruciform shape when viewed in plan view. The cross-junction layer **202** has, at its lowest layer, an M-layer that covers the inner sealing mat **201** followed by a middle R-layer and an outer M-layer.

The inner core **105** of the partition **100** is positioned at the junction **101** approximately equidistant to each of the adjacent buoyant panels **102**. While the junction **100** is adjacent to four buoyant panels, it will be understood that the partition **100** can be placed at junctions adjacent to two or three buoyant panels **102** which would typically be the case for junctions

5 **100** located at the outer edges/boundary of the floating cover. Due to sizing variations between buoyant panels **102**, the inner core **105** can be cut to better fit the junction. The inner core **105** can be secured to the junction, specifically the cross-junction layer **202** by placing the inner core **105** before the cross-junction layer **202** has cured and placing a weight on top of the inner core **105** during process. Referring to Fig. 2C, and once the cross-junction layer **202** is

10 cured, a perimeter wall **106** is applied to enclose the vertical surfaces of the inner core **105**. The perimeter wall **106** is a glass fibre reinforced composite consisting of an inner M-layer applied directly to the inner core **105** followed by an outer V-layer. The perimeter wall **106** has projections **107** that are projected outward and extend from points on the vertical surfaces of the perimeter wall **106** to contact each of the adjacent buoyant panels **120**. Optionally, a

15 through hole **104** can be made in each of the projections **107**.

Referring to Fig. 2D, the cross-junction layer **202** is extended to cover a section of the canals **103**. An infill section **203** is inserted before the extension of the cross-junction layer **202** is cured and weighted down till curing is completed. It is the separation of the infill section **203** from the cross-junction layer **202** that creates a channel in which liquid can migrate throughout

20 the canals in absence of the partition **100**. The infill section **203** is a honeycomb structure made from polypropylene to improve the structural rigidity of the floating cover as whole while maintaining buoyancy. Alternative materials that exhibit similar properties may be used as substitutes to the honeycomb propylene. The process of extending the cross-junction layer, inserting and apply a weight to an infill section **203** is repeated throughout until the canals **103**

25 have been filled with infill sections and additional partitions **100** as depicted in Fig. 2E.

In embodiments where a hole **104** is made in each of the projections **107**, the infill section **203** is slightly smaller than the width of the canals **103**, such that an air passage between vertical surface of the buoyant panels **102** and an oppositely adjacent vertical surface of the infill section **203** is formed. The air passage is continuous with the hole **104** that may be present in

30 some embodiments, which permits the movement of air throughout the floating cover.

The infill sections **203** are level with the upper surface of adjacent buoyant panels and partitions **100** thus forming a continuous upper surface where an upper structural portion **204** is applied starting with an innermost M-layer, followed by an R-layer, an M-layer and an outermost V-layer. The polyester or vinyl resin applied to the V-layer may contain

graphite/carbon powder to improve conductivity and durability. The upper structural portions cover the entire width of the canal **103** and overlaps with adjacent buoyant panels **102**.

Due to improvements to the overall structural rigidity of the buoyant panel **102**, it preferable to fabricate the infill sections **203** and sandwich layers namely cross-junction layer **202** and upper structural portion **204** layer-by-layer *in-situ*, however as an alternative they may be
5 prefabricated before being moved to the site of assembly.

CLAIMS

1. A junction partition for adjacent buoyant panels of a floating cover, the partition comprising:
 an inner core; and
 5 a perimeter wall surrounding the inner core, the perimeter wall having a projection with a height proximate to the adjacent buoyant panels, wherein the projection extends to at least one adjacent buoyant panel.
2. The partition according to claim 1, further comprising at least one additional projection wherein each projection extends to at least one adjacent buoyant panel.
- 10 3. The partition according to claim 1 or 2, wherein each projection has a through hole.
4. A floating cover comprising:
 adjacent buoyant panels;
 a junction partition disposed between the adjacent buoyant panels, the partition comprising:
 an inner core having substantially vertical surfaces; and
 15 a perimeter wall surrounding the inner core, the perimeter wall having a projection with a height proximate to the adjacent buoyant panels, wherein the projection extends to at least one adjacent buoyant panel.
5. The floating cover according to claim 4, further comprising at least one additional projection wherein each projection extends to at least one adjacent buoyant panel.
- 20 6. The floating cover according to claim 4, wherein the adjacent buoyant panels comprise:
 a first buoyant panel;
 a second buoyant panel adjacent to and defining a first passage with the first rectangular panel; and
 a third buoyant panel adjacent to and defining a second passage with the second rectangular
 25 panel;
 wherein the at least one adjacent buoyant panel is the second rectangular panel, and
 the projection permits a fluid communication between the first passage and the second passage.

7. The floating cover according to claim 4, wherein the projection at least partially surrounds the at least one adjacent panel.
8. The junction partition according to claim 1 or 4, wherein the inner core is selected from a group of structural foam boards consisting of polyvinyl chloride, polyurethane, polystyrene,
5 styrene acrylonitrile, polyetherimide and polymethacrylimide.
9. The junction partition according to claim 8, wherein the inner core is polyvinyl chloride foam board.
10. The junction partition according to claim 1 or 4, wherein the perimeter wall is a glass fibre reinforced composite.
- 10 11. A method of making a floating roof cover comprising the steps of:

placing on a working surface a first buoyant panel;

placing and securing edge-to-edge a second buoyant panel to the first buoyant panel;

placing and securing an inner core at a junction between the first and second buoyant panels;

15 enclosing vertical surfaces of the inner core in a perimeter wall and projecting a projection of the perimeter wall to contact each of the first and second buoyant panels;

inserting and securing an infill section between the first buoyant panel and second buoyant panel; and

applying an upper structural portion above the infill section.
- 20 12. The method accordingly to claim 11, further comprising the step of making a through hole in the projection.