CLAIMS

1. A process for pasteurization or sterilization of a bottled liquid using a microwave heating system, the process comprising:

(a) providing a plurality of sealed bottles at least partially filled with a liquid, in which the pressure within each of the sealed bottles is not more than 1.5 atm;

(b) passing the at least partially filled bottles through a microwave heating chamber; and

(c) during at least a portion of the passing, heating the bottles, in which at least a portion of the heating is performed using microwave energy; and

in which each of the bottles is formed from a polymeric material and in which the ratio of the dry empty weight of an individual bottle measured without a cap to the volume capacity for liquid in the individual bottle is not more than 0.040 g/mL.

2. A process according to Claim 1, in which the polymeric material has a glass transition temperature, in which the heating is sufficient to increase the minimum temperature of the coldest region of the liquid to a temperature at or above a target temperature for a predetermined amount of time, and in which the target temperature is greater than the glass transition temperature of the polymeric material.

3. A process according to Claim 2, in which during the heating, the maximum temperature of the liquid at the wall of each of the bottles is above the glass transition temperature of the polymeric material for a total time of at least 0.5 seconds and not more than 3 minutes.

4. A process according to Claim 2, in which the heating includes discharging microwave energy into the microwave heating chamber via two or more microwave launchers; and further comprising, passing each of the bottles by each of the launchers, in which the temperature of the liquid at the wall of each of the bottles increases to a temperature greater than the glass transition temperature when the bottle is passing by one of the launchers and decreases to a temperature less than the glass transition temperature when the bottle is not passing by one of the launchers, and in which each of the launchers discharges at least 5 kW and not more than 25 kW of microwave energy into the microwave heating chamber and in which the maximum temperature of the liquid at the wall of each of the bottles is greater than the glass transition

temperature for at least 0.5 seconds and not more than 20 seconds while passing by one of the launchers.

5. A process according to Claim 2, in which during the heating, the minimum temperature of the coldest region of the liquid in the bottles is maintained at or above a target temperature for a first period of time, t_1, and in which during the heating, the maximum temperature of the liquid material at the wall of the bottles is maintained at or above the glass transition temperature for a second period of time, t_2, and in which the ratio of t_1 to t_2 is at least 0.40.

6. A process according to Claim 2, in which the target temperature is at least about 75°C and in which the glass transition temperature is at least 50°C or in which the target temperature is at least 115°C and the glass transition temperature is at least 85°C.

7. A process according to Claim 1, in which at least a portion of the passing includes at least one of passing the bottles through the microwave heating zone in an upright configuration, passing the bottles through the microwave heating zone in an inverted configuration, and passing the bottles through the microwave heating zone in a single-file line in an end-to-end or a side-by-side configuration, and passing the bottles through the microwave heating zone in a carrier, and in which at least a portion of the passing is assisted by gravity.

8. A process according to Claim 1, in which the microwave heating chamber is at least partially filled with a liquid medium, in which the bottles are submerged in the liquid medium during at least a portion of the passing and at least a portion of the heating, in which the heating is sufficient to increase the minimum temperature of the coldest region of the liquid or semi-liquid material to temperature at or above a target temperature for a predetermined amount of time, in which the target temperature is greater than the glass transition temperature of the polymeric material, in which the average temperature of the liquid medium at the wall of each of the bottles is below the glass transition temperature of the polymeric material during at least a portion of the heating, and, further comprising during at least a portion of the passing and/or the heating, agitating the bottles with at least one agitation device.

9. A process according to Claim 1, in which the providing includes at least partially filling the bottles with the liquid and sealing the at least partially filled bottles with a cap in a filling and sealing zone to provide the sealed bottles, and in which none of the liquid, the bottle, and the cap have been pasteurized or sterilized prior to the filling and sealing.

10. A process according to Claim 1, in which the polymeric material is selected from the group consisting of polyethylene terephthalate, polyethylene, polypropylene, polylactic acid, polyhydroxyalkanoates, polybutylene succinate, biopolymers, and combinations thereof and in which each of the bottles has a nominal liquid capacity in the range of from 5 to 50 fluid oz.

11. A process according to Claim 10, in which the bottles do not have expansion panels.

12. A process according to Claim 1, in which the liquid has at least one of a pH greater than 3.5, a total sugar content of at least 1° Brix, and a total preservative content of less than 2 percent by weight.

13. A process according to Claim 1, in which the liquid has a pH of not more than 3.5.

14. A process according to Claim 1, in which the liquid comprises solid particulates having an average particle size in the range of from 1 to 25 mm.

15. A process according to Claim 1, in which the liquid is selected from the group consisting of tea, juice, mineral drinks, electrolyte drinks, energy drinks, vitamin drinks, shakes, smoothies, dairy drinks, alcoholic drinks, and coffee drinks.

16. A process according to Claim 1, in which the liquid is a medical liquid, a pharmaceutical liquid, a nutraceutical liquid, or a veterinary liquid and in which the microwave heating system has an overall production rate in the range of from 5 to 900 bottles per minute.

17. A process for the pasteurization or sterilization of bottled water using a microwave heating system, the process comprising:

(a) at least partially filling a plurality of bottles with water;

(b) sealing the at least partially filled bottles of water with at least one sealing device;

(c) passing the sealed bottles of water through a microwave heating chamber;

(d) continuously directing microwave energy toward the bottles of water passing through the microwave heating chamber; and

(e) heating the bottles of water to a target temperature sufficient to pasteurize or sterilize the water within the bottles using at least a portion of the microwave energy.

18. A process according to Claim 17, prior to the filling, filtering the water to remove at least a portion of any dissolved and undissolved solids, in which the water has not been subjected to reverse osmosis, UV treatment, distillation, micron filtration, or ozonation prior to the heating of step (e) and in which neither of the bottle nor the sealing device has been sterilized prior to the filling and sealing.

19. A process according to Claim 17, in which the bottles are formed from a polymeric material having a glass transition temperature, in which the heating is sufficient to increase the minimum temperature of the coldest region of the water to a temperature at or above a target temperature for a predetermined amount of time, and in which the target temperature is greater than the glass transition temperature of the polymeric material, in which the maximum temperature of the water at the wall of each of the bottles is above the glass transition temperature of the polymeric material for a total time of at least 0.5 seconds and not more than 3 minutes during the heating, in which the polymeric material is selected from the group consisting of polyethylene terephthalate, polyethylene, polypropylene, polylactic acid, polyhydroxyalkanoates, polybutylene succinate, biopolymers, and combinations thereof, and in which each of the bottles has a nominal liquid capacity in the range of from 10 fl. oz. to 40 fl. oz.