Short description of the invention

A first aspect of the present invention 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 second aspect of the present invention 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 third aspect of the present invention 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 fourth aspect of the present invention 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 fifth aspect of the present invention 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 aspect 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 invention 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