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(54) **PROCESS AND METHOD OF STERILIZING
ASEPTIC CONTAINERS**

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(57) **ABSTRACT**

Methods for sterilizing containers, which include sterilizing preformed, or partially preformed, aseptic containers. The method includes sterilizing the containers, heating the sterilized containers to an appropriate temperature, molding the heated containers, or partially preformed containers, by an orientation blow molding process, if necessary, and filling the molded containers with an aseptic material. The filled containers are then hermetically sealed with an aseptic closure. The sterilizing is accomplished within an enclosure completely filled with an atmosphere consisting of ozone in air, and further by bringing a sterilizing fluid consisting of ozone in oxygen, or ozone in air, or ozone dissolved in water into contact with internally disposed surfaces of the containers, and injecting the gaseous mixtures containing ozone, or ozonated water, into the empty preformed containers.

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(60) Provisional application No. 60/601,371, filed on Aug. 13, 2004.

PROCESS AND METHOD OF STERILIZING ASEPTIC CONTAINERS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/601,371, filed Aug. 13, 2004, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] The term aseptic packaging, in generic terms, means performing microbiological sterilization of product and package separately, and then filling the package with the product under sterile condition. The aseptic packaging and its extended term ultra clean, expand to cover a wide array of packaging material, shapes, and forms. This includes cups, bricks, pouches, bottles, and jars. These packages are generally made of paper, plastic, etc. Many foodstuffs, such as drinks, milk, milk products, sauces, soups, etc., are aseptically packaged to increase their shelf-life and product quality.

[0003] The technology for commercial aseptic packaging has been available for over 50 years, and has been used with great acceptance in Europe since the early 1960's. This process was not approved for use in the United States until 1981. Initially only used for single serving milk and juice containers, recently this process has grown in popularity. This is due to the reduction in cost of mass produced aseptic packaging equipment and the increase in energy costs over the past 5 to 10 years. Much less energy is required to run an aseptic plant, compared to a packaging plant with conventional technology, and the storage costs are greatly reduced, since there is no need to refrigerate. It is expected that the over 500 aseptic packaging installations in the United States alone produce between 15 and 20 billion packages a year. Today, aseptic packages range in size from small consumer juice boxes, to multi-thousand gallon commercial containers of orange juice or tomato paste.

[0004] In the traditional canning process, the food is introduced into a non-sterilized container, and then heated. The container is maintained at a high temperature for a sustained length of time (typically 20 to 50 minutes), which effectively cooks the food within the container as it disinfects the container itself.

[0005] Conventional aseptic container sterilization methods comprise the steps of sterilizing preforms, heating the sterilized preforms to a temperature appropriate to orientation, molding the heated preforms into containers by an orientation blow molding process, filling the molded containers with an aseptic material, and hermetically sealing the filled containers with an aseptic closure. One type of sterilization method is typically performed by dipping container preforms in a sterilizing solution, withdrawing the preforms from the solution, and thereafter, applying hot dry sterile air to the preforms to remove the residual adhering solution.

[0006] The hot dry air used in the conventional method for drying preforms cannot be heated to very high temperatures due to the likelihood of deforming certain plastic or composite type preforms. Therefore, certain types of preforms may require considerable time periods for drying. Further-

more, unless dried completely, the preforms cannot be heated uniformly, which may be an important requirement in a subsequent plastic or composite type container blow molding process.

[0007] Another similar sterilization technique involves spraying hydrogen peroxide solutions, or oxonia solutions, a combination of hydrogen peroxide and peristaltic acid or hydrogen peroxide, and peroxyacetic acid, into, or into and onto, aseptic containers during the forming process [A. M. Mohan, Packaging Digest, Vol. 41, No. 7, pp. 26-29 (July, 2004)], and subsequently, blowing heated sterile air into the empty treated containers to remove and dry out the residual sterilizing solutions, prior to filling with aseptic materials and then, executing a final sealing and closure process.

[0008] For the foregoing reasons, a need exists within the industry for a system that will provide an aseptic container molding-filling method, which minimizes conventional usage volume requirements of sterile hot air needed for drying, and eliminates problems related to the disposal of waste hydrogen peroxide types of solutions. Additionally, a method is needed which makes it possible to sterilize and produce aseptic containers within a shortened period of time, and also keeps the container performs uniformly heated for a subsequent blow molding and sealing process.

SUMMARY

[0009] The present invention is directed to a method that satisfies the need in society, in general, for a system that will provide an aseptic container molding and/or filling method which minimizes conventional usage volume requirements of sterile hot air needed for drying, and also eliminates problems related to the disposal of waste hydrogen peroxide types of solutions. Additionally, the invention is directed to a method which makes it possible to sterilize and produce aseptic containers within a shortened period of time, and also keeps the container performs uniformly heated for a subsequent blow molding and sealing process.

[0010] The present invention provides a method of sterilizing and filling preformed or aseptic containers. The method includes the steps of sterilizing these containers by bringing a sterilizing fluid that is either gaseous ozone in oxygen, gaseous ozone in air, or ozone dissolved in water, into contact with internally disposed surfaces of the containers. The containers are then heated to an appropriate temperature, filled with an aseptic material, and then hermetically closed with an aseptic closure.

[0011] A second aspect of the present invention provides a method for automatically aseptically bottling aseptically sterilized foodstuffs or medical products. The method includes the steps of providing a plurality of aseptically sterilized containers and aseptically filling the containers with aseptically sterilized foodstuffs or medical products within an enclosure filled with partially ozonated air.

[0012] A third aspect of the present invention provides a method of automatically aseptically bottling aseptically sterilized foodstuffs or medical products. The method includes providing a plurality of containers, providing a means for aseptically disinfecting the containers using ozonated gas mixtures or solutions of ozone dissolved in water, and a means for aseptically filling the containers with aseptically sterilized foodstuffs or medical products within an enclosure filled with partially ozonated air.

[0013] A fourth aspect of the present invention provides an aseptic processing apparatus for aseptically bottling aseptically sterilized foodstuffs or medical products. This apparatus includes:

[0014] a) a sterile tunnel for surrounding a plurality of containers filled with slightly pressurized sterile air containing ozone;

[0015] b) a conveying apparatus for moving the plurality of containers through the sterile tunnel;

[0016] c) an exterior container sterilizing apparatus, comprising a container sterilizing fluid in-feed injector, a sterilizing fluid sprayer, and conveying apparatus for sterilizing an exterior surface of each container;

[0017] d) an interior container sterilization apparatus for applying a sterilant to an interior surface of each container;

[0018] e) a product filler apparatus for filling the aseptically sterilized plurality of containers with the desired aseptically sterilized products;

[0019] f) a lidding apparatus for applying an aseptic closure to each container; and

[0020] g) a container discharge apparatus for removing the containers from the sterile tunnel.

DESCRIPTION

[0021] This invention provides a method of sterilizing preformed, or partially preformed, aseptic containers, comprising the steps of sterilizing these containers, heating the sterilized containers to an appropriate temperature, molding the heated containers, or partially preformed containers, by an orientation blow molding process, if necessary, filling the molded containers with an aseptic material, and hermetically closing the filled containers each with an aseptic closure. The sterilizing is accomplished within an enclosure completely filled with an atmosphere consisting of ozone in air and further by bringing a sterilizing fluid consisting of ozone in oxygen, or ozone in air, or ozone dissolved in water into contact with internally disposed surfaces of the containers and injecting the gaseous mixtures containing ozone, or ozonated water, into the empty preformed containers.

[0022] One embodiment of the present invention is to provide an aseptic container molding-filling method, which minimizes conventional usage volume requirements of sterile hot air needed for drying. The present invention also eliminates problems related to the disposal of waste hydrogen peroxide types of solutions. Such an elimination makes it possible to sterilize and produce aseptic containers within a shortened period of time, and to keep the container preforms uniformly heated for a subsequent blow molding and sealing process.

[0023] Another embodiment of the present invention provides a method of molding and filling aseptic containers, which comprises the steps of sterilizing container preforms, heating the sterilized container preforms to a temperature appropriate to orientation, molding the heated container preforms by an orientation blow molding process, filling the molded containers with an aseptic material and hermetically closing the filled containers, each with an aseptic closure. The sterilizing step is performed by bringing a sterilizing fluid, such as ozone, or ozone in oxygen, or ozone in air, or

ozone dissolved in water, into contact with, at least, interiorly disposed surfaces of the preforms.

[0024] In the aseptic container molding-filling method of the present invention, the sterilizing step is preferably performed by bringing the sterilizing fluid into contact with the surfaces of inverted preformed containers, so that the removal of residual traces of the sterilizing fluid, or fluids, can be accomplished more rapidly and completely, and at lower temperatures. This makes it possible to sterilize the containers or preforms within a shortened period of time, and to hold the containers at lower uniformly heated temperatures for blow molding prior to the filling process. Preferably, the sterilizing step, heating step, molding step, filling step, and closing step, are all performed within a totally enclosed aseptic chamber, which is completely filled with a slightly pressurized atmosphere consisting of air, or some other gas containing ozone, at concentration levels of at least 10 times higher than that typically found in an ambient air environment.

[0025] The sterilizing fluid to be brought into contact with the internally disposed surfaces of the containers or preforms, may be produced using a conventional or non-conventional type of ozone generator, employing relatively pure oxygen or air as the main feed gas. If a solution of ozone dissolved in water is used instead of a gas during the sterilization process, the ozonated water may be made on-site by dissolving ozone in the treatment water using conventional and well-known techniques. In a preferred embodiment, an ozonated gas mixture, or ozonated water mixture, is directed into inverted (i.e., upside down) containers during the sterilization process so that the water solution, or heavier than air sterilization gas mixture, will easily fall out of the inverted containers after the sterilization treatment process has been completed. In the case of the ozonated water solution process, a stream of warm dry sterile air may be blown into the inverted containers to hasten the drying process, if necessary. The containers may travel through the aseptic chamber on a conveyor belt system that is designed to automatically re-orientate the containers to be right side up, prior to the filling/closure process.

[0026] The sterile hot air heating process may be performed at temperatures that are up to or significantly less than 100° C., due to the inverted orientation of the containers during the drying process. This temperature advantage can be significant in cases involving container types that soften at relatively low temperatures.

[0027] The molding step may or may not be necessary, depending on the particular embodiment. The molding step, if necessary, in the case of completely preformed bottles or other types of containers, may be performed by fitting the preforms into a mold and injecting a pressurized aseptic gas into the mold.

[0028] The lidding, or closing step, may be performed by employing a molding/closure procedure and/or feeding lids, or caps sterilized in-situ, or in advance, outside the aseptic chamber, and fitting the caps over mouths of the respective containers.

[0029] Illustrative embodiments of the invention are described above. While the invention is susceptible to various modifications and alternative forms, specific embodi-

ments, thereof, have been described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

[0030] It will, of course, be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developer's specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless, be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

What is claimed is:

1. A method of sterilizing and filling aseptic containers comprising the steps of:

- a) sterilizing said containers, wherein said sterilizing step comprises bringing a sterilizing fluid selected from the group consisting of gaseous ozone in oxygen, gaseous ozone in air, and ozone dissolved in water, into contact with internally disposed surfaces of said containers;
- b) heating said sterilized containers to an appropriate temperature;
- c) filling said sterilized containers with an aseptic material; and
- d) hermetically sealing said filled sterilized containers, each with an aseptic closure.

2. The method of claim 1, further comprising the step of injecting ozonated gas mixtures, and/or ozonated water into partially sealed sterilized containers.

3. The method of claim 1, wherein said containers are made of a material selected from the group consisting of:

- a) metal glass;
- b) plastic;
- c) paper; and
- d) composite packaging material, wherein the composite packaging material is conventional or unconventional.

4. The method of claim 1, wherein said sterilizing, heating, filling, and sealing steps, are all performed within an aseptic enclosure containing a gaseous atmosphere at pressures slightly above the ambient condition and containing concentration levels of ozone that are at least about 10 times higher than ambient level.

5. The method of claim 1, wherein said sterilizing fluid is produced by a device selected from the group consisting of:

- a) conventional ozone generating device that employs relatively pure oxygen as the primary feed gas;
- b) a conventional ozone generating device that employs air as the primary feed gas;
- c) an unconventional ozone generating device that employs relatively pure oxygen as the primary feed gas; and

d) an unconventional ozone generating device that employs air as the primary feed gas.

6. The method of claim 1, wherein said ozonated water is produced by dissolving ozone in water before the sterilization process.

7. The method of claim 1, wherein said ozonated water is produced by dissolving ozone in water during the sterilization process.

8. The method of claim 1, wherein said heating step is performed by applying a heated gas to the container, wherein said heated gas is selected from the group consisting of:

- a) air;
- b) inert gas; and
- c) an inert gas mixture.

9. The method of claim 1, wherein said sealing step is performed by feeding lids or caps sterilized within the aseptic chamber or in advance outside the aseptic chamber, and fitting the caps over mouths of said containers.

10. The method of claim 1, further including a feedback control system for maintaining aseptic process conditions.

11. The method of claim 1, further comprising sterilizing the outside surfaces of the containers by a means selected from the group consisting of:

- a) ambient ozonated gas mixtures;
- b) injected ozonated gas mixtures; and
- c) injected solutions of ozone dissolved in water.

12. A method of sterilizing and filling containers comprising the steps of:

- a) sterilizing preforms, which are to be converted into aseptic containers, wherein said sterilizing step comprises bringing a sterilizing fluid selected from the group consisting of gaseous ozone in oxygen, gaseous ozone in air, and ozone dissolved in water, into contact with internally disposed surfaces of said preforms;
- b) heating said sterilized preforms to an appropriate temperature;
- c) molding said heated preforms by an orientation blow molding process to form the containers;
- d) filling said molded containers with an aseptic material; and
- e) hermetically sealing said filled containers, each with an aseptic closure.

13. The method of claim 12, further comprising the step of injecting ozonated gas mixtures and/or ozonated water into partially sealed sterilized containers.

14. The method of claim 12, wherein said containers are made of a material selected from the group consisting of:

- a) metal glass;
- b) plastic;
- c) paper; and
- d) composite packaging material, wherein the composite packaging material is conventional or unconventional.

15. The method of claim 12, wherein said sterilizing, heating, molding, filling, and sealing steps are all performed within an aseptic enclosure containing a gaseous atmosphere at pressures slightly above the ambient condition and con-

taining concentration levels of ozone that are at least about 10 times higher than ambient level.

16. The method of claim 12, wherein said sterilizing fluid is produced by a device selected from the group consisting of:

- a) conventional ozone generating device that employs relatively pure oxygen as the primary feed gas;
- b) a conventional ozone generating device that employs air as the primary feed gas;
- c) an unconventional ozone generating device that employs relatively pure oxygen as the primary feed gas; and
- d) an unconventional ozone generating device that employs air as the primary feed gas.

17. The method of claim 12, wherein the ozonated water is produced by dissolving ozone in water before the sterilization process.

18. The method of claim 12, wherein the ozonated water is produced by dissolving ozone in water during the sterilization process.

19. The method of claim 12, wherein the heating step is performed by applying a heated gas to the preforms, wherein said heated gas is selected from the group consisting of:

- a) air;
- b) inert gas; and
- c) an inert gas mixture.

20. The method of claim 12, wherein the molding step is performed by fitting the preforms into a mold and injecting a pressurized aseptic gas or gas mixture that may or may not contain ozone into the mold.

21. The method of claim 12, wherein said sealing step is performed by feeding lids or caps sterilized within the aseptic chamber, or in advance outside the aseptic chamber and fitting the caps over mouths of said containers.

22. The method of claim 12, further including a feedback control system for maintaining aseptic process conditions.

23. The method of claim 12, further comprising sterilizing the outside surfaces of the containers by a means selected from the group consisting of:

- a) ambient ozonated gas mixtures;
- b) injected ozonated gas mixtures; and
- c) injected solutions of ozone dissolved in water.

24. A method for automatically aseptically bottling aseptically sterilized product comprising the steps of providing a plurality of aseptically sterilized containers, and aseptically filling each of said containers with aseptically sterilized product within an enclosure filled with partially ozonated air.

25. The method of claim 24, wherein said product is foodstuffs products or medical products.

26. A method of automatically aseptically bottling aseptically sterilized product comprising:

- a) means for providing a plurality of containers;
- b) means for aseptically disinfecting the containers using ozonated gas mixtures or solutions of ozone dissolved in water; and
- c) means for aseptically filling the containers with aseptically sterilized product within an enclosure filled with partially ozonated air.

27. The method of claim 26, wherein said product is foodstuffs products or medical products.

28. An aseptic processing apparatus for aseptically bottling aseptically sterilized products comprising:

- a) a sterile tunnel for surrounding a plurality of containers filled with slightly pressurized sterile air containing ozone;
- b) a conveying apparatus for moving the plurality of containers through said sterile tunnel;
- c) an exterior container sterilizing apparatus, comprising a container sterilizing fluid in-feed injector, a sterilizing fluid sprayer, and conveying apparatus for sterilizing an exterior surface of each container;
- d) an interior container sterilization apparatus for applying a sterilant to an interior surface of each container;
- e) a product filler apparatus for filling the aseptically sterilized plurality of containers with the aseptically sterilized product;
- f) a lidding apparatus for applying an aseptic closure to each container; and
- g) a container discharge apparatus for removing said completed containers from the sterile tunnel.

29. The apparatus of claim 28, further comprising a drying apparatus for activating and removing the sterilant from the interior and exterior surface of each container.

30. The apparatus of claim 28, wherein the product is foodstuffs products or medical products.

31. The apparatus of claim 28, wherein said sterile tunnel further comprises a plurality of partitions forming a plurality of sterilant concentration zones.

32. The apparatus of claim 28, wherein said sterile tunnel further comprises a container zone, in which said containers are inverted during the gas or liquid phase sterilization process.

33. The apparatus of claim 32, wherein said sterile tunnel further comprises a container zone, in which the containers are re-inverted after the sterilization or drying process.

34. The apparatus of claim 28, further comprising a feedback control system for maintaining aseptic process control throughout the entire process.

35. The apparatus of claim 28, wherein said sterile tunnel encloses the interior container sterilization apparatus, the activation and drying apparatus, the product filler apparatus, and the lidding apparatus, and further encloses a slightly pressurized and slightly ozonated air environment throughout the entire tunnel enclosure.