ABSTRACT

Artificial environment apparatus is provided for maintaining crustaceans live in a saline solution. The apparatus includes a receptacle for saline solution and crustaceans and an exchanger tank unit through which the solution is circulated and in which plastic refrigerant circulating tube means is disposed for maintaining the solution in the receptacle at a predetermined temperature and in an uncontaminated condition.

6 Claims, 5 Drawing Figures
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LOBSTER TANK INCLUDING HEAT EXCHANGE MEANS

This invention relates to artificial environment apparatus for sea life and, more particularly, to artificial environment apparatus for maintaining edible sea life such as crustaceans live in a saline solution.

It is well known that crustaceans such as shrimp and lobsters either caught or cultivated for consumption as food preferably are maintained live by use of artificial environment apparatus until such time as they are to be cooked or sold. Such artificial environment apparatus generally includes a receptacle or the like in which the crustaceans are retained in a saline solution similar to that of their natural environment in salt content and temperature. The desired solution temperature is generally cooler than that of the ambient temperature and thus cooling means is provided to maintain a constant predetermined solution temperature. Cooling may be achieved, for example, by refrigeration means in the form of evaporator coils surrounding the solution receptacle or, as a further example, by means of a heat exchanger unit including refrigerant coils past which the saline solution is circulated in heat transfer relationship. The latter arrangement for cooling the saline solution is preferred in that it advantageous provides for circulating movement of the solution in the receptacle, either continuously or intermittently, as opposed to having the solution dormant.

Heretofore, such solution circulating arrangements include pump means to circulate the saline solution in the receptacle past the evaporator coils of a refrigeration unit. The evaporator coils may be disposed in the solution receptacle or in a compartment adjacent thereto and through which the solution is circulated, or in a tank separate from the solution receptacle and through which the solution is circulated. In any event, the saline solution is circulated past the coils in heat transfer relationship therewith.

It will be appreciated that it is of utmost importance in an artificial environment system for crustaceans and the like that the saline solution be kept as free as possible of contaminants which can affect both the life of the crustaceans and the flavor of the latter as food. Heretofore, metal tanks and copper or other metal evaporator units have been employed in constructing artificial environment systems and these materials affect and are themselves affected by the saline solution causing metallic contaminants to be present in the solution and causing deterioration of the metallic components of the system. These undesirable conditions not only require frequent time consuming shut down of the system to permit cleaning of the coils and tank and replacement of the solution, but also require frequent replacement of the system components as a result of deterioration thereof by the saline solution. Another shortcoming of systems heretofore known lies in the fact that the various components of the system, such as the heat exchanger coils and their housing, are not readily, if at all, accessible for maintenance purposes such as cleaning, repair or replacement. Thus, after a cleaning operation, for example, certain amounts of contaminants remain on the system components, and it will be appreciated that this lends to requiring more frequent shut down of the system if an effort is made to keep the saline solution clean.

Of further importance in an artificial environment system involving circulation of saline solution past a cooling coil unit is the provision for circulation in a manner to achieve maximum heat exchange between the solution and coil unit in a minimum amount of space. In systems heretofore known, solution circulating and cooling arrangements are characterized by inefficient heat transfer relationships which result in the necessity for larger evaporator units and/or for longer periods of circulation of refrigerant through the evaporator unit to maintain a desired solution temperature. Such inefficiency is costly both from the standpoint of the expense of running the refrigeration unit and from the standpoint of the decrease in the expected life of the refrigeration unit based on operation.

The present invention advantageously overcomes the disadvantages of artificial environment systems for sea life heretofore known, including the disadvantages pointed out in particular hereinabove.

An object of the present invention is the provision of artificial environment apparatus for maintaining sea life live in a saline solution.

Another object is the provision of apparatus of the character mentioned which is inexpensive to construct, operate and maintain and which advantageously eliminates contamination of the saline solution.

A further object is the provision of apparatus of the above character in which a saline solution is circulated past heat exchanger tube or coil means and in contact therewith in a manner whereby maximum heat transfer between the solution and heat exchanger is achieved.

Yet another object of the present invention is to provide a heat exchanger tank unit for use in artificial environment apparatus of the character set forth above, which unit houses heat exchanger coils or tubing and provides for solution flow therethrough in a manner to achieve maximum contact of the solution with the coils.

Still another object is the provision of a heat exchanger tank unit for artificial environment apparatus wherein the heat exchanger coils and the housing therefor are separable to facilitate maintenance and cleaning of connected the housing and coils.

A further object of the present invention is the provision of a heat exchanger unit of the character mentioned wherein the surfaces of the housing and heat exchanger coils exposed to the saline solution are comprised of plastic material to eliminate contamination of the solution and reduce maintenance and replacement expenses.

Other objects will in part be obvious and in part more fully pointed out hereinafter.

In the drawing, disclosing a preferred embodiment of the present invention:

FIG. 1 is a perspective view of a solution receptacle, heat exchanger tank unit, refrigeration unit and solution circulating unit of the artificial environment apparatus of the present invention;

FIG. 2 is a side elevation view, in section, of the heat exchanger tank unit of the apparatus, taken along line 2—2 of FIG. 1;

FIG. 3 is a side elevation, in section, of the heat exchanger tank unit taken along line 3—3 of FIG. 2;

FIG. 4 is a plan view of the heat exchanger tank unit with the cover removed; and
FIG. 5 is a perspective view illustrating a portion of a modification of a partition component in the heat exchanger tank unit, still within the scope of the present invention.

Referring now to FIG. 1 of the drawing, there is illustrated artificial environment apparatus comprising a saline solution receptacle 10, heat exchanger means 12 and solution circulating pump means 15. Receptacle 10 is adapted to contain crustaceans and a saline solution 11, and heat exchanger means 12 is comprised of heat exchanger tank unit 13 and refrigeration unit 14. Pump means 15 may be defined by any one of many suitable solution pumping arrangements and in the embodiment illustrated includes a pump 15a driven by electric motor 15b. Heat exchanger tank unit 13 includes tank means 16 through which saline solution 11 is circulated during operation of pump means 15, in contact with heat exchanger tube means, as more fully described hereinafter. Tank means 16 includes solution inlet means connected to tube means 17 which extends into one end of receptacle 10, and solution outlet means connected to tube means 18 leading to the inlet side of pump 15a. The outlet side of pump 15a is connected to tube means 19 leading to the other end of receptacle 10. The heat exchanger tube means housed in tank means 16 is in the form of an evaporator coil section connected to refrigeration unit 14, whereby refrigerant can be circulated through the heat exchanger tube means to cool the latter in a well known manner.

In operation of the apparatus, pump means 15 operates to draw saline solution from one end of receptacle 10 through tube means 17 into tank means 16 and past the heat exchanger tube means therein and thence through tube means 18 into pump 15a and out through tube means 19 back to receptacle 10 at the other end thereof. It will be appreciated, therefore, that the solution is circulated from one end of receptacle 10 to the other, is passed through the heat exchanger tank means for cooling and is returned to the one end of the receptacle, thus to maintain the solution at a predetermined temperature. Suitable controls will, of course, be provided to control operation of the refrigeration unit 14 in accordance with temperature conditions of the solution.

Receptacle 10 preferably is constructed from wood or plastic, but metal may be used. Further, the receptacle may be provided with support means such as legs 10a to maintain the tank in an elevated position above a floor or the like to facilitate introduction or removal of crustaceans therewith. Tank means 16, refrigeration unit 14 and pump means 15 preferably are separately supported on support means, such as a wheeled stand 20. This provides for selectively positioning the tank means, refrigeration unit and pump means relative to the periphery of receptacle 10 and further provides for moving these components away from the receptacle 10 so that they are more readily accessible for cleaning, maintenance and the like. It will be clearly understood, however, that the receptacle and tank means do not have to be separable and may be suitably constructed as an integral unit, and that the refrigeration unit and pump means can, in such an instance, be permanently or separably supported relative to the receptacle and tank means. Moreover, if the tank means and receptacle are separable, as in the preferred embodiment, the refrigeration unit and pump means may be separably supported with regard to either or both tank means and receptacle 10.

With reference now to FIGS. 2, 3 and 4 of the drawing, heat exchanger tank unit 13 of heat exchanger means 12 is illustrated in detail. Tank means 16 of tank unit 13 includes a bottom wall 21, opposed pairs of upstanding side walls 22a and 22b and opposed pairs of upstanding end walls 23a and 23b. Walls 21, 22a, 22b, 23a and 23b preferably are of plastic sheet material such as polyvinylchloride and are united in water tight relationship such as by plastic welding or adhesively bonding the joints therebetween. The upper marginal edges of side walls 22a and 22b and end walls 23a 23b may be reinforced by attaching separate plastic strips 24 thereto or by providing the upper edges with integral enlarged areas corresponding in contour to the separate strips. Tank means 16 further includes a removable cover 25 which also is preferably plastic and which is adapted to be removably fastened to the upper edges of side walls and end walls by any suitable fastening means such as threaded bolt means 26 and cooperating wing nuts 26a. Bolt means 26 have the lower ends thereof suitably embedded in the plastic material of the side and end walls, or they may be threaded into apertures drilled or otherwise provided in the side walls. The upper ends of bolt means 26 project through slots or other suitable openings such as apertures 25a provided in cover 25. A sealing gasket 50, or other suitable sealing means, is provided between the upper edges of the side and end walls and cover 25 to provide against fluid leakage therebetween during use of the apparatus.

Cover 25 is provided with suitable saline solution inlet means such as opening 27 about which a plastic nipple 28 is disposed. Nipple 23 is suitably secured in fluid tight relationship with the cover such as by plastic welding or adhesive bonding and the outer end of nipple 28 is threaded so as to be releasably and separably interconnectable with inlet tube means 17 through a suitable union coupling 29, as illustrated in FIG. 1. Further, cover 25 is provided with suitable solution outlet means such as opening 30 about which a plastic nipple 31 is disposed. Nipple 31 is also secured to cover 25 in fluid tight relationship and is threaded at its outer end so as to be releasably and separably interconnectable with outlet tube means 18 through union coupling 32, as illustrated in FIG. 1. It will be appreciated that inlet and outlet lines 17 and 18 could be otherwise releasable attached to cover 25 or could be permanently attached to the cover or to nipples 28 and 31 without affecting the removability of cover 25 from tank means 16. It is most desirable, however, to have the fluid circulation lines disconnectable close to the cover to facilitate handling of the components upon removal of the cover.

Tank unit 13 further includes heat exchanger tube means 33 removably disposed in tank means 16. Tube means 33 is a continuous conduit extending in a serpentine configuration within tank means 16 and having inlet and outlet ends 34 and 35, respectively, for circulation of a refrigerant such as Freon 12 therethrough from refrigeration unit 14 and thence back to the refrigeration unit. The inlet and outlet ends 34 and 35 of tube means 33 extend through suitable openings
therefore in cover 25 and are threaded for releasable and separable interconnection with union type couplings 36 and 37 which couple the inlet and outlet ends respectively with lines 38 and 39 connected to refrigeration unit 14. Thus, it will be seen that tube means 33 can be separated from the refrigeration unit and removed from tank means 16 to facilitate cleaning and maintenance of the tube means. As pointed out momentarily hereinafter, the tube means may be connected to or may be separable from cover 25.

Tube means 33 preferably is comprised of straight plastic tube sections 40 interconnected at corresponding ends by plastic elbow components 41 in a manner to form the serpentine coil configuration. The tube means may, however, be comprised of a single continuous plastic tube bent into serpentine configuration. Further, within the present invention, the tube means may be comprised of continuous metallic tubing or metallic tubes and fittings coated with plastic material so that the portions thereof exposed to saline solution circulated through tank means 16 are plastic, thus to decrease contamination of the solution. The plastic material of the tube means may be any suitable plastic and preferably is polyvinylchloride. It will be appreciated that the plastic material is not affected reactively by the saline solution and thus, the solution remains free from contamination normally realized when metallic tubing is used. Moreover, the tubing remains unaffected by the saline solution and thus materially reduces maintenance and replacement expenses.

As pointed out hereinabove, inlet and outlet ends 34 and 35 of tube means 33 may be connected to or may be separable from cover 25. In either event, the openings in cover 25 through which the ends extend are sealed against fluid leakage along the tube ends from within tank means 16. If the tube ends are connected to cover 25, as in the preferred embodiment, sealing can be achieved by plastic welding or adhesive bonding the tube and cover joints. If, on the other hand, it is desired to have the tube means and cover separable, it will be appreciated that any suitable sealing means such as resilient annular gaskets, for example, can be disposed about the tube means between the tube surfaces and cover opening to permit tube and cover separation.

It will be readily appreciated at this point that the heat exchanger tank unit as thus far described is adapted to receive and discharge saline solution in a manner whereby the solution engages the heat exchanger tube means in heat exchange relationship, thus to cool the solution. Moreover, the circulated solution remains uncontaminated as a result of contact with the heat exchanger tube means in that the latter are plastic or plastic coated and thus do not react with the saline solution. Further, the tube means is removable from the tank means to facilitate cleaning, repair or replacement of both the tube means and tank means.

End support plates 42 and 43 preferably are disposed adjacent the ends of tube means 33 and are provided respectively with openings 44 and 45 through which the tube sections 40 extend. The bottom edges of plates 42 and 43 engage bottom wall 21 of tank means 16 and are provided with suitable openings such as V-shaped notches 46 to permit circulation of solution thereunder. Plates 42 and 43 are of plastic sheet material and serve to support tube means 33 within tank means 16.

To enhance the efficiency of the heat transfer relationship between the solution and heat exchanger tube means, partition means 47 is provided in tank means 16 and is substantially centrally disposed and parallel with respect to end walls 23a and 23b and extends between side walls 22a and 22b. Thus, the partition divides the inside of tank means 16 into inlet and outlet chambers 49 and 49, respectively. The bottom edge of partition 47 is spaced above bottom wall 21, whereby chambers 48 and 49 are in fluid flow communication. The upper edge of the partition is maintained in sealed relationship with cover 25 by means of sealing gasket 50 which may be integral with or separate from gasket 50. Tube sections 40 of tube means 33 extend through suitable openings in partition 47, whereby portion 33a of the tube means is disposed in inlet chamber 48 and portion 33b of the tube means is disposed in outlet chamber 49. This provides for solution entering inlet means 27 to first flow downwardly through inlet chamber 48 in heat exchange contact with all of portion 33a of the tube means and thence flow upwardly through outlet chamber 49 in heat exchange contact with all of portion 33b of the tube means, thus to assure maximum solution and heat exchanger tube contact and maximum efficiency in cooling the saline solution as it passes through the heat exchanger tank unit.

To further enhance the efficiency of heat transfer between the tube means and solution, a distributor plate 51 is disposed above portion 33a of tube means 33 in the upstream end of inlet chamber 48, and a similar distributor plate 52 is disposed beneath portion 33b of the tube means in the upstream end of outlet chamber 49. Plates 51 and 52 preferably are plastic such as polyvinylchloride and are disposed substantially parallel to bottom wall 21 of the tank means 16 and thus transverse to the direction of flow of solution entering inlet means 27 and leaving outlet means 30. Plate 51 extends between partition 47 and end wall 23a and between side walls 22a and 22b. Plate 52 extends between partition 47 and coil end support plate 42 and between side walls 22a and 22b. A plurality of holes 53 are provided in plate 51 for distributing inlet solution transversely across inlet chamber 48 so as to assure a more even flow of the solution downwardly past portion 33a of tube means 33. Similarly, plate 52 is provided with holes 54 to assure a more even flow of solution past portion 33b of the tube means in outlet chamber 49. Plates 51 and 52 may be suitably secured to partition 47 and the respective end plates 43 and 42, such as by plastic welding or adhesive bonding, so as to be removable from tank means 16 with tube means 33, partition 47 and end plates 42 and 43.

Alternatively, to facilitate greater access to the tube means upon removal thereof from the tank, such as for cleaning and maintenance purposes, distributor plates 51 and 52 may be supported in a manner whereby the plates can be removed from the tank, partition and end plates. In this respect, outlet chamber 49 of tank means 16 is provided with support means such as plastic strips 55 suitably secured to side walls 22a and 22b and upon which plate 52 is adapted to seat. Further, partition 47 is provided with a plastic support strip 56 upon which
one end of plate 51 rests. The opposite end of plate 51 rests on the upper edge of end plate 43. It will be appreciated from the foregoing description that in the preferred embodiment, heat exchanger tube means 33 and tank inlet and outlet nipple means 28 and 31 are detachable, respectively, from the refrigeration unit lines and solution circulating lines, and that the cover 25 can be released to provide for lifting, as a unit, the tube means 33, partition 47, end plates 42 and 43 and distributor plates 51 and 52 from tank means 16. This provides for leaving the tank free of any obstacles which would impair thorough cleaning thereof and, further, provides for the tube means to be readily accessible from all sides thereof to facilitate cleaning and maintenance operations thereon.

With regard to the removable tubing and partition section, it will be appreciated that end support plates 42 and 43 may be eliminated and the tubing means and partition 47 otherwise suitably supported within tank means 16 such as, for example, by suspension from cover 25. Further, partition 47 may be constructed to support or to cooperate with other means to support the tube means, rather than to be supported by the tube means as depicted in FIGS. 2 and 3. In this respect, the partition may be extended to engage bottom wall 21 of tank means 16, such as is illustrated by the structure of partition 57 in FIG. 5, and suitable openings such as holes 58 or notches 59 or both would be provided in the lower end thereof to interconnect the inlet and outlet chambers for flow communication. With such construction, the partition would adequately support the tube means without necessity for support means at the end turns thereof.

In operation of the system of the present invention, refrigerant, such as Freon 12, is circulated from refrigeration unit 14 through line 38 to tube means 33 and thence back to the refrigeration unit through line 39, in a well known manner, whereby tube means 33 functions as an evaporator section for the refrigerant and is cooled thereby. Saline solution, in response to operation of pump unit 15 enters tank inlet 27 and is distributed laterally thereof by plate 51 so as to flow downwardly and evenly past portion 33a of heat exchanger tube means 33 and thence under partition 47. Plate 52 then serves to laterally distribute the solution for even flow thereof upwardly through outlet chamber 49 past portion 33b of the tube means to outlet 30. During travel through tank means 16, the solution is uniformly cooled to a desired temperature and then reintroduced into the receptacle in which the crustaceans are retained.

Although considerable emphasis has been placed herein on the fact that the solution inlet and outlet means are in the cover 25, it will be readily appreciated that these openings could be provided in the side or end walls of the tank means. Moreover, it will be understood that the arrangement of tube means 33 in the tank means could be of a different form from the horizontal runs illustrated herein. In this respect, the coils could extend in serpentine or any other configuration so as to define coil portions in the inlet and outlet chambers which are interconnected by a section of tubing extending under the partition means, whereby there would be no tubing pieces extending through apertures in the partition. It will be appreciated, too, that partition 47 could be horizontally disposed in the tank means so as to divide the latter into upper and lower chambers, one of which would define the inlet chamber and the other the outlet chamber. All of these modifications are deemed to be well within the present invention.

As many possible embodiments of the present invention may be made and as many possible changes may be made in the particular embodiment described, all of the material herein set forth is to be interpreted merely as descriptive and not as a limitation.

I claim:

1. A heat exchanger tank unit for use in a fluid circulating system, said unit comprising, tank means, cover means closing off space within said tank means and removably associated with said tank means, partition means inside said tank means and partitioning off said space into fluid inlet and outlet chambers, said chambers communicating in series with one another in a fluid flow path leading from one side to an opposite side of said partition means and said heat exchanger tank unit having an inlet to said fluid inlet chamber and an outlet from said fluid outlet chamber and further including, heat exchanger tube means having first portions disposed longitudinally leading across said fluid flow path downstream in said fluid inlet chamber from said inlet and second portions disposed longitudinally leading across said fluid flow path upstream in said fluid outlet chamber from said outlet, and said heat exchanger tube means and said partition means being members of a unitary removable unit with said cover means for being removed with said cover means from said tank means, and first and second distributor plate structures, said first distributor plate structure being supported extending transversely of said partition means and having apertures spaced apart in said fluid flow path upstream in said fluid inlet chamber from said first portions of said tube means and downstream from said inlet and said second distributor plate structure being downstream in said fluid path from said first portions of said tube means and supported extending transversely of said partition means and having apertures spaced apart in said fluid flow path upstream in said fluid outlet chamber from said second portions of said tube means and upstream from said outlet for said first and second distributor plate structures to distribute fluid of fluid with reference to said first and second portions of said tube means.

2. A heat exchanger tank unit as set forth in claim 1 wherein said tank means, said cover means, said partition means, said heat exchanger tube means, and said first and second distributor plate structures, at least at surfaces to be exposed to a saline solution flowing from said outlet to said inlet in said heat exchanger tank unit, are of organic plastic.

3. A heat exchanger tank unit as set forth in claim 1 wherein said inlet and said outlet are through said cover means and said fluid inlet and outlet chambers communicate with one another in series in said fluid path leading through a passage from said one side to said opposite side of said partition means adjacent to the bottom of said tank means.

4. A heat exchanger tank unit as set forth in claim 1 wherein said heat exchanger tube means is arranged between said first and second portions thereof are attached to
said partition means, and extensions of said heat exchanger tube means from said first and second portions are attached to said cover means and are connected communicating, for said heat exchanger tube means and said partition means to be members of said removable unit with said cover means and for heat exchange fluid to be in communication with the interior of said heat exchanger tube means in passing through said cover means.

5. A heat exchanger tank unit as set forth in claim 4 wherein said inlet and said outlet are through said cover means and said fluid inlet and outlet chambers communicate with one another in series in said flow path leading through a passage from said one side to said opposite side of said partition means adjacent to the bottom of said tank means.

6. A heat exchanger tank unit as set forth in claim 5 wherein said tank means, said cover means, said partition means, said heat exchanger tube means, and said first and second distributor plate structures, at least at surfaces to be exposed to a saline solution flowing from said inlet to said outlet in said heat exchanger tank unit, are of organic plastic.

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