Short description of the invention

An exampleof the present disclosure relates to a method for filling a compartment in an inner part of a container with an amount of liquid CO_2 which is partially converted into an amount of solid CO_2 upon injection of the liquid CO_2 into said compartment, said container being designed to contain one or more products loaded into it, wherein said products are to be maintained at a defined temperature, below a defined temperature, or within a defined temperature range, which temperature or temperature range is below environmental temperature, using said solid CO_2, wherein said container is subjected to a weighing operation using weighing means resulting into a weight of said container, wherein said weight of said container, is determined by said weighing means at least before and after said container has been supplied with said amount of converted solid CO_2.

A first aspect of the present disclosure relates to a method for estimating a remaining residence time of solid CO2 in a container, comprising: receiving the container with the solid CO2, wherein the container is configured to contain one or more products; and wherein the products are to be maintained using the solid CO2 at a defined temperature, below a defined temperature, or within a defined temperature range, the defined temperature or the defined temperature range being below an environmental temperature; scanning a machine-readable optical label or connecting to a radiofrequency (RF) transmitter, said machine-readable optical label or said RF transmitter affixed to or included with the container or accompanying packaging; launching application software; accessing unique identification information for the container from the machine-readable optical label or the RF transmitter, said unique identification information residing locally on the machine-readable optical label or the RF transmitter; or residing locally or remotely in a database or a combination thereof, said unique identification information including a tare weight of the container and a standard sublimation rate associated with the container; determining a real-time weight of the solid CO2 in the container by subjecting the container to a weighing operation using a scale resulting in the real-time weight of the container; calculating the residence time remaining, that the one or more products can be maintained at the defined temperature, below the defined temperature, or within the defined temperature range; said residence time

remaining based, at least in part, on the real time weight of the solid CO2 in the container and the standard sublimation rate.

A second aspect of the present disclosure relates to a method of preparing a container with solid CO_2 introduced inside the container, wherein the container is adapted to provide an estimate of residence time of the solid CO_2 in the container on a real-time basis, comprising: determining a standard sublimation rate of the container; determining a tare weight of the container; filling an inner part of the container with the solid CO_2 until a fill weight of the solid CO_2 is generated inside the container; wherein the container is configured to contain one or more products; and wherein the products are to be maintained using the solid CO_2 at a defined temperature, below a defined temperature, or within a defined temperature range, the defined temperature or the defined temperature range being below an environmental temperature; affixing to or including within the container or associated packaging a machine-readable optical label or RF transmitter; inputting into a database or into the machine-readable optical label or RF transmitter or a combination thereof unique identifier information of the container, said unique identifier information of the container comprising the standard sublimation rate, the tare weight of the container, and the fill weight of the container; wherein the standard sublimation rate, the tare weight, and the fill weight can be accessed by application software upon scanning the machine-readable optical label or connecting to the RF transmitter; said application software configured to calculate the (i) residence time of the solid CO_2 in the container based on the tare weight, the fill weight, and the standard sublimation rate, or the (ii) remaining residence time based on the tare weight, the standard sublimation rate and the weight of the solid CO_2 remaining in the container measured subsequent to the fill weight.

A third aspect of the present disclosure relates to a method for estimating a remaining residence time of a refrigerant in a container, comprising: receiving the container with the refrigerant, wherein the container is configured to contain one or more products; and wherein the products are to be maintained using the refrigerant at a defined temperature, below a defined temperature, or within a defined temperature range, the defined temperature or the defined temperature range being below an environmental temperature; scanning a machine-readable optical label or connecting to a RF transmitter, said machine-readable optical label or said RF transmitter affixed to or included with the container or associated

packaging; launching application software; accessing unique identification information for the container from the machine-readable optical label or the RF transmitter, said unique identification information residing locally on the machine-readable optical label or the RF transmitter, or residing locally or remotely in a database or a combination thereof, said unique identification information including a tare weight of the container and a standard refrigerant evaporation rate associated with the container; determining a real-time weight of the refrigerant in the container by subjecting the container to a weighing operation using a scale resulting in the real-time weight of the container; calculating the residence time remaining, that the one or more products can be maintained at the defined temperature, below the defined temperature, or within the defined temperature range; said residence time remaining based, at least in part, on the real time weight of the refrigerant in the container and the standard refrigeration evaporation rate.

A fourth aspect of the present disclosure relates to a method of preparing a container with refrigerant inside the container, wherein the container is adapted to provide an estimate of residence time of the refrigerant in the container on a real-time basis, comprising: determining a standard refrigerant evaporation rate associated with the container; determining a tare weight of the container; filling an inner part of the container with the refrigerant until a fill weight of the refrigerant is generated inside the container; wherein the container is configured to contain one or more products; and wherein the products are to be maintained using the refrigerant at a defined temperature, below a defined temperature, or within a defined temperature range, the defined temperature or the defined temperature range being below an environmental temperature; affixing to or including within the container or associated packaging a machine-readable optical label or RF transmitter; inputting into a database, into the machine-readable optical label or RF transmitter, or into a combination thereof, unique identifier information of the container, said unique identifier information of the container comprising the standard refrigerant evaporation rate, the tare weight of the container, and the fill weight of the container; wherein the standard refrigerant evaporation rate, the tare weight, and the fill weight can be accessed by application software upon scanning the machine-readable optical label or connecting to the RF transmitter; said application software configured to calculate the (i) residence time of the refrigerant in the container based on the

tare weight, the fill weight, and the standard refrigerant evaporation rate, or the (ii) remaining residence time based on the tare weight, the standard refrigerant evaporation rate and the weight of the refrigerant remaining in the container measured subsequent to the fill weight.

Further, in another example there is provided a method for filling a container with an amount of liquid CO_2 which is partially converted into an amount of solid CO_2 in said container, for the purpose of maintaining one or more products, loaded into said container, at a defined temperature, below a defined temperature, or within a defined temperature range, which temperature or temperature range is below environmental temperature, wherein said container, optionally loaded with one or more products, is subjected to a weighing operation using weighing means resulting into a weight of said container, wherein said weight of said container, optionally loaded with one or more products, is determined by said weighing means at least before and after said container has been supplied with said amount of converted solid CO_2.

The inventive method according to the disclosure will contribute to increased accuracy of the determination of the amount of solid CO_2 supplied to the container, compared to prior art methods and systems. This leads to less CO_2 consumption, and hence to a lower carbon dioxide footprint.

Furthermore, because of a weighing operation, in case of an emergency situation like a power failure, the filling process does not need to

CLAIMS

1. A method for estimating a remaining residence time of solid CO_2 in a container, comprising:

receiving the container with the solid CO_2, wherein the container is configured to contain one or more products; and wherein the products are to be maintained using the solid CO_2 at a defined temperature, below a defined temperature, or within a defined temperature range, the defined temperature or the defined temperature range being below an environmental temperature;

scanning a machine-readable optical label or connecting to a radiofrequency (RF) transmitter, said machine-readable optical label or said RF transmitter affixed to or included with the container or accompanying packaging;

launching application software;

accessing unique identification information for the container from the machine-readable optical label or the RF transmitter, said unique identification information residing locally on the machine-readable optical label or the RF transmitter; or residing locally or remotely in a database or a combination thereof, said unique identification information including a tare weight of the container and a standard sublimation rate associated with the container;

determining a real-time weight of the solid CO_2 in the container by subjecting the container to a weighing operation using a scale resulting in the real-time weight of the container;

calculating the residence time remaining, that the one or more products can be maintained at the defined temperature, below the defined temperature, or within the defined temperature range;

said residence time remaining based, at least in part, on the real time weight of the solid CO_2 in the container and the standard sublimation rate.

2. The method according to claim 1, wherein the step of determining the real-time weight of the solid CO_2 in the container includes subjecting the container to the weighing operation in a presence of the accompanying packaging or accessories using the scale and resulting in the real-time weight of the container and the accompanying packaging or the accessories.

3. The method according to claim 1, further comprising the steps of confirming (i) the scale is tared and (ii) the container is placed on the scale.

4. The method of claim 1, comprising the step of sending an alert when the real-time weight of the container is greater than a fill weight of the container, said fill weight defined as the weight of the container after a most recent filling of the container with an initial amount of the solid CO_2, said fill weight previously obtained and stored in a database of the application software.

5. The method according to claim 1, wherein the container is loaded with the one or more products.

6. The method according to claim 1, wherein the step of launching the application software further comprises a device hosting the application software.

7. The method according to claim 6, wherein the device is in a wired or wireless communication with a network and a server.

8. The method according to claim 1, a notification alert being generated when the calculated residence time remaining is less than a specified critical limit, said notification alert instructing return of the container to a supplier of the container.

9. The method according to claim 1, wherein an actual sublimation rate is determined based on a fill weight, the real-time weight, the weight of the one or more products that may be loaded into the container, and a time transpired between the fill weight and the real-time weight, said fill weight defined as the weight of the container after a most recent filling of the container with an initial amount of the solid CO_2, said fill weight previously obtained and stored in a database of the application software.

10. The method according to claim 9, wherein a notification alert is generated when the actual sublimation rate is outside a specified tolerance of the standard sublimation rate.

11. The method according to claim 1, wherein data for the real-time weight of the solid CO_2 in the container is stored in a database of the application software.

12. A method of preparing a container with solid CO_2 introduced inside the container, wherein the container is adapted to provide an estimate of residence time of the solid CO_2 in the container on a real-time basis, comprising:

determining a standard sublimation rate of the container;

determining a tare weight of the container;

filling an inner part of the container with the solid CO_2 until a fill weight of the solid CO_2 is generated inside the container;

wherein the container is configured to contain one or more products; and wherein the products are to be maintained using the solid CO_2 at a defined temperature, below a defined temperature, or within a defined temperature range, the defined temperature or the defined temperature range being below an environmental temperature;

affixing to or including within the container or associated packaging a machine-readable optical label or RF transmitter.

inputting into a database or into the machine-readable optical label or RF transmitter or a combination thereof unique identifier information of the container, said unique identifier information of the container comprising the standard sublimation rate, the tare weight of the container, and the fill weight of the container;

wherein the standard sublimation rate, the tare weight, and the fill weight can be accessed by application software upon scanning the machine-readable optical label or connecting to the RF transmitter;

said application software configured to calculate the (i) residence time of the solid CO_2 in the container based on the tare weight, the fill weight, and the standard sublimation rate, or the (ii) remaining residence time based on the tare weight, the standard sublimation rate and the weight of the solid CO_2 remaining in the container measured subsequent to the fill weight.

13. The method of claim 12, further comprising arranging for delivering of the container to a destination site via a commercial carrier.

14. The method of claim 12, wherein the step of measuring the weight of the solid CO_2 remaining in the container is performed in the presence of accompanying packaging or accessories.

15. The method of claim 12, wherein the step of preparing the container further comprises assigning an identification (ID) number for the container into a database of the application software, said ID number forming part of the unique identifier information of the container.

16. The method of claim 12, further comprising retrieving historical information of the container, said historical information located in a database.

17. The method of claim 12, further comprising receiving notification when the container has been subject-to a weighing operation using a scale resulting in a real-time weight of the container and accompanying packaging.

18. The method of claim 12, further comprising performing a weight measurement after confirming (i) a weighing scale is tared; and (ii) the container is placed on the weighing scale.

19. The method of claim 12, further comprising:

determining an actual sublimation rate;

comparing the actual sublimation rate with the standard sublimation rate; and

sending an alert to inspect the container when the actual sublimation rate is outside a specified tolerance of the standard sublimation rate.

20. The method of claim 12, further comprising accessing the database through a dedicated secured Internet website.

21. A method for estimating a remaining residence time of a refrigerant in a container, comprising:

receiving the container with the refrigerant, wherein the container is configured to contain one or more products; and wherein the products are to

be maintained using the refrigerant at a defined temperature, below a defined temperature, or within a defined temperature range, the defined temperature or the defined temperature range being below an environmental temperature;

scanning a machine-readable optical label or connecting to a RF transmitter, said machine-readable optical label or said RF transmitter affixed to or included with the container or associated packaging;

launching application software;

accessing unique identification information for the container from the machine-readable optical label or the RF transmitter, said unique identification information residing locally on the machine-readable optical label or the RF transmitter, or residing locally or remotely in a database or a combination thereof, said unique identification information including a tare weight of the container and a standard refrigerant evaporation rate associated with the container;

determining a real-time weight of the refrigerant in the container by subjecting the container to a weighing operation using a scale resulting in the real-time weight of the container;

calculating the residence time remaining, that the one or more products can be maintained at the defined temperature, below the defined temperature, or within the defined temperature range;

said residence time remaining based, at least in part, on the real time weight of the refrigerant in the container and the standard refrigeration evaporation rate.

22. A method of preparing a container with refrigerant inside the container, wherein the container is adapted to provide an estimate of residence time of the refrigerant in the container on a real-time basis, comprising:

determining a standard refrigerant evaporation rate associated with the container;

determining a tare weight of the container;

filling an inner part of the container with the refrigerant until a fill weight of the refrigerant is generated inside the container;

wherein the container is configured to contain one or more products; and wherein the products are to be maintained using the refrigerant at a defined

temperature, below a defined temperature, or within a defined temperature range, the defined temperature or the defined temperature range being below an environmental temperature;

affixing to or including within the container or associated packaging a machine-readable optical label or RF transmitter;

inputting into a database, into the machine-readable optical label or RF transmitter, or into a combination thereof, unique identifier information of the container, said unique identifier information of the container comprising the standard refrigerant evaporation rate, the tare weight of the container, and the fill weight of the container;

wherein the standard refrigerant evaporation rate, the tare weight, and the fill weight can be accessed by application software upon scanning the machine-readable optical label or connecting to the RF transmitter;

said application software configured to calculate the (i) residence time of the refrigerant in the container based on the tare weight, the fill weight, and the standard refrigerant evaporation rate, or the (ii) remaining residence time based on the tare weight, the standard refrigerant evaporation rate and the weight of the refrigerant remaining in the container measured subsequent to the fill weight.