Apparatuses and methods are provided in which a self-contained warmer is attached to a vessel to at least warm food therein. The self-contained warmer may include a container, and an exothermic composition provided within the container that produces heat by a chemical reaction upon activation of the exothermic composition. The self-contained warmer is configured to be removably placed in contact with a surface of the vessel to provide heat transfer from the chemical reaction to the vessel such that the heat generated by the exothermic reaction generates sufficient heat to at least warm food in the vessel.
SELF-CONTAINED WARMER
CROSS-REFERENCE TO RELATED APPLICATIONS

0001 This application claims priority from U.S. Provisional Application No. 60/706,958, filed on Aug. 10, 2005, the entire disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

0002 1. Field of the Invention

0003 Apparatuses and methods consistent with the present invention relate to a self-contained warmer that may be used as a portable heating device or heat food, beverages or other items by placing in contact with a vessel, such as a dish, plate, bowl, cup, or the like.

0004 2. Description of the Related Art

0005 Conventional heat sources used for the heating of food in a dish or other food container suffer from a number of disadvantages. For instance, the materials and methods previously used in some portable heat sources result in the formation of flammable and/or toxic by-products. These by-products are potentially dangerous and may require special disposal as hazardous materials. Further, conventional portable heat sources have a low efficiency of heat production such that there is a small quantity of heat generated for a given weight or volume of heater material.

0006 In addition, self-heating food modules that are integrated with a heat source cannot be used with conventional dishes. One such example is U.S. Pat. No. 5,220,909 to Pickard et al., in which a rectangular shaped tray includes an exothermic chemical pad disposed in a main compartment of the tray and an electrolytic pouch provided in a side compartment of the tray. The tray provides heat when the electrolytic pouch is ruptured, thereby activating the exothermic chemical pad in the tray to provide heat to food contained within the tray. However, the food must be placed within the specialized tray itself and then heated. Thus, such integrated heating modules cannot be used with conventional dishes, plates, bowls, cups, or other food or beverage containers.

0007 Other conventional food heating modules require an external supply of an activating agent, such as water, to facilitate the chemical reaction which generates the heat. For instance, one such self-heating module must be immersed in water to activate the heat generating reaction of the module. Such modules, however, are not practical for use in warming or heating a dish, plate, bowl, or other such vessel.

0008 Further, conventional food heating modules fail to provide a convenient and effective mechanism of placement on and/or attachment to dishes, cups, or other types of food containers to thereby heat the food or beverages within such containers to a desired temperature for a sufficient period of time. Also, as noted above, the chemical reactions involved in prior approaches suffer from the disadvantage of involving the use of substances which result in the formation of flammable and toxic by-products.

SUMMARY OF THE INVENTION

0009 According to an aspect of the present invention, a self-contained warmer provides heat without the need for a stove, fire, external fuel source, electrical or other power source.

0010 According to another aspect of the present invention, a self-contained warmer is provided which includes a container and an exothermic composition provided within the container that produces heat by a chemical reaction upon activation of the exothermic composition, wherein the warmer is configured to be removable and is placed in contact with a surface of a vessel to provide heat transfer from said chemical reaction to the vessel such that the heat generated by the exothermic reaction generates sufficient heat to at least warm food in the vessel.

0011 According to another aspect, the self-contained warmer may further include a membrane provided on a surface of the container, and a removable seal covering the membrane, wherein removal of the removable seal activates the exothermic composition by allowing air to enter the container and initiate the chemical reaction.

0012 According to another aspect, the self-contained warmer may further include an adhesive layer provided on a surface of the container, wherein the adhesive layer is configured to attach the self-contained warmer to the vessel.

0013 Additionally, the chemical reaction of the exothermic composition may generate heat so that the temperature of a surface of the container is between 60 to 90° C. Further, the self-contained warmer may undergo the chemical reaction for a maximum duration of 20-120 minutes from activation, at which time a temperature of the surface of the container is less than 60° C.

0014 According to another aspect, the self-contained warmer may include an air-tight package which encloses the container and which, upon removal, activates the exothermic composition.

0015 According to another aspect, the vessel may be a dish having an indentation formed by a rim on an underside of the dish, and the container is shaped to be placed under the dish and within the indentation. Further, the self-contained warmer may be placed under the dish such that the dish can be stably supported on a flat surface.

0016 According to another aspect, the container may be a flexible pouch that encloses the exothermic composition.

0017 According to another aspect, the container may be rigid and shaped to be placed at the underside of the vessel to at least warm food in the vessel and is removable from the underside of the vessel without altering the self-contained warmer.

0018 A still further aspect of the present invention provides a method of heating food in a food containing vessel, including providing a self-contained warmer that includes a container, and an exothermic composition provided within said container that produces heat by a chemical reaction upon activation of the exothermic composition, and placing the self-contained warmer in contact with a surface of the vessel to transfer the heat from said chemical reaction to the vessel, in which the heat generated by the exothermic reaction generates sufficient heat to at least warm food in the vessel.

0019 A still further aspect of the present invention provides a system for warming a food containing vessel, comprising a self-contained warmer, which includes a container, and an exothermic composition provided within the container that produces heat by a chemical reaction upon
activation of the exothermic composition; and a vessel in which food is contained, wherein the container is configured to be removable placed in contact with a surface of the vessel to provide heat transfer from the chemical reaction to the vessel such that the heat generated by the exothermic reaction generates sufficient heat to at least warm food in the vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The above and other aspects of the present invention will become more apparent from the description of the following exemplary embodiments of the present invention with reference to the accompanying drawings, in which:

[0021] FIGS. 1A and 1B are perspective views of a self-contained warmer according to an exemplary embodiment of the present invention;

[0022] FIGS. 2A-2D illustrate the removal of a seal to expose a membrane of the self-contained warmer according to an exemplary embodiment of the present invention;

[0023] FIGS. 3A and 3B illustrate an exemplary embodiment in which the self-contained warmer is sealed in an air-tight bag;

[0024] FIG. 4 shows an exemplary embodiment of a self-contained warmer applied to an indentation on the underside of a dish;

[0025] FIG. 5 shows an exemplary embodiment of a self-contained warmer applied to a rectangular shaped dish; and

[0026] FIG. 6 shows an exemplary embodiment of a self-contained warmer and a cooking pot.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS OF THE INVENTION

[0027] Illustrative, non-limiting embodiments of the invention will be described with reference to the accompanying drawings, wherein like reference numerals refer to like elements throughout.

[0028] With reference to FIGS. 1A and 1B, an exemplary embodiment of a self-contained warmer 10 according to the present invention is shown. Self-contained warmer 10 includes a container 11, an exothermic composition 12 that is contained within container 11, a gas permeable membrane 13 provided on a surface of container 11. Container 11 may be, for example, a pouch made of a flexible material. In other exemplary embodiments, the container 11 may be a rigid structure containing the exothermic composition. In addition, an adhesive layer 14 may be provided on a surface of the container 11 to facilitate attachment of the self-contained warmer 10 to a vessel, such as a plate, dish, or cup. The adhesive layer 14, however, is optional, and the self-contained warmer may be placed under a vessel to provide heat transfer to the vessel without being adhered.

[0029] In the exemplary embodiment depicted in FIGS. 1A and 1B, a removable seal 15, which is impermeable, is provided over membrane 13 and removed to expose the membrane 13 to allow the flow of air into container 11 thereby initiating the exothermic reaction of the exothermic composition 12 contained therein. Membrane 13 may be permeable or semi-permeable.

[0030] However, an external supply of air is not necessary to initiate and maintain the exothermic reaction in other exemplary embodiments of the invention. In such exemplary embodiments, the exothermic composition is contained within a container and a frangible internal seal is ruptured to initiate an exothermic reaction of the exothermic composition, in which case exposure to an external supply of air would not be required.

[0031] Container 11 of self-contained warmer 10 acts as a reaction container and may be constructed of a thin, flexible material which has adhesive layer 14 on one surface for application to a vessel, such as a dinner plate, or other food dish. However, container structures other than a pouch-like structure, as noted above, may be employed to enclose the exothermic composition and facilitate the exothermic reaction (e.g., a press-type composition). Adhesive layer 14 optionally allows self-contained warmer 10 to be securely attached to the underside of a dish, plate, bowl, cup or other food containing vessel in order to efficiently transfer heat generated by the exothermic reaction of exothermic composition 12 by direct contact. If the adhesive layer is employed, then the vessel and the self-contained warmer can easily be moved as a single unit.

[0032] However, as discussed above, the self-contained warmer 10 may be positioned under a vessel without being adhered by an adhesion layer. Rather, the contact of the self-contained warmer with the vessel, such as a plate, placed on top of the self-contained warmer, would provide for heat transfer to the vessel.

[0033] When activated and attached to or placed under a dinner plate, for example, self-contained warmer 10 will transfer heat to the dish. Thus, the heat transfer from the self-contained warmer 10 to the dish serves to keep food on the dish warm while serving and eating meals. The self-contained warmer may be individually sealed, wrapped, or packaged in an airtight package. The heat production of the self-contained warmer may be activated by opening the package or removing a seal, which thereby initiates a chemical reaction of material contained inside the flexible material.

[0034] In the exemplary embodiment depicted in FIGS. 1A and 1B, the permeable membrane 13 is sealed by removable seal 15. The removal of seal 15 is illustrated in FIGS. 2A and 2B, which depict the removable seal 15 being peeled back to expose the permeable membrane 13. The exposure of the permeable membrane 13 allows the heat producing reaction to begin. Similarly, release paper or film 17 may be removed from the opposite side of the self-contained warmer 10 to expose the adhesive layer 14, as shown in FIG. 4. As seen in FIGS. 2C and 2D, permeable membrane 13 can be a porous structure which allows air to enter pouch 11 of self-contained warmer 10.

[0035] In another exemplary embodiment shown by FIGS. 3A and 3B, the self-contained warmer 10 is sealed in an air-tight bag 16 that encloses self-contained warmer 10. As seen in FIG. 3B, the self-contained warmer 10 is removed from air-tight bag 16 to expose the permeable membrane 13 to air flow and allow the self-contained warmer to be attached to a dish or other food containing vessel by adhe-
sive layer 14. Additionally, the self-contained warmer 10 may be sealed by both the removable seal 15 and the air-tight bag 16.

[0036] The particlual adhesive used for adhesive layer 14, if present, is not critical. In general, adhesive layer 14 provides additional adhesion to a dish or other vessel to allow transfer of the heat generated by self-contained warmer 10 and withstand the heat generated without becoming detached unintentionally. Adhesive layer 14 may enable easy removal from the vessel when use is terminated, regardless of whether the reaction itself is terminated. If the self-contained warmer 10 is applied to the underside of a dish 20, as depicted by the exemplary embodiment in FIG. 4, dish 20 and self-contained warmer 10 can be freely moved as a single unit during the course of food preparation and serving. Various types of rubber adhesives and acrylic adhesives may be used for adhesive layer 14. Also, the adhesive may be a high polymer material having an adhesive property. Further, a hot-melt type adhesive may also be used. The adhesive may additionally be a combination of two or more adhesives. Placement of adhesive layer 14 is not limited to a surface opposing permeable membrane 13, but may be provided on any surface of the warmer.

[0037] In one exemplary embodiment, the self-contained warmer 10 upon activation reaches a maximum temperature range in approximately 1-10 minutes and remains in this range for approximately 20-40 minutes. The quantity of heat generated by the chemical reaction of exothermic composition 12 within container 11 is sufficient to warm a plate or serving dish and maintain a temperature significantly above room temperature. Thus, when placed under a vessel such as a dish, the self-contained warmer 10 would enable food that is served on or inside of the dish to remain warm for a sustained period of time without requiring any additional heat source or reheating of the food itself.

[0038] Although the self-contained warmer 10 is described above as producing temperatures in the range of 60-70°C, i.e., sufficient to keep food warm, in other exemplary embodiments higher temperatures in the range of 75-90°C or higher may be produced. These higher temperatures would be sufficient to cook certain foods within the dish, bowl, or other vessel when the self-contained warmer is applied.

[0039] The self-contained warmer 10 itself contains the heat or power source and no additional external power such as electricity, microwave or water is required to activate the warmer. The chemical reaction which provides the heat is generated by exothermic composition 12 enclosed within container 11 of self-contained warmer 10. According to an exemplary embodiment, the self-contained warmer 10 is used once and may then be disposed of or recycled at the end of its use. Further, the self-contained warmer 10 may be used with dishes or bowls made of glass, ceramic, china, or plastic, or other containers for food or beverages. However, self-contained warmer 10 is not limited to a particular material and may be adapted for use with paper or other types of dishes or containers when the heat transfer characteristics of such containers are accounted for.

[0040] In exemplary embodiments in which a membrane 13 is employed, membrane 13 allows air to enter through an external film in order to react with the reactive agents of exothermic composition 12. Membrane 13 may be any type of porous or breathable film which allows a sufficient amount of reactive gas, such as oxygen, to enter and facilitate the heat producing chemical reaction. As shown in FIGS. 1A and 1B, membrane 13 may be provided on the opposite surface as the adhesive layer 14 of container 11. However, adhesive layer 14 may, in other exemplary embodiments, be provided on a other surfaces of container 11, such as side surfaces, for example.

[0041] The exothermic reaction provided by exothermic composition 12 is described below. The particular composition described is merely exemplary, and other combinations of ingredients may be selected to provide the desired exothermic effect.

[0042] The self-contained warmer 10 according to an exemplary embodiment of the present invention includes exothermic composition 12 enclosed in a container 11, which may be a generally flat-shaped pouch having at least one gas-permeable surface. Air entering the pouch through membrane 13 causes a chemical reaction with the reaction agents contained therein, such as metal powder, metallic chloride, and water. Iron powder may be used as the metal powder for the exothermic reaction. Certain exothermic compositions based on iron oxidation chemistry are known in applications to different exothermic devices, i.e., body warmers (U.S. Pat. No. 4,366,804 to Abe; U.S. Pat. No. 5,046,479 to Ushii; U.S. Pat. No. 6,099,556 to Ushii; U.S. Pat. No. 5,918,590 to Burkett et al.; U.S. Pat. No. 5,984,995 to White) and body fluid warmers (U.S. Pat. No. 5,042,455 to Yue et al.).

[0043] According to an exemplary embodiment, the exothermic composition 12 may comprise approximately 30% to 80% by weight iron powder; approximately 3% to 25% by weight activated carbon, non-activated carbon, or mixtures of carbon and non-activated carbon; approximately 0.5% to 10% by weight metal salt; approximately 1% to about 40% by weight water; and various amounts of inert ingredients.

[0044] Iron is the anode for the electrochemical reaction involved in the exothermic oxidation of iron. Suitable sources for iron powder include cast iron powder, reduced iron powder, electrolytic iron powder, scrap iron powder, pig iron, wrought iron, various steels, iron alloys, and the like and treated varieties of these iron powders. There is no particular limitation to their purity, kind, etc. so long as it can be used to produce heat-generation with electrically conducting water and air in an exemplary embodiment.

[0045] In an exemplary embodiment of the present invention, iron powder comprises from approximately 30% to about 80% by weight, of the particulate exothermic composition. Further, the iron powder composition may be from about 50% to about 70% by weight of the exothermic composition.

[0046] While oxygen is necessary for the oxidation reaction of iron to occur, an internal oxygen source is not required in the heat cells of exothermic composition 12. However, oxygen-producing chemical materials may be incorporated in the particulate exothermic composition at the time of preparation thereof in other exemplary embodiments. The oxygen sources used for exothermic composition 12 include air and artificially made oxygen of various purity.

[0047] Activated carbon serves as the cathode for the electrochemical reaction involved in the exothermic oxida-
tion of iron. Active carbon is extremely porous in the inner structure giving it particularly good water-retention capa-
bilities. Moreover, active carbon not only absorbs water well, but also adsorbs water vapor evaporated by the heat
generation of the exothermic composition and helps prevent the escape of the water vapor. Therefore, it can also serve as a
water-holding material, which will serve to regulate the rate and extent of the exothermic reaction. Further, active carbon
can absorb odors such as those caused by the oxidation of iron powder.

[0048] The active carbon may be prepared from coconut shell, wood, charcoal, coal, bone coal, etc. In addition, the
active carbon may be prepared from other raw materials such as animal products, natural gas, fats, oils and resins for
use in the exothermic cell. There is no limitation to the kinds of active carbon that can be used. However, according to an
exemplary embodiment of the present invention, the active carbon that is selected may have desirable water holding
characteristics.

[0049] The cathode capabilities can be extended by using non-activated carbon powder, i.e., carbon blended to reduce
cost. Therefore, mixtures of the above carbons are also useful for an exothermic cell.

[0050] Typically, activated carbon, non-activated carbon, and mixtures thereof, may comprises from about 3% to
about 25% of the exothermic composition. Further, the activated carbon, non-activated carbon, and mixtures may
comprise about 8% to about 20%, or even from about 9% to about 15% by weight of the exothermic composition.

[0051] Metal salt serves as a reaction promoter for activating the surface of the iron powder to ease the oxidation
reaction with air and provides electrical conduction to the exothermic composition to sustain the corrosive reaction.
Useful metal salts include sulfates such as ferric sulfate, potassium sulfate, sodium sulfate, mannan sulfate, mag-
nesium sulfate; and chlorides such as cupric chloride, potassium chloride, sodium chloride, calcium chloride, manga-
nese chloride, magnesium chloride and cuprous chloride. Also, carbonate salts, acetate salts, nitrates, nitrates and
other salts can be used.

[0052] Among these metal salts, the deliquescent salts such as calcium chloride, magnesium chloride, etc. are very
hygroscopic and hence these compounds, even when added in a small amount, show efficacy in inhibiting the escape of
water vapor. Such salts are the least preferred in the exo-
thermic composition of the present invention. Sodium chlor-
ide shows small solubility difference vs. temperature differ-
ence and hence no crystal is precipitated at low
temperatures, and also provides reasonable heat-generation.
Thus, deviation of heat-generation due to any temperature
difference in atmospheric air does not occur. Further, sodium chloride is very inexpensive. In one exemplary embodiment,
the active heat-producing components are a mixture of an
acidic anhydride or an acidic salt and a basic anhydride or
a basic salt. Acidic anhydrides include phosphorus pentox-
ide. Acidic salts include aluminum chloride and magnesium
chloride. Basic anhydrides include calcium oxide. In gen-
eral, several suitable alkali, alkaline earth, and transition
metal salts exist which can also be used, alone or in
combination, to sustain the corrosive reaction of iron.

[0053] The metal salts of exothermic composition 12 may
be sodium chloride, cupric chloride, and mixtures thereof. In
an exemplary embodiment, the metal salt or metal salt
mixture comprises approximately 0.5% to 10% by weight. Further, the metal salt or metal salt mixture may comprise
approximately 1.0% to 5% by weight of the particular exothermic composition.

[0054] The water used herein may be from any appropriate
source. There is no particular limitation to its purity, kind,
etc. Water may comprise from about 1% to about 40% by
weight. Further, the water composition may be less than
about 5% to 10% by weight of the particular exothermic
composition of the present invention.

[0055] In addition to the above-described components of
the particulate exothermic composition of the present inven-
tion, other components may also be added as appropriate.
These other components include waxes, oils, surfactants,
and natural or synthetic polymeric solids such as wood flour
or vermiculite.

[0056] It has been appreciated in the construction and
manufacture of body warmers that the inclusion of water
absorbers within an exothermic composition controls the
exothermic temperature by releasing adsorbed water and
adsorbing free moisture from around the metal powder.
Thus, water absorbers may be excluded from exothermic
composition 12 so as to not limit the exothermic temperature
to low levels usually needed in the manufacture of body
warmers. In the event of a body warmer, when the resulting
heat of the exothermic reaction raises the temperature of the
water absorber above a predetermined temperature, the
water absorber releases adsorbed water to form barrier
layers of released water around the metal powder to retard
the exothermic reaction. Thus, regardless of gas permeabil-
ity, water-vapor permeability, variations in the exothermic
composition, and ambient temperature, the exothermic tem-
perature may thereby be limited to a desired maximum

[0057] Further, the amount of heat generated by the self-
contained warmer 10 may be controlled such that the
self-contained warmer does not create an emission of heat so
intense that, when left for the duration of the reaction, the
self-contained warmer damages tables (i.e. wood, glass),
counter tops, cloth, plastic or leather furniture. Such a
limitation on heat generation may be achieved, for example,
by varying the amount of exothermic composition 12.

[0058] The container 11 containing the exothermic com-
position 12 may be formed with a gas-permeable membrane
13 that has both oxygen and water-vapor permeability. A
water-vapor permeability of a gas-permeable film less than
50 g/m² per 24 hr may result in little heating and does not
provide a sufficient heating effect. Conversely, a water-vapor
permeability exceeding 5000 g/m² per 24 hr may result in an
exothermic temperature above 70° C. For these reasons,
membrane 13 may be selected to have a perme-
ability of 2000-5000 g/m² per 24 hr, both to promote the
rapid oxidation of iron by influx of oxygen and permit the
rapid efflux of generated water vapor.

[0059] A heating element according to an exemplary
embodiment of the present invention is made from the
exothermic composition of the invention, air-permeable
film, air-impermeable film, and adhesive layer. The element
is constructed such that the exothermic medium is sandwiched between two films which are sealed at their edges by
heat-sealing or by melt-blow-sealing using a hot-melt resin. Then, the adhesive layer is partially or wholly formed on the air-impermeable film. When in use, the heating element is attached to the plate, bowl or other food-containing vessel with the aid of the adhesive layer.

[0060] When conventional powder-type exothermic medium is used, a non-woven fabric may be used outside the films to prevent the films from being torn and the powder of the exothermic composition from spilling out. On the other hand, if a pressed-type united exothermic composition (as previously described in U.S. Pat. No. 6,915,798) is used, a heating element can be constructed without non-woven fabrics because the exothermic medium is flexibly united.

[0061] It is also possible to eliminate the air-permeable film which controls the air permeability and the reaction between the metal powder and oxygen in the air and thereby reduce the cost of manufacture. By using a united, pressed-type exothermic composition and controlling the reaction rate by adjusting the composition of the exothermic medium, the preparation conditions and the like, a heating element can be constructed in such a way that the exothermic composition is directly exposed to the atmosphere.

[0062] The container may be stored in an air-tight bag, e.g. a pouch made from Perfeceal 35785G, until used to prevent oxygen in the air from prematurely activating the exothermic composition contained in the product.

[0063] The pressed-type united exothermic composition, as previously described in U.S. Pat. No. 6,915,798, is comprised of:

[0064] 59.5 parts iron powder (SCM Metal Products Inc. grade A131);

[0065] 5.95 parts activated carbon (Norit Americas Inc., grade HDC);

[0066] 3.5 parts sodium chloride;

[0067] 29 parts water;

[0068] 3.5 parts Sanfresh ST30; and

[0069] 4.3 parts methyl methacrylate/ethyl methacrylate copolymer (G.C Dental Products Unifast II powder).

[0070] These materials are mixed and stirred. Then, 3.6 g of the mixture are added to 0.5 g methyl methacrylate containing quaternary ammonium chloride (G.C Dental Products Unifast II liquid) and placed into a metal die press and pressed at 840 kg/cm² for 30 seconds.

[0071] The result is a flexible exothermic medium. The medium is then heat treated at 150°C for two minutes in a nitrogen atmosphere, which will increase the flexibility of the medium.

[0072] The exothermic characteristics of the resulting medium can be measured in the following way: The heating element is constructed by sandwiching the exothermic medium between an air-permeable film (such as Tokuyama Corporation PN30) with a thickness of 30 micrometers, and an air-impermeable polyethylene film (such as polyethylene film made by Wada Chemical Industries Co. Ltd.) with a thickness of 70 micrometers, laminated with a non-woven fabric of 30 g/m² (such Shinwa Co. Ltd. 7830). The films and fabric are heat-sealed at their edges. An adhesive of a styrene/isoprene copolymer is formed on the non-woven fabric in the amount of 150 g/m². The temperature change of the heating element thus constructed is measured by attaching a thermocouple to the adhesive layer. Using a self-contained warmer constructed as described will show that the temperature will rise to 61°C after 3 minutes and remain above 40°C for approximately 2 hours.

[0073] The exothermic composition may be a known one comprising iron powder as a main ingredient and, incorporated therein, water, a water-retaining material (charcoal, vermiculite or the like), an oxidation promoter such as activated carbon, and salt. More particularly, the exothermic composition comprises about 55 to 65% by weight of iron powder, 18 to 22% by weight of water, 9 to 11% by weight of a water-retaining agent, 3.5 to 4.5% by weight of activated carbon, and about 4.5 to 6% by weight of salt, and the temperature of heat generation accompanying oxidation is adjusted in such a manner that the maximum temperature is 65°C, preferably 62°C to 63°C and the average temperature is 50°C to 55°C. Sodium chloride is the preferred salt because of its low price and suitability. Also, it is generally recognized as being safe. In the above-described mixing, the amount of water is smaller than that of the ordinary body warmer, while the amount of the water-retaining agent is slightly larger than that of the ordinary body warmer, i.e., 7 to 8% by weight.

[0074] For commercialization, release paper may be adhered to the self-adhesive layer and the bag put in an air-impermeable packaging bag, whereupon hermetic sealing of periphery of the packaging bag is conducted.

[0075] As discussed above, the self-contained warmer may optionally include an adhesive layer. However, a self-contained warmer without an adhesive layer is also possible such that the warmer is affixed with a separate device, e.g. with an elastic or adhesive bandage or Velcro, or may simply be placed under a vessel.

[0076] In the self-contained warmer, an air permeation layer comprising an air-permeable member and a perforated film, the perforated film having air-permeable holes at a ratio of 0.055-0.001 relative to the area of the hot compress structure may be utilized in an exemplary embodiment. Therefore, the moisture permeation may be as large as 2,000 g/m²/24 hr as measured according to an ASTM method. In such an exemplary embodiment, the amount of oxygen permeated through the air permeation layer from the outside air is large and the amount of heat generated large, the resulting temperature exceeding 60°C. Further, since steam is released to the exterior of the system, the internal pressure of the bag containing the heating composition does not become high and the partial pressure oxygen is held at about 1/16 atmosphere like the outside air, so the heating temperature is maintained high. Similarly, since the amount of moisture permeated through the perforated film is large, the internal pressure of the bag which contains the heating composition does not appreciably rise and remains approximately one atmosphere.

[0077] Because of the heat generation at a high temperature, the vaporization of water is accelerated, and because of the large moisture permeability, the escape of steam to the exterior of the system is rapid. Consequently, the amount of water contained in the exothermic composition becomes
smaller as the reaction proceeds, so the oxidation of iron powder becomes insufficient and the duration of heat generation is shortened.

[0078] The chemical reaction of the exothermic composition, regardless of the particular type of composition utilized, may generate heat so that the surface temperature of the surface of the container is between 60 to 90°C. In food warming applications, the temperature generated will typically be in the range of 60-70°C, while temperatures generated for cooking applications may be 90°C or higher. Further, the duration of the chemical reaction, in an exemplary embodiment, is such that the exothermic composition undergoes the chemical reaction for a maximum duration of 20-120 minutes from activation, at which time the temperature of the surface of the container will have decreased and be less than 60°C.

[0079] Various exemplary embodiments of the structure of the self-contained warmer are discussed below. The physical dimensions of the self-contained warmer may be such that the self-contained warmer is small and thin enough to affix to the bottom of a plate, bowl or other serving dish without interfering with holding of the dish around the outside edges or handles. Further, the self-contained warmer may be constructed such that the dish, bowl, or other container continues to rest level on a table or counter top after the dish heating apparatus is attached to the underside.

[0080] In exemplary embodiments, the self-contained warmer may be constructed to adhere to the underside of a dish, plate, bowl, cup or other vessel, either inside the center indented area (e.g., up to approximately 4" in diameter), or around the center indentation area (e.g., up to approximately 11" in diameter), such that no material is covering the center underside of the plate. However, smaller or larger diameters are also within the scope of the present invention depending on the dimensions of a particular dish or other type of vessel. In addition, the self-contained warmer is not limited to a circular shape, and may be formed in any suitable shape to provide attachment to and/or placement under vessel, such as a plate, bowl, cup, or the like.

[0081] Further, the thickness across the entire self-contained warmer may be approximately 1/8 to 1/4 inch thick to allow for placement under with or without adhesion to the underside of a dish or other container without interfering with placement of the dish on a level surface, such as a table or counter top. Thus, the warmer may be placed under a dish such that the dish can be stably supported on a flat surface. However, the thickness of the self-contained warmer likewise is not critical and may vary for particular applications in which dishes, plates, bowls, or other containers have more or less contact surface available for attachment to or placement under their underside.

[0082] In one exemplary embodiment of the present application, for instance, the thickness of the self-contained warmer is 1/4 inches, which provides adequate clearance for placement under a typical serving plate. In other exemplary embodiments, such as applications in which the self-contained warmer is to be placed under a buffet dish or for cooking, the thickness could be greater (e.g., approximately 3 inches).

[0083] An exemplary embodiment shown in FIG. 4, depicts a circularly-shaped self-contained warmer 10 having a diameter which allows attachment to or placement under the underside of dish 20 within the indentation 22 formed by a rim 21 of the dish 20. As shown in FIG. 4, the dish heating apparatus 10 includes the exposed adhesive 14, which is exposed by removal of release paper 17, on the surface opposite to membrane 13. Dish heating apparatus 10 is then adhered to the indentation 22 of dish 20 and the heat produced by the reaction of air entering the pouch 11 of dish heating apparatus and reacting with exothermic composition 12 is transferred to the underside of dish to heat dish 20 and food (not shown) on the upper side.

[0084] In the exemplary embodiment depicted in FIG. 4, the diameter of the self-contained warmer 10 may be 5 inches, and from 1/8 to 1/4 inches thick, although other thicknesses and diameters are envisioned depending on the dimensions of the dish and the duration required for generating heat. The heating provided by the self-contained warmer may be approximately 60-70°C, sufficient to warm food in the dish.

[0085] A further exemplary embodiment of a self-contained warmer is illustrated by FIG. 5, in which a self-contained warmer is adapted to the shape of a rectangular shaped dish 50, which may be a buffet-type serving dish. The self-contained warmer 40 is likewise rectangular in shape, and may be, for example, 12 inches by 30 inches, corresponding to the dimensions of the buffet-type serving dish 50. The buffet-type dish is not limited to such dimensions, and may have dimensions in the ranges of 10-21 inches in length, 6-14 inches in width, and 5-13 inches in height.

[0086] The buffet dish self-contained warmer 40 may be up to 1 inch in thickness or greater. Further, rectangular self-contained warmer 40 may include a plurality of exothermic compositions 42 and permeable membranes 43 disposed within container 41 and separated by air pockets 45. Air pockets 45 may be provided to allow air flow between the regions of exothermic composition 42. Self-contained warmer 40 may be attached to the underside of dish 50 by an optional adhesion layer 44. In one exemplary embodiment, temperatures sufficient for warming food within the buffet-type serving dish 50 of approximately 60-70°C are provided.

[0087] A further exemplary embodiment is shown in FIG. 6, in which a cooking self-contained warmer suitable for cooking 70 is placed under a cooking pot 60. The dimensions of self-contained warmer 70 and the exothermic composition contained therein provide sufficient heat transfer for cooking food in the cooking pot (e.g., 75-90°C or higher). Container 71 of the cooking self-contained warmer 70 is rigid and may by cylindrical in shape. For instance, the cooking pot 60, which could also be a cooking pot such as used for camping, could be up to 12 inches in diameter, and the container 71 of the self-contained warmer 70 could be up to 3 inches in thickness.

[0088] Although attachment or placement of the self-contained warmer to the bottom of a vessel, such as a plate is described above, the exemplary embodiments of the present invention are not limited thereto, as other forms of placement, such as the sides, top, or internal placement are also within the scope of the present invention.

[0089] Although various shapes of the self-contained warmer have been illustrated, shape is not critical, and any
shape, such as rectangular, circular, oval, pentagonal, hexagonal, etc., can be provided and/or adapted to a particular application (e.g., the shape of the vessel).

As described above, aspects of the present invention provide a heat source which is safe to store, transport, and operate. Additional aspects of the present invention provide a heat source which convenient to use, has minimal weight and volume yet capable of generating sufficient heat for various applications, and further provide a heat source that is readily and safely disposable after use.

Although exemplary embodiments of the present invention have been shown and described, it will be appreciated by those skilled in the art that changes may be made to the exemplary embodiments without departing from the principles and spirit of the invention, the scope of which is defined by the appended claims and their equivalents.

What is claimed is:

1. A self-contained warmer, comprising:

   a container; and

   an exothermic composition provided within said container that produces heat by a chemical reaction upon activation of the exothermic composition,

   wherein the warmer is configured to be removably placed in contact with a surface of a vessel to provide heat transfer from said chemical reaction to the vessel such that the heat generated by the exothermic reaction generates sufficient heat to at least warm food in the vessel.

2. The self-contained warmer of claim 1, further comprising:

   a membrane provided on a surface of the container; and

   a removable seal covering the membrane,

   wherein removal of the removable seal activates the exothermic composition by allowing air to enter the container and initiate the chemical reaction.

3. The self-contained warmer of claim 1, further comprising an adhesive layer provided on a surface of the container, wherein the adhesive layer is configured to attach the self-contained warmer to the vessel.

4. The self-contained warmer of claim 1, wherein the chemical reaction of the exothermic composition generates heat so that the temperature of a surface of the container is between 60 to 90°C.

5. The self-contained warmer of claim 4, wherein the exothermic composition undergoes the chemical reaction for a maximum duration of 20-120 minutes from activation, at which time a temperature of the surface of the container is less than 60°C.

6. The self-contained warmer of claim 1, further comprising an air-tight package which encloses the container and which, upon removal, activates the exothermic composition.

7. The self-contained warmer of claim 1, wherein the vessel is a dish having an indentation formed by a rim on an underside of the dish, and the container is shaped to be placed under the dish and within said indentation.

8. The self-contained warmer of claim 7, wherein the self-contained warmer is placed under the dish such that the dish can be stably supported on a flat surface.

9. The self-contained warmer as claimed in claim 1, wherein the container has a thickness within a range of approximately 1/8 to 3 inches.

10. The self-contained warmer as claimed in claim 1, wherein said container is a flexible pouch that encloses the exothermic composition.

11. The self-contained warmer as claimed in claim 1, wherein the container is rigid and shaped to be placed at the underside of the vessel to at least warm food in the vessel and is removable from the underside of the vessel without altering the self-contained warmer.

12. A method of heating food in a vessel, the method comprising:

   providing a self-contained warmer that includes a container, and an exothermic composition provided within said container that produces heat by a chemical reaction upon activation of the exothermic composition; and

   placing the self-contained warmer in contact with a surface of the vessel to transfer the heat from said chemical reaction to the vessel, in which the heat generated by the exothermic reaction generates sufficient heat to at least warm food in the vessel.

13. The method of heating food as claimed in claim 12, wherein the self-contained warmer is attached to the vessel by an adhesive layer provided on a surface of the container.

14. The method of heating food as claimed in claim 12, further comprising:

   activating said chemical reaction by removing a removable seal to expose a membrane provided on a surface of the container,

   wherein removal of said removable seal allows air to enter said container through said membrane and react with the exothermic composition provided therein.

15. The method of claim 12, wherein the chemical reaction of the exothermic composition generates heat so that a surface of the container is between 60 to 90°C.

16. The method of claim 15, wherein the exothermic composition undergoes the chemical reaction for a duration of 20-120 minutes from activation, at which time a temperature of the surface of the container is less than 60°C.

17. The method of claim 12, wherein the vessel is a dish having an indentation formed by a rim on an underside of the dish, and the container is shaped to be placed under the dish and within said indentation.

18. The method of claim 17, wherein the self-contained warmer is placed under the dish such that the dish can be stably supported on a flat surface.

19. The method of claim 12, wherein the container has a thickness within a range from approximately 1/8 to 3 inches.

20. The method of claim 12, wherein the container is a flexible pouch that encloses the exothermic composition.

21. The method of claim 12, wherein the container is rigid and shaped to be placed at the underside of the vessel to at least warm food in the vessel and is removable from the underside of the vessel without altering the self-contained warmer.

22. A system for warming a food containing vessel, comprising:

   a self-contained warmer, which includes a container, and an exothermic composition provided within said container that produces heat by a chemical reaction upon activation of the exothermic composition; and
a vessel in which food is contained,

wherein the warmer is configured to be removably placed in contact with a surface of the vessel to provide heat transfer from said chemical reaction to the vessel such that the heat generated by the exothermic reaction generates sufficient heat to at least warm food in the vessel.

23. The system of claim 22, wherein the self-contained warmer further comprises:

a membrane provided on a first surface of the container;

and

a removable seal covering the membrane,

wherein removal of the removable seal activates the exothermic composition by allowing air to enter the container and initiate the chemical reaction.

24. The system of claim 22, wherein the self-contained warmer further comprises an adhesive layer provided on a second surface of the container, wherein the adhesive layer is configured to attach the self-contained warmer to the vessel.

25. The system of claim 22, wherein the chemical reaction of the exothermic composition generates heat so that a surface of the container is between 60 to 90° C.

26. The system of claim 22, wherein the exothermic composition undergoes the chemical reaction for a maximum duration of 20-120 minutes, at which time a temperature of the surface of the container is less than 60° C.

27. The system of claim 22, wherein the self-contained warmer comprises an air-tight package which encloses the container and which, upon removal, activates the exothermic composition.

28. The system of claim 22, wherein the vessel is a dish having an indentation formed by a rim on an underside of the dish, and the container is shaped to be placed under the dish and within said indentation.

29. The system of claim 28, wherein the self-contained warmer is placed under the dish such that the dish can be stably supported on a flat surface.

30. The system of claim 22, wherein the wherein the container of the self-contained warmer has a thickness within a range of approximately 1/16 to 3 inches.

31. The system of claim 22, wherein the container is a flexible pouch that encloses the exothermic composition.

32. The system of claim 22, wherein the container is rigid and shaped to be placed at the underside of the vessel to at least warm the food in the vessel and is removable from the underside of the vessel without altering the self-contained warmer.