Claims

1. A method of automatically filling carbon dioxide (CO2) snow block into a container within an automatic dispensing station, comprising:

receiving a first signal corresponding to a pressure of liquid CO2 into a controller as a first set point;

inputting into the controller a volume of the CO2 snow block to be generated as a second set point;

the controller determining a fill time to generate the volume of the CO2 snow block based on the first set point and the second set point;

the controller selecting the container with an interior volume corresponding to the second set point, said container located within the automatic dispensing station, and said automatic dispensing station comprising two or more containers of different interior volumes;

flowing a gaseous CO2 into a fill conduit to pressurize the fill conduit at or above a pressure sufficient to prevent a phase change of the liquid CO2;

the controller causing a liquid CO2 control valve to allow the liquid CO2 to flow along the fill conduit and into the container when the controller determines the pressure in the fill conduit is at or above the pressure sufficient to prevent the phase change of the liquid CO2;

introducing said liquid CO2 into the container;

at least a portion of said liquid CO2 undergoing a phase change to transform into said CO2 snow block and offgas CO2 within the container;

withdrawing said offgas CO2 from the container through a plate permanently affixed or removably affixed to the container, said plate permeable to the offgas CO2 and at least partially impermeable to a solid phase CO2;

measuring an elapsed time of filling the container with the liquid CO2 and generating a second signal corresponding to the elapsed time;

transmitting the second signal corresponding to the elapsed time to the controller;

the controller (i) allowing said liquid CO2 to continue to flow into the container, in the absence of an override, when the elapsed time is less than the fill time, and (ii)

preventing said liquid CO2 to flow in the container when the elapsed time has reached the fill time.

2. The method of claim 1, further comprising:

the controller detecting the elapsed time to reach the fill time; and in response thereto

the controller transmitting a third signal to configure the container from a filling orientation into a dispensing orientation, said container in the dispensing orientation containing the volume of the CO2 snow block.

3. The method of claim 2, further comprising:

releasing the CO2 snow block from the container into an access region of the automatic dispensing station.

4. The method of claim 3, further comprising:

configuring the container into an idle orientation or the filling orientation within the automatic dispensing station.

5. The method of claim 1, further comprising the plate positioned with sufficient pressure onto the container to form a seal along the periphery of the container.

6. The method of claim 1, further comprising:

introducing said liquid CO2 into the container without incurring substantial blockage of said liquid CO2.

7. The method of claim 1, further comprising:

the controller performing integrity checks prior to performing the step of flowing the sufficient amount of gaseous CO2 into the fill conduit.

8. The method of claim 1, wherein the controller is configured to actuate the container from an idle orientation into a filling orientation.

9. A method of automatically filling carbon dioxide (CO2) snow block into a container within an automatic dispensing station and vending said CO2 snow block from the selected container, comprising:

inputting into a controller a set point to be used for determining completion of fill of CO2 snow block into the container, said set point based on i) fill duration; (ii) a pre-defined weight of the CO2 snow block, (iii) a pressure in the selected container, (iv) a capacitance of the CO2 snow block, (v) a temperature in the container or (vi) a deformation of a plate, said plate permanently affixed or removably affixed to the container;

the controller receiving a volume of the CO2 snow block to be generated;

the controller selecting the container having an interior volume that is capable of receiving the volume of the CO2 snow block to be generated, said container located within the automatic dispensing station comprising two or more containers of different interior volumes;

flowing a sufficient amount of gaseous CO2 into and along a fill conduit;

the controller transmitting a first signal to a liquid CO2 control valve to cause the liquid CO2 to flow along the fill conduit and into the container and therein undergo a phase change to transform into CO2 snow block and offgas CO2;

withdrawing said offgas CO2 from the selected container through the plate, said plate permeable to the offgas CO2 and at least partially impermeable to a solid phase CO2, and further wherein said fill conduit is operably connected to the container;

measuring a real-time variable corresponding to the set point and generating a second signal corresponding to the real-time variable;

transmitting the second signal to the controller;

the controller (i) allowing said liquid CO2 to continue to flow into the container, in the absence of an override, when determining the real-time variable has not reached the set point; and

the controller (ii) preventing said liquid CO2 to flow in the container when the real-time variable has reached the set point, and in response thereto, the controller transmitting a third signal to configure the container into a dispensing orientation, said container in the dispensing orientation containing the volume of the CO2 snow block.

10. The method of claim 9, further comprising:

the controller performing integrity checks prior to initiating the automated filling of the CO2 snow block into the container.

11. The method of claim 9, wherein the controller receives the second signal corresponding to the real-time variable equal to the set point, and in response thereto, said controller transmits a fourth signal to the liquid CO2 control valve to configure the liquid CO2 control valve into a closed position.

12. The method of claim 9, further comprising the controller validating that the container is in a filling orientation, and if said controller determines the container is not in the filling orientation, the controller either (i) transmitting one or more signals to cause the container to actuate into the filling orientation, or (ii) transmitting an alert notification for a user to manually configure the container into the filling orientation.

13. A method of automatically charging carbon dioxide (CO2) snow block into a container, comprising:

inputting into a controller a set point to be used for determining completion of fill of the CO2 snow block into the container, said set point based on i) fill duration; (ii) a pre-defined weight of the CO2 snow block, (iii) a pressure in the container, (iii) a capacitance of the CO2 snow block, (v) a temperature in the container or (vi) a deformation of a plate, said plate permanently affixed or removably affixed to the container;

the controller performing integrity checks and determining said integrity checks to meet applicable criteria; and in response thereto,

flowing a sufficient amount of gaseous CO2 from a supply manifold into a fill conduit;

the controller receiving a first signal corresponding to the pressure in the supply manifold and the fill conduit;

the controller transmitting a second signal to a liquid CO2 control valve situated along the supply manifold to configure the liquid CO2 valve into the open position when the controller determines the first signal corresponding to the pressure in the

supply manifold and the fill conduit is at or above a pressure sufficient to prevent a phase change of liquid CO2;

withdrawing the liquid CO2 from a CO2 source into the supply manifold at a pressure higher than that of the gaseous CO2, thereby stopping flow of the gaseous CO2 through the fill conduit, said CO2 source operably connected upstream of the supply manifold;

introducing the liquid CO2 into the container through the fill conduit;

the CO2 liquid undergoing a phase change to transform into said CO2 snow block and offgas CO2 within the container;

withdrawing said offgas CO2 from the container;

measuring a real-time variable corresponding to the set point and generating a third signal corresponding to the real-time variable;

transmitting the third signal corresponding to the real-time variable to the controller;

wherein said liquid CO2 continues to enter the container, in the absence of an override, until the controller determines the real-time variable to reach the set point.

14. The method of claim 13, further comprising:

the controller receiving the third signal corresponding to the real-time variable having a value equal to the set point; and in response thereto

the controller transmitting a fourth signal to the liquid CO2 control valve in the supply manifold to configure the liquid CO2 valve into the closed position to stop withdrawal of the liquid CO2 from the CO2 source into the supply manifold.

15. The method of claim 13, further comprising:

loading the container into a charging station;

operably connecting the container to the fill conduit; and

operably connecting the container to an exhaust.

16. The method of claim 15, further comprising the step of the controller performing the integrity checks, and in response thereto, preventing the automatic charging of the gaseous CO2 and the liquid CO2 into the container when the controller

determines (a)(i) an exhaust is not operating; or (a)(ii) an access door to the charging station is not closed; or (a)(iii) the pressure in the fill conduit and the supply manifold is below the threshold pressure sufficient to prevent the phase change of liquid CO2; or

the controller performing the integrity checks, and in response thereto, allowing the automatic charging of CO2 snow block into the container to proceed when the controller determines (b)(i) the exhaust is operating; and (b)(ii) the access door to the charging station is closed; and (b)(iii) the pressure in the fill conduit and the supply manifold is at or above the pressure sufficient to prevent the phase change of the liquid CO2.

17. The method of claim 13, further comprising validating the container is in a filling orientation, and if the container is determined to not be in the filling orientation, said controller either (i) transmitting one or more signals to cause the container to actuate into the filling orientation, or (ii) transmitting an alert notification for a user to manually configure the container into the filling orientation.

18. The method of claim 15, wherein said container comprises getter material situated within one or more walls of the container.

19. The method of claim 14, further comprising:

resuming the flow of the gaseous CO2 through the fill manifold and into the container to purge any residuals and/or impurities.

20. A method of preparing a container for automated charging carbon dioxide (CO2) snow block into a single container, comprising:

inputting into a controller a set point to be used for determining completion of fill of the CO2 snow block into the container, said set point based on i) fill duration; (ii) a pre-defined weight of the CO2 snow block, (iii) a pressure in the container, (iii) a capacitance of the CO2 snow block, (v) a temperature in the container or (vi) a deformation of a plate, said plate permanently or removably affixed to the container;

the controller performing integrity checks and determining said integrity checks to meet applicable criteria; and in response thereto,

the controller validating the container is in a filling orientation, and if the container is determined to not be in the filling orientation, said controller either (i) transmitting a first signal to cause the container to actuate into the filling orientation, or (ii) transmitting an alert notification for a user to manually configure the container into the filling orientation.

21. The method of claim 20, further comprising the step of pressurizing a supply manifold and the fill conduit to a pressure that is at or above a pressure sufficient to prevent a phase change of liquid CO2.

22. A method of configuring a container into a filling orientation suitable for receiving CO2 liquid, comprising:

transmitting a signal to an actuator arm configured to operably connect a plate to the container, said plate permanently affixed or removably affixed to the container, said plate permeable to a gaseous phase CO2 and at least partially impermeable to a solid phase CO2;

forming a seal along the periphery of the plate; and

operably connecting and locking a fill conduit of the plate to a CO2 supply manifold.

23. The method of claim 22, further comprising:

generating CO2 snow block into the container;

releasing the CO2 snow block from the container into a second container provided by a user.

24. A method of selecting a container within an automatic dispensing station to automatically fill carbon dioxide (CO2) snow block into the container, comprising:

inputting into the controller a volume of the CO2 snow block to be generated as a set point;

the controller selecting the container with an interior volume corresponding to the set point, said container located within the automatic dispensing station, and said

automatic dispensing station comprising two or more containers of different interior volumes; and

the controller validating the container is in a filling orientation, and if the container is determined to not be in the filling orientation, said controller either (i) transmitting a signal to cause the container to actuate into the filling orientation, or (ii) transmitting an alert notification for a user to manually configure the container into the filling orientation.