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(54) METHOD FOR COOLING

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(57) **ABSTRACT**

A method is described for lowering the temperature of products in a manner that results in relatively low adherence of coolant to the processed packages. The method includes establishing a source of aqueous potassium acetate solution having a pre-determined temperature, and contacting the products with at least a portion of that solution for an appropriate time so as to lower the temperature of the products to a desired temperature.

METHOD FOR COOLING

FIELD OF THE INVENTION

[0001] The present invention relates to a method for cooling products by contacting the products with a heat transfer fluid made up as an aqueous potassium acetate solution so as to lower their temperature in a manner which tends to avoid having portions of the fluid adhering to the products after leaving the location where the products were cooled.

BACKGROUND OF THE INVENTION

[0002] Many types of food spoil over time and many food items subject to spoilage can be stored longer with reduced losses when held at temperatures well below ambient. Extending shelf life by freezing fresh meat is an example. Meat processing plants can, for example, produce small portions of film-wrapped cooled meat sized and packaged for retail sale, so-called "case ready" products, which can be shipped to distribution centers and retail outlets. Cooling and freezing this packaged meat prevents spoilage during shipping and storage prior to sale. Cooling also has other functions in food processing. For example, cheese processing involves steps that are best carried out after cooling the cheese. U.S. Pat. No. 6,916,500 issued to Abler discloses using heat transfer fluid at 30 to 35 degrees Fahrenheit to cool mozzarella cheese in a production line setting to enable handling of the cheese without deforming its shape. The cheese referred to in the Abler patent does not need to be frozen, but it does need to be cooled in order to be processed. In this example the food product, i.e. cheese, is immersed in brine heat transfer fluid. In other examples of prior practices, later referred to, the food packages are described as moving on a conveyor through a spray of heat transfer fluid as part of a flowing stream of products being processed.

[0003] Currently, various food packaging materials are in use. Some foods are film-wrapped. Here, "film wrapped" means that the product is covered by a pliable sheet of wrapping material such as paper or plastic. Polypropylene film is used to enclose some kinds of ground meat products, such as tubular containers known as "chubs" which often contain ground meat. Other polymer food-packaging films, as well as natural casings, are in use, some of which are laminated. Still other film-packaged foods have at least part of their wrappers made from paper products.

[0004] Cooling a product such as packaged meat can be accomplished by contacting the outer layer of the food package to be cooled with a chilled heat transfer fluid such as cold air. The item to be cooled is typically placed in a cold room and cold air is circulated around the packages that contain the meat. However, this cold air process is time consuming and can take several hours. Meat packages can be cooled much faster by using a cold liquid as the heat transfer fluid and coolant and creating contact between the cold liquid and the package. One reason for this is that many liquids have a much higher heat capacity than does air. In this case "heat capacity" is the quantity of heat that can be removed from a product or package per degree rise in coolant temperature. Thus a cold liquid when used as the coolant provides the advantage of removing more heat from a product per degree rise in coolant temperature than can be removed using cold air. This principle is demonstrated by the fact that a person immersed in air at 35 degrees Fahrenheit will live much longer than a person floating in water at 35 degrees Fahrenheit.

[0005] Another desirable characteristic of a heat transfer fluid used as a coolant for film-wrapped food processing is the ability of the heat transfer fluid to maintain its liquid state well below 32 degrees Fahrenheit. Most food products will freeze only at temperatures that are well below the freezing point of pure water. Furthermore, in order to increase the rate of heat transfer from a food or other product into a surrounding cooling liquid, the temperature of that liquid must be significantly below the final target temperature of the product. In order to create an efficient liquid aqueous heat transfer fluid for such purposes, something thus must be added to pure water to lower the freezing point of the resultant solution.

[0006] Propylene glycol is such an additive, and an aqueous propylene glycol solution is currently used in some food package processing plants as a heat transfer fluid and coolant to quickly reduce the temperature of, and often freeze, various food products in packages as part of a stream of food product packages in process. The heat transfer fluid created by the aqueous propylene glycol solution is first cooled and is then allowed to contact the package surrounding the enclosed food products flowing as part of the stream of food product packages in process.

[0007] U.S. Pat. No. 3,315,489 filed by Zebarth on Dec. 20, 1965 discloses an example of the use of an aqueous propylene glycol solution as a heat transfer fluid for cooling poultry. The Zebarth process involves poultry wrapped in plastic traveling on a conveyor belt passing under nozzles that spray a heat transfer fluid consisting of aqueous propylene glycol solution chilled to zero degrees Fahrenheit. Zebarth mentions that the aqueous propylene glycol solution used as a heat transfer fluid tends to "cling" strongly to the poultry carcasses being chilled.

[0008] U.S. Pat. No. 4,329,850 issued to Drummond discloses another example of the use of aqueous propylene glycol solution as a heat transfer fluid for cooling food items. This chiller for edible food products uses an endless conveyor to move the food products along a serpentine path through an insulated enclosure. Cooled aqueous propylene glycol solution heat transfer fluid is evenly distributed over the conveyor so that the heat transfer fluid falls over the food products. The system is designed to cool plastic-wrapped sausage chubs having an elongated cylindrical shape. Heat transfer fluid that has passed over the chubs is captured in a sump and removed using two pumps. The output from one pump passes through a refrigeration apparatus, while the output from the other does not. The two outputs are combined and flow over newly arrived chubs to cool them. The temperature of the combined output is regulated by varying the relative output rates of the two pumps.

[0009] Although recovery and reuse of a heat transfer fluid can reduce costs, one important practical consideration associated with use of aqueous propylene glycol as a heat transfer fluid to cool packages is the fact that there is a tendency for some of the heat transfer fluid to cling to the wrapper of the packages and be carried out of the plant, thus preventing recovery and reuse of such portion of the heat transfer fluid as clings to the wrapper. Some of the aqueous propylene glycol solution clings in spite of use of a stream of air from a so-called air knife to remove residual heat transfer solution clinging to the package. This clinging may be explained by interactions between the propylene glycol and the wrapper surface at the molecular level, although this mechanism, as far as the inventor is aware, has not been proved. What is significantly clear in any event is that prior to the present invention, so far as the inventor is aware, it has not been previously recognized that when an aqueous potassium acetate solution is used as the heat transfer fluid for contacting and cooling food packages, there is substantially less residue left clinging to the packages than when an aqueous propylene glycol solution is used as the heat transfer fluid.

[0010] In addition to costs associated with loss of the heat transfer fluid, another problem resulting from the "dinginess" of aqueous propylene glycol solution as a heat transfer fluid is aesthetic. Food packages to which a thin film of the aqueous propylene glycol solution still clings can feel slimy. This is unpleasant, particularly for packages of food that will be sold to retail customers. Although use of an aqueous propylene glycol solution as a heat transfer fluid is widespread, an improved heat transfer fluid composition which is free of known toxins, which is cheaper than aqueous propylene glycol solution, and which does not cling to the food packaging would be welcome in the trade.

[0011] One principal object of the current invention is to provide a method for cooling and freezing food that does not leave an offensive level of cooling solution residue on the package.

[0012] Another object is to provide a method for cooling and freezing products by use of a heat transfer coolant liquid and which method incurs a minimum loss of the coolant liquid due to retention on the surface of the products.

[0013] Other objects of the invention include providing a method for cooling and freezing items by use of an aqueous heat transfer liquid coolant solution that is free of known toxins, that can be produced and replaced when needed for a minimum of expense, that can be recovered and re-concentrated easily, and that is less expensive to pump than propylene glycol due to lower viscosity.

[0014] Still further objects and advantages of the invention will become apparent to persons skilled in the art from the specification and claims set forth herein, including applications of the invention to products other than packaged foods.

SUMMARY OF THE INVENTION

[0015] The invention provides a method for cooling items, such as packaged foods, that uses a chilled aqueous solution of potassium acetate as a heat transfer fluid to contact the food packages and which solution is formed so as to be free of presently known toxins, so as to have a low viscosity, so as to be relatively inexpensive, and not cling to the packages. The method of the invention is achieved by use of an aqueous potassium acetate solution which is less viscous than an aqueous propylene glycol solution, thereby making the aqueous potassium acetate solution less expensive than aqueous propylene glycol solution to pump through the apparatus. While aqueous propylene glycol solution with a freezing point of 20 degrees Fahrenheit has a viscosity of 6 cP, aqueous potassium acetate solution with the same freezing point has a viscosity of only 1.56 cP (ASHRE TRANS. Vol. 106 p 267 (2000)). Products can be cooled using the inventive method on an individual basis as well as on an assembly line or other processing line basis.

[0016] The present invention can be applied, in one embodiment, to providing an improved method for lowering the temperature of each of a series of food packages being processed in a processing line to be at or below a target temperature. If one wants to freeze the contents of the package, the target temperature typically will be below the freezing point of its contents. If it is only desired to cool the product and not freeze it, the target temperature typically will be above the freezing temperature of the contents. Practice of the invention includes the steps of (a) establishing a source of aqueous potassium acetate solution of a known concentration and which by its nature tends to shed excess portions thereof on said packages after the packages leave a location at which they are contacted by or immersed in said aqueous potassium acetate solution; (b) controlling the temperature of the said source of aqueous potassium acetate solution; (c) supplying the aqueous potassium acetate solution to piping, contacting and timing means associated with a processing line along which a series of food packages move and also operatively associated with said source of aqueous potassium acetate solution in a manner which enables each package of food to be contacted for a sufficient time to cause each such package to reach a desired target temperature or below by application of a portion of the aqueous potassium acetate solution; (d) contacting each package so as to lower the temperature of each package of food to said desired target temperature or below; and (e) moving each package of food along the processing line without any substantial portion of the aqueous potassium acetate solution adhering to the food packages after the packages move beyond the region where contact takes place. The method can, and preferably does, include the step of adding corrosion inhibitor to the potassium acetate solution, as well as the step of purging the system piping and contacting means of any zinc or brass parts and fittings that might corrode. The method of the invention may and preferably does also include the steps of adjusting the concentration of the potassium acetate solution such that it is greater than the concentration at which the potassium acetate solution starts to freeze at the target temperature of the food and controlling the temperature of the potassium acetate solution to be below the target temperature of the food. The potassium acetate solution contacts the food packages until the temperature of the food packages is below the target temperature.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Flexible packaging for food products is made from a variety of materials, too varied to be comprehensively described herein. Some is thin and flexible, some is thin, relatively heavy and inflexible, some is at least partly made from paper and some assumes the form of being an opaque plastic bag containing food products loose inside. As an example, a moderately thin film of polypropylene can be formed into a tube and used in chubs or in bags.

[0018] To start the process of the invention, an aqueous potassium acetate solution is prepared. The solution comprises at least water and potassium acetate and preferably is constituted so that when applied to plastic film and the like food packaging materials it does not significantly adhere to the surface of those materials or, in other words, does not leave a residue that would be offensive to the typical consumer. The solution preferably will be constituted with a potassium acetate concentration greater than the concentration at which the potassium acetate solution starts to freeze at the target temperature proposed. In a preferred embodiment, the solution is made up by mixing potassium acetate with water to form an aqueous potassium acetate solution with a concentration of 50% by weight. Preferably a non-toxic corrosion inhibitor is added to the solution. Such a solution can be ordered pre-mixed from Cryotech De-Icing Technology, 6103 Orthoway, Fort Madison, Iowa 52627. Other concentrations of aqueous potassium solution greater or smaller than

50% can also be used. The water preferably will be pure enough to meet local drinking water standards. Solutions more dilute than 50% can be used; preferably the use of such dilute solutions is limited to situation where the solution is to be used above −76 degrees Fahrenheit. The concentration can be measured by measuring the refractive index of the solution. A person skilled in the art can consult standard references to determine the freezing point of aqueous potassium acetate solutions at different concentrations. The potassium acetate solution concentration is adjusted to optimize performance. If the concentration is too high, the solution will be more expensive to prepare and more viscous and difficult to pump. If the concentration is too low, the freezing point of the solution may be too close to the desired resultant temperature, i.e. the target temperature, of the item to be cooled and either the cooling will take too long or the solution will start to freeze and thus become difficult to pump. Satisfactory handling characteristics can be achieved at reasonable concentrations and persons skilled in the art can readily determine appropriate concentrations for processing particular foods of interest. For example, although a wide range of concentrations can be used, a 50% aqueous solution of potassium acetate constituted as described above has a freezing point of approximately −76 degrees Fahrenheit. A temperature of −76 degrees Fahrenheit is well below the freezing point of many food items, including meat; thus, 50% by weight is within a range of typically satisfactory concentrations. The solution is then supplied to piping and contacting means operatively associated with the source in a manner which enables each package to be contacted for an appropriate amount of time by a portion of the solution. This means can include pipes, pumps, valves, temperature measuring equipment, timers, spray heads to spray the solution, tubs to contain the solution for immersing the packages, trays for holding a flowing stream of the solution, and other apparatus for contacting the package with the solution. Each package is contacted by the solution so as to lower its temperature to below the target temperature. After being contacted by the solution, each package moves along the processing line without any substantial portion of the solution adhering to the packages that have been treated with the solution. While substantial portions of the propylene glycol solution presently used in the meat processing industry typically will cling to the polypropylene film on the outside of the package, often creating an offensive residue effect, potassium acetate solution prepared as described hereinabove, when applied in the manner of the invention, does not. More specifically, it has been shown that levels of "carryout" are reduced by as much as 75% when aqueous potassium acetate solution is substituted for aqueous propylene glycol solution.

[0019] As an example of the invention being applied, the temperature of each of a series of polyethylene-wrapped chubs being processed in a processing line is lowered to be at or below a target temperature. The equipment used for this process in this example is a Liquid Contact Chiller manufactured by Midwest Metalcraft, of Windsor Mo. Chubs 24 inches long and 4 inches in diameter filled with 90% lean ground beef at 43 degrees Fahrenheit were chilled using a 25% aqueous solution of potassium acetate at 5 degrees Fahrenheit as a heat transfer fluid. After 20 minutes their core was 34 degrees Fahrenheit and their crust was 24 degrees Fahrenheit.

[0020] In another example of the invention being applied, the same model of Liquid Contact Chiller and the method of the present invention was applied to cheese packaged in the cylindrical chubs in which it was to be shipped to another plant for further processing. These cheese chubs, with a core temperature of 110 degrees Fahrenheit and a crust temperature of 105 degrees Fahrenheit, were chilled using a 25% aqueous potassium acetate solution at 17 degrees Fahrenheit as a heat transfer fluid. After 45 minutes the core temperature was 60 degrees Fahrenheit and the crust temperature was 25 degrees Fahrenheit.

[0021] To describe application of the invention more specifically it may be noted that the above two examples were processed according to the invention in the following way. The equipment used was a Midwest Metalcraft Liquid Contact Chiller test unit built on a trailer for experimental use. A 50% by weight aqueous potassium acetate solution obtained from Cryotech De-Icing Technology, diluted with an equal volume of water, together with a corrosion inhibitor, was placed in a storage tank on the test unit. The solution was circulated through a refrigerant chiller to reduce the temperature to the desired point. The solution left the refrigerant chiller through pipes and flowed to the liquid contact chiller where the solution cascaded over the packaged food product, lowering the temperature of the food product much more quickly and much more cost effectively than placing the product in cold air. The solution was then recycled through the refrigerant chiller, and returned back to the liquid contact chiller. This recycling process ensured that the temperature of the solution remained sufficiently cold.

[0022] In food processing plants, it is common for the liquid contact chiller and the refrigerant chiller to be shut down during non-process hours and restarted each day. It takes approximately an hour to bring the above-described aqueous potassium acetate solution from ambient to 5 degrees Fahrenheit, for example. During the normal process of food processing plant operations, it also is common that plant sanitation water rinses are performed throughout the plant. During these operations, additional water may accidentally be added to the aqueous potassium acetate solution. Since dilution of the aqueous potassium acetate solution raises its freezing point, such additional water in the solution could hinder performance characteristics. In the preferred embodiment, therefore, the solution is re-concentrated in order to correct the potassium acetate concentration. Re-concentration can be accomplished by, for example, pumping the solution into a vessel that raises the temperature above the boiling point of water, thereby boiling off excess water; boiling also can have sanitizing value. As another example, the solution could be re-concentrated by adding more potassium acetate to the solution. The potassium acetate concentration in the solution is measured using a refractometer as described above.

[0023] The method of the invention does not require novel equipment. Instead, it can be practiced using conventional equipment that in the past has operated using aqueous propylene glycol as the heat transfer fluid, by substituting aqueous potassium acetate solution as the heat transfer fluid. (For example, the method can be practiced using the Midwest Metalcraft Liquid Contact Chiller, referenced above, available from Midwest Metalcraft & Equipment, 200 Industrial Drive, P.O. Box 85, Windsor, Mo. 65360.

[0024] Preferably, if the inventive method is practiced using existing liquid contact chillers, the system piping and contacting means should be purged of any zinc or brass parts and fittings, and parts and fittings made of compounds such as stainless steel or plastic should be substituted, since zinc and brass (which are commonly used for fittings in such apparatus) can corrode in the presence of potassium acetate.

[0025] Many variations are contemplated in addition to those described above. For example, although the invention has been described with reference to packaged food products, the products to be chilled need not be food, and need not be packaged. The "products" could be any item requiring chilling. While embodiments of the invention have been illustrated and described in detail herein, the same is considered illustrative and not restrictive in character, it being understood that only the preferred embodiments have been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected.

What is claimed is:

1. A method for lowering the temperature of one or more food packages being processed to a temperature at or below a target temperature, the method comprising:

(a) establishing a source of aqueous potassium acetate solution of a known concentration;

(b) controlling the temperature of said solution to be at or below said target temperature;

(c) supplying said solution to a location;

(d) placing one or more of said packages in said location, in a manner which enables each said package to be contacted by at least a portion of said solution;

(e) contacting each said package with at least said portion of said solution so as to lower the temperature of each said package to a temperature at or below said target temperature; and

(f) discontinuing said contacting.

2. The method of claim **1** wherein, after said contacting has been discontinued, said packages substantially shed said solution.

3. The method of claim **1** further comprising the step of adding corrosion inhibitor to said solution.

4. The method of claim **1** further comprising the step, after contacting said packages with said solution, of recovering and returning at least a portion of said solution to said source.

5. The method of claim **4** further comprising the step of adjusting the concentration of said recovered solution contacting said packages.

6. The method of claim **5** wherein the step of adjusting the concentration of said recovered solution comprises the step of boiling said recovered solution.

7. The method of claim **6** wherein the step of adjusting the concentration of said recovered solution comprises the step of adjusting the concentration of the recovered solution by adding potassium acetate.

8. The method of claim **1** further comprising the step of adapting one or more pre-existing liquid contact chillers to supply said solution to said location or to contact said packages with said solution, by removing from said pre-existing liquid contact chiller those zinc and brass parts or fittings that might corrode from contact with said solution.

9. A method for lowering the temperature of one or more products to a temperature at or below a target temperature, the method comprising:

(a) establishing a source of aqueous potassium acetate solution of a known concentration;

(b) controlling the temperature of said solution to be at or below said target temperature;

(c) supplying said solution to a location in a manner which enables each said product to be contacted by at least a portion of said solution;

(d) placing one or more of said products in said location, in a manner which enables each of said products to be contacted by at least a portion of said solution;

(e) contacting each of said products with at least said portion of said solution so as to lower the temperature of each of said products to a temperature at or below said target temperature; and

(f) discontinuing said contacting.

10. The method of claim **9** wherein, after said contacting has been discontinued, said products substantially shed said solution.

11. The method of claim **9** further comprising the step of adding corrosion inhibitor to said solution.

12. The method of claim **9** further comprising the step, after contacting one or more of said products with said solution, of recovering and returning at least a portion of said solution to said source.

13. The method of claim **12** further comprising the step of adjusting the concentration of said recovered solution contacting said products.

14. The method of claim **13** wherein the step of adjusting the concentration of said recovered solution comprises the step of boiling said recovered solution.

15. The method of claim **14** wherein the step of adjusting the concentration of said recovered solution comprises the step of adjusting the concentration of the recovered solution by adding potassium acetate.

16. The method of claim **9** further comprising the step of adapting one or more pre-existing liquid contact chillers to supply said solution to said location or to contact said products with said solution, by removing from said pre-existing liquid contact chiller those zinc and brass parts or fittings that might corrode from contact with said solution.

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