

SECTIONAL PANEL TANK

[0001] The present application relates to a sectional panel tank. The present application also relates to a method of making the sectional panel tank, and a method of repairing the sectional panel tank. The present application further relates to a method of making prefabricated unit panels for the sectional panel tank.

[0002] Current tanks for aggressive chemicals and hazardous wastes are prefabricated in a factory and then transported as a whole or as semi-finished parts to be assembled on site. However, known technologies of manufacturing the tanks are time consuming, machinery/labour intensive and host specific.

[0003] Meanwhile, sectional panel tanks for water are widely demanded due to their economical, scalable and potable advantages. However, the current technologies are not suitable for the water tightness due to a weakness of elastomeric gaskets or seals that join the panels together. The water or chemical sectional panel tanks are also limited by their poor chemical resistance of panel materials, such as fiberglass, reinforced polymer, hot dipped galvanized, and stainless steel. Therefore, the present application aims to provide one or more sectional panel tanks that are more durable and scalable for storing or transporting water or chemical solutions securely or reliably. Alternatively speaking, the present application aims to provide a new purpose for sectional panel tank.

[0004] As a first aspect, the present application discloses a sectional panel tank (i.e. panel tank, panel assembled tank or concealed container). The sectional panel tank

comprises one or more side walls that are joined together in forming the sectional panel tank. The side wall comprises a first unit panel having a first extension at a first edge of the first unit panel and a second unit panel having a second extension at a second edge of the second unit panel. By combining the second extension to the second extension, the second unit panel is then connected or attached to the first unit panel for providing a continuous surface of the side wall. As a whole, the first unit panel and the second unit panel provide structural support to the side wall or the sectional panel tank. The first unit panel or the second unit panel may have a flexible design in terms of shape and dimensions. In some implementations, the first or the second unit panel size has a size not more than four square meter and a thickness up to 20mm, preferably 16mm, preferably 10mm, preferably 6mm, preferably 4mm (millimetres), such as 2mm or below (e.g. 1.2mm, 1mm, 0.5mm).

[0005] The first unit panel and the second unit panel are optionally made of impermeable, corrosion resistive or resistant and structurally robust materials. For example, the unit panels or the side wall of the sectional panel tank may comprise hot pressed metals or metal alloys sheets, such as stainless steel (SUS 304 or SUS 316), mild steel (such as hot dipped galvanized (HDG) or epoxy coated), copper, bronze, brass or galvanized steel; plastics, such as polyethylene or polypropylene; and composites, such as fiberglass reinforced polymers (FRP) (FRP/SUS or HDG/SUS), or glass reinforced plastics (GRP), including rubbers, EPDM, and mixture of rubber and plastics. The unit panels made of plastics or composites are particularly suitable for chemical equipment such as tanks or vessels. For example, the chemical equipment with a size ranging from less than 1 meter to 20 meters are fabricated by FRP unit panels. In addition, the first unit panel and/or the second unit panel may be

treated with any coating for additional functions, e.g. an impermeable coating (such as fluoropolymer, epoxy, phenolic, phosphate, PTFE and FEP) for water sealing; a water repellent coating (such as silicone, polyurethane and zinc) for water resisting; and a corrosion-proof or chemical resistant coating (such as PE, PP, PVDF and ECTFE) for preventing corrosion. In particular, a gel coating is applied onto the FRP unit panel for preventing any damage caused by ultraviolet (UV) rays and meanwhile making a smooth surface.

[0006] The first unit panel and the second unit panel have substantially similar or identical shapes (e.g. square, rectangular, hexagonal), profiles, sizes, structures, materials and/or mechanical strength so that the first and second panels can be mass produced and standardized. In addition, surfaces or contours of the first unit panel, the second unit panel, the side wall or a combination of any of these (segments, panels, walls) can be curved (e.g. 3D geometric shape or 2D geometric shape) or straight. For example, the first unit panel and the second unit panel are aligned at an angle substantially larger than 90°, 120°, 150° (e.g. around 180° for being a flat side wall).

[0007] The first unit panel and the second unit panel are joined, affixed, or fastened together either detachably or permanently. In particular, they are contiguously, directly or immediately joined with direct surface contact at and/or by the first extension and the second extension without any intermediate materials, e.g. in the absence of any gasket, mechanical seal by the at least one fastener on the first extension and the second extension. In other words, the extensions or flanges of the first and second unit panels directly contact each other without any intermediate

material so that the extensions or flanges can be tightened together strongly. Therefore, the first unit panel and the second unit panel have a line of division exposed, known as a seam joint.

5 [0008] The first extension and the second extension may adopt any form that provides structural support to the first unit panel and the second panel respectively. In particular, the first extension and the second extension are firmly and inflexibly jointed by touching each other directly without any foreign component between their contacting surfaces in order to form the side wall in a rigid form.

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[0009] In some implementations, the first extension has one or more first flanges (or any other first external or internal ridge or rim for attachment) at the edges of the first unit panel. A flange is an example of the first extension or second extension, which is an external or internal ridge of the first unit panel, the second unit pane or another
15 panel as an extra rim or lip, which provides structural support for strength, as a flange of an iron beam, an I-beam or a T-beam; or for attachment to another object, as the flange on the end of a pipe, steam cylinder, etc., or for a flange of a rail car or tram wheel. The first flange is folded from an inner side to an external side of the first unit panel or the sectional panel tank. Similarly, the second extension has one or more
20 second flanges (or any other second external or internal ridge or rim for attachment) at the edges of the second unit panel. The second flange is also folded from an inner side to an external side of the second unit panel or the sectional panel tank. As discussed above, the first flange and the second flange are firmly and inflexibly jointed by touching each other directly without any foreign component (such as a gasket)
25 between their contacting surfaces.

[0010] In some implementations, the first extension comprises a first margin of the first unit panel at its edges; while the second extension comprises a second margin of the second unit panel at its edges. The first margin and the second margin are directly fastened together (e.g. stacked) for making the first unit panel and the second unit panel as a unitary piece, thereby forming the side wall of the sectional panel tank. In particular, the first margin and the second margin have substantially similar or identical materials and/or thicknesses respectively, so that the first margin and the second margin can be produced along with the first unit panel and the second unit panel respectively. The first margin or the second margin may be also known as flange.

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[0011] The sectional panel tank optionally comprises a sealant, a plaster, a paste, an adhesive, or any solidified plastic material applied at the seam on inner sides of the first unit panel and the second unit panel of the sectional panel tank. In particular, the sealant is made of a same material as the first unit panel and the second unit panel, i.e. stainless welding on SUS panel, PP welding on homogenous PP panels.) The sealant is applied for preventing any leakage of the liquid in the sectional panel tank from the seam. The sealant may be formed by any suitable method according to a specific material of the sealant. For example, a thermoplastic welding is adopted when the sealant comprises one or more thermoplastic materials.

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[0012] The first unit panel optionally comprises a structural panel extending between the first extensions (such as the first flanges) at the first edges of the first unit panel for resisting pressure and weight of a fluid inside the sectional panel tank. The structural panel may comprise any component that has a high strength and good durability under pressure (e.g. water pressure) and various environmental conditions

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(such as temperature, ultraviolet (UV) radiation, corrosion, wind and rain). In addition, the structural panel may also have embossments (such as a cross embossment at a center of the structural panel) for further resisting the pressure. The structural panel may have various shapes and sizes, such as a square shape with an edge of around 1.2 meter (or around 4.0 feet) or 1.0 meter in length.

[0013] The sectional panel tank optionally comprises one or more linings joined, attached, affixed, adhered or fixed onto the inner side of the first unit panel or the side wall in order to prevent corrosion and leakage of the fluid inside the sectional panel tank. The lining may have a dimension large enough for covering an inner area of the sectional panel tank. Moreover, the lining may comprise a plurality of lining sheets. The lining sheets may have a same or various dimensions for covering the first unit panel or the second unit panel. For example, one single lining sheet is used for covering the first unit panel. Alternatively, multiple lining sheets are joined together for covering the second unit panel. In addition, the lining is optionally connected to the sealant at the seam for further strengthening the sealant. In some implementations, the lining has a thickness in a range of 0.5 millimetre (mm) to 6 millimetre (mm), such as 2~4mm (i.e. from two to four millimetres) preferably, or 1 to 5 mm (i.e. from one to five millimetres) preferably. One or more of the lining or linings are extendable and/or flexible. Hence, the one or more linings are able to hold water inside the sectional panel tank even if the unit panels of the sectional panel tank are broken or breached. The unique ability of holding liquid content (e.g. water or hazardous chemical solutions) is beneficial, desired and/or critical for keeping integrity of the sectional panel tank, even when the sectional panel tank experience earthquake, collision and/vibration.

[0014] The lining may comprise a thermoplastic material, a thermoset material or both. The thermoplastic material includes thermoplastics and thermoplastic elastomers. Thermoplastics include but are not limited to PerFluoroAlkoxy (PFA), PolyFluoroEth, Polyethylene (PE) (such as low density PE (LDPE), Cross Link PE (XLPE), High Density PE (HDPE), and Ultra High Molecular Weight Polyethylene (UHMWPE)), Polypropylene (PP) (such as PP Random (PPR)), PolyTetraFluoroEthylene (PTFE), EthyleneChloroTrifluoroEthylene, PolyVinylideneFluoride (PVDF), Fluorinated Ethylene Propylene (FEP) and Perfluoroalkoxy Alkanes (PFA). The thermoset material includes but is not limited to EthyleneVinylalcohol (EVOH), PolyVinylChloride (PVC), PolyStyrene (PS), PolyCarbonate (PC), PolyMethylMethAcrylate (PMMA) and Acrylonitrile Butadiene Styrene (ABS). Therefore, the lining is bound or secured to the inner side of the side wall by a hybrid joining method if the first unit panel is made of metals or metal alloys (such as stainless steel sheet) or a plastic joining if the first unit panel is made of plastic or composites. In particular, the hybrid joining comprises adhesive and solvent bonding (such as hot-metal adhesive bonding), as well as welding (such as thermal welding). The hybrid joining method is optionally conducted in combination of suitable mechanical bonding (such as gaskets) or joining methods (such as clinching or press joining). An adhesion strength of the lining to the first unit panel is optionally examined or tested by peel test and/or shear test with multiple force-extension courses.

[0015] The lining is optionally preformed (e.g. moulded, adhered or casted) onto the inner side including the first extension (such as the flanges) of the first unit panel. The preforming process may be conducted by any suitable method accordingly to a nature of the sectional panel tank. For example, the sectional panel tank is made of metals

(such as stainless steel), the preforming process is conducted by mechanical fastening, adhesive bonding, welding, moulding or a combination of any foregoing technologies.

5 [0016] The mechanical fastening method often uses clamping components or fasteners (such as, nuts, bolts, screws or rivets) or integrated design elements (such as snap-fit or press-fit). In addition, the mechanical fastening may also require mechanical operations such as drilling holes or making screw threads. The mechanical fastening method has several advantages such as simplicity, reliability
10 and easy inspection and repair.

[0017] The adhesive bonding method applies adhesives (such as polymeric adhesive) between the lining and the first unit panel. The adhesives bond the lining (such as polyester, fiberglass, felt, geotextile, and fabric backed liner (FBL)) and the first unit
15 panel together by creating chemical and/or physical reactions for forming intermolecular forces at an interface of the lining and the first unit panel. The adhesive bonding method has a major advantage of homogeneously distributing internal stresses throughout both the lining and the first unit panel, especially if incorporating an intermediate layer (e.g. fabric material) between the lining and the first unit panel.

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[0018] The welding method comprises shielded metal arc welding (SMAW), gas tungsten arc welding (GTAW), gas metal arc welding (GMAW), submerged arc welding (SAW), ultrasonic welding, laser welding, friction stir welding, or friction spot welding when the lining and the unit panel are made of metal materials. For example,
25 the lining material is titanium, whilst the panel material is stainless steel. The specific

welding method is selected according to chemical and physical natures of the lining material and the panel material. The specific welding method is selected according to chemical and physical natures of the lining material and the panel material.

5 [0019] The moulding method is conducted by firstly pre-heating the thermoplastics lining, granules or pellets to a soften state and then directly applying the soften lining onto the panel. The moulding method further comprises compression moulding, injection moulding, blow moulding, rotational moulding, extrusion moulding, and thermoforming. In contrast, the preforming process is conducted by a polymeric joining
10 method if the unit panel is made of polymers or polymeric composites (such as Fiberglass Reinforced Polymer (FRP)). The preforming process is thus conducted by mechanical fastening, adhesive bonding, welding, solvent bonding or a combination of any foregoing technologies. The mechanical fastening method and the adhesive bonding method are generally similar to those described above for the sectional panel
15 tank made of metals. The preforming process is applicable to FRP or metal (e.g. stainless steel), basically independent of the materials of which the unit (substrate) panel is made.

[0020] The welding method for polymers or polymeric materials comprises external
20 heating methods including hot-gas welding, hot wedge welding, extrusion welding, hot plate welding, infrared (IR) welding and laser welding; as well as internal heating methods. The internal heating methods further comprises mechanical ways including spin welding, stir welding, vibration welding (i.e. friction welding) and ultrasonic welding; and electromagnetic ways including resistance welding (also known as
25 implant welding or electrofusion welding), induction welding, dielectric welding and

microwave welding. In addition, thermal spraying technologies are also suitable for welding of polymers or polymeric materials, including electrical means (such as plasma or arc) or chemical means (combustion flame). In particular, plasma spraying or plasma coating is adopted for welding a thin layer of polymers or polymeric materials.

[0021] The solvent bonding method is particularly suitable for preforming the lining onto the unit panel when the unit panel is made of polymers or polymeric materials. In particular, the polymers or polymeric materials are amorphous (such as PolyVinylChloride (PVC), acrylic (AK) and PolyStyrene (PS), PolyCarbonate (PC), PolyMethylMethAcrylate (PMMA) and Acrylonitrile Butadiene Styrene (ABS)). A solvent is applied at the interface of two unit panels for plasticizing the surfaces of the polymers or polymeric materials.

[0022] The lining optionally comprises a bonding layer on one surface or both surfaces of the lining. For example, the bonding layer comprises a fabric backed liner (FBL) having a thin layer of any fabric material (such as felt, polyester) to provide a rough or coarse surface for adhesives. For another example, the bonding layer comprises a thin homogenous layer of mechanical fixtures having a plurality of anchors, surface texture, extensions, legs, studs. In particular, various fillers may be embedded inside gaps between studs for specific purposes. When the fillers are porous materials (such as aerogel, rigid polyurethane (PUR), polyisocyanurate (PIR), mineral wool), the lining provides a thermal insulation function, fire resistance function, noise reduction function and a mechanical cushion function. The thermal insulation function ensures that the sectional panel tank is workable in special regions (such as high latitude countries in

cold winter) or for special applications (such as spa). The mechanical cushion function ensures that the lining is tightly pushed against the unit panel under a pressure of the water stored inside the sectional panel tank. In addition, the lining may work as a matrix for holding firmly various functional particular substances inside the lining without losing the functional particles when in contact with water. For example, the lining may hold a self-cleaning particular substance (such as titanium dioxide (TiO₂)) for removing any debris or sediments from the self-cleaning surface automatically. The self-cleaning particular substance is optionally superhydrophobic, superhydrophilic or photocatalytic. The lining may further hold an antimicrobial particular substance (such as silver nanoparticles) for killing any microbial-organism in the water.

[0023] The lining optionally comprises a fore layer (or first layer) and a base layer (or second layer). In particular, the fore layer and the base layer are co-extruded at manufacturing to form a homogenous bonded liner. Typically, the fore layer and the base layer have a fore colour and a base colour respectively. The base colour is preferably distinctively different to human's eyes from the fore colour, so that any erosion, wear or destruction of an exposed fore layer of the two layers will uncover an underneath base layer of the two layers for an easy vision inspection. If the base colour is observed in the inner side of the sectional panel tank, repair or replacement is then warranted.

[0024] Both layers are joined by co-extrusion and/or The base and fore layers are optionally made of a same or similar materials for a homogenous joint. In addition, the lining has a total thickness neither too thick (i.e. >20mm) nor too thin (i.e. <0.5mm). In some implementations, the total thickness is in a range from 1.0 to 6.0

millimetres (mm). The base layer and the fore layer have a base thickness and a fore thickness respectively. Typically, the fore layer thickness account for no more than 50% (such as 10%) of the total thickness

5 [0025] The sectional panel tank may further comprise a thermal insulation layer for reducing temperature fluctuation of the fluid inside the sectional panel tank. The thermal insulation layer is made of thermal insulation material that slows down heat transfer by conduction or convection. The thermal insulation material comprises fiberglass, mineral wool, cellulose, polyurethane foam, polystyrene, aerogel, pyrogel,
10 natural fibres (such as hemp, sheep's wool, cotton and straw) and polyisocyanurate (PIR) foam. The mineral wool further comprises glass wool, rock wool and slag wool. The polystyrene also further comprises expanded polystyrene (EPS) and extruded polystyrene (XEPS). In particular, the thermal insulation material is preferred to be hydrophobic or non-absorbing to water, such as fiberglass.

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[0026] The thermal insulation layer further comprises a plurality of thermal insulation sheets assembled at an external side of the sectional panel tank. The external side is exposed to an outside environment and not in contact with the fluid inside the sectional panel tank. In some implementations, one or more thermal insulation sheets
20 are attached to an external side of the first unit panel or the second unit panel. The thermal insulation sheets are further assembled together into the thermal insulation layer during or after the first unit panel and the second unit panel are joined together into the sectional panel tank. Alternatively, the thermal insulation layer is fabricated as a unitary part and attached to the external side of the sectional panel tank as a
25 whole after the first unit panel and the second unit panel are joined together.

[0027] Alternatively, the thermal insulation layer, the external side of the first unit panel is treated or processed for being substantially reflective to light, heat, infrared wave or any other types of irradiation. In particular, since stainless steel (also known as inox steel or inox) is reflective to solar and thermal irradiations, the first unit panel made of stainless steel may achieve a same or similar reflective effect without the treatment. In addition, the reflective effect of stainless steel is further compounded by not converting wavelengths of incoming light. Therefore, solar energies carried by the incoming light are directly sent back into space substantially without atmospheric absorption, which effectively prevents re-radiation from the outside environment.

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[0028] In addition to the thermal insulation layer, the sectional panel tank may also comprise a radiant barrier layer for further suppressing temperature fluctuation of the fluid inside the sectional panel tank. The radiant barrier layer is reflective to heat radiation (such as visible light or infrared waves) and thus reduces heat transfer. The radiant barrier layer optionally comprises a very thin and mirror-like aluminium foil. Alternatively, an external side first unit panel maybe treated with low heat transmission material such as chromium oxide and Iriotec pigments.

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[0029] The sectional panel tank may also comprise a fireproofing layer encapsulating the thermal insulation layer if the thermal insulation material is flammable, such as cellulose, polyurethane foam and polystyrene. The fireproofing layer is preferably compatible with the thermal insulation material. For example, hexabromocyclododecane (HBCD) is used to make the fireproofing layer when polystyrene is selected as the thermal insulation material.

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[0030] In some implementations, the fireproofing layer comprises a plurality of fireproofing sheets. One or more fireproofing sheets are attached to the first unit panel or the second unit panel. The fireproofing sheets are further assembled together into the fireproofing layer during or after the first unit panel and the second unit panel are joined together into the sectional panel tank. As a result, the thermal insulation sheets are sandwiched between the first panel unit and the fireproofing sheets. Alternatively, the fireproofing layer is fabricated as a unitary part and attached to the external side of the sectional panel tank as a whole after the first unit panel and the second unit panel are joined together.

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[0031] The sectional panel tank optionally further comprises a shield layer for protecting the thermal insulation layer and the fireproofing layer. The shield layer is made of structural material resisting to loads and impacts. The structural material comprises iron, concrete, aluminium (Al), composites, masonry, timber, adobe, alloy, bamboo, carbon fibres, fiber reinforced plastics and mudbrick. The iron further comprises wrought iron, cast iron, steel and stainless steel. The concrete further comprises reinforced concrete and pre-stressed concrete. The shield layer is optionally positioned externally to the thermal insulation layer and the fireproofing layer.

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[0032] The sectional panel tank optionally further comprises a cover, an access hole (e.g. manhole), a ladder or a combination of the foregoing objects. The cover is used for partially or completely covering the sectional panel tank for preventing foreign contaminates. The cover optionally comprises a plurality of cover unit panels that are assembled and/or joined together into the single unitary piece of cover. Alternatively,

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the cover may be a pre-fabricated part and loaded as a whole onto the side wall of the sectional panel tank. The access hole is made as an opening to access the inner space of the sectional panel tank by a worker or technician for inspection, maintenance, or even modification (e.g. upgrading). The access hole is preferably located near a periphery edge of the sectional panel tank of the cover for easy access. The ladder comprises a bottom end at or near the ground; and a top end at or slightly higher than the cover. In particular, the top end is in vicinity of the access hole such that an operator can easily get to the access hole by climbing the ladder until the top end.

[0033] The sectional panel tank optionally further comprises a framework (e.g. structural bracing) that is either detachably or permanently connected to the first unit panel, the second unit panel or both for upholding structural integrity of the sectional panel tank. For example, the structural bracing may comprise an internal bracing and/or an external bracing. The internal bracing and the external bracing is often made of steel (such as steel rods) or even polymer which can withhold the designed pressure. The framework is optionally made of wood, engineered wood, concrete, structural steel or a combination of any of these. In addition, the framework comprises a side frame detachably connected to the side wall of the sectional panel tank. The side frame may further comprise a steel beam structure, a portal frame structure (also known as goal post structure), or box frame structure (also known as picture frame structure), or a cage frame structure. The box frame structure is particularly suitable since multiple horizontal bars and multiple vertical poles are combined together to create the box frame structure. Furthermore, the framework may also comprise a roof

beam detachably connected to the cover of the sectional panel tank for maintaining a shape of the cover.

[0034] The sectional panel tank optionally further comprises an external foundation (also known as or structure) for supporting the framework. For example, the sectional panel tank comprises a concrete foundation (such as concrete flat foundation or plinth spaced at regular intervals) as the external foundation for supporting the sectional panel tank including the framework. The external foundation may also comprise a I-shaped (double-T) foundation, a slab-on-ground foundation or a frost protected foundation. One or more corner bracings (such as angle bar) are applied at the external foundation for structurally supporting the foundation. The corner bracing has a shape and a size adaptable to a specific foundation.

[0035] The framework comprises at least one rod, shaft or tie rod that connects or fixes the inner sides of two opposite unit panels. In contrast to the side frame detachably connected to the external side of the sectional panel tank, the rods are secured inside the sectional panel tank by connecting the rods to the inner sides of two first unit panels at opposite sides of the sectional panel tank (i.e. opposite first unit panels). In addition, some internal bracings are tied diagonally to the unit panel.

[0036] The sectional panel tank optionally further comprises one or more sensors, communication modules (e.g. Internet-of-Things IoT device), or a combination of these for a monitoring operation status (such as water level) of the sectional panel tank. In addition, the sectional panel tank may also have a warning device connected to the sensors and/or the communication modules for generating a warning signal

(such as sound or light) to an operator of the sectional panel tank. Furthermore, the sectional panel tank may comprise solar panels for generating and providing electrical power to other components such as the sensors and the communication modules.

5 [0037] The sectional panel tank optionally further comprises a drainage panel having a drainage hole, orifice or valve for discharging the fluid away from the sectional panel tank. In some implementation, the drainage hole is positioned at a bottom of the sectional panel water tank for automatically discharging the fluid due to the gravity. In addition, the sectional panel tank may also comprise an inlet for filling the liquid into
10 the sectional panel tank, an overflow pipe for diffusing the liquid out of the sectional panel tank, and an air vent for ventilation or pressure relief if the sectional panel tank is sealed when in operation.

[0038] The sectional panel tank optionally further comprises a cross connector (e.g.
15 T-bracket) configured to join four corners of neighbouring unit panels together. The cross connector provides an additional mechanical force for joining the unit panels and thus makes the sectional panel tank a unitary storage device.

[0039] The sectional panel tank optionally further comprises an inner partition or
20 board for providing an inner portion of the sectional panel tank. In this way, the sectional panel tank is divided into a plurality of smaller and independent cells for storing a same liquid or different liquids. Therefore, each cell may be constructed, maintained, inspected and repaired without any interference from any other cell. In addition, the lining may also be joined or attached to the inner partition for preventing
25 communication of the liquids from individually cells.

[0040] The sectional panel tank optionally further comprises a base frame for holding the sectional panel tank at a building site (e.g. ground, rooftop). The base frame is either detachably or permanently attached to the bottom of the sectional panel tank. In addition, the base frame is optionally connected to the external foundation and or the framework of the sectional panel tank.

[0041] In addition to the side wall, the sectional panel tank may further comprise a bottom having a bottom extension. The bottom and the side wall are directly joined at the bottom extension and the side wall. For example, the first unit panel further comprises a side extension (such as a side flange) matching the bottom extension (such as a bottom flange) of the bottom. The bottom and the first unit panel are directly joined by fixing the side extension and the bottom extension together. In some implementations, the side extension is folded in a horizontal direction and is thus parallel to the bottom. In some implementations, the bottom extension is folded in a vertical direction and is thus parallel to the first unit panel.

[0042] The plastic welding alone can join a bottom seam between the bottom extension and the side extension. In addition, the sectional panel tank also comprises a bottom sealant or bottom protector applied at a bottom seam (also known as bottom gap or bottom joint) between the bottom extension and the side wall. The bottom sealant is applied to the bottom seam between the bottom extension and the side extension on the inner side of the first unit panel and an inner side of the bottom respectively. The bottom sealant is similar to the sealant at the seam between the first extension and the second extension. The bottom sealant is used for providing additional insurance that there is no leakage at the bottom seam. The bottom sealant

is particularly important in a scenario when the plastic welding cannot reach a standard quality.

[0043] The bottom sealant is formed by any suitable method according to a specific material of the bottom sealant. For example, the bottom sealant is made by a thermoplastic welding method. The thermoplastic welding method is conducted by a mechanical welding means, a thermal welding means, an electromagnetic welding means, or a chemical welding means (also known as solvent welding). The mechanical means includes but not limited to ultrasonic welding (20-40 kHz), stir welding (1-100 Hz), vibration welding (100-250 Hz) and spin welding (1-100 Hz). The electromagnetic welding means includes but is not limited to induction welding (5-25 MHz), microwave welding (1-100 GHz), dielectric welding (1-100 MHz) and resistance, implant or electrofusion. The thermal welding means includes but is not limited to hot gas welding (such as tack welding and rod welding), extrusion welding, infrared welding, laser welding, hot wedge welding and hot plate or butt fusion welding. The thermoplastic welding is examined by using various methods for testing welding integrity. The methods include but are not limited to creep test (such as creep rupture test and tensile creep test), impact test, shear test, peel test (BS EN 12814-4), bend test (DVS 2203-1 and DVS), tensile test (DVS 2203-5) and hydrostatic pressure test (ASTM). For example, the thermoplastic welding is examined by a non-destructive test (NDT) for ensuring a welding quality of the bottom. The non-destructive test includes but is not limited to holiday spark test, ultrasonic test, leak-tightness test, radiography and visual inspection (DVS 2202-1). In particular, the non-destructive test comprises a holiday spark test for identifying unacceptable discontinuities such as pinholes, holidays, bare spots or thin points.

[0044] The bottom for the sectional panel tank may comprise a single component of any load bearing material (such as concrete, metal or compacted soil) and the lining is attached thereon for interfacing with the unit wall panel. The single component of the bottom may comprise one or more weight-bearing parts, such as a stainless steel plate, sump and compacted soil plate for providing a flat bottom surface. The lining is then applied for completely covering the flat bottom surface; and then the sectional panel tank is directly built on the lining and the flat bottom surface. This technology is particularly used for oil storage tanks and chemical waste tanks. Alternatively, the bottom of the sectional panel tank may also comprise a third unit panel and a fourth unit panel similar to the first unit panel or the second unit panel. The third and the fourth unit panels are joined together for forming the bottom. For example, the bottom extension comprises a third extension (such as a third flange) and a fourth extension (such as a fourth flange) at peripheral edges of the third unit panel and the fourth unit panel respectively. The third extension and the fourth extension are joined together for forming the bottom. In some implementations, the bottom made of unit panels is supported above the ground by plinth or other heavy base. It is understood that the unit wall panels are not limited to a square shape, but might be of any other shapes, which are suitable for constructing a container (e.g. cylindrical container).

[0045] Similarly, the sectional panel tank may further comprise a roof. In particular, the roof is made of a chemically resistant material to chlorine gas or other corrosive chemical containing chlorine groups. Similar to the bottom of the sectional panel tank, the roof may be made of a single component (such as a monolithic covering) or assembled by a plurality of the unit panels (i.e. top unit panels) having top extensions.

Similarly, the top extensions are joined together for forming the roof. The top

extensions may be joined at top joints by nuts or bolts either inwardly (i.e. the top extension extending or pointing into the inner side of the sectional panel tank) or outwardly (i.e. the top extension extending or pointing out of the outer side of the sectional panel tank). In the former case, one or more supporting structures (such as steel bar) are provided below the roof for supporting the top joints since a human or an inspection machine often to walk on the roof. In the latter case, a flat and strong structure may be laid on the roof for covering the top unit panels and the top joints for the human or the inspection machine to walk on the roof. In addition, one or more supporting structures (such as steel bar) are provided at the top extension for supporting the roof. Meanwhile, the roof and the side wall are directly joined at the top extension and the side wall. For example, the first unit panel further comprises a side extension (such as a side flange) matching the top extension (such as a top flange) of the roof. The roof and the first unit panel are directly joined by fixing the side extension and the top extension together. In some implementations, the side extension is folded in a horizontal direction and is thus parallel to the roof. In some implementations, the top extension is folded in a vertical direction and is thus parallel to the first unit panel. It is noted that all the above technologies joining the bottom and the side wall (such as plastic welding) are also suitable for joining the roof and the side wall.

[0046] The sectional panel tank optionally comprises a securing means for securing the first extension and the second extension of the side wall. For example, the first extension and the second extension have a first engaging hole and a second engaging hole respectively. The first engaging hole and the second engaging hole match each other in terms of size and position. The securing means comprises an

engaging screw and an engaging nut. The engaging screw passes through the first and second engaging holes from the first extension and then rests on the first extension by a slotted head of the engaging screw. Then the engaging nut secures the engaging screw from the second extension on a thread of the engaging screw and thus fastens the first securing means. In addition, the securing means may further comprise a reinforcement plate arranged between the slotted head of the engaging screw and the first extension for avoiding damages to the first extension. Similarly, the sectional panel tank comprises another securing means for securing the third extension and the fourth extension of the bottom.

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[0047] The first securing means and the second securing means may comprise a first coating and a second coating respectively for preventing any leakage from the first and second extensions. The first coating and the second coating are optionally compatible with the lining when covered by the lining. For example, the first coating and the second coating are made of the thermoplastic material such as FEP, PFA, or UHMWPE. In particular, the first coating or the second coating is integrated with the first lining or the second lining for forming a unitary component by any method described above (such as co-extruding).

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[0048] The sectional panel tank optionally comprises a fixture for fixing the side extension and the bottom extension. Similarly, the fixture may also comprise a fixing coating compatible with the lining such as thermoplastic material including FEP, PFA, or UHMWPE. In particular, the fixing coating is also integrated with the lining as a unitary component by any method described (such as co-extruding).

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[0049] As a second aspect, the present application also discloses a prefabricated unit panel for the sectional panel tank of the first aspect. The prefabricated unit panel comprises a structural panel having an extension; and a lining sheet preformed on an inner side of the structural panel for completely covering the structural panel including the extension. The lining sheet optionally comprises a thermoplastic material (such as FEP, PFA, or UHMWPE); while the structural panel optionally comprises metals or metal alloys (such as stainless steel, copper, bronze, brass or galvanized steel), plastics (such as polyethylene or polypropylene), composites (such as fiberglass reinforced plastics (FRP) or glass reinforced plastics (GRP)).

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[0050] Similar to the lining of the first aspect, the lining sheet comprises a base layer of a first colour and a fore layer of a second colour, such that erosion of one of the layers (such as the fore layer) will expose another layer (such as the base layer) for vision inspection of premature wear or damage.

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[0051] Similar to the securing means of the first aspect, the extension optionally comprises an engaging hole for a securing means such as an engaging screw and an engaging nut. Accordingly, the lining sheet may comprise a through hole matching the engaging hole of the extension in terms of size and position for the securing means. Therefore, the extension and the lining sheets of one prefabricated unit panel are fixed together with those of another prefabricated unit panel by the securing means.

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[0052] As a third aspect, the present application also discloses a method of making the side wall for the sectional panel tank of the first aspect. The method of making

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comprises a step of providing a first unit panel having a first extension at its peripheral edge; a step of providing a second unit panel having a second extension at its peripheral edge; a step of directly joining the first unit panel and the second unit panel together by securing a securing means at the first extension and the second extension; and a step of applying a sealant at a seam between the first extension and the second extension on inner sides of the first unit panel and the second unit panel. The sealant is applied by any suitable method discussed in the first aspect. If made of fiberglass reinforced plastics (FRP), the first unit panel and the second unit panel are provided by any suitable method, including sheet moulding compound (such as compression moulding), hand laid, bulk moulding compound (such as injection moulding, transfer moulding and compression moulding), and compression moulding. In particular, the applying step may comprise a thermoplastic welding process. The thermoplastic welding process is optionally conducted by a mechanical welding means, a thermal welding means, an electromagnetic welding means or a chemical welding means.

[0053] The method of making optionally comprises a step of joining or attaching a lining onto the inner sides of the first unit panel and the second unit panel. The lining has all the characteristics described in the first aspect. The lining is prepared by any suitable method, including but not limited to injection moulding, pultrusion, rotational moulding, compression moulding, extrusion, thermoforming or vacuum forming, calendaring and blow moulding. In particular, the joining step optionally comprises a thermoforming process. The method of making optionally further comprise a step of examining the sealant by a non-destructive test. The non-destructive test comprises a holiday spark test.

[0054] The method of making optionally comprises a step of selecting the lining for resisting corrosion of a predetermined host. For example, the lining is selected not to be made of step-growth polymers (such as polyesters, polyamides or polycarbonates) when the sectional panel tank stored an acid solution or a base solution as the predetermined host. In addition, the method of making also optionally comprises a step of coating the securing means for avoiding a leakage of the predetermined host. Preferably, the coating is made of a same or similar material with the lining for easily and firmly joining the coating and the lining together. In some implementations, the coating and the lining are integrated together as a unitary component before they are joined onto the unit panel.

[0055] The joining step may further comprise a first step of providing a fore layer and a base layer; a second step of co-extruding the fore layer and the base layer for forming a homogenous bonded layer; and a third step of attaching the homogeneous bonded layer onto the inner side of the first unit panel. As described above, the fore layer has a fore colour; and the base layer has a base colour different from the fore colour for an easy visual inspection. In particular, the joining step comprises a step of joining the lining onto the first extension and the second extension for directly joining the first unit panel and the second unit panel. In this way, the method of making does not need any gasket inserted between the first extension and the second extension. Therefore, existing problems of the gasket such as leakage and corrosion are overcome; and the first unit panel and the second unit panel are joined more tightly and durably at the first and second extension.

[0056] As a fourth aspect, the present application also discloses in the case of thermoset lining such as PVC, ABS, PMMA (Acrylic), etc. a method of joining an individual lined sectional panel tank having two parts. The method of joining comprises a step of pressing the two parts; and a step of applying a sealant at a seam
5 between the two parts. The two parts of the sectional panel tank is pressed together tightly such that the seam has a dimension less than 0.5 millimetres (mm) for creating a capillary effect. The sealant is in a liquid state and then goes into the seam due to the capillary effect. The sealant is finally fixed at the sealant and completely covers the seam for preventing any leakage. For example, a solution with a resin dissolved
10 or suspended enters into the seam due to the capillary effect; and then the resin is fixed inside and near the seam by solvent welding.

[0057] As a fifth aspect, the present application also discloses a method of repairing an existing sectional panel tank. The existing sectional panel tank has a bottom and
15 a side wall as the two parts. The method of repairing may further comprise a step of providing a lining; a step of applying the sealant at a seam between the bottom and the side wall; and a step of attaching the lining to an inner surface of the existing sectional panel tank. Since the inner surface of the existing sectional panel tank comprises a bottom surface of the bottom and a side surface of the side wall, the
20 lining covers both the bottom surface and the side surface completely for preventing any leakage.

[0058] When the lining has a larger dimension than the inner surface of the existing sectional panel tank, the lining is then attached to the inner surface as a whole. In
25 particular, the lining covers the sealant at the seam without any joining process. The

lining needs to be soft and pliable for being fit into the existing sectional panel tank. For example, the lining comprises a thermoplastic material. Before attaching the lining to the existing sectional panel tank, the thermoplastic material may be softened by being heated at a temperature slightly above a glass transition temperature of the thermoplastic material. Alternatively, some materials with lower heat requirements (such as PE and PP) do not need such softening step. The softening step also depends on a shape and a design of the host unit panels. Alternatively, the lining optionally comprises a plurality of lining sheets. Each of the lining sheets has a dimension smaller than the inner surface of the existing sectional panel tank. In this case, the method of repairing further comprises a step of joining the lining sheets together for completely covering the inner side of the existing sectional panel tank.

[0059] The existing sectional panel tank maybe a cubic tank having a rectangular or square shape in a cross-sectional view with four side surfaces (i.e. a front surface, a rear surface, a left surface and a right surface). Accordingly, the cubic tank has four joints around the side surfaces, i.e. a first joint between the front surface and the right surface, a second joint between the right surface and the rear surface, a third joint between the rear surface and the left surface and a fourth joint between the left surface and the front surface. The method of repairing further comprises a step of applying four bonds at the four joints respectively, i.e. a first bond at the first joint, a second bond at the second joint, a third bond at the third joint and a fourth bond at the fourth joint.

[0060] The seam of the cubic tank comprises four linear seams, i.e. a first linear seam between the front surface and the bottom surface, a second linear seam between the

right surface and the bottom surface, a third linear seam between the rear surface and the bottom surface and a fourth linear seam between the left surface and the bottom surface. The sealant thus comprises a first sealant, a second sealant, a third sealant and a fourth sealant at the first linear seam, the second linear seam, the third linear seam and the fourth linear seam respectively.

[0061] In comparison, the existing sectional panel tank may have a cylindrical tank having a circular shape in the cross-sectional view with only one side surface that is closed on itself with one or more joints subject to the size of liner available under current manufacturing capabilities. Therefore, the seam of the cylindrical tank comprises only one circular seam between the bottom surface and the side surface.

[0062] The step of applying optionally comprises a thermoplastic welding process when the lining comprises a thermoplastic material. The thermoplastic welding process comprises a mechanical welding means, a thermal welding means, an electromagnetic welding means or a chemical welding means. In particular, a hot gas welding may be conducted for temporarily welding several selected spots; in contrast, an extrusion welding is used for joining the lining sheets of to the first and second unit panels which represents a necessary feature of the present application. In the extrusion welding, a molten thermoplastic filler is fed from a barrel of a hand-held extruder, through a PTFE shoe shaped for matching a profile of a joint. The lining is firstly rolled to fit the cylindrical tank, then two ends of the cylindrical tank are overlapped and finally welded together. The extrusion welding is a quick and convenient welding technique and also can be conducted continuously.

[0063] The method of repairing may further comprise a step of examining the sectional panel tank by a non-destructive test. The non-destructive test may also comprise a step of performing a holiday spark test.

- 5 [0064] The method of repairing may further comprise a step of selecting the lining according to the existing sectional panel tank. The method of repairing may also comprise a step of selecting the lining for resisting corrosion of a predetermined host.

[0065] The step of attaching optionally further comprises a first step of providing a
10 fore layer and a base layer; a second step of co-extruding the fore layer and the base layer as a homogeneous bonded liner; and a third step of attaching the homogeneous bonded liner to the inner side of the sectional panel tank. As described above, the fore layer has a fore colour; and a base layer having a base colour different from the fore colour for easy visual inspection.

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[0066] As a sixth aspect, the present application also discloses a method of making the prefabricated unit panel for the sectional panel tank described in the second aspect. The method of making the prefabricated unit panel comprises a step of providing a structural panel having an extension; a step of providing a lining sheet
20 larger than the structural panel; and a step of attaching the lining sheet onto an inner side of the structural panel. In particular, the lining sheet completely covers the extension of the structural panel.

[0067] The lining optionally comprises a thermoplastic material. Accordingly, step of attaching may be conducted by a thermoforming method that is suitable for the thermoplastic material.

5 [0068] The lining optionally comprises a fore layer having a fore thickness and a base thickness having a base thickness. In some implementations, the fore thickness accounts for around 50% of the total thickness, such as ranging from 150 to 200 micrometres.

10 [0069] The structural panel is made of impermeable, corrosion resistive and structurally robust material, including metals or metal alloys (such as stainless steel, copper, bronze, brass, galvanized steel, aluminium, titanium, etc.), plastics (such as polyethylene or polypropylene), composites (such as fiberglass reinforced plastics (FRP) or glass reinforced plastics (GRP) carbon fiber).

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[0070] The method of making the prefabricated unit panel optionally comprises a step of attaching a thermal insulation layer at an external side of the structural panel for reducing temperature fluctuation.

[0071] The accompanying figures (Figs.) illustrate embodiments and serve to explain principles of the disclosed embodiments. It is to be understood, however, that these figures are presented for purposes of illustration only, and not for defining limits of relevant applications.

- 5 Fig. 1 illustrates a partially exploded view of a first sectional panel tank with an external foundation;
- Fig. 2 illustrates a partially exploded view of the first sectional panel tank without an external foundation;
- Fig. 3 illustrates an isometric view and a cross-sectional view of a first unit panel;
- 10 Fig. 4 illustrates a cross-sectional view of the first unit panel with studs;
- Fig. 5 illustrates a cross-sectional view of two first unit panels of Fig. 2 vertically joined together;
- Fig. 6 illustrates an enlarged cross-sectional view of a lining sheet;
- Fig. 7 illustrates a cross-sectional view of two unit panels of Fig. 3 orthogonally
- 15 joined together;
- Fig. 8 illustrates a cross-sectional view of a bent unit panel;
- Fig. 9 illustrates a cross-sectional view of another unit panel;
- Fig. 10 illustrates a cross-sectional view of two unit panels of Fig. 9 vertically joined together;
- 20 Fig. 11 illustrates a partially exploded view of a second sectional panel tank with an external foundation;
- Fig. 12 illustrates a partially exploded view of a second sectional panel tank without an external foundation;
- Fig. 13 illustrates a cross-sectional view of a third sectional panel tank;
- 25 Fig. 14 illustrates a partially exploded view of a fourth sectional panel tank;

Fig. 15 illustrates a cross-sectional view of another unit panel;

Fig. 16 illustrates a cross-sectional view of two unit panels of Fig. 15 joining together.

Fig. 17 illustrates a cross-sectional view of a partition tank using the unit panels of Fig. 3.

Fig. 18 illustrates a cross-sectional view of another partition tank using the unit panels of Fig. 9.

[0072] Fig. 1 illustrates a partially exploded view of a first sectional panel tank 100

with an external foundation 130. The first sectional panel tank 100 has a cubic dimension with a bottom 102, a roof or cover 104 and four side walls, including a front wall 106, a rear wall 108 (not shown), a left wall 110 (not shown) and a right wall 112.

Therefore, twelve (12) edges 138 are formed for the first sectional panel tank 100.

The bottom 102, the cover 104 and the side walls 106, 108, 110, 112 are assembled

by multiple unit panels 114 joined together. The first sectional panel tank 100 further comprises an access hole or manhole 116 at a corner of the cover 104, a ladder 118 fixed to the right wall 112, a drainage hole 120 connected to a drainage tube 122, an inlet 124 and an outlet 126 at an upper part and a lower part of the front wall 106 respectively. In particular, a top end 128 of the ladder 118 is located in vicinity of the

access hole 116. In addition, the external foundation 130 is laid on the ground for supporting the first sectional tank 100; and an external framework 132 connected to the multiple unit panels for upholding structural integrity of the sectional panel tank 100. The sectional panel tank 100 is used for storing a liquid 134 (not shown) inside

a space defined by the bottom 102, the top 104 and the four side walls 106, 108, 110, 112. The liquid 134 is filled into and discharged out of the space through the inlet 124

and the outlet 126. In addition, the liquid 134 is removed from the space through the drainage tube 122 and the drainage hole 120 in a quicker manner.

[0073] Fig. 2 illustrates a partially exploded view of the first sectional panel tank 100 without an external foundation 130. All features of the first sectional panel tank 100 are identical to those in Fig. 1, except that the bottom 102 is not needed. A compacted and flat soil plate (not shown) is prepared from the ground; and then a piece of lining 136 is spread on the compacted and flat soil plate. The first sectional panel tank 100 is directly built on the lining 136 by erecting the side walls 106, 108, 110, 112 and the joining the cover 104 with the side walls 106, 108, 110, 112. This first sectional panel tank 100 in Fig. 2 is particularly used for oil storage and chemical waste treatment.

[0074] Fig. 3 illustrates an isometric view (Fig. 3(a)) and a cross-sectional view (Fig. 3(b)) of a first unit panel 200. The first unit panel 200 comprises a first structural panel 202, a first lining sheet 204, a first thermal insulation layer 206, and a first extension 208. The first extension 208 further comprises four flanges folded at substantially 90 degrees at four peripheral edges of the first unit panel 200 respectively, i.e. a first front flange 210 folded at a first front edge 212, a first rear flange 214 folded at a first rear edge 216, a first left flange 218 folded at a first left edge 220, and a first right flange 222 folded at a first right edge 224. The first structural panel 202 thus extends between the four flanges 210, 214, 218, 222. The first structural panel 202 is made of stainless steel that is impermeable, corrosion resistive, and mechanically robust for resisting pressure of the fluid 134. The four flanges 210, 214, 218, 222 are formed by folding the four edges 212, 216, 220, 224 respectively at substantially 90 degrees. In other words, the four flanges 210, 214, 218, 222 are substantially vertically positioned to the

four edges 212, 216, 220, 224 respectively. In particular, the first structural panel 202 has a size less than four square meters and a thickness of around 2 millimetres (mm); while the first lining sheet 204 also has a thickness of around 2 millimetres (mm). Therefore, the first unit panel 200 has a total thickness of around 4 millimetres (mm).

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[0075] As shown in Fig. 3(b)), the first lining sheet 204 has two flat sides, i.e. a first side 242 and a second side 244. The first side 242 is joined to an inner surface 226 of the first structural panel 202 for forming the first unit panel 200 by a thermoforming method. In particular, the first lining sheet 204 completely covers the inner surface 206, including the first structural panel 202 and the first extension 208. The first lining sheet 204 is made of a thermoplastic material such as UHMWPE. Since in direct contact with the liquid 134, the first lining sheet 204 is required to be water-proof and corrosion resistant to water and almost all chemical solutions. The first thermal insulation layer 206 is formed on an external surface 228 of the first structural unit panel 202 for reducing temperature fluctuation of the fluid 134. The first thermal insulation layer 206 is made of fiberglass that is light in weight and also hydrophobic to water. Furthermore, the first unit panel 200 comprises an embossment 230 on the first structural panel 202 for further strengthening mechanical properties of the first structural panel 202.

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[0076] As described above, multiple unit panels 114 are joined together for forming the first sectional panel tank 100. Therefore, a second unit panel 250 is provided for being joined with the first unit panel 200. The second panel 250 is identical to the first unit panel 200 as described in Fig. 2. In other words, the second unit panel 200 comprises a second structural panel 252, a second lining sheet 254, a second thermal

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insulation layer 256, and a second extension 258. The second extension 258 further comprises a second front flange 260 folded at a second front edge 262, a second rear flange 264 folded at a second rear edge 266, a second left flange 268 folded at a second left edge 270, and a second right flange 272 folded at a second right edge 274. The second lining sheet 254 and the second thermal insulation layer 256 are formed on an inner surface 276 and an external surface 278 of the second unit panel 250. The second unit panel 250 also comprises a second embossment 280 for further strengthening mechanical properties of the second structural panel 252.

[0077] Fig. 4 illustrates a cross-sectional view of the first unit panel 200 with studs 240. The first lining sheet 204 is made with a first side 242 having a plurality of studs 240 and a second side 242 having a flat surface. The first side 242 is assembled towards the first structural panel 202; and the second side 242 is in direct contact with water stored in the first unit panel tank 100. A continuous gap 246 is thus formed between the first structural panel 202 and the first side 242 of the first lining sheet 204. A porous filler 248 (such as aerogel) is filled inside the gap 246 for providing a thermal insulation function and a mechanical cushion function. The thermal insulation function ensures that the first sectional panel tank 100 is still workable in high latitude countries in a cold winter or for special applications (such as spa). The mechanical cushion function ensures that the first lining sheet 204 is tightly pushed against the first structural panel 202 under a pressure of the water stored inside the first sectional panel tank 100. In particular, the first lining sheet 204 at the flanges 210, 214, 218, 222 does not have the studs 240 at the first side 242 for being tightly and reliably joined with the first structural panel 202.

[0078] Fig. 5(a) illustrates a cross-sectional view of two unit panels 200, 250 vertically joined together for forming the side walls 106, 108, 110, 112 of the first sectional panel tank 100 in Fig. 1 and Fig. 2. The second unit panel 250 is identical to the first unit panel 200 and thus has all the features shown in Fig. 3. The second unit panel 250 has a second structural panel 252, a second lining sheet 254 and a second thermal insulation layer 256

[0079] identical to the first structural panel 202, the first lining sheet 204 and the first thermal insulation layer 206, respectively. The second unit panel 250 also has a second extension 258 (including a second front flange 260 at a second front edge 262, a second rear flange 264 at a second rear edge 266, a second left flange 268 at a second left edge 270 and a second right flange 272 at a second right edge 274), and second embossment 280. The first unit panel 200 and the second unit panel 250 are joined at a joint 290 between the first rear flange 214 and the second front flange 260 by a thermoplastic welding method. In addition, a fastener 235 (such as a screw) also binds the first rear flange 214 and the second front flange 260 at the joint 209.

[0080] Fig. 5(b) illustrates an enlarged cross-sectional view of the joint 290. It is clearly seen that the first rear flange 214 and the second front flange 260 are joined together at the joint 290. In detail, the first lining sheet 204 and the second lining sheet 254 are pressed in direct contact at the joint 290. The joint 290 comprises a seam 292 even if the first lining sheet 204 and the second lining sheet 254 are closely pressed against each other. The thermoplastic welding introduces a sealant 294 for joining the first lining sheet 204 and the second lining sheet 254. The sealant 294 is so strong and reliable that the joint 290 can seal the liquid 134 during a life time of the first sectional

panel tank 100. In contrast to traditional techniques, no gasket is needed for preventing any leakage from the joint 290. In addition, the first thermal insulation layer 206, the first embossment 260, the second thermal insulation layer 256 and the second embossment 280 terminate outside the joint 290.

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[0081] Fig. 6 illustrates an enlarged cross-sectional view of the lining sheet 204, 254.

The lining sheet 204, 254 comprises a first layer 296 attached on the inner side 226, 276 of the unit panel 200, 250; and a second layer 298 attached on the first layer 296.

In this way, the second layer 298 is in contact with the liquid 134 stored inside the

10 first sectional panel tank 100. The first layer 296 and the second layer 298 has a first thickness 297 and a second thickness 299 of 200 micrometres and 1.8 millimetres respectively. The first layer 296 and second layer 298 are both made of a same thermoplastic material such as UHMWPE for easy and reliable attachment.

Therefore, the lining sheet 204, 254 has dual protections for liquid leakage since both

15 the first layer 296 and the second layer 298 are water-proof. In particular, the first layer 296 has a blue colour; while the second layer 298 has a black colour. Any erosion or destruction of the second layer 298 will uncover the first layer 296 for an

easy vision inspection. If the first colour is observed in the inner side 226, 276 of the unit panel 204, 254, the second layer 298 needs to be replaced or repaired since it is

20 already eroded or destructed. Similarly, the unit panels 200, 250 are also horizontally joined together for forming the bottom 102 and/or the cover 104 of the first sectional panel tank 100.

[0082] Fig. 7 illustrates a cross-sectional view of two unit panels 200, 250 joined

25 orthogonally or substantially at a right angle for forming the edge 138 of the first

sectional panel tank 100. The first unit panel 200 of side walls 106, 108, 110, 112 and the second unit panel 250 of the bottom 102 or the cover 104 are positioned vertically and then joined together by the thermoplastic welding method. In a similar way, an additional unit panel (not shown) is provided to join with both the first and second unit panels 200, 250 for forming a corner of the first sectional panel tank 100. The additional unit panel and the first unit panel 200 or the second unit panel 250 are identical, but belong to two adjacent side walls 106, 108, 110, 112. In other words, the additional unit panel, the first unit panel 200 and the second unit panel 250 are all positioned orthogonally and joined together at the corner of the first sectional panel tank 100.

[0083] Alternatively, Fig. 8 illustrates a cross-sectional view of a bent unit panel 400. The bent unit panel 400 is provided for forming the edge 138 of the first sectional panel tank 100. The bent unit panel 400 shares all the features of the first unit panel 200 or second unit panel tank 250, except that the bent unit panel 400 has a bent portion 402 as the edge 138. The bent unit panel 400 is bent orthogonally or substantially at a right angle at the bent portion 402. The bent unit panel 400 thus has a first portion 404 and a second portion 406. The bent portion 402 is position at the edge 138 of the first sectional panel tank 100. The first portion 404 is joined with the first unit panel 200 for forming the side walls 106, 108, 110, 112; while the second portion 406 is joined together with the second unit panel 250 for forming the bottom 102 or the cover 104.

[0084] Fig. 9 illustrates a cross-sectional view of another unit panel, i.e. a third unit panel 300. Similar to the first unit panel 200 or the second unit panel 250, the third

unit panel 300 comprises a third structural panel 302, a third thermal insulation layer 306, and a third extension 308. The third extension 308 further comprises a third front flange 310 folded at a third front edge 312, a third rear flange 314 folded at a third rear edge 316, a third left flange 318 (not shown) folded at a third left edge 320 (not shown), and a third right flange 322 (not shown) folded at a third right edge 324 (not shown). However, the third unit panel 300 does not have a third lining sheet 304 similar to the first lining sheet 204 or the second lining sheet 254.

[0085] In addition to the third unit panel 300, a fourth unit panel 350 is provided for being joined with the third unit panel 300. The fourth panel 350 is identical to the third unit panel 300 as described in Fig. 9. In other words, the fourth unit panel 300 comprises a fourth structural panel 352, a fourth thermal insulation layer 356, and a fourth extension 358. The fourth extension 358 further comprises a fourth front flange 360 folded at a fourth front edge 362, a fourth rear flange 364 folded at a fourth rear edge 366, a fourth left flange 368 folded at a fourth left edge 370, and a fourth right flange 372 folded at a fourth right edge 374.

[0086] Fig. 10 illustrates a cross-sectional view of two unit panels 300, 352 vertically joined for forming the side wall 106, 108, 110, 112 of the first sectional panel tank 100 in Fig.1 or Fig. 2. The third unit panel 300 and the fourth unit panel 350 are joined at a joint 390 between the third rear flange 314 and the fourth front flange 360 by a metal welding method. The joint 390 comprises a seam 392 even if the third rear flange 314 and the fourth front flange 360 are closely pressed against each other. The metal welding introduces a sealant 394 for joining the third rear flange 314 and the fourth front flange 360. In contrast to traditional techniques, no gasket is needed for

preventing any leakage from the joint 390. To further prolong the life time of the first sectional panel tank 100, a single and continuous lining 340, instead of the two lining sheet 204, 254 joined together, is used to cover an inner surface 326 of the third unit panel 300, the inner surface 376 of the fourth unit panel 350 and the joint 390 for preventing any leakage. Similarly, the unit panels 300, 350 are also horizontally joined together for forming the bottom 102 and/or the cover 104 of the first sectional panel tank 100. In addition, an adhesive 330 is applied to the third structural panel 302 and the fourth structural panel 352 before the lining 340 is applied for further fixing the lining in place.

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[0087] Fig. 10 illustrates an enlarged cross-sectional view of a joint 390. In contrast to Fig.4, the third rear flange 314 and the fourth front flange 360 are pressed against each other without a lining sheet or a traditional gasket in-between. The joint 390 comprises a seam 392 that is sealed by a sealant 394 by the solvent welding method.

15 The lining 340 is then joined onto the joint 390 from the inner surfaces 326, 376 for further preventing any leakage from the joint 390.

[0088] Fig. 11 illustrates a partially exploded view of a second sectional panel tank 500. Similar to the first sectional panel tank 100, the second sectional panel comprises a bottom 502, a cover 504, a front wall 506, a rear wall 508 (not shown), a left wall 510 (not shown) and a right wall 512 that are built up by multiple unit panels 514. The second sectional panel 500 also comprises an access hole 516, a ladder 518, a drainage hole 520, a drainage tube 522, an inlet 524, an outlet 526 and an external foundation 530. A liquid 534 is stored inside the second sectional panel tank 500.

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[0089] Instead of the external framework 132, the sectional panel tank 500 comprises an internal framework 532. The internal framework 532 comprises one or more rods 536 that connect the inner sides of two opposite unit panels 514. The rod 536 further comprises one or more beams 538 configured to connect inner sides of the opposite side walls 506, 508, 510, 512; and one or more poles 540 configured to connect inner sides of the bottom 502 and the cover 504. Similar to the structural panel 202, 252, 302, 352, the rod 536 optionally comprises metals or metal alloys (such as stainless steel, copper, bronze, brass or galvanized steel), plastics (such as polyethylene or polypropylene), composites (such as fiberglass reinforced plastics (FRP) or glass reinforced plastics (GRP)). In addition, the rod 536 is completely encapsulated by a lining 542 for resisting corrosion of the liquid 534. Accordingly, the lining 542 is either preformed or applied later on-site. The beam 538 and the pole 540 are arranged vertically to and thus support the side walls 506, 508, 510, 512 and the cover 504 respectively.

[0090] Fig. 12 illustrates a partially exploded view of the second sectional panel tank 500 without the external foundation 530. All features of the second sectional panel tank 500 are identical to those in Fig. 11, except that the bottom 502 is not needed. A compacted and flat soil plate (not shown) is prepared from the ground; and then a piece of lining 542 is spread on the compacted and flat soil plate. The second sectional panel tank 500 is directly built on the lining 542 by erecting the side walls 506, 508, 510, 512 and the joining the cover 504 with the side walls 506, 508, 510, 512. This second sectional panel tank 500 in Fig. 12 is particularly used for oil storage and chemical waste treatment.

[0091] Fig. 13 illustrates a cross-sectional view of a third sectional panel tank 600. The third sectional panel tank 600 shares some features of the first sectional panel tank 100 or the second sectional panel tank 200, basically comprising a bottom 602, a cover 604 (not shown), a front wall 606 (not shown), a rear wall 608 (not shown), a left wall 610 and a right wall 612 that are built up by multiple unit panels 614. However, the sectional panel tank 600 is not an independent device that stands by itself, the bottom 602 and the four side walls 606, 608, 610, 612 are surrounded and supported by a facility 636. As shown in Fig. 13, the facility 636 comprises a hole 638 dug in a ground 640 of the earth. Since the ground 640 provides mechanical support to the bottom 602 and four side walls 606, 608, 610, 612, the unit panels 614 are loaded with less pressure from a liquid 634 (not shown) stored in the third sectional panel tank 600. Therefore, the third sectional panel tank 600 does not need additional features such as the external foundations 130, 530, the external framework 132 or the internal framework 532 and embossments 230, 280. Therefore, the third sectional panel 600 is less costly to build and maintain.

[0092] Fig. 14 illustrates a partially exploded view of a fourth sectional panel tank 700. In contrast to the sectional panel tanks 100, 500, 600 having a cubic dimension, the fourth sectional panel tank 700 has a cylindrical dimension. The fourth sectional panel tank 700 comprises a bottom 702 (not shown), a cover 704 and a side wall 706 that are assembled by multiple unit panels 714. The fourth sectional panel 700 also comprises an access hole 716, a ladder 718, a drainage hole 720, a drainage tube 722 (not shown), an inlet 724, an outlet 726 and an external foundation 730. A liquid 734 (not shown) is stored inside the fourth sectional panel tank 700.

[0093] Fig. 15 illustrates a perspective view and a cross-sectional view of the unit panel 714. The unit panel 714 further comprises a structural panel 752 and a thermal insulation layer 756 and an extension 758. In contrast to the extension 208, 258, 308, 358, the extension 758 comprises four margins at four peripheral edges of the unit panel 714 respectively, i.e. a front margin 760 (not shown) at a front edge 762, a rear margin 764 (not shown) at a rear edge 766, a left margin 768 at a left edge 770, and a right margin 772 at a right edge 774. In particular, the four margins 760, 764, 768, 772 are not folded at an angle (such as 90 degrees) to the edges 762, 768, 770, 774 respectively. The structural panel 752 thus extends between the four margins 760, 764, 768, 772.

[0094] Similar to the Fig. 5 or Fig. 10, two unit panels 714 are joined together for forming the fourth sectional panel tank 700. Similarly, more unit panels 714 are joined together for forming the fourth sectional panel tank 700. Alternatively, a single unit panel 714 can also join itself for forming a cylindrical component; and multiple cylindrical components are joined vertically together for forming the fourth sectional panel tank 700. Fig. 16 illustrates a cross-sectional view of two unit panels 714 joining together, i.e. a fifth unit panel 750 and a sixth unit panel 751. The right margin 772 of the fifth unit panel 750 and the left margin 768 of the sixth unit panel 752 are overlapped and joined together. A single and continuous lining 754 is then joined onto inner surfaces of the fifth unit panel 750 and the sixth unit panel 751.

[0095] Fig. 17 illustrates a cross-sectional view of a partition tank 800 based on a sectional panel tank 801 described above, i.e. anyone of the sectional panel tanks 100, 500, 600, 700. The partition tank 800 is completely separated by a partition part

802 into a first sub-tank 804 and a second sub-tank 806. The first sub-tank 804 and the second sub-tank contain a first fluid 808 (not shown) and a second fluid 810 (not shown) respectively. In particular, the first fluid 808 and the second fluid 810 do not communicate through the partition part 802. The partition part 802 comprises a first side 812 and a second side 814 in contact with the first fluid 808 and the second fluid 810 respectively.

[0096] As described in the Fig. 5, the partition part 802 is firstly assembled from the second side 814 by joining the first unit panel 200 and the second unit panel 250 together at the joint 290 between the first lining sheet 204 and the second lining sheet 254. The first and second unit panels 200, 250 are then further joined at the joint 290 from the first side 812 of the partition part 800. The partition part 800 finally further comprises an additional lining sheet 816 covering the first side 812, particular the joint 290. Therefore, the joint 290 is protected from the first side 812 by the additional lining sheet 816 and from the second side 814 by the first and second lining sheets 204, 254. In other words, the partition part 802 is protected from the first fluid 808 by the pre-formed lining sheets 204, 254 at the first side 812; and from the second fluid 810 by the post-formed additional lining sheet 816 after the partition part 800 is assembled from the first side 812.

[0097] Fig. 18 illustrates a cross-sectional view of another partition tank 850 using the third unit panels 300 and the fourth unit panel 352 described in Fig. 10. Similar to the partition part 800, a partition part 852 is assembled for completely separating the partition tank 850 into a first sub-tank 854 and a second sub-tank 856 for containing a first fluid 858 and a second fluid 860 respectively. In contrast to the partition part

802, the partition part 852 is assembled by joining the third unit panel 300 and the fourth unit panel 350 at the joint 390 from both a first side 862 and a second side 864 of the partition part 852. The partition part 852 further comprises a first additional lining sheet 866 and a second additional lining sheet 868 for covering the first side 862 and the second side 864 respectively. In particular, the joint 390 is protected by the first and second lining sheets 866, 868 from the first side 862 and the second side 864 respectively. In other words, the partition part 852 is protected from the first fluid 858 and the second fluid 860 by the post-formed first and second additional lining sheets 866, 868 respectively after the partition part 850 is assembled.

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[0098] In the application, unless specified otherwise, the terms "comprising", "comprise", and grammatical variants thereof, intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, non-explicitly recited elements.

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[0099] As used herein, the term "about", in the context of concentrations of components of the formulations, typically means +/- 5% of the stated value, more typically +/- 4% of the stated value, more typically +/- 3% of the stated value, more typically, +/- 2% of the stated value, even more typically +/- 1% of the stated value, and even more typically +/- 0.5% of the stated value.

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[0100] Throughout this disclosure, certain embodiments may be disclosed in a range format. The description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the disclosed ranges. Accordingly, the description of a range should be considered to have

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specifically disclosed all the possible sub-ranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

[0101] It will be apparent that various other modifications and adaptations of the application will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the application and it is intended that all such modifications and adaptations come within the scope of the appended claims.

Reference Numerals

	100	first sectional panel tank;
	102	bottom;
5	104	cover;
	106	front wall;
	108	rear wall;
	110	left wall;
	112	right wall;
10	114	unit panel;
	116	access hole;
	118	ladder;
	120	drainage hole;
	122	drainage tube;
15	124	inlet;
	126	outlet;
	128	top end of the ladder;
	130	external foundation;
	132	external framework;
20	134	liquid;
	136	lining;
	138	edge of the sectional panel tank;
	200	first unit panel;
	202	first structural panel;
25	204	first lining sheet;

	206	first thermal insulation layer;
	208	first extension;
	210	first front flange;
	212	first front edge;
5	214	first rear flange;
	216	first rear edge;
	218	first left flange;
	220	first left edge;
	222	first right flange;
10	224	first right edge;
	226	inner surface of the first structural unit panel;
	228	external surface of the first structural unit panel;
	230	first embossment;
	235	fastener;
15	240	stud;
	242	first side of the first lining sheet;
	244	second side of the first lining sheet;
	246	gap;
	248	filler;
20	250	second unit panel;
	252	second structural panel;
	254	second lining sheet;
	256	second thermal insulation layer;
	258	second extension;
25	260	second front flange;

	262	second front edge;
	264	second rear flange;
	266	second rear edge;
	268	second left flange;
5	270	second left edge;
	272	second right flange;
	274	second right edge;
	276	inner surface of the second unit panel;
	278	external surface of the second unit panel;
10	280	second embossment;
	290	joint;
	292	seam;
	294	sealant;
	296	first layer of the lining sheet;
15	297	first thickness;
	298	second layer of the lining sheet;
	299	second thickness;
	300	third unit panel;
	302	third structural panel;
20	306	third thermal insulation layer;
	308	third extension;
	310	third front flange;
	312	third front edge;
	314	third rear flange;
25	316	third rear edge;

	318	third left flange;
	320	third left edge;
	322	third right flange;
	324	third right edge;
5	326	inner surface of the third unit panel;
	330	adhesive;
	340	lining;
	350	fourth unit panel;
	352	fourth structural panel;
10	354	fourth lining sheet;
	356	fourth thermal insulation layer;
	358	fourth extension;
	360	fourth front flange;
	362	fourth front edge;
15	364	fourth rear flange;
	366	fourth rear edge;
	368	fourth left flange;
	370	fourth left edge;
	372	fourth right flange;
20	374	fourth right edge;
	376	inner surface of the fourth unit panel;
	390	joint;
	392	seam;
	394	sealant;
25	396	first layer of the lining;

	398	second layer of the lining;
	400	bent unit panel;
	402	bent portion;
5	404	first portion;
	406	second portion;
	500	second sectional panel tank;
	502	bottom;
	504	cover;
10	506	front wall;
	508	rear wall;
	510	left wall;
	512	right wall;
	514	unit panel;
15	516	access hole;
	518	ladder;
	520	drainage hole;
	522	drainage tube;
	524	inlet;
20	526	outlet;
	528	top end of the ladder;
	530	external foundation;
	532	internal framework;
	534	liquid;
25	536	rod;

	538	beam;
	540	pole;
	542	lining;
	600	third sectional panel tank;
5	602	bottom;
	604	cover;
	606	front wall;
	608	rear wall;
	610	left wall;
10	612	right wall;
	614	unit panel;
	634	liquid;
	636	facility;
	638	hole;
15	640	ground;
	700	fourth sectional panel tank;
	702	bottom;
	704	cover;
	706	side wall;
20	714	unit panel;
	716	access hole;
	718	ladder;
	720	drainage hole;
	722	drainage tube;
25	724	inlet;

	726	outlet;
	728	top end of the ladder;
	730	external foundation;
	734	liquid;
5	750	fifth unit panel;
	751	sixth unit panel;
	752	structural panel;
	754	lining;
	756	thermal insulation layer;
10	758	extension;
	760	front margin;
	762	front edge;
	764	rear margin;
	766	rear edge;
15	768	left margin;
	772	right margin;
	800	partition tank;
	801	sectional panel tank;
	802	partition part;
20	804	first sub-tank;
	806	second sub-tank;
	808	first fluid;
	810	second fluid;
	812	first side of the partition part;
25	814	second side of the partition part;

- 816 additional lining sheet;
- 850 partition tank;
- 852 partition part;
- 854 first sub-tank;
- 5 856 second sub-tank;
- 858 first fluid;
- 860 second fluid;
- 862 first side;
- 864 second side;
- 10 866 first additional lining sheet;
- 868 second additional lining sheet;

Claims

1. A sectional panel tank, comprising:

at least one side wall for joining other side walls in forming the sectional panel
5 tank;

wherein the at least one side wall comprises:

a first unit panel having a first extension at its edge for supporting the first unit
panel;

a second unit panel having a second extension at its edge;

10 at least one lining attached onto an inner side of the first unit panel for
preventing corrosion of the first unit panel; and

a jointer applied at a seam on inner sides of the first unit panel and the second
unit panel of the sectional panel tank to bridge a gap between neighboring unit
panels and form a continuous surface impermeable to solid, liquid or gas;

15 wherein the first unit panel and the second unit panel are joined together
contiguously at the first extension and the second extension by at least one
fastener.

2. The sectional panel tank of claim 1, wherein the at least one lining comprises a
20 thermoplastic material.

3. The sectional panel tank of claim 1, wherein the at least one lining comprises a
bonding layer for fixing the at least one lining onto the first unit panel securely.

4. The sectional panel tank of claim 1, wherein the at least one lining comprises a first layer of a first colour and a second layer of a second colour.

5. The sectional panel tank of claim 1, wherein an external side of the first unit panel
5 is treated for being substantially reflective.

6. The sectional panel tank of claim 1, wherein the first unit panel is made of impermeable, corrosion resistive and/or structurally robust material.

10 7. The sectional panel tank of claim 1, further comprising a framework that is connected to the first unit panel, the second unit panel or both for upholding structural integrity of the sectional panel tank.

15 8. The sectional panel tank of claim 1, further comprising at least one sensor, a communication module, or a combination of these for monitoring operation status of the sectional panel tank.

9. The sectional panel tank of claim 1, further comprising a cross connector configured to join corners of neighbouring unit panels together.

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10. The sectional panel tank of claim 1, further comprising

a bottom having a bottom extension, the bottom and the at least one side wall being directly joined at the bottom extension; and

a bottom jointer applied at a bottom seam between the bottom extension and
25 the at least one side wall.

11. The sectional panel tank of claim 1, further comprising a securing means for securing the first extension and the second extension together.

12. The sectional panel tank of claim 10, wherein the first securing means and the second securing means comprise a first coating and a second coating respectively, the first coating and the second coating are compatible with the lining for avoiding a leakage.

13. The sectional panel tank of claim 11, further comprising a fixture for joining the first extension and the second extension.

14. A prefabricated unit panel for constructing the sectional panel tank of claim 1, comprising

a structural panel having an extension; and

a lining sheet preformed on an inner side of the structural panel for covering the structural panel.

15. The prefabricated unit panel of claim 14, wherein the lining sheet comprises a thermoplastic material.

16. The prefabricated unit panel of claim 14, wherein the lining sheet comprises a first layer of a first colour and a second layer of a second colour.

17. The prefabricated unit panel of claim 14, wherein the extension comprises an engagement hole for receiving a securing means.

18. The prefabricated unit panel of claim 14, wherein the lining sheet comprises a through hole matching the engagement hole.

19. A method of making a side wall for a sectional panel tank of claim 1, comprising:

- 5 providing a first unit panel having an extension at its edge as a first extension;
 providing a second unit panel having an extension at its edge as a second extension;
 directly joining the first unit panel and the second unit panel together via a securing means at the first extension and the second extension; and
10 applying a jointer at a seam between the first extension and the second extension on inner sides of the first unit panel and the second unit panel.

20. The method of claim 19, comprising attaching a lining onto the inner sides.

- 15 21. The method of claim 20, wherein the attaching the lining comprise a thermoforming process.

22. The method of claim 19, wherein applying the jointer by a thermoplastic welding process.

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23. The method of claim 22, wherein the thermoplastic welding process is conducted by a mechanical welding means, a thermal welding means, an electromagnetic welding means, a chemical welding means or a combination of any of these.

24. A method of making a prefabricated unit panel for the sectional panel tank of claim 1, the method comprising

providing a structural panel having an extension;

providing a lining sheet substantially larger than the structural panel; and

5 attaching the lining sheet onto an inner side of the structural panel;

wherein the lining sheet covers the extension of the structural panel substantially.

25. The method of claim 24, further comprising attaching a thermal insulation layer
10 onto an external side of the structural panel for reducing temperature fluctuation.

26. The method of claim 25, wherein the attaching step comprises a thermoforming process for bonding the lining sheet and the structural panel tightly into a unitary component.

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27. The method of claim 26, wherein the thermoforming process comprises a vacuum forming process.

28. The method of claim 27, wherein the vacuum forming process comprises

20 aligning the lining sheet over the inner side of the structural panel;

heating the lining sheet to be pliable for deformation; and

forming the lining sheet to the inner side for bonding the lining sheet and the structural panel by a negative pressure.

29. The method of claim 27, further comprising applying a thermal insulation layer between the lining sheet and the inner side of the structural panel.

30. The method of claim 19, wherein the jointer is applied by a solvent welding method.