Claims

[Claim 1] Fibre-reinforced polyurethane/polyisocyanurate foam block (20) of a thermal insulation body (30) of a sealed and thermally insulating tank, the density of the fibre-reinforced foam block (20) being between 30 and 300 kg/m^3, the fibre-reinforced polyurethane/polyisocyanurate foam block (20) exhibiting a mean density of fibres T_f of between 1% and 60% by weight of fibres (10), and exhibiting a width L of at least ten centimetres, advantageously of between 10 and 500 centimetres, and a thickness E, from the lower face of said block (20) up to its upper face, of at least ten centimetres, advantageously of between 10 and 100 centimetres, the fibre-reinforced polyurethane/polyisocyanurate foam block (20) being composed of cells storing a gas, advantageously having low thermal conductivity, characterized in that:

- the foam block (20) comprises, along its thickness E, two peripheral zones (21, 22), one said to be upper (21), extending from the upper face of the block (20), and the other said to be lower (22), extending from the lower face of the block (20), these two zones (21, 22) each representing at most 20% along the thickness E of the block (20) and being separated by a zone said to be intermediate (23); and
- the peripheral zones (21, 22), upper (21) and lower (22), respectively exhibit a density of fibres $T_{f\ upp.}$ and $T_{f\ low.}$ such that: $2/3 \leq (T_{f\ upp.} / T_{f\ low.}) \leq 3/2$; and
- the density of fibres $T_{f\ int.}$ of the intermediate zone (23) is less than the densities of the peripheral zones (21, 22), i.e.: $T_{f\ int.} < T_{f\ upp.}$ and $T_{f\ int.} < T_{f\ low.}$.

[Claim 2] Fibre-reinforced polyurethane/polyisocyanurate foam block (20) according to Claim 1, in which the two abovesaid peripheral zones (21, 22) each represent at most 10% along the thickness E of the block (20).

[Claim 3] Fibre-reinforced polyurethane/polyisocyanurate foam block (20) according to Claim 1 or 2, in which the intermediate zone (23) comprises a central zone (26), surrounded by two median zones (24, 25), representing at most 20% along the thickness E, preferably at most 10% along the thickness E, the density of fibres $T_{f\ cen.}$ of this central zone (26) being at least one and a half times greater than that of the median zones (24, 25) $T_{f\ med.}$, i.e. $T_{f\ cen.} \geq 1.5\ T_{f\ med.}$.

[Claim 4] Fibre-reinforced polyurethane/polyisocyanurate foam block (20) according to Claim 3, in which the density of fibres $T_{f\ cen.}$ of this central zone (26) is defined with respect to the density of fibres $T_{f\ upp.}$ and $T_{f\ low.}$ of the peripheral zones (21, 22), upper (21) and lower (22), such that $0.5 \leq T_{f\ cen.} /(T_{f\ low.}$ or $T_{f\ upp.})$

[Claim 5] Fibre-reinforced polyurethane/polyisocyanurate foam block (20) according to one of the preceding claims, in which the density of the fibre-reinforced foam block (20) is between 50 and 250 kg/m^3, preferably between 90 and 210 kg/m^3.

[Claim 6] Fibre-reinforced polyurethane/polyisocyanurate foam block (20) according to any one of the preceding claims, in which at least 60%, preferably at least 80%, of the abovesaid cells storing a gas, advantageously having low thermal conductivity, exhibit a shape elongated or stretched along an axis parallel to the axis of a thickness E of the fibre-reinforced polyurethane/polyisocyanurate foam block (20).

[Claim 7] Fibre-reinforced polyurethane/polyisocyanurate foam block (20) according to any one of the preceding claims, in which the fibres consist of glass fibre or of basalt fibre, preferably of glass fibre.

[Claim 8] Fibre-reinforced polyurethane/polyisocyanurate foam block (20) according to any one of the preceding claims, in which the fibres are long to continuous fibres.

[Claim 9] Fibre-reinforced polyurethane/polyisocyanurate foam block (20) according to any one of the preceding claims, in which the mean density of fibres T_f is between 2% and 25%, preferably between 6% and 20%.

[Claim 10] Fibre-reinforced polyurethane/polyisocyanurate foam block (20) according to any one of the preceding claims, in which the lower face and/or the upper face (41), preferably the upper face (41), of said block exhibits(s) anchorings (40) capable of engaging with an engaging means of the thermal insulation body (30) in order to anchor the foam block to said body (30), preferably said anchorings (40) being made of a different material from the foam or from the fibres.

[Claim 11] Sealed and thermally insulating tank (71), said tank (71) consisting of:

- a tank integrated in a supporting structure comprising a sealed and thermally insulating tank comprising at least one sealed metal membrane composed of a plurality of metal strakes or metal plates which can comprise corrugations and a thermally insulating body (30) comprising at least one thermally insulating barrier adjacent to said membrane, or
- a tank of type A, B or C according to the definition given by the IGC Code comprising at least one thermally insulating body (30),
characterized in that the thermally insulating body (30) comprises a plurality of fibre-reinforced polyurethane/polyisocyanurate foam blocks (20) according to any one of the preceding claims.

[Claim 12] Ship (70) for the transportation of a cold liquid product, the ship comprising at least one hull (72) and one sealed and thermally insulating tank (71) according to Claim 11, positioned in the hull or mounted on said ship (70) when said tank (71) is of the type A, B or C according to the definition given by the IGC Code.

[Claim 13] Transfer system for a cold liquid product, the system comprising a ship (70) according to the preceding claim, insulated pipes (73, 76, 79, 81) arranged so as to connect the tank (71) installed in the hull of the ship to a floating or onshore storage unit (77) and a pump for driving a flow of cold liquid product through the insulated pipes from or to the floating or onshore storage unit to or from the ship (70).

[Claim 14] Process for loading or unloading a ship (70) according to Claim 12, in which a cold liquid product is conveyed through insulated pipes (73, 76, 79, 81) from or to a floating or onshore storage unit (77) to or from the ship (71).

[Claim 15] Process configured ~~for~~ to ~~the~~ prepar~~e~~ation ~~of~~ the ~~a~~ fibre-reinforced polyurethane/polyisocyanurate foam block (20) of ~~a~~ the thermal insulation body of ~~a~~ the sealed and thermally insulating tank according to one of Claims 1 to 10, characterized in that it comprises the stages:
a) of mixing (12) chemical components necessary for obtaining a polyurethane/polyisocyanurate foam, said components comprising reactants for obtaining polyurethane/polyisocyanurate, optionally at least one reaction catalyst, optionally at least one emulsifier, and at least one blowing agent,

b) of impregnation, by gravitational flow of the abovesaid mixture (12) of chemical components, of a plurality of fibre reinforcements (10), said fibre reinforcements being positioned in superimposed layers and exhibiting variable densities of fibres, in which the fibre reinforcements (10) extend essentially along a direction perpendicular to the direction of said gravitational flow,

c) of formation and of expansion of the fibre-reinforced polyurethane/polyisocyanurate foam,

in which the expansion of the fibre-reinforced polyurethane/polyisocyanurate foam is said to be by free expansion, i.e. without the constraint exerted by a volume of closed section on at least one face, preferably the upper face, or in which the expansion of the fibre-reinforced polyurethane/polyisocyanurate foam is physically constrained by walls of a double belt laminator, preferably is physically constrained by the walls of a double belt laminator forming a tunnel of rectangular section with a distance between the walls positioned laterally equal to L and a distance between the walls positioned horizontally equal to E, thus enclosing the expanding fibre-reinforced foam so as to obtain the abovesaid fibre-reinforced polyurethane/polyisocyanurate foam block (20).

[Claim 16] Process configured ~~for~~ to ~~the preparation~~ prepare ~~of a~~the fibre-reinforced polyurethane/polyisocyanurate foam block (20) according to Claim 15, in which, in the case where the expansion of stage c) is carried out by free expansion, one at least of the peripheral zones (21, 22), preferably the upper zone (21), is formed independently and fixed, once a cutout on at least the free expansion face has been carried out, to form said foam block (20).