

CLAIMS

We claim:

1. A method for processing articles, the method comprising:
 - (a) obtaining an operating profile for heating a type of article in a liquid-filled microwave heating system, the operating profile including a temperature-time profile for a target F_0 value and a group of set point values for achieving the temperature-time profile, the group of set point values including a target for a control parameter of the microwave heating system;
 - (b) using a control system operatively coupled to the microwave heating system, operating the microwave heating system by:
 - (i) passing a carrier loaded with a plurality of articles of the type of article corresponding to the operating profile through a liquid-filled microwave heating chamber along a convey line such that the plurality of articles are submerged in a liquid medium within the microwave heating chamber, and
 - (ii) while passing the carrier through the microwave heating chamber, discharging microwave energy into the microwave heating chamber, the microwave energy used to heat the plurality of articles; and
 - (c) removing the plurality of articles from the microwave heating system,wherein operating the microwave heating system results in each of the plurality of articles achieving an F_0 value that is greater than or equal to the target F_0 value.
2. The method of claim 1, wherein the control parameter is a total net microwave power discharged and the target is at least one of greater than about 20 kW and less than about 300 kW.
3. The method of claim 1, wherein the control parameter is liquid temperature in the microwave heating chamber and the target is from and including about 40°C to and including about 105°C.
4. The method of claim 1, wherein the control parameter is liquid temperature in the microwave heating chamber and the target is from and including about 95°C to and including about 135°C.

5. The method of claim 1, wherein:

the discharging is performed using a plurality of microwave launchers configured to emit microwave energy into said microwave heating chamber, the microwave launchers being spaced apart from one another along a direction of travel of the carrier along the convey line;

the operating of step (b) further comprises:

passing the carrier past a first launcher of the plurality of microwave launchers and into a space between the first launcher and a second launcher of the plurality of microwave launchers adjacent the first launcher; and

holding the carrier in the space for a dwell time during which the articles are not exposed to microwave energy during the dwell time,

wherein the control parameter is total dwell time and the target is at least one of greater than about 10 seconds and less than about 10 minutes.

6. The method of claim 1, wherein the operating of step (c) further comprises:

passing the carrier through a liquid-filled preheating section along a convey line prior to passing the carrier through the microwave heating chamber; and

submerging the articles in a warm liquid medium in the preheating section during the passing of the carrier through the preheating section,

wherein the control parameter is liquid temperature in the preheating section and the target is at least one of greater than about 45°C and less than about 95°C.

7. The method of claim 1, wherein the operating of step (c) further comprises:

passing the carrier through a liquid-filled holding section along a convey line subsequent to passing the carrier through the microwave heating chamber; and

submerging the articles in a warm liquid medium in the preheating section during the passing of the carrier through the preheating section,

wherein the control parameter is liquid temperature in the preheating section and the target is at least one of greater than about 65°C and less than about 140°C.

8. The method of claim 1, wherein the operating of step (c) further comprises:

passing the carrier through a liquid-filled cooling section along a convey line subsequent to passing the carrier through the microwave heating chamber; and

submerging the articles in a cool liquid medium in the cooling section during the passing of the carrier through the cooling section,

wherein the control parameter is liquid temperature in the cooling section and the target is from and including about 35°C and less than about 65°.

9. The method of claim 1, wherein the operating of step (b) further comprises:

- (i) during at least a portion of the heating, measuring the value of the system control parameter to provide a measured value;
- (ii) comparing the measured value with the target value for the control parameter to determine a difference; and
- (iii) comparing the difference with a predetermined allowable difference (PAD); and
- (iv) when the difference is greater than the PAD, one or more of:
 - discarding the articles;
 - rerunning the articles through the microwave heating system;
 - changing a total net microwave power discharged into the microwave heating chamber;
 - changing a liquid flow rate in the microwave heating chamber;
 - changing a liquid temperature in the microwave heating chamber; and
 - changing a convey speed of the carrier through the microwave heating chamber.

10. The method of claim 1, wherein the control parameter is a liquid flow rate in a section of the microwave heating system and the target is at least one of greater than about 1 gallon per minute (gpm) and less than about 75 gpm.

11. The method of claim 1, wherein the control parameter is convey speed through a section of the microwave heating system and the target is at least one of greater than about 0.25 inches per second (in/s) and less than about 6 in/s.

12. A method for processing articles, comprising:

- (a) obtaining an operating profile for heating a type of article in a liquid-filled microwave heating system, the operating profile including a temperature-time profile for a target F_0 value and a first group of set point values for achieving the temperature-time profile;
- (b) selecting the first group of set point values from the operating profile, the first group of set point values including a first target value for a control parameter of the microwave heating system, the first target value used by a control system operatively coupled to the microwave heating system as a first operating set point for the control parameter; and

(c) using the control system operatively coupled to the microwave heating system, operating the microwave heating system by:

(i) passing a carrier loaded with a plurality of articles through a liquid-filled microwave heating chamber along a convey line, wherein the articles are submerged in a liquid medium during passing through the microwave heating chamber;

(ii) while passing the carrier through the microwave heating chamber, discharging microwave energy into the microwave heating chamber to heat the plurality of articles;

(iii) while heating the plurality of articles, measuring an actual value of the control parameter to provide a measured value; and

(d) in response to determining a difference between the measured value and the first target value exceeds a predetermined allowable difference, selecting a second group of set point values from the operating profile, the second group of set point values including a second target value for the control parameter; and

(e) using the control system, operating the microwave heating system according to the second group of set point values, including using the second target value as a second operating set point for the control parameter.

13. The method of claim 12, wherein the control parameter is selected from the group consisting of total net microwave power discharged into the microwave heating chamber, liquid temperature in a section of the microwave heating system, liquid flow rate in a section of the microwave heating system, and convey speed of the carrier through a section of the microwave heating system.

14. The method of claim 12, wherein the second group of second group of set point values is for achieving the temperature-time profile.

15. The method of claim 12, wherein the temperature-time profile is a first temperature-time profile, the target F_0 value is a first target F_0 value, and the operating profile includes a second temperature-time profile for a second target F_0 value, the second group of set point values for achieving the second temperature-time profile.

16. The method of claim 15, wherein the first temperature-time profile is different than the second temperature-time profile.

17. The method of claim 15, wherein the first target F_0 value is different than the first target F_0 value.

18. The method of claim 15, wherein the selecting of step (d) is further in response to determining a difference between the second target value for the control parameter and the measured value differ by less than the predetermined allowable difference.

19. The method of claim 49, wherein:
the control parameter is a first control parameter,
the first group of set point values includes a first target value for a second control parameter different from the first control parameter,
the second group of set point values includes a second target value for the second control parameter,
the selecting of step (b) includes using the first target value for the second system control parameter as a first operating set point for the second system control parameter during the operating of step (d), and
the selecting of step (e) includes using the second target value for the second system control parameter as a second operating set point for the second system control parameter during the operating of step (e).

20. A microwave heating system comprising:
a plurality of liquid-filled processing sections including a microwave heating chamber section, each of the plurality of processing sections comprising a respective convey segment configured to transport a carrier with a plurality of articles through the processing section such that the articles are submerged in a liquid medium during passing through the processing section; and

a control system operatively coupled to each of the plurality of processing sections to control operation of the processing sections, the control system adapted to:

(a) access an operating profile associated with a type of article, the operating profile including a temperature-time profile for a target F_0 value and a first group of set point values for achieving the temperature-time profile, the first group of set point values including a first target value for a control parameter of a processing section of the plurality of processing sections;

- (b) operate the processing section in accordance with the group of set point values including using the first target value as a first operating set point for the control parameter;
- (c) pass a carrier loaded with a plurality of articles through each processing section including the microwave heating chamber;
- (d) while passing the carrier through the microwave heating chamber, discharge microwave energy into the microwave heating chamber to heat the plurality of articles;
- (e) measure an actual value of the control parameter to provide a measured value;
- (f) in response to determining a difference between the measured value and the first target value exceeds a predetermined allowable difference, select a second group of set point values from the operating profile, the second group of set point values including a second target value for the control parameter; and
- (g) following selecting of the second group of set point values, operate the processing section according to the second group of set point values, including using the second target value as a second operating set point for the control parameter.