

DEVICE FOR FREEZING, TRANSPORTING AND THAWING FLUIDS

FIELD OF THE INVENTION

This invention relates to a device for freezing,
5 transporting and thawing fluids, in particular sterile
fluids, solutions and suspensions for the chemical,
biotechnological, pharmaceutical and food industry, of
the type defined in claim 1 and a method of thawing such
fluids as defined in claim 10.

10

BACKGROUND OF THE INVENTION

Increasing globalisation of production processes used for
production in the chemical, pharmaceutical and
biotechnological industry but also in the food industry
15 have placed more and more demands on the logistics involved
in storing and transporting product stages, e.g. from cell
cultures, for downstream processing. In order to deal with
this problem, it has become increasingly necessary to
freeze smaller or larger batches of liquid intermediate
20 and/or end products and transport the frozen batches.
Various devices suitable for this purpose are known from
the prior art, which comprise a container with a
freeze-thaw unit, by means of which batches of a few to
several hundred litres can be frozen.

25

For example, patent specification US 5,524,706 discloses
a device with an upright cylindrical container with a
funnel-shaped base with a central outlet orifice. The
container wall and base are of a double-skin design and
30 coolant flows through them during the freezing process.
In order to ensure gentle and uniform freezing, a plurality
of cooling elements is provided in the container. The
cooling elements are hollow cylinders, the diameters and

lengths of which are adapted to one another so that they are disposed concentrically with one another and extend through the container interior respectively from a top region, which predefines the maximum filling level, to approximately the base. The distance of the cooling elements from the container base and of the cooling elements from one another is the same overall. Coolant can be fed in and out of top-end pipes connecting all the cooling elements via a single inlet pipe and outlet pipe on the top face of the lid. For thawing purposes, an appropriately warm medium is fed through the cooling elements and once the container contents have completely thawed, the container is emptied via the central bottom outlet orifice in the region of the deepest point of the container. Since the cooling elements disclosed in US 5,524,706 occupy a large part of the container volume and have a very large surface area, freezing and thawing is quick and gentle and does not require additional process steps. For economic reasons, however, it is very desirable to reduce the size of the cooling elements massively in order to save on costs and increase the usable volume of the container.

The applicant has developed a freezing and transport device for which the freezing process was quantified in terms of temperatures and phase transitions on the basis of time and location. The device, known under the brand name FreezeContainer®, is illustrated in Figures 1a and 1b and, with a scalable volume of up to 300 litres, offers a whole series of advantages. The weight of the device is more than 10% less than is the case with other known devices. FreezeContainer® has an optimal sterile design with very good CIP properties. The design of the cooling elements

ensures a phase transition that is homogenous in time throughout the kettle volume, which in turn guarantees short process times. Apart from these advantages, the general design of the device is sufficiently variable to enable the FreezeContainer® to be integrated in complex production procedures and thus fulfil the high demands placed on it by the pharmaceutical industry in terms of functional and process reliability.

- 10 For thawing purposes, a warm medium is fed through the container wall, container base and the cooling coil. The thawing process is preferably assisted by shaking the container lightly.
- 15 The closed container is filled with fluids, in particular sterile fluids, solutions and suspensions for the chemical, biotechnological, pharmaceutical and food industry, hereafter referred to as product, from the top via an inlet pipe mounted in the cover. The inlet pipe opens exactly
- 20 above a central outlet orifice at the deepest point of the base so that the product can be drawn off through the base outlet or via the inlet pipe once it has completely thawed.
- 25 In order to increase the already high degree of functional versatility and process adaptability still further, it is desirable to be able to pump the product in circulation during thawing, which is not possible with the existing device.

30

SUMMARY OF THE INVENTION

Accordingly, the objective of this invention is to propose a device for freezing, transporting and thawing fluids,

in particular sterile fluids, solutions and suspensions for the chemical, biotechnological, pharmaceutical and food industry, which does not have the disadvantages of the known devices and which permits a maximum amount of operating options. Another objective of the invention is to propose a device and a method whereby the frozen product can be thawed more rapidly and gently than in the past whilst simultaneously facilitating mixing of the thawed substrate.

10

These objectives are achieved by a device as defined in claim 1 and a method as defined in claim 10, by means of a heated immersion pipe which thaws at an early stage and therefore enables thawed and preferably pre-heated product to be pumped in circulation, i.e. drawn off and recirculated, during the entire thawing process. The disadvantages of the known methods are avoided and more rapid thawing is achieved.

20

The new device proposed by the invention has at least one immersion pipe which has an active thermal connection to the heat exchanger elements at least across a part-region of its longitudinal extension, which preferably extends from approximately a deepest point of the container as far as a maximum filling level. The maximum filling level is the filling level to which the container can be filled with product to be frozen and then thawed on a controlled basis. It is primarily defined by the position of the heat exchanger elements, making allowance for the expansion in volume caused by changes in density. In the case of the embodiments described below, it is between a top container edge and top portions of the heat exchanger elements. The immersion pipe is preferably in direct

30

contact with at least one heat exchanger element and can be passively heated. During thawing, liquefied product can be drawn off from at least one heatable immersion pipe, which in turn preferably extends through the container interior from above and opens above a deepest point of the base. The heatable immersion pipe has an advantage over the known devices, in which the inlet pipe is disposed freely in the container interior and hence freely in the frozen product, because the frozen product thaws very rapidly in the interior of the immersion pipe and the process of drawing off the thawed liquid product is blocked only during an initial phase of the thawing process. Whilst it is being drawn off, the thawed product is also gently heated as it passes through the heated immersion pipe so that it can be discharged at a temperature significantly above freezing point, preferably from above, onto parts of the product still frozen and accelerates the thawing process. In a preferred embodiment of the invention, return pipes are provided on the internal face of the container lid for this purpose.

Heating the thawed product in the immersion pipe as it is drawn off offers a significant advantage over drawing it off from an outlet orifice in the base. In the case of a device of the type known from US 5,524,706, the thawed product is drawn off through the bottom outlet and the product is at a temperature that is only just above freezing point. When this cold product is pumped through the filler neck onto the still frozen product, this barely accelerates the thawing process. In the case of the invention, the product pumped onto the still frozen parts is now pre-heated, which significantly speeds up the thawing process. Furthermore, drawing off the thawed product

through the outlet orifice in the base is technically a disadvantage in terms of conductance.

Another advantage of the new device resides in the fact
5 that the distance which the liquid product must travel
as it is being pumped out of the container can be kept
very short because it does not have to be directed from
the outlet in the base to the inlet in the lid of the
container. This obviates the need for undesirable pipes
10 on the outside of the container on the one hand and
discharging and emptying as well as pumping conveniently
take place from the top of the new device on the other
hand, because all connectors can be disposed in the lid
or at least in a top region of the container.

15

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the stirrer proposed by the
invention will be described below with reference to the
20 appended drawings. Of these:

Fig. 1a shows a longitudinal section through a
freeze-thaw container based on the prior art
with a cooling element in the interior of the
25 container and a base outlet;

Fig. 1b is a side view of the container illustrated in
Figure 1a, in which an inlet pipe may be seen,
the fittings disposed in the interior being
30 shown by broken lines;

Fig. 2a is a longitudinal section through a
container of a device based on an embodiment

d

of the invention, in which a cooling element and an immersion pipe are illustrated although not in section;

5 Fig. 2b is a view from above at an angle showing an immersion pipe based on one embodiment, actively co-operating with a cooling coil, where only the parts which lie in the interior of a container are illustrated;

10

 Fig. 3 is a longitudinal section through a device based on another embodiment of the invention with an immersion pipe extending on the walls, and again a cooling element is illustrated but
15 not in section;

15

 Fig. 4 is a side view of a device based on another embodiment of the invention, in which the internally lying fittings are illustrated by
20 broken lines;

20

 Fig. 5a is a view from below at an angle showing a lid of a device illustrated in Figure 2 with cooling, immersion and return elements mounted
25 on the lid; and

25

 Fig. 5b is a side view of the lid and cooling, immersion and return elements illustrated in Figure 5a.

30 **DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

Figure 1a is a longitudinal section illustrating a freeze-thaw container B designed by the applicant. As

explained above, this container is known from the prior art under the name of FreezeContainer. The container B can be closed and sealed by means of a top lid BD. Together with a bottom base BB and a side wall BS, the lid BD defines an interior I of the container B, in which a cooling coil KS is disposed. As indicated in Figure 1a, the cooling coil is connected so as to communicate with the double-skin inner container wall by means of an isolated cooling pipe KL. Coolant fed in through an appropriate inlet pipe AM to the double-skin container wall BW, flows through the container wall BW and base BB via the cooling pipe KL and is then directed through the cooling coil KS. It will be clear to the person skilled in the art that technically reversible processes of freezing and thawing can be effected using the device illustrated in Figure 1 and with other similar generic devices on which the invention is based. For the sake of simplicity, therefore, the essential elements of the devices will primarily be described in the context of cooling. Where cooling elements, cooling coils and similar elements are mentioned below, it is clear that these heat exchanger elements are suitable not only for circulating a cold medium or a medium used during a freezing process, but also for circulating and co-operating with a warm medium during the thawing process.

25

The geometry of the cooling coil KS is designed to produce an optimum sequence of temperatures and phase transitions in time and locally in the container interior I and is connected to a plurality of vertically extending portions E_v , which are each mutually connected via top, respective bottom horizontal portions E_H . Whilst the top and bottom horizontal portions E_H respectively lie more or less in one plane, a vertical portion E_z disposed centrally in

30

the container extends farther down into the container to just short of a deepest point. This ensures that the region directly above a central outlet orifice A in the container base BB is thawed early during the thawing process. This
 5 has proved to be of particular advantage because it is very difficult to provide heat exchanger elements in the region of the base outlet. The top horizontal part-pieces EHO facing the lid BD extend in a region just below the maximum filling level FH of the container B, respectively
 10 define the maximum filling level. The vertical part-pieces at the beginning and at the end of the cooling coil extend through the container lid BD and are respectively connected to a coolant inlet ZM and to the cooling pipe KL and thus indirectly to the outlet AM.

15

The freeze-thaw container B illustrated in Figure 1 with a usable capacity of 300 litres is of an essentially cylindrical shape with a central longitudinal axis L. Freeze-thaw containers B of the generic type usually have
 20 a capacity of a few to several hundred litres.

Figure 1b is a side view of the freeze-thaw container B illustrated in Figure 1a, rotated by 90° , in which an inlet pipe ZR may be seen, connected so as to establish a
 25 communication from the lid top face to more or less the deepest point in the interior I of the container B. Extending through the inlet pipe ZR between two vertical portions E_v and more or less at an equal distance from them is a top vertical pipe-piece ZV. Above a bottom
 30 horizontal portion E_{HU} , it bends down and is directed by means of a portion ZS lying at an angle as far as the deepest point T of the container B, where it opens through an orifice ZO.

The container B is preferably filled with the product to be frozen through the inlet pipe ZR in the closed state, i.e. with the lid fitted. Once the desired filling level is reached, an appropriate inlet valve at the upper end of the inlet pipe is closed and the cooling process initiated by circulating cold medium through the cooling circuit which, in addition to the cooling coil and the container wall and container base, additionally comprises at least one pump, not illustrated in the drawing, and a cooling unit or coolant reservoir, also not illustrated in the drawing, until the product in the container interior has been completely frozen on a controlled basis and the minimum temperature desired for storage or transport has been reached. In this state, the product, which is also disposed in the interior of the inlet pipe ZR, is frozen and the latter blocked. For thawing purposes, a warm medium is circulated through the circuit and in order to accelerate the thawing process, the container, which is mounted on a base stand P, is lightly shaken. The deeply extending, central vertical piece EZ ensures that the region above the central outlet orifice is thawed relatively quickly. Although the inlet pipe ZR opens exactly into this region, the thawed product can not be drawn down until the entire volume of the inlet pipe has thawed. As briefly explained above, this is not achieved until practically all the product has thawed. Thawed product can be drawn off relatively early during the thawing process through the bottom central outlet orifice A, which communicates via an outlet pipe AL with an outlet connector AA in an end face of the base stand P. However, since the known container does not have any means of recirculating this liquefied product, it can not be pumped

back round. Furthermore, the product contained above the bottom central outlet orifice A is still very cold and would barely have the effect of assisting the thawing process if it were recirculated through the container interior.

Figure 2 illustrates a preferred embodiment of the freeze-thaw device 1 proposed by the invention, which is based on the freeze-thaw container B described above. As illustrated in the longitudinal section shown in Figure 2a, a new feature in the form of an immersion pipe 60 is provided in the freeze-thaw container 10. At a first end above a lid 20, the immersion pipe is preferably provided with a fitting 64 comprising an inlet connector 65 and an outlet connector 66 and co-operating valves 67, 68 and a shut-off valve 69. From the fitting 64, the immersion pipe 60 extends downwards by means of a first vertical portion, runs through the lid 20 and is then run above a lid bottom edge 21 with a slight gradient via a radial part-piece 52 to the centre of the more or less cylindrical container interior 11. On reaching the container longitudinal axis L, the immersion pipe 60 then bends downwards and extends by means of a second central vertical piece 63 along the central axis L to more or less the deepest point of the container interior, where it opens through an orifice 63'. More or less along the entire course of the longitudinal axis L, the immersion pipe 60 is concentrically surrounded by a coaxially extending vertical part-piece 51 of a cooling element. In terms of design, the other portions of the cooling element conform to the essentially tried and tested shape used for the applicant's known FreezeContainers described above. The wall 30 and base 40 of the container 10 are also based

on the known double-skin design and contribute to the heat exchange process. The advantage achieved by the invention as a result of the new technical feature is that the portion of the immersion pipe 60 disposed between the container base 30 and the maximum filling level $F_{\max}$ establishes an optimum active communication with the heat exchanger element extending freely through the container interior, namely the cooling coil 50.

During pumping, the disposition of the immersion pipe and cooling coil and/or other heating elements ensures that the lumen of the immersion pipe thaws very quickly after the start of circulating warm medium through the circuit. The thawed product, which in turn collects at the deepest point of the container, can be drawn off upwards through the immersion pipe 60 at an early point during the thawing process. The second, extremely advantageous effect is that the still very cold liquefied product is heated as it is conveyed through the central part-piece 63 because warm medium is flowing round its entire circumference.

The central part-piece 63 of the immersion pipe preferably forms the inner wall of the hollow cylindrical part-piece 51 of the cooling coil so that the immersion pipe and cooling coil are integrally connected to one another in a "pipe in pipe" arrangement and the immersion pipe is integrated in the region of the cooling element that is directly thermally active. A lowermost part-piece 63' of the immersion pipe is no longer surrounded by the vertical part-piece 51 of the cooling coil and extends down out of it by a few centimetres. The lowermost part-piece 63' can be very easily adapted to the size of the container 10 by cutting it to a length that will ensure that the

bottom opening of the immersion pipe still lies at the desired short distance of preferably 5 mm but at least 1 mm from the container base or lies in the base via a bottom outlet orifice, including in the warm state (e.g. during thawing and pumping). For example, existing devices can be retro-fitted with the combination of cooling element and immersion pipe proposed by the invention, as illustrated in Figure 2b with the portions lying underneath the lid, and the length of the immersion pipe can be readily and exactly adapted on site. The loss of product which can not be drawn out of the container can be easily minimised as a result. In the advantageous embodiment of the invention illustrated in Figure 2b, the immersion pipe has an internal diameter of 18.1 mm and a wall thickness of 1.6 mm. The central part-piece 51 of the cooling coil has a diameter of 42.4 mm in the case of a container with a usable volume of 300 litres for example, and the remaining portions of the cooling coil have a diameter of 21.3 mm respectively. The free flow cross-section in the cooling coil is therefore kept approximately the same in all part-pieces as a result. The individual part-portions of the immersion pipe and cooling coil are preferably made from austenitic steel, for example 4435/316L, and Hastelloy, and welded to one another orbitally and manually using a Tungsten Inert Gas (TIG) process. In order to make manufacture of the "pipe in pipe" solution as efficient as possible and to ensure that it can be cleaned without any difficulty, it has proved to be of advantage if a top inlet point of the central part-piece 63 of the immersion pipe 60 into the central vertical piece 51 of the cooling coil 50 and an appropriate bottom outlet orifice are closed by means of an annular stopper 53. The heat exchange medium is fed to and/or away from the central, vertical part-piece

51 of the cooling coil 50 via a top horizontal part-piece 56 and a bottom inclined part-piece 57, respectively disposed in the immediate vicinity of the respective ends of the vertical part-piece 51 and open laterally into it.

5

The immersion pipe and cooling coil may also be manufactured in two pieces and inserted one in the other so that the immersion pipe wall comes into contact with an internal wall of the central part-piece 51. The one-piece design may be used for containers that will be used more than once because it is significantly easier to clean.

The thawing process and the drawing-off of thawed product will be described below with reference to Figure 2a. It is assumed that the freeze-thaw container 10 is filled with frozen product to a maximum filling level F_{MAX} . When warm medium is now directed through the cooling coil, the substrate S in the active region WB of the heat exchanger elements, i.e. in the active region of the cooling coil and the double-skin container wall and double-skin container base, is thawed, preferably gently and slowly.

As indicated in Figure 2a, the parts of the cooling coil disposed low down, namely the bottom inclined radial piece 57 of the cooling coil and the bottom region of the central part-piece 51, ensure that the product on and around the deepest point of the container thaw very quickly during the thawing process. Within the meaning of the invention, the lumen of the central portion 63 of the immersion pipe 60 is one of the first regions in the container interior to become free of ice. The thawed product, which collects at the deepest point of the container 10, can therefore

be drawn off from the container 10 at a very early stage of the thawing process. As it is conveyed further upwards through the central immersion pipe portion, the liquefied product is heated and, when valves 69 and 68 are open, fed via the outlet connector 66 of the fitting 64 to a fluid conveyor unit not illustrated in the drawings, preferably a conveyor or a pump. The pre-heated product is conveyed by the latter through a return line 70, as illustrated in Figure 5 with its parts on the lid top face and on the lid bottom face, back into the interior of the container 10. In the side view onto said lid/cover 20 illustrated in Figure 5b, the conveyor means (for example a pump) and the pipes connecting the outlet connector 66 of the immersion pipe fitting 64 and an inlet connector 71 above the lid to one another are not illustrated. When valve 72 is open, the heated product is fed back into the container via the return line 70, which extends through the lid 20 by means of a vertical piece 73 and a downwardly angled leg 74. A terminal outlet orifice 75 of the tubular leg 74 opens laterally onto a vertical part-piece of the cooling coil above the level defined by the maximum filling level F_{MAX} . As it is pumped round, the pre-heated product is directed onto the frozen product surface from above and thus assists the thawing process from above. The position of the outlet orifice 75 of the tubular leg 74 is such that the circulated product is directed onto the vertical part-piece of the cooling coil. This significantly reduces the formation of foam as the product is being pumped round.

30

The combination of removing and pre-heating thawed product with an immersion element 60 proposed by the invention and recirculating it via the direct return line 70 at an

early point in time at which a major part of the product in the interior 11 of the container 10 is still frozen leads to rapid and gentle thawing.

- 5 Instead of running the immersion pipe through the central part-piece of the cooling coil as described above, it is run in an alternative arrangement, as illustrated in Figure 4, in another advantageous embodiment of the invention. In this instance, the immersion pipe 60' extends through
10 a part-piece 51' of a cooling coil 50' running parallel in an upper region between the container wall 40 and longitudinal axis L and inclined towards the deepest point of the container 10 in a bottom region. This construction again ensures that the immersion pipe is concentrically
15 surrounded by the expediently adapted part-piece 51' of the cooling coil 50' along the entire distance from the deepest point of the container to the maximum filling level.
- 20 In other embodiments, the immersion pipe surrounds the cooling coil so that the immersion pipe lies on the outside in the "pipe in pipe" construction and is cooled or heated by the internally lying part-piece of the cooling coil. These embodiments are less preferred in terms of heat
25 conduction. The same applies to embodiments in which the immersion pipe and a co-operating part-piece of the cooling coil are designed as mutually abutting half-pipes, since this also results in poorer flow dynamics.
- 30 Figure 3 illustrates another embodiment in which an immersion pipe 80 is actively connected to a double-skin container wall 40' and a double-skin container base 30' rather than to a cooling coil KS. To avoid making it more

difficult to clean the container interior, the immersion pipe 80 is completely recessed into the wall 40' and base 30' and opens by means of a bottom orifice 81 in the region of the deepest point of the container 10', preferably in a central, bottom outlet orifice 31' in the base 30'. In the top region of the container wall 40', the immersion pipe runs to the outside and establishes a connection communicating with the container interior via a lateral connector 82. In order to avoid adversely affecting the flow of heat exchange medium in the container wall and base, the immersion pipe may also be run along the external faces of the double-skin container wall 40' and double-skin container base 30', in other words essentially in the insulation casing 12.

15

The inventive idea of placing an immersion pipe in active communication with heat exchanger elements is not restricted to the elements specifically described and illustrated in the drawings so far and instead, can be used with a plurality of other elements. Freeze-thaw elements with heat exchangers disposed in a spiral shape may be placed in active communication with an immersion pipe for drawing off and pre-heating product, as well as plate-shaped or star-shaped heat exchanger elements.

25

The decisive factor is that a thermal connection exists between the heat exchanger element and at least the portion of the immersion pipe which lies in the region of the frozen product, namely approximately from the deepest point of the container as far as the maximum filling level, respectively where it is filled with it in the frozen state. A direct contact between the immersion element and the heat exchanger element based on the "pipe in pipe" design

30

and the "pipe in wall" design described above is not absolutely necessary but is of advantage.

5 The technical teaching of the invention may also be used for disposable devices, which are becoming increasingly popular as they are particularly economic in the CIP/SIP sector due to reduced costs. In the case of such "single-use" devices, the entire device may be made from appropriate plastics in a genuine disposable version. In 10 another embodiment, the thermally passive parts, in other words essentially the base, lid and wall of the container and the immersion pipe, may be made from plastic as "disposables", whilst the heat exchanger elements are made from metal and are removed from the container after use, 15 cleaned and re-used.

Figure 5 illustrates a spray pipe 90, which is used for cleaning/CIP the container interior with its fittings. Cleaning solution is fed in via a connector 91 which, in 20 the embodiment illustrated as an example, is sprayed by spray heads fitted to the ends of two spray pipes. The fact that the cooling coil and immersion pipe are free of fins, components and baffle plates with a large surface area means not only that the surfaces to be cleaned, but 25 also the spray blind spots are reduced to a minimum. This also contributes to the fact that cleaning and CIP/SIP of the device proposed by the invention is extremely simple and efficient.

30 In another embodiment, the immersion pipe, which essentially corresponds to that illustrated in Figure 1b in terms of dimensions and positioning on the inlet pipe ZR in a device, can be electrically or inductively heated.

For the electrical variant, heating wires, coils and other elements are preferably disposed in the wall of the immersion pipe isolated from the product and environment. For the inductive variant, at least major portions of the immersion pipe are preferably made from ferromagnetic material. Since a voltage source is necessary for electrically heating the immersion pipe and an appropriately strong magnetic source is needed for inductive heating, both variants are used under specific conditions only.

List of references

	A	Outlet orifice
	AA	Outlet connector
	AL	Outlet pipe
5	AM	Coolant outlet
	B	Freeze-thaw container
	BB	Base
	BD	Lid
	BW	Wall
10	E_{Ho}	Top horizontal portions
	E_{Hu}	Bottom horizontal portions
	E_v	Vertical portions
	E_z	Central portion
	F_{MAX}	Maximum filling level of the container
15	I	Interior
	KS	Cooling coil
	KL	Cooling pipe
	L	Container longitudinal axis
	P	Base stand
20	T	Deepest point of the container
	ZM	Coolant inlet
	ZO	Orifice
	ZR	Inlet pipe
	ZS	Inclined portion of the ZR
25	ZV	Vertical inlet pipe piece
	1, 1', 1"	Device
	10, 10', 10"	Freeze-thaw container
	11	Container interior
	12	Insulation
30	20	Lid of B
	30, 30'	Base of B
	31'	Bottom outlet orifice
	40, 40'	Wall of B

	50	Cooling element
	51	Vertical part-piece
	52	Radial part-piece
	53	Stopper
5	54	Inlet, inlet port
	55	Outlet, outlet port
	56	Top horizontal part-piece of the cooling coil
	57	Bottom inclined radial piece
	60, 60'	Immersion element, immersion pipe
10	61	Top vertical part-piece
	62	Top horizontal part-piece
	63	Vertical part-piece
	64	Fitting
	65	Inlet connector
15	66	Outlet connector
	67, 68, 69	Valves
	70	Return line
	71	Inlet connector
	72	Valve
20	73	Valve piece
	74	Tubular leg
	75	Outlet orifices
	80	Immersion pipe
	81	Bottom orifice
25	82	Connector (immersion pipe)
	90	Spray pipe
	91	Spray pipe connector

CLAIMS

- 1 Device for freezing, transporting and thawing fluids, in particular sterile fluids, solutions and suspensions for the chemical, biotechnological, pharmaceutical and food industry, with a container comprising a lid, a wall and a base, and at least one heat exchanger element actively communicating with the fluids with which the container is filled so that they can be cooled or heated, characterised in that an immersion pipe is actively connected to at least one heat exchanger element via at least a part-region of its longitudinal extension and that a return line is provided on the container in a region above the maximum filling level (F_{MAX}), preferably in the lid, so that a fluid liquefied during a thawing operation and fed off via the immersion pipe from the deepest point of the container and pre-heated can be pumped via the return line onto still frozen fluid from above.
- 2 Device as claimed in claim 1, characterised in that the immersion pipe establishes a connection communicating between a first bottom orifice in the region of a deepest point in the interior of the container

and a top-end second orifice disposed at the container or at the lid.

- 3 Device as claimed in claim 1 characterised in that the immersion pipe is in an active thermal connection with the heat exchanger element by means of a part-piece from more or less the deepest point of the container up to a maximum filling level (F_{MAX}).
- 4 Device as claimed in claim 1, characterised in that the heat exchanger element comprises a cooling coil and the immersion pipe is run coaxially in a part-piece of the cooling coil along a part-region of its longitudinal extension and is actively in thermal, preferably direct, contact with it.
- 5 Device as claimed in claim 4, characterised in that a vertical part-piece of the immersion pipe is run coaxially in a central portion of the cooling coil and along a longitudinal axis (L) in a region which extends more or less from the maximum filling level (F_{MAX}) to the deepest point of the container.

- 6 Device as claimed in claim 5, characterised in that the axial part-piece of the immersion pipe forms an internal wall of the hollow cylindrical, central portion of the cooling coil so that the immersion pipe and cooling coil are integrally connected to one another as a "pipe in pipe" arrangement in this region.
- 7 Device as claimed in claim 1, characterised in that the heat exchanger element comprises a double-skin base and a double-skin wall, and the immersion pipe is run inside or outside the base and wall across a part-region of its longitudinal extension and is in active thermal contact with them, preferably in direct contact.
- 8 Device as claimed in claim 1, characterised in that the return line extends through the lid and opens into at least one, preferably two discharge orifices above the maximum filling level (F_{MAX}) which are disposed so that the pumped fluid is directed onto top part-pieces of heat exchanger elements, preferably of the cooling coil, and reduce the formation of foam.

- 9 Method of thawing frozen fluids, in particular sterile fluids, solutions and suspensions for the chemical, biotechnological, pharmaceutical and food industries in a device as claimed in claim 1, characterised in that a warm medium is fed through at least one heat exchanger element and frozen fluid in an immersion pipe actively connected to the at least one heat exchanger element is thawed, after which thawed fluid can be drawn off from the deepest point in the interior of a container through the immersion pipe and pre-heated before it is pumped via a return line onto the fluid still contained in the container from above.