A shipping package for use in transportation of a temperature sensitive product. The shipping package includes layers of insulation and phase change material surrounding a payload cavity. The layers of insulation and phase change material are provided as separable panels. The panels may be inserted into an outer container in such manner that no insulation or phase change material are proximate to inner corners of the container. In one embodiment, the panels are provided in an overlapping relationship within the container so as to define corner discontinuities within the container.
FIG. 3
TEMPERATURE MAINTAINING PACKAGE HAVING CORNER DISCONTINUITIES

RELATED APPLICATIONS


TECHNICAL FIELD

[0002] The present disclosure is directed to a package for temperature sensitive product and a method of use. More particularly, the disclosure relates to a package for shipping temperature sensitive materials having corner discontinuities provided by an insulation structure and/or a phase change material structure.

BACKGROUND OF THE INVENTION

[0003] Storing and transporting temperature sensitive materials in a passive container that is easy to assemble and has the smallest number of different components is desirable. Whereas various methods have been advanced for this purpose, prior known methods are designed to employ insulation and phase change material panels that extend into the three dimensional corners of the packages’ individual layers.

[0004] Shipping packages are often tested during design or manufacturing for resistance to damage or failure. A drop test is often used to evaluate a package’s resistance to damage from free-falls. A variety of methods are known for determining the ability of fiberboard containers to protect their contents and/or to withstand impact in free-fall drops. Some of these procedures are specifically designed for controlled drop testing of solid fiber or corrugated shipping containers. The procedures often involve dropping the package at predetermined heights onto a flat, nongripping base. Multiple drop orientations can be used to evaluate corners and edges of the package. Prior passive thermal shipping containers are often unable to survive even modest drop tests. A need therefore exists for a robust passive thermal shipping container.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The present invention relates to a package and method of encasing a payload cavity with phase change material (PCM) and/or insulation, wherein discontinuities are defined at the corners of either the insulation material structure or the PCM material structure or both. In one embodiment, a payload cavity is surrounded with phase change material and insulation panels that do not extend into the three dimensional corners of the package. A package in accordance with the present invention may include multiple identical panels of phase change material layer and/or insulation layer to define a cubic form.

[0007] An embodiment of the present invention includes a package defined by an outer container which contains one or more insulation panels and one or more PCM panels surrounding a payload cavity. In one example, a void or discontinuity can be defined at corners of the insulation panels and/or PCM panels through proper sizing of multiple panels. Such a void can be located at each corner or a smaller subset of corners. These voids can be defined for both the insulation panels and the PCM panels. One embodiment of the present invention utilizes multiple panels of identical form arranged in a particular pattern to define the voids.

[0008] The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter which form the subject of the claims of the invention. It should be appreciated by those skilled in the art that the conception and specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims. The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages will be better understood from the following description when considered in connection with the accompanying figures. It is to be expressly understood, however, that each of the figures is provided for the purpose of illustration and description only and is not intended as a definition of the limits of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] For a more complete understanding of the present invention, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

[0010] FIG. 1 is an exploded perspective view of a package in accordance with the present invention.

[0011] FIG. 2 is a perspective view of the PCM structure or insulation structure defined by corner discontinuities and depicting insertion into a container structure to define a package having corner thermal discontinuities.

[0012] FIG. 3 is a perspective view of a PCM structure defined by a plurality of overlapping PCM panels.

[0013] FIG. 4 is a perspective view of a shipping package defined by a plurality of adjacent PCM panels and insulation panels.

DETAILED DESCRIPTION OF THE INVENTION

[0014] A phase change material is a substance with a high heat of fusion which, melting and solidifying at certain temperatures, is capable of storing or releasing large amounts of energy. Initially, solid-liquid phase change materials perform like conventional heat storage materials; their temperature rises as they absorb heat. Unlike conventional heat storage materials, however, when phase change materials reach a phase change temperature, i.e., melting point, they absorb large amounts of heat without a significant rise in temperature. When the ambient temperature around a liquid material falls, the phase change material cools and solidifies, releasing
its stored latent heat. Certain phase change materials store 5 to 14 times more heat per unit volume than conventional heat storage materials such as iron, masonry, or rock.

[0015] Phase change materials can be broadly grouped into two categories: “Organic Compounds”, including but not limited to propylene and/or ethylene glycols and “Salt-based Products”, including but not limited to Glauber’s salt. The most commonly used phase change materials are salt hydrides, fatty acids and esters, and various paraffins, such as octadecane. Certain ionic liquids have also been identified as promising phase change materials.

[0016] One embodiment of the present invention utilizes an efficient method of packaging realizing a reduction in the use of higher-priced phase change materials. Desirably, the packaging includes water-based phase change materials, which are among the least expensive phase change materials in current use. Water has a transition temperature close to 0 degrees C. Water-based phase change materials are often not suitable for certain temperature sensitive products. Other, generally more expensive, phase change materials may be necessary to avoid thermal damage to the temperature sensitive product. For example, red blood cells are temperature sensitive and should not be subjected to temperatures below 1 degree C. The temperature of sub-cooled water-based phase change materials may be significantly lower. As a result, if water-based phase change materials are employed, sufficient insulation is typically needed between the temperature sensitive payload and the water based phase change material.

[0017] Embodiments of the present invention may employ a second phase change material to act as a thermal buffer between a water based phase change material and the temperature sensitive payload. In one example, the second phase change material solidifies while protecting the payload from the temperature of the colder or hotter water based phase change material. In one example, the second phase change material is initially in solid form and then used as a heat sink to protect the payload from heat.

[0018] In another embodiment the thermally conditioned phase change material is heated to a temperature above the desired range of protection for the payload. In such an embodiment, the second phase change material again acts as a thermal buffer so as to maintain the payload temperature within the desired range. As a result, it is envisioned that embodiments of the present invention will be utilized to protect a payload against ambient temperatures that are hotter or colder than the payload’s desired temperature range.

[0019] Embodiments of the present invention may also protect the payload from ambient temperatures that are both colder and hotter than the desired payload protection temperature range. If the ambient temperature is colder than the desired protection temperature range during one period of the package delivery, some period of time may be necessary in order to precondition the liquid phase change materials.

[0020] The present invention also promotes efficient packaging methods for thermally acclimating phase change materials. For example, a water based phase change material can be placed into the package directly from the freezer or other suitable preparation device. For example, the phase change material can be stored in solid or liquid form and then, along with the temperature sensitive payload, be packaged without having to wait for the phase change material to arrive at a desired packaging temperature.

[0021] The present invention is also directed to a package and method for encasing a payload cavity with phase change materials and insulation. In one example, a water based phase change material is combined with another phase change material to provide thermal protection for the payload. By properly selecting the phase change materials, a package can be configured to provide maximum thermal protection for a temperature sensitive product during delivery. Employing a combination of solid and liquid phase change materials in the container can provide protection from both hotter and colder ambient temperatures during delivery, and a beneficial reduction in the amount of phase change materials can result.

[0022] With reference to FIG. 1, there is shown an exploded perspective view of a package 10 for shipping a temperature sensitive payload 12. As depicted, package 10 is prepared for transport by inserting the components and payload 12 into the outer container 14. The components of package 10 include insulation contained within or defined by insulation panels 16 and phase change material contained within separated panels 18. Six phase change material panels 18 and six insulation panels 16 are employed in the package 10 of FIG. 1. The temperature sensitive payload 12 is received within a payload cavity, defined generally as the interior volume contained within the walls of panels 18. In the illustrated embodiment, container 14 assumes a generally cubic form. Container 14 may be corrugated paper or corrugated plastic or other suitable material. Insulation panels 16 can include vacuum insulation panels and/or forms and fiber-based materials. A combination of different insulation materials may be used to form the insulation panels 16.

[0023] While panels 16, 18 are shown in rectangular form and generally define layers of insulation and phase change material, each panel 16, 18 can assume a variety of different shapes and forms in alternative embodiments of the invention. In other examples, panels 16, 18 may be shaped in relation or allowed to conform to the payload 12. Panels 18 may be defined by plastic and/or metal shells for containing phase change material therewith. Phase change material panels 18 may assume different shapes or forms in alternative embodiments. Examples of phase change material panels 18 can include HDPE containers, form fill and seal films, or any other suitable containers sized to be inserted into the package 10.

[0024] Selection of the phase change materials may include consideration of multiple factors including, but not limited to, the desired protected temperature range, anticipated ambient temperatures during shipment, thermal properties of the different phase change materials, thermal properties of the container and/or insulation panels, and thermal properties of the temperature sensitive product being shipped. The design and sizing of containers for the phase change materials and the insulation panels would vary depending on these factors as well.

[0025] Package 10 may be a thermal shipping package such as disclosed in U.S. Ser. No. 12/115,530, entitled “Package Having Phase Change Materials and Method of Use in Transport of Temperature Sensitive Payload”, filed May 5, 2008, incorporated herein by reference.

[0026] Insulation panels 16 can include vacuum insulation panels. While insulation panels 16 in the embodiment of FIG. 1 are generally rectangular in form, panels 16 can assume a variety of other shapes and forms in alternative embodiments of the invention. Similarly PCM panels 18 may assume different shapes or forms in alternative embodiments. Six generally identical PCM panels 18 are employed in the embodiment of package 10 of FIG. 1.
As shown in FIG. 2, the insulation panels 16 and/or PCM panels 18 are installed into the outer container and insulation structure in such a manner that no insulation or phase change material extends into the three dimensional corners of the insulation structure or phase change material structure. Thus, in the illustrated embodiment a plurality of voids 20 are defined at corners of the insulation structure or PCM structure. In other embodiments of package 10, voids 20 are primarily thermal discontinuities and may be vacant or filled with another material.

Through proper sizing of multiple panels, the voids 20 can be defined at corners of the package. Such a void 20 can be located at each corner or a smaller subset of corners of the insulation structure or PCM structure. These voids 20 can be defined for one or both of the insulation panel 16 structure and the PCM panel 18 structure. For example, in one embodiment only PCM panels 18 would define voids 20, while in another embodiment only the insulation panels 16 would define voids 20. In the illustrated embodiment, multiple panels 16, 18 of identical shape are arranged in a particular manner to define the voids 20. Voids 20 may remain vacant or alternatively, a different type of material can be inserted within voids 20.

FIG. 3 depicts a PCM structure 18 being defined as a plurality of overlapping PCM panels 30, 31. In one embodiment of the invention, panels 30, 31 would be preconditioned separate from one another and joined just prior to shipment.

FIG. 4 depicts a shipping package 10 wherein the insulation panels 16 and PCM panels 18 are comprised of separable panels. The separable panels can be joined together such as with a film or adhesive, or may remain separate from each other. In this manner, package 10 may utilize a plurality of customarily available vacuum insulation panels to create a large shipping container.

The present invention is directed to a package and method for encasing a payload cavity with phase change materials and insulation to define voids 20. In one example, a water based phase change material is combined with another phase change material to provide thermal protection for the payload. By properly selecting the phase change materials, a package can be configured to provide maximum thermal protection for a temperature sensitive product during delivery. Employing a combination of solid and liquid phase change materials in the container can provide protection from both hotter and colder ambient temperatures during delivery, and a beneficial reduction in the amount of certain phase change materials can result.

Embodiments of the present invention may include two or more different phase change materials. In one embodiment, a water-based phase change material is utilized along with a 2nd, non-water-based phase change material. In one embodiment, a temperature sensitive product is protected against thermal damage from the water-based phase change material by an intermediate phase change material. Depending on the desired temperature range, a variety of different phase change materials may be utilized to keep a temperature sensitive product warm or cold during shipment through an environment having substantially different temperatures than desired. For example, prior to shipment one or both of the phase change materials can be preconditioned so that phase change material is in liquid form or solid form. Depending on the anticipated ambient temperature profile, the most effective combination of solid and liquid phase change material can be selected. If additional protection is needed, auxiliary phase change material in solid, liquid, or solid and liquid phase can be added to augment the thermal capabilities of the container. Phase change material can be contained in HDPE containers, form fill and seal film, or any other suitable containers sized to be inserted into the payload cavity.

Selection of the phase change materials may include consideration of multiple factors including, but not limited to, the desired protected temperature range, anticipated ambient temperatures during shipment, thermal properties of the different phase change materials, thermal properties of the container and/or insulation panels, and thermal properties of the temperature sensitive product being shipped. The design and sizing of containers for the phase change material and the insulation panels could vary depending on these factors as well.

A method of packaging a container for temperature maintenance includes preparing an outer container into a cubic or rectangular prism shape, lining an interior of the outer container with insulation material such a manner as to have no insulation material proximate to one or more of the corners of the outer container, and lining the interior of the insulation material layer with phase change material in such a manner as to have no phase change material proximate to one or more corners of the outer container.

The step of lining includes inserting multiple, generally identical insulation panels to define a void proximate to corners of the outer container. The step of lining may also include inserting multiple, generally identical phase change material panels to define a void proximate to corners of the outer container.

Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present invention, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present invention. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.

What is claimed is:
1. A shipping package for a temperature sensitive payload comprising:
an outer container;
an insulation structure within the interior of the outer container;
a phase change material structure within the interior of the insulation structure; and
a payload section surrounded by the insulation structure and adapted to receive a temperature sensitive product, and with a corner discontinuity being defined at a corner of the insulation structure or phase change material structure or both.
2. The package of claim 1 wherein the shipping package has eight corners and the corner discontinuity includes eight voids proximate to each of the eight corners of the shipping package.

3. The package of claim 2 wherein the insulation structure and phase change material structure include a plurality of panels and the eight voids are defined at corner intersections of the plurality of panels.

4. The package of claim 1 wherein the insulation structure includes multiple insulation panels of generally identical form.

5. The package of claim 4 wherein the insulation panels are vacuum insulation panels.

6. The package of claim 5 wherein the insulation panels overlap each other generally along edges of the container.

7. The package of claim 1 wherein the phase change material structure includes multiple panels of generally identical form.

8. The package of claim 7 wherein the phase change material structure includes at least two different phase change materials.

9. The package of claim 8 wherein the at least two different phase change materials are provided in at least two separable panels.

10. The package of claim 3 wherein the plurality of panels are generally rectangular in form and the plurality of panels overlap each other generally along edges of the container.

11. A shipping package for a temperature sensitive payload comprising:

   an outer container defined by a plurality of inner walls and a plurality of corners;
   a layer of phase change material surrounding a payload cavity;
   a layer of insulation surrounding the layer of phase change material, wherein said layer of insulation contacts the inner walls of the outer container but does not extend into the plurality of corners of the outer container.

12. The package of claim 11 wherein the plurality of insulation panels are generally identical in size and shape.

13. The package of claim 11 wherein the plurality of phase change material panels are generally identical in size and shape.

14. A shipping package for a thermally sensitive payload comprising:

   preparing an outer container of corrugated paper or plastic; placing within the interior of the outer container an insulation material including one or more insulation panels, said placing defining an insulation structure; and placing within the interior of the outer container a phase change material that is precondeded to be solid, liquid, or solid and liquid and acting as a thermal buffer to protect the temperature sensitive product against thermal damage, said placing defining a phase change material structure, wherein at least one thermal discontinuity is defined at a corner of either the insulation structure or the phase change material structure.

15. The package of claim 14 wherein the layer of insulation is defined by a plurality of overlapping insulation panels.

16. A method of packaging a temperature sensitive product comprising:

   preparing an outer container of corrugated paper or plastic; placing within the interior of the outer container an insulation material including one or more insulation panels, said placing defining an insulation structure; and placing within the interior of the outer container a phase change material that is precondeded to be solid, liquid, or solid and liquid and acting as a thermal buffer to protect the temperature sensitive product against thermal damage, said placing defining a phase change material structure, wherein at least one thermal discontinuity is defined at a corner of either the insulation structure or the phase change material structure.

17. The method of claim 16 wherein said placing includes placing multiple identically formed insulation panels according to a pattern resulting in multiple voids at corners of the insulation structure.

18. The method of claim 16 wherein said placing includes placing multiple identically formed phase change material panels according to a pattern resulting in multiple thermal discontinuities at the corners of the phase change material structure.

19. A method of packaging a container for temperature maintenance comprising:

   preparing an outer container into a cubic or rectangular prism shape;
   lining an interior of the outer container with insulation material in an overlapping manner as to have no insulation material proximate to one or more of the corners of the outer container; and
   lining the interior of the insulation material layer with phase change material provided within separable panels.

20. The method of claim 19 wherein said lining the interior of the outer container includes inserting multiple, generally identical insulation panels to define a void proximate to corners of the outer container.

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