

A TEMPERATURE CONDITIONING SYSTEM

TECHNICAL FIELD

This invention relates generally to a temperature conditioning system for conditioning
5 liquids and articles in containment.

Background

In glass production, there is usually a need to determine or ensure the formed glass's resistance to high temperatures. Such formed glass comprises laminated glass panels or the
10 like glass articles. The typical approach is to heat the glass in a water tank filled with boiled water. For different temperature profiles, the water tank needs to be emptied and refilled with water of the appropriate temperature which leads to inefficiency, higher energy requirement to reheat and in heat resistance detection inaccuracy contributed by time lapse between heating and reheating during water change. The long duration required for heating
15 water in a typical water tank and the risk of water evaporation during heating of the water results in the need for the water heating process to be constantly monitored. The long duration required for manual monitoring of the water tank during the typical heating process may also result in observation lapses and erratic temperature cycles or profile due to employment of thermostat-based switches for heating control and control set-point.
20 Therefore, there exists a need for an improved temperature conditioning system for addressing the foregoing problems.

Summary

In accordance with a first aspect of the invention, there is disclosed a temperature
25 conditioning system comprising a first compartment, a second compartment and a controller. The first compartment defines a first opening for receiving liquids thereinto. The first compartment comprises a first heating element assembly being positioned and operable for heating liquids received in the first compartment and a first transducer adapted for transducing temperature of liquids in the first compartment into first temperature signals
30 wherefrom a first temperature can be derived. The second compartment defines a second

opening for receiving liquids therein. The second compartment comprises a second heating element assembly being positioned and operable for heating liquids received in the second compartment and a second transducer adapted for transducing temperature of liquids in the second compartment into second temperature signals wherefrom a second temperature
5 can be derived, the second compartment being disposed away from the first compartment. The controller is in signal communication with the first transducer and the second transducer and in operational communication with each of the first heating element assembly and the second heating element assembly for controlling heating of the liquid in the first compartment to a first temperature level and the liquid in the second compartment to a
10 second temperature level. Wherein the liquid in the first compartment is maintained at the first temperature level for a first duration from a first start time and the liquid in the second compartment is maintained at the second temperature level for a second duration from a second start time.

15 In accordance with a second aspect of the invention, there is disclosed a temperature conditioning method comprising heating liquid in a first compartment of a temperature conditioning system towards a first temperature level in tandem with heating liquid in a second compartment of the temperature conditioning system towards a second temperature level, disposing an article in the first compartment for a first duration when the liquid
20 therein is at the first temperature level, and displacing the article from the first compartment into the second compartment when the liquid in the second compartment is substantially at the second temperature level. Wherein the article is retained in the liquid of the second compartment at the second temperature level for a second duration.

Brief Description of the Drawings

FIG. 1 shows an exemplary partial front sectional view of a temperature conditioning system in accordance with an aspect of the invention with lids covering a first opening of a first compartment and a second opening of a second compartment;

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FIG. 2 shows an exemplary partial plan view of the temperature conditioning system of FIG. 1 without the lids;

FIG. 3 shows a controller with a user interface (UI) of the temperature conditioning system of FIG. 1;

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FIG. 4 shows a partial sectional view of an insulator layer interposing an outer casing and an inner wall of the temperature conditioning system of FIG. 1;

FIG. 5 shows a process flow diagram of a temperature conditioning method employed by the temperature conditioning system of FIG. 1;

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FIG. 6 shows an exemplary partial perspective view of a holder employable with the first compartment and the second compartment of the temperature conditioning system of FIG. 1;

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FIG. 7 shows a hook apparatus adapted for use with the holder of FIG. 6; and

FIG. 8 shows an exemplary ladder diagram being representative of programming codes operating the controller of FIG. 3.

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Detailed Description

An exemplary embodiment of the present invention, a temperature conditioning system 20 utilising a temperature conditioning method 100, is described hereinafter with reference to
 5 FIG. 1 to FIG. 8.

Preferably, the temperature conditioning system system 20 comprises a first compartment 22, a second compartment 24 and a controller 26. The first compartment 24 defines a first opening 28 for receiving liquids thereinto. The first compartment 24 comprises a first
 10 heating element assembly 30 being positioned and operable for heating liquids received in the first compartment 22. The first compartment further comprises a first transducer adapted for transducing temperature of liquids in the first compartment 22 into first temperature signals wherefrom a first temperature can be derived. The second compartment 24 defines a second opening 38 for receiving liquids thereinto. The second compartment 24
 15 comprises a second heating element assembly 40 being positioned and operable for heating liquids received in the second compartment 24. The second compartment 24 further comprises a second transducer adapted for transducing temperature of liquids in the second compartment 24 into second temperature signals wherefrom a second temperature can be derived. Preferably, the second compartment 24 is spatially displaced away from the first
 20 compartment 22. Each of the first compartment 22 and the second compartment 24 are preferably insulated by cotton of the like thermal insulating materials. The first compartment 22 and the second compartment 24 are preferably formed with an outer casing 47a for structurally integrating the first compartment 22 and the second compartment 24. The first compartment 22 and the second compartment 24 form inner walls 47b with the
 25 insulating material forming an insulator layer 47c disposed between the inner walls as well as between the outer casing 47a and each of the inner walls 47b. Hence, the thermal insulating materials are preferably disposed between the outer casing 47 and each of the first compartment 22 and the second compartment 24.

Preferably, the controller 26 is in signal communication with the first transducer and the second transducer and in operational communication with each of the first heating element assembly 30 and the second heating element assembly 40 for controlling heating of the liquid in the first compartment 22 to a first temperature level and the liquid in the second compartment 24 to a second temperature level. Preferably, the liquid in the first compartment 22 is maintained at the first temperature level for a first duration from a first start time and the liquid in the second compartment 24 is maintained at the second temperature level for a second duration from a second start time.

10 The temperature conditioning system 20 further comprises a user interface (UI) 60 in signal communication with the controller 26. The UI 60 is operable by a user for providing command for initiating the first start time and for providing command for initiating the second start time.

15 Each of the first compartment 22 and the second compartment 24 has a lid 61 coupled adjacent to each of the first opening 28 and the second opening 38 thereof. The lid 61 is adapted for displacing between an open position for enabling access and a closed position for impeding access through the corresponding one of the first opening 28 and the second opening 38 such that the liquid in each of the first compartment 22 and the second compartment 24 is enclosed when the lid 61 of each of the first compartment 22 and the second compartment 24 is in the closed position.

The temperature conditioning system 20 further comprises a holder 62 being shaped and dimensioned for being received by and into each of the first compartment 22 and the second compartment 24. The holder 62 is adapted for holding at least one piece of article. The at least one piece of article is preferably planar and is further preferably at least one planar glass structure. Such planar glass structure comprises laminated glass panels or the like glass articles. The holder is formed from at least one of a stainless steel mesh and a stainless steel cage to enable resistance to the high temperature of the liquid the holder 62 will be in contact with and to enable unimpeded flow of the liquid therethrough to enable immersion

of the at least one article held by the holder 62 into the liquid of the respective one of the first compartment 22 and the second compartment. As the holder 62 will get heated together with the article in the liquid and will therefore be too hot to handle with ones bare hands, a hook apparatus 65 is adapted for engagement with the holder 62 for disposing of
5 the holder 62 into and away from each of the first compartment 22 and the second compartment 24.

As the temperature conditioning system is preferably for subjecting the at least one article to a variety of temperature conditions for regulatory, reliability, research or developmental
10 testing, it is preferred that when glass panels are use as the at least one article that the first temperature level be 65 °C, the second temperature level be 100 °C and the second duration be 2 hours.

Preferably, the controller 26 comprises at least one of a programmable logic controller
15 (PLC), a programmable integrated circuit (PIC), at least one relay and a solenoid array. The temperature conditioning system 20 further comprising a plurality of wheels 66 for imparting mobility to the temperature conditioning system 20. For example, if a PLC is employed with the solenoid array, programming of sequential and conditional codes for activating the solenoids for controlling the first heating assembly 30 and the second heating
20 assembly 40 based on temperature feedback from either the first transducer and the second transducer or on command inputs captured from the UI 60 is structured based on a ladder diagram 67 reference.

In a preferred example of use of the temperature conditioning system 20, the first start time
25 is initiated in response to the temperature of the liquid in the first compartment reaching the first temperature level subsequent to the command for initiating the first start time being received by the controller 26. Further, the second start time is initiated in response to the temperature of the liquid in the second compartment reaching the second temperature level subsequent to the command for initiating the second start time being received by the
30 controller 26.

When in use, the temperature conditioning system 20 employs the temperature conditioning method 100 which comprises a step 110 of heating liquid in a first compartment 22 of a temperature conditioning system 20 towards the first temperature level in tandem with heating liquid in a second compartment 24 of the temperature conditioning system 20 towards a second temperature level. In a step 112, the article is disposed in the first compartment 22 for the first duration when the liquid therein is heated towards, substantially at or reaches the first temperature level. The article is then displaced from the first compartment 22 into the second compartment 24 when the liquid in the second compartment 24 is substantially at the second temperature level in a step 114. The article is then retained in the liquid of the second compartment 24 at substantially the second temperature level for the second duration in a step 116. Heating of the liquid in at least one of the first compartment 22 and the second compartment 24 is terminated at the elapse of the second duration in a step 118. Termination of the heating in the step 118 can be programmed to occur automatically or after an alarm, audible and visual, is generated from the UI 60.

An outlet adapted with a valve may be provided to each of the first compartment 22 and the second compartment 24 for draining the liquid therein subsequent to the step 118. The valve adapted to each thereof is for controlling draining of the liquid through the outlet of the respective one of the first compartment 22 and the second compartment 24.

There are a few approaches to employing the temperature conditioning method 100 as aforescribed. Once command has been provided by a user to the UI 60 to initiate the temperature conditioning method 100, the heating of the liquid in both of the first compartment 22 and the second compartment 24 in the step 110 may initiate together or at different times. In the step 112, the article may be placed in the first compartment 22 using the holder 62 before, at initiation of or during heating of the liquid of in the first compartment 22 or only when the liquid in the first compartment 22 reaches the first temperature level.

The UI 60 comprises input means 68 such as a keypad or switches for capturing input from the user and output means 70 such as one or multiple displays, speakers or alarm systems, for example an analog display unit or multiple LCD displays for providing feedback, prompts, error messages, temperature readings and the like indications to the user. In
5 addition or alternatively, the UI 60 may employ a touch screen interface which merges the input means 68 and the output means 70, or part of each thereof, to provide better interactivity between the controller 26 and the user.

In the step 114, the article may be transferred from the first compartment 22 to the second
10 compartment 24 once the liquid in the first compartment 22 reaches the first temperature level, at the elapse of the first duration after the first temperature level has been reached, when the liquid in the second compartment 24 reaches the second temperature level or when the liquid in the second compartment 24 is at the second temperature level subsequent to
15 elapse of the first duration. The UI 60 may provide a prompt at each step of the temperature conditioning method 100 and the user may be required to interact with the UI 60 to progress from one step to another, intervene to change operating parameters along the way, to repeat specific steps or to terminate the temperature conditioning method 100 prematurely.

Preferably, the first compartment 22 serves to pre-heat the article prior to being transferred
20 to the second compartment 22 where actual temperature conditioning or testing conditions are imposed. During transfer of the article in the step 114, the temperature of the liquid in the second compartment 24 may drop below the second temperature level when the lid 61 to the second opening 38 is opened. A limit switch or sensor may be adapted to the lid 61 to recognize that the lid 61 has been opened and the controller 26 may prevent heating of the
25 liquid in trying to maintain the liquid at the second temperature level with the lid 61 being opened for safety reasons. Once the lid 61 is closed, the controller 26 may request further interaction, for example the tapping of a button of the touchscreen to continue the heating of the liquid in the second compartment 24 or may be programmed to automatically progress with the heating and onto the step 116.

In the step 116, the temperature of the liquid may be maintained substantially at the second temperature level using varying temperature control strategies that may employ a thermostat-type control response or a more sophisticated proportional-integral-differential (PID) control response.

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Various temperature response limits, for example lower limits and upper response limits for maintaining the second temperature levels may be employed together with various temperature profiles that may alternatively allow the temperature of the liquid in the second compartment 24 to taper away from the second temperature level over time during the

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The first compartment 22 and the second compartment 24 may be employed to pre-heat one article at or to the first temperature level and to heat another article to or at the second temperature level to form a test process line. Alternatively, the first compartment 22 and the second compartment is for enabling separate heating and independent heat resistant testing of different pieces of articles at different temperatures and time durations. Segregating a typically large water tank into multiple standalone sub-system compartments, for example the first compartment 22 and the second compartment 24, will also result in energy efficiency due to reduced energy required for heating each compartment and also reduced rate of heat loss and evaporation.

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Typical water tanks employs a single heating tube requiring heating power of heating power 4kw or more. For a large water tank, the reduced speed of heating is aggravated and may take up to two hours to heat water from room temperature to 100 °C. By compartmentalizing the eater tank, for example into the first compartment 22 and the second compartment 24 sub-system, each compartment or heating chamber will require only a 1kw heating pipe or array. Due to the reduced volume and thermal inertia required, fast heating from room temperature to about 100 °C can be achieved in minutes.

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Aspects of particular embodiments of the present disclosure address at least one aspect, problem, limitation, and/or disadvantage associated with existing temperature conditioning methods and systems. While features, aspects, and/or advantages associated with certain embodiments have been described in the disclosure, other embodiments may also exhibit

5 such features, aspects, and/or advantages, and not all embodiments need necessarily exhibit such features, aspects, and/or advantages to fall within the scope of the disclosure. It will be appreciated by a person of ordinary skill in the art that several of the above-disclosed structures, components, or alternatives thereof, can be desirably combined into alternative structures, components, and/or applications. In addition, various modifications, alterations,

10 and/or improvements may be made to various embodiments that are disclosed by a person of ordinary skill in the art within the scope of the present disclosure, which is limited only by the following claims.

Claims

1. A temperature conditioning system comprising:

a first compartment defining a first opening for receiving liquids therein, the first compartment comprising a first heating element assembly being positioned and operable for heating liquids received in the first compartment and a first transducer adapted for transducing temperature of liquids in the first compartment into first temperature signals wherefrom a first temperature can be derived;

a second compartment defining a second opening for receiving liquids therein, the second compartment comprising a second heating element assembly being positioned and operable for heating liquids received in the second compartment and a second transducer adapted for transducing temperature of liquids in the second compartment into second temperature signals wherefrom a second temperature can be derived, the second compartment being disposed away from the first compartment; and

a controller in signal communication with the first transducer and the second transducer and in operational communication with each of the first heating element assembly and the second heating element assembly for controlling heating of the liquid in the first compartment to a first temperature level and the liquid in the second compartment to a second temperature level,

wherein the liquid in the first compartment being maintained at the first temperature level for a first duration from a first start time and the liquid in the second compartment being maintained at the second temperature level for a second duration from a second start time.

2. The temperature conditioning system as in claim 1, further comprising a user interface (UI) in signal communication with the controller, the UI being operable for providing command for initiating the first start time and for providing command for initiating the second start time.

3. The temperature conditioning system as in claim 1, the first start time being initiated in response to the temperature of the liquid in the first compartment reaching the first temperature level subsequent to the command for initiating the first start time being received by the controller and the second start time being initiated in response to the temperature of the liquid in the second compartment reaching the second temperature level subsequent to the command for initiating the second start time being received by the controller.
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4. The temperature conditioning system as in claim 1, the first temperature level being 65 °C, the second temperature level being 100 °C and the second duration being 2 hours.
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5. The temperature conditioning system as in claim 1, each of the first compartment and the second compartment has a lid coupled adjacent to each of the first opening and the second opening thereof, the lid being adapted for displacing between an open position for enabling access and a closed position for impeding access through the corresponding one of the first opening and the second opening, wherein the liquid in each of the first compartment and the second compartment is enclosed when the lid of each of the first compartment and the second compartment is in the closed position.
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6. The temperature conditioning system as in claim 1, further comprising a holder being shaped and dimensioned for being received by each of the first compartment and the second compartment and being adapted for holding at least one piece of planar article.
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7. The temperature conditioning system as in 6, the holder being formed from at least one of a stainless steel mesh and a stainless steel cage.

8. The temperature conditioning system as in 6, the at least one piece of planar article being at least one glass structure.
9. The temperature conditioning system as in 1, the controller comprising at least one of a programmable logic controller (PLC), a programmable integrated circuit (PIC), at least one relay and a solenoid array.
10. The temperature conditioning system as in 1, further comprising a plurality of wheels for imparting mobility to the temperature conditioning system.
11. A temperature conditioning method comprising:
 - heating liquid in a first compartment of a temperature conditioning system towards a first temperature level in tandem with heating liquid in a second compartment of the temperature conditioning system towards a second temperature level;
 - disposing an article in the first compartment for a first duration when the liquid therein is at the first temperature level; and
 - displacing the article from the first compartment into the second compartment when the liquid in the second compartment is substantially at the second temperature level,
 - wherein the article is retained in the liquid of the second compartment at the second temperature level for a second duration.
12. The temperature conditioning method as in claim 11, further comprising:
 - terminating heating of the liquid in at least one of the first compartment and the second compartment at the elapse of the second duration.
13. The temperature conditioning method as in claim 11, the article being a glass panel.
14. The temperature conditioning method as in claim 11, further comprising:

providing command for initiating a first start time of the first duration and providing command for initiating a second start time of the second duration.

- 5 15. The temperature conditioning method as in claim 11, the first start time being initiated in response to the temperature of the liquid in the first compartment reaching the first temperature level subsequent to the command for initiating the first start time being received by the controller and the second start time being initiated in response to the temperature of the liquid in the second compartment reaching the second temperature level subsequent to the command for initiating the
- 10 second start time being received by the controller.
16. The temperature conditioning method as in claim 11, the first temperature level being 65 °C, the second temperature level being 100 °C and the second duration being 2 hours.