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United States Patent	12390743
Kind Code	B2
Date of Patent	August 19, 2025
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System and method for an automated adjustment of Brix in a liquid

Abstract

The present disclosure relates to a system and to a method for calibrating Brix in a liquid, sap, syrup or taffy. The system comprises: a tank for receiving a volume of the liquid; a temperature reading apparatus for measuring a temperature of the liquid; a weighing apparatus for measuring a weight of the volume of liquid received in the tank; a volume measurement system for measuring the volume of the liquid received in the tank; an evaporator comprising a plurality of water injectors for spraying water, and a computer operatively connected to the apparatuses and using the data received from the same to calibrate the Brix in the liquid. The method comprises providing the Brix calibrating system; measuring the Brix, temperature, weight, volume, and determining the Brix measurement based on the data received and using the computer to adjust the Brix by actioning the evaporator or the water injectors.

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Appl. No.: 18/165752

Filed: February 07, 2023

Prior Publication Data

Document Identifier	Publication Date
US 20230350388 A1	Nov. 02, 2023

Related U.S. Application Data

us-provisional-application US 63336341 20220429

Publication Classification

Int. Cl.: **B01D1/00** (20060101); **A23L5/20** (20160101); **A23L27/10** (20160101); **B01D1/30** (20060101); **C13B25/06** (20110101); **G05D23/20** (20060101)

U.S. Cl.:

CPC **B01D1/0082** (20130101); **A23L5/21** (20160801); **A23L27/10** (20160801); **B01D1/30** (20130101); **C13B25/06** (20130101); **G05D23/20** (20130101); G05B2219/37371 (20130101); G05B2219/50333 (20130101)

Field of Classification Search

USPC: None

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application claims the benefit of U.S. provisional application No. 63/336,341 filed on Apr. 29, 2022.

TECHNICAL FIELD

(1) The invention relates to a system and to a method for an automated calibration and measuring of Brix in a liquid.

BACKGROUND

(2) The maple syrup industry, which has produced maple syrup in an artisanal way for a hundred years until the 1960s, has undergone transformation towards industrialization in order to initiate an increase in production performance and lower production costs which became prohibitive.

(3) The classical way of harvesting sap was using buckets hanging from the trees. Thereafter, each bucket was to be emptied one by one into a large container, which was pulled by a horse, a tractor or another type of all-terrain vehicle into the sugar bush. Subsequently, the sap from the large

container was sent to the sugar shack in order to be boiled using an evaporator to obtain a 66% brix sugar maple syrup. The main problem with the classical way of collecting maple sap was that maple growers were unable to expand their business due to the huge workload required to harvest sap from trees. As a result, profitability of maple syrup productions was almost impossible to reach. (4) In the 1970s, an alternative method of collecting maple sap has been developed. This alternative way involved collecting the sap from the maple trees using a tubing system, much the same way as in the dairy industry. This collection method was made possible thanks to spouts engaging notches of the trees and to a network of tubing and lines permanently installed on the entire sugar bush area and coupled to these spouts, where the sap of each of the maple trees is conveyed to a pumping station, which is then routed to the main sugar shack to be transformed into maple syrup. In many instances, the network of tubing is under vacuum, while in other instances the topography of the land allows the sap to descend by gravity to the pumping or harvesting station, thereby allowing the sap to be harvested in this way. Since they did not require a human presence as extensive as the classical bucket method, map sap collection systems allowed maple producers to significantly expand their businesses and make them much more profitable.

(5) Since the 1990s, automation has become increasingly important in the production of maple syrup because finding personnel and/or operators for operating maple syrup production facilities has become a constant challenge and, the profitability of such facilities and enterprises an important factor to ensure long-term viability. Thus, in addition to relying on tubing networks to collect maple sap, producers have considered a number of technologies to improve efficiency and time required for production, including reverse osmosis apparatuses, evaporators, pumps and computerized controls for these apparatuses.

(6) Regardless of the degree of automation of the maple syrup production in a given facility, the Brix must be monitored regularly to ensure the final product meets the 66% Brix requirement. Brix can be measured in maple sap, in the sap holding tanks, at the entry and exit of inverted osmosis and/or evaporator, and in the final product. By monitoring the Brix at these various steps of the production, the product can monitor in real time the sugar content of the raw, intermediate and final products.

(7) The conventional method for measuring Brix in the maple syrup industry has relied on the use of maple syrup hydrometer density meter or a hydrotherm, which is an instrument that combines the hydrometer and the thermometer into one measuring unit (the actual density of the syrup being measured can be determined directly by reading the two scales on the stem, namely a Brix scale and a density correction scale). While this type of instruments for measuring Brix is relatively inexpensive, it tends to find use in smaller scale operations and/or for punctual uses, because it requires some manipulation and cleaning by the personnel rendering it inefficient in larger scale or in automated production facilities. In some other operations, handheld digital or manual refractometers are also used, but again they tend to be used for punctual measurements, which present essentially the same drawbacks as the use of hydrometers, namely they require manipulation.

(8) Therefore, in large scale productions, the use of inline refractometers has increased over the last years to avoid the manipulation required with more traditional Brix measurement apparatuses and measure the Brix in real time, and at various stages of maple syrup collection and production. These inline refractometers are often coupled to a controller or computer and are configured to automatically compensate or correct the Brix measurement according to the temperature of the maple sap and/or maple syrup. While they present advantages over more classical Brix measurement instruments, inline refractometers also have drawbacks. Among other things, the elevated costs of inline refractometers tend to be prohibitive for their acquisition in smaller scale operations. Further, to ensure proper and accurate Brix reading, the lens of the refractometer must be cleaned regularly, especially when it is being used with unfiltered maple sap. Another problem associated with this type of equipment is that the automatic compensation for the sap or syrup

temperature for an accurate Brix reading must be adjusted regularly in order to get an optimal reading. The need for these regular adjustments are attributable to the fact that inline refractometers (e.g. Atago CM-800) are generally designed to measure the Brix of liquids having a temperature that varies between 5 and 100 degrees Celsius, while the boiling temperature of high Brix sap can reach 105 degrees Celsius. Therefore, the automatic compensation of Brix measurements must be “cheated” as they are outside the maximum operational range of such inline refractometers.

(9) It is also known in the prior art that the faster the sap boils, the greater the potential for producing a higher quality of product is.

(10) An example of implementing computer controls in maple syrup production is publication US20210285066, presenting a system and method to manage the final Brix of the syrup. The system monitors syrup characteristics in the evaporator and opens the outlet valve when predetermined threshold values for the characteristics are met. However, often in the early stages of the evaporation process, or when the evaporator is re-ignited after a first batch of syrup has been produced, the evaporator is unlikely to heat the sap evenly leading to quality problems or to a longer production time.

(11) There is therefore a need for a system and method for calibrating the Brix of a liquid, while being able to control the heat of the evaporator during the production process, which would overcome at least one of the above-identified drawbacks.

SUMMARY

(12) According to a broad aspect, there is provided a system for an automatic calibration of Brix of a liquid, the system comprising: a tank for receiving therein a volume of the liquid; an inlet opening fluidly connected to the tank for conveying the liquid into the tank; an outlet opening fluidly connected to the tank for evacuating the liquid from the tank; a temperature reading apparatus for measuring a temperature of the liquid prior to entering the tank, while received in the tank or after being evacuated from the tank; a weighing apparatus for measuring a weight of the volume of liquid received in the tank; a volume measurement system for measuring the volume of the liquid received in the tank; an evaporator fluidly connected to the tank, the reading apparatus, the weighing apparatus and the volume measurement system, the evaporator being configured to reduce the level of water in the liquid, the evaporator comprising a plurality of water injectors for spraying water to the liquid; and a computer operatively connected to the temperature reading apparatus, the weighing apparatus and the volume measurement system and the evaporator and receiving data from same, the computer being programmed to determine a Brix measurement based on the data received from the temperature reading apparatus, the weighing apparatus and the volume measurement system, the computer being programmed to action at least one of the plurality of water injectors for adjusting the temperature of the evaporator and calibrating the Brix to a predetermined level.

(13) In one embodiment, the computer is programmed with an algorithm correlating a Brix value of the liquid received in the tank based on the volume, the weight and the temperature of the liquid received in the tank to determine the Brix measurement of the liquid received in the tank.

(14) In another embodiment, the computer may be programmed with an algorithm to action at least one of the plurality of water injectors to control the temperature of the evaporator.

(15) The water injectors may be fluidly coupled to a main local aqueduct for direct water supply.

(16) The water injectors may be selected from the group consisting of nozzles, sprinklers and sprayers.

(17) In another embodiment, the temperature reading apparatus comprises at least one temperature sensor.

(18) In still another embodiment, the at least one temperature sensor is selected from a group consisting of a thermometer, a negative temperature coefficient (NTC) thermistor, a resistance temperature detector (RTD), a semiconductor-based sensor, an infrared sensor and a bimetallic device.

- (19) In yet another embodiment, the system further comprises an inlet pipe fluidly connect to the inlet opening for conveying the liquid into the tank and an outlet pipe fluidly connected to the outlet opening for evacuating the liquid from the tank. In this feature, the temperature reading apparatus is mounted to at least one of the tank, the inlet pipe and the outlet pipe.
- (20) In a further embodiment, the temperature reading apparatus comprises at least one temperature sensor mounted to at least one of: the tank, the inlet pipe and the outlet pipe.
- (21) In still a further embodiment, the temperature reading apparatus comprises a first temperature sensor mounted to the tank, a second temperature sensor mounted to the inlet pipe and a third temperature sensor mounted to the outlet pipe.
- (22) In another embodiment, the evaporator comprises a plurality of temperature sensors for reading the temperature of the liquid inside the evaporator. The temperature sensors may also be adapted to read the temperature inside the evaporator and transmit these temperature readings to the computer.
- (23) In yet a further embodiment, the weighing apparatus comprises at least one load cell operatively associated with the tank for measuring the weight of the volume of liquid received in the tank.
- (24) In one embodiment, the at least one load cell is supported on a floor surface, and the tank is supported onto the load cell.
- (25) In a different embodiment, the at least one load cell is suspended to a ceiling structure and the tank is suspended by the load cell.
- (26) In another embodiment, the tank has a defined maximum volume, and the volume measurement system is configured for filling the tank with the liquid to the defined maximum volume.
- (27) In yet another embodiment, the volume measurement system further comprises gas removing means associated with the tank for removing gas present in the liquid contained in the tank.
- (28) In an additional embodiment, the volume measurement system comprises at least one level sensor operatively associated with the tank, the computer being configured for receiving data from the level sensor and extrapolating a volume of liquid contained in the tank for predetermined levels.
- (29) In another embodiment, the system further comprises a Brix reading apparatus for measuring the Brix of the liquid prior to entering the tank, while received in the tank or after being evacuated from the tank, the computer being operatively connected to the Brix reading apparatus and receiving data from same, the computer being programmed to account for the data received from the Brix reading apparatus to determine the Brix measurement.
- (30) In still another embodiment, the Brix reading apparatus comprises a refractometer.
- (31) In another embodiment, the plurality of water injectors are independently actionable by the computer. The computer receives data from the temperature sensors inside the evaporator and actions the water injectors to adjust the temperature to a predetermined level.
- (32) In yet another embodiment, the liquid is selected from a group consisting of sap, syrup and taffy. Preferably, the sap comprises maple sap and the syrup comprises maple syrup.
- (33) In the embodiments, the Brix level of the liquid may be between 30 and 80%, preferably, the Brix level of the liquid measures 66 to 67%.
- (34) According to another broad aspect, there is provided a method for calibrating Brix in a liquid, the method comprising: Providing a system as described above; Measuring the temperature of the liquid received in the tank using the temperature reading apparatus; Measuring the weight of the liquid received in the tank using the weighing apparatus; Measuring the volume of the liquid received in the tank using the volume measurement system; Receiving data from the temperature reading apparatus, the evaporator, the weighing apparatus and the volume measurement system; and Calibrating the Brix content of the liquid to a predetermined level based on the data received from the temperature reading apparatus, the weighing apparatus, the evaporator and the volume measurement system using the computer.

(35) In an embodiment the calibrating comprises actioning at least one of the water injectors to begin spraying, cease spraying, or modulate a rate of spraying of water to the liquid.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration example embodiments thereof and in which:

(2) FIG. 1 is a schematic diagram of a system for measuring a Brix of a liquid in accordance with one embodiment;

(3) FIG. 2 is a schematic diagram of a system for measuring a Brix of a liquid in accordance with another embodiment; and

(4) FIG. 3 is a schematic diagram of a system allowing the calibration of a system for measuring Brix similar to the one shown in FIG. 1.

(5) FIG. 4 is a schematic diagram of a system showing the evaporator for allowing the calibration of Brix of a liquid, the evaporator being fluidly coupled to a system similar to the one shown in FIG. 1.

DETAILED DESCRIPTION OF EMBODIMENTS

(6) In the following description, the same numerical references refer to similar elements.

Furthermore, for the sake of simplicity and clarity, namely so as to not unduly burden the figures with several reference numbers, not all figures contain references to all the components and features, and references to some components and features may be found in only one figure, and components and features of the present disclosure which are illustrated in other figures can be easily inferred therefrom. The embodiments, geometrical configurations, materials mentioned and/or dimensions shown in the figures are optional and are given for exemplification purposes only.

(7) Moreover, it will be appreciated that positional descriptions such as “above”, “below”, “forward”, “rearward”, “left”, “right” and the like should, unless otherwise indicated, be taken in the context of the figures only and should not be considered limiting. The use of “including,” “comprising,” or “having” and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional suitable items. Unless specified or limited otherwise, the terms “mounted,” “connected,” “supported,” and “coupled” and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings and are thus intended to include direct connections between two members without any other members interposed therebetween and indirect connections between members in which one or more other members are interposed therebetween. Further, “connected” and “coupled” are not restricted to physical or mechanical connections or couplings. Additionally, the words “lower”, “upper”, “upward”, “down” and “downward” designate directions in the drawings to which reference is made.

(8) It is to be understood that the phraseology and terminology employed herein is not to be construed as limiting and are for descriptive purpose only. The principles and uses of the teachings of the present disclosure may be better understood with reference to the accompanying description, figures and examples. It is to be understood that the details set forth herein do not construe a limitation to an application of the disclosure.

(9) Furthermore, it is to be understood that where the claims or specification refer to “a” or “an” element, such reference is not to be construed that there is only one of that element. It is to be understood that where the specification states that a component, feature, structure, or characteristic “may”, “might”, “can” or “could” be included, that particular component, feature, structure, or

characteristic is not required to be included.

(10) Variants, examples and preferred embodiments of the invention are described hereinbelow. According to one embodiment, there is provided a system and a method for measuring, continuously (in real time) or not, the Brix of a liquid, and especially the Brix of maple sap or maple syrup, that are relatively inexpensive, that avoid the need of frequent reading of lenses of inline refractometers and that compensate or correct the Brix for temperatures ranging between 5 degrees Celsius and 110 degrees Celsius. In this embodiment, the system and method can measure Brix of 0% to 90%.

(11) According to this embodiment, and referring to FIG. 1, the system **1** comprises a reservoir or tank **10** having a peripheral wall **12** defining a chamber **14** for receiving a liquid therein, an inlet opening **16** fluidly coupled to an inlet pipe **18**, for conveying the liquid into the chamber **14** of the reservoir **10**, an outlet end **20** operatively coupled to an outlet pipe **22**, for evacuating the liquid from the chamber **14** of the reservoir **10**.

(12) The system **1** further comprises a plurality of temperature sensors **26a** to **26c** for measuring or evaluating the temperature of the liquid contained in chamber **14**, inlet pipe **18**, or outlet pipe **22**, a weighing system **28** for measuring the weight of the liquid contained in the tank **10** and a volume measurement system **30** for measuring or determining the volume of the liquid contained in the tank **10**. The system **1** also comprises a controller or computer **32** in communications with the at least one temperature sensor **26a-26c**, the weighing system **28** and the volume measurement system **30** and receiving inputs or data from them, the computer **32** being programmed to process the inputs or data received from the at least one temperature sensor **26a-26c**, the weighing system **28** and the volume measurement system **30** and determine a Brix measurement of the liquid contained in the tank **10**, as it will be described in greater details below.

(13) As it will be apparent, the controller or computer **32** may be a programmable logic controller (PLC) or programmable controller or a supervisory control and data acquisition (SCADA) system.

(14) As it will be appreciated, the system **1** could be used in connection with a number of tanks (better seen in FIG. 3) for holding either sap, syrup or taffy, where tank **10** could be a container storage tank, a stainless steel tank, a plastic tank, an isolated syrup calibration tank, a vertical silo, or any other type of tank, whether horizontal or vertical, and regardless of the material(s) from which such tank is manufactured. Likewise, it will be appreciated that tank **10** could be used at various steps of maple syrup productions, whether in the pumping station in the sugar bush where it receives maple sap from the tubing collecting the sap from maple trees, in a storage station closer to the sugar shack, prior or after reverse osmosis, prior to boiling, between the various boiling stages and/or after the boiling process but before filling barrels. As such, the inlet and/or outlet pipes **18**, **22** can also be made of different materials, depending on the stage of maple syrup production the tank **10**, inlet or outlet pipes **18**, **22** are being used.

(15) In the embodiment illustrated in FIG. 1, the system **1** comprises three temperature sensors **26a-26c** that are used to provide the computer with a measure or indication of the temperature of the liquid contained in the chamber **14** of the tank **10**, so as to account for such temperature in the calculation of the Brix of the liquid. In this embodiment, temperature sensors **26a-26c** are positioned in various locations to provide a more accurate reading or indication of the liquid temperature. More specifically, the system comprises a temperature sensor **26a** mounted to the peripheral wall **12** of the tank **10**, a temperature sensor **26b** mounted to the inlet pipe **18** and a temperature sensor **26c** mounted the outlet pipe **22**.

(16) As it will be best described below, in other embodiments, the system **1** could be provided with a different number of sensors and/or temperature sensors at other locations. For instance, the system **1** could be provided with two temperature sensors, mounted to the inlet and outlet pipes **18**, **22** (but no sensor mounted to the tank **10**) or to the tank **10** and to one of the inlet pipe **18** and the outlet pipe **22**. Alternatively, the system **1** could be provided with only one sensor, mounted either to the inlet pipe **18**, to the outlet pipe **22** or to the tank **10**. In this embodiment, the temperature

sensors **26a-26c** are simultaneously connected to the computer **32** to provide a compensation of the Brix based on aggregated temperature data from these three locations.

(17) As it will be appreciated, various types of temperature sensors could be used to measure the temperature of the liquid in the inlet pipe **18**, the chamber **14** of the tank **10** and/or in the outlet pipe **22**, including thermometers, negative temperature coefficient (NTC), thermistors, resistance temperature detectors (RTDs), semiconductor-based sensors, infrared sensors, bimetallic devices and the like. In one embodiment, a single temperature sensor is used to measure or extrapolate the temperature of the liquid in the reservoir.

(18) To provide the computer **32** with the weight of the liquid contained in the tank **10**, the weighing system **28** is provided. In the embodiment illustrated in FIG. **1**, the weighing system **28** is configured such that the tank **10** is supported by or hangs from a weight sensing sensor **42** comprising an upper hook **48** and a lower hook **46**, for instance a tension load cell (e.g. a tension weight module). In such an embodiment, the tank **10** is provided with a plurality of suspension cables **44a-44d** (only suspension cables **44a** to **44c** are shown in FIG. **1**), or alternatively to frame members (not shown). The suspension cables **44a** to **44d** are configured to allow the tank **10** to be hung to the lower hook **46** of the weight sensor **42**, which attaches to or suspends from a structure such as a ceiling beam, a truss or any other type of structure (not shown) using the upper hook **48**.

(19) As it will be apparent, the weight sensor **42** and/or computer **32** can be configured to tare the weight of the empty tank **10** and of the various components of the system that can be attached thereto (e.g. the pipes **18**, **22** and the like) and/or the inertial frame of reference of the system so that the weight of the liquid contained in the tank **10** is measured with precision and excludes any weight measurements not attributable to the liquid contained in the tank **10**.

(20) Further, weight sensor **42** and/or computer **32** can be configured to account for other factors that could affect the measurement of the weight, for instance the way the tank is supported by the weight sensor, the tension forces in the suspension cables **44a** to **44c**, the length of the suspension cables **44a** to **44c**, and any other forces due to movement of the tank **10** and of the various components of the system that can be attached thereto (e.g. the pipes **18**, **22** and the like), changes due to the temperature of the liquid contained in the chamber **14** and or the external temperature, as well as coefficients of thermal changes of the different materials used, which tend to expand under warm temperatures and to contract under colder temperatures.

(21) To correlate the weight of the liquid contained in the tank **10** with its volume, the volume measurement system **30** is provided. The embodiment illustrated in FIG. **1**, the volume measurement system **30** comprises the tank **10**, for which the precise volume is known at a standard temperature (e.g. 20 degrees Celsius), as well as a whirlpool or venturi device **50** for evacuating air bubbles that may be present in the liquid, and which may affect the actual volume of the liquid contained in the tank **10**. By ensuring that the tank **10** is completely filled with liquid (e.g. maple sap, maple syrup or taffy) and that all air, bubbles or gasses contained the liquid are evacuated using the whirlpool device **50** or any other similar device that would allow for such evacuation, the exact volume of liquid for which the weight is measured is known with precision, and the volume information or data can be sent to or factored in by the computer or controller **32**, to account for this information in the calculation or determination of the Brix measurement.

(22) As it will be appreciated, the volume of the tank **10** may itself be affected by the temperature of the liquid contained in the chamber **14** and or the external temperature, as materials tend to expand under warm temperatures and to contract under colder temperatures. As it will further be appreciated, this variation of volume of the tank **10** would in turn affect the exact volume of liquid contained in the tank **10** and measured at a given level. As such, the volume of the tank may be determined or calibrated at a standard temperature (e.g. the volume at 20 degrees Celsius), and a correction based on the temperature internal and/or external to the tank **10** can be applied to correct the volume of the tank **10** according to the temperature (and thus to the volume of liquid contained therein). Like the three temperature sensors **26a-26c** for measuring the temperature of the liquid

contained in the chamber **14**, various types of temperature sensors could be used to determine the temperature external to the tank **10**, thereby providing a correction value for the volume of the tank **10**.

(23) In an alternate embodiment, the system **1** could also comprise an optional Brix measurement apparatus such as an inline refractometer **24** operatively coupled to the chamber **14**, the inlet pipe **18** or the outlet pipe **22** for directly measuring the Brix of the liquid contained in the chamber **14** of the tank **10** or for directly measuring the Brix of the liquid circulating in the inlet and/or outlet pipes **18**, **22**. In such an alternate embodiment, the optional inline refractometer **24** is in communication with the computer or controller **32**, much like the three temperature sensors **26a-26c**, the weighing system **28** and the volume measurement system **30**. As such, the computer **32** receives inputs or data from the optional refractometer **24**, in addition to receiving data or inputs from the temperature sensors **26a-26c**, the weighing system **28** and the volume measurement system **30**. In this embodiment, the computer or controller **32** may be programmed to process the inputs or data received from the at least one of temperature sensor **26a-26c**, the weighing system **28** and the volume measurement system **30**, and the refractometer **24** either to apply a correction to the Brix measurement based on the weight (mass) of the liquid contained in the tank **10**, its volume and temperature as described above, as well as to apply a correction to the Brix readings from the inline refractometer **24**, or to provide a comingled Brix measurement value based on the Brix measurement based on the weight (mass) of the liquid contained in the tank **10**, its volume and temperature as described above, and the readings from the refractometer **24**.

(24) As it will be appreciated, various types of inline refractometers **24** could be used. Further, the inline refractometer could be mounted to the piping system (e.g. the inlet pipe **18** or the outlet pipe **22**), inside the chamber **14** on the peripheral wall **12** of the tank **10**, or otherwise mounted in the chamber **14**. While in the above embodiment, the system **1** has been described in connection with a single optional refractometer **24**, it will be appreciated that the system could comprise multiple refractometers (e.g. similar to refractometer **24**).

(25) In operation, the system **1** comprises the inlet pipe **18** which may be in fluid connection with a network of pipes (not shown), said network of pipes may be connected to a number of trees (not shown) for collecting the sap therefrom. In one embodiment, the inlet pipe **18** may be connected to a number of maple trees (not shown) and the system **1** is configured for measuring Brix from maple sap and/or maple syrup.

(26) In embodiments it will be understood that the inlet pipe **18** could instead be connected to a different type of trees, and the system **1** could be configured to measure the Brix of a different type of sap or liquid. In some embodiments, the network of pipes is linked to intervening devices such as pumps (see, for instance, pump **80** in FIG. **1**), to facilitate the transport of sap from the trees (not shown) to the inlet pipe **18**.

(27) While the sap is conveyed in the inlet pipe **18**, its temperature is measured for a first time, when the system **1** is equipped with a temperature sensor in the inlet pipe **18** (e.g. temperature sensor **26b** shown in FIG. **1**), and the temperature data is sent to the computer or controller **32**, either through a wired connection or a wireless connection, to be processed by the computer. The sap or liquid then goes through the inlet opening **16**, to reach the chamber **14** of the tank **10**, until a volume of sap or liquid to be measured is contained in the tank **10**.

(28) While in operation, the temperature of the liquid contained in the tank **10** is measured with the temperature sensor mounted to the tank (e.g. temperature sensor **26a** in FIG. **1**), and the temperature data is sent to the computer or controller **32**, either through a wired connection or a wireless connection, to be processed. At that point, the weight of the liquid contained in the tank **10** is measured by the weighing system **28** and the volume of the liquid is determined by the volume measurement system **30**. The data obtained by the weighing system **28** and the volume measurement system **30** is sent to the computer or controller **32** by wired or wireless connection, also to be processed. At that point, when in embodiments the system **1** is provided with an optional

refractometer **24**, the refractometer **24** takes measurement of the Brix of the liquid contained in the tank **10**, and also sends the measurement to the computer or controller **32**, again by wired connection or wireless connection.

(29) Still referring to FIG. **1**, in embodiments, when the liquid is allowed to exit the chamber **14** of the tank **10**, for instance by opening a valve (not shown), the liquid exits the chamber **14** through the outlet opening **20** to flow through the outlet pipe **22**. When the system **1** is equipped with a temperature sensor in the outlet pipe **22** (e.g. temperature sensor **26c** in FIG. **1**), the temperature sensor measures the temperature of the liquid in the outlet pipe **22** and sends data to the computer, to be processed.

(30) In embodiments, upon receipt of the temperature data from the temperature sensors **26a**, **26b** and/or **26c**, the weight of the liquid from the weighing system **28** and the volume of the liquid from the volume measurement system **30** (and, when applicable, Brix data from the optional refractometer **24**), the computer or controller **32** applies a preprogrammed algorithm accounting for the temperature of the liquid, its weight and volume to determine a Brix measurement (or to apply an appropriate correction or comingled Brix measurement value by also using the data measurement from the optional refractometer). For instance, in one embodiment, the computer **32** is programmed with an algorithm correlating a Brix value of the liquid received in the tank **10** based on the volume, the weight and the temperature of the liquid received in the tank, in order to determine the Brix measurement of the liquid received in the tank **10**. As it will be appreciated, such algorithm may take multiple forms, and can include preset tables correlating Brix measurement values to weight (mass), volume and temperature of the liquid (e.g. maple sap syrup, or taffy), or mathematical formulas for dynamically calculating the Brix based on weight, volume and temperature of the liquid contained in the tank **10** or elsewhere in the system **1**. As it will be appreciated, the system may also use data from the optional refractometer **24** to more accurately determine the Brix measurement and/or make the necessary corrections.

(31) To facilitate the operation of the computer or controller **32** and of the system **1**, and the adjustment of the various parameters, the computer can be provided with a graphical interface **34**. Such interface allows the control and monitoring of the various elements of the system (e.g. the temperature sensors **26**, a level sensor, the weighing system, etc.), and can be accessed directly from the computer **32** or remotely using internet or other type of connection, whether wired or wireless, using other computers or personal handheld electronic devices such as smart phones or tablets. Such interface **34** may be an input interface.

(32) As it will be appreciated, it may be desirable to use to system **1** to determine the Brix value of different types of liquids. For instance, the system **1** may be used to measure the Brix of maple syrup, or of maple sap, taffy or a different type of liquid. In such circumstances, when a same system **1** is used to process different types of liquids, the system **1** may be cleaned between the various Brix measurements, simply by circulating water and/or a cleaning agent in the inlet pipe **18**, tank **10**, outlet pipe **20** and any other relevant parts of the system **1**.

(33) Turning now to FIG. **2**, there will be described an alternative embodiment of a system **101** for measuring, continuously (in real time) or not, the Brix of a liquid. According to this embodiment, the system **101** comprises a reservoir or tank **110** having a peripheral wall **112** defining a chamber **114** for receiving a liquid therein, a top opening **116** in alignment with an inlet pipe **118**, for conveying the liquid into the chamber **114** of the tank **110**, an outlet end **120** defined at the bottom of the tank **110** and operatively coupled to an outlet pipe **122**, for evacuating the liquid from the chamber **114** of the reservoir **110**.

(34) The system **101** further comprises a temperature sensor **126a** for measuring or evaluating the temperature of the liquid contained in chamber **114**, a weighing system **128** for measuring the weight of the liquid contained in the tank **110** and a volume measurement system **130** for measuring or determining the volume of the liquid contained in the tank **110**. The system **101** also comprises a controller or computer **132** in communications with the temperature sensor **126a**, the weighing

system **128** and the volume measurement system **130** and receiving inputs or data from them, the computer **132** being programmed to process the inputs or data received from the temperature sensor **126a**, the weighing system **128** and the volume measurement system **130** to determine a Brix measurement of the liquid contained in the tank **110**, as it will be described in greater details below.

(35) As it will be apparent, the controller or computer **132** may be a programmable logic controller (PLC) or programmable controller or a supervisory control and data acquisition (SCADA) system.

(36) Much like the system **1**, the system **101** could be used in connection with a number of tanks for holding either sap or syrup, where tank **110** could be a container storage tank, a stainless steel tank, a plastic tank, an isolated syrup calibration tank, a vertical silo, or any other type of tank, whether horizontal or vertical, and regardless of the material(s) from which such tank is manufactured. Likewise, it will be appreciated that tank **110** could be used at various steps of maple syrup productions, whether in the pumping station in the sugar bush where it receives maple sap from the tubing collecting the sap from maple trees, in a storage station closer to the sugar shack, prior of after reverse osmosis, prior to boiling, between the various boiling stages and/or after the boiling process but before filling barrels. As such, the inlet and/or outlet pipes (**118**, **122**) can also be made of different materials, depending on the stage of maple syrup production the tank **110**, inlet **118** or outlet pipes **122** are being used. The inlet and/or outlet pipes (**118**, **122**) may be completely made of flexible material or partially made of flexible material. Flexible pipes may include steel, ductile iron, thermoplastics such as Polyvinyl Chloride (PVC) and High Density Polyethylene (HDPE), thermosetting plastics such as fiberglass-reinforced polymer (FRP), bar-wrapped concrete cylinder pipe, and corrugated steel pipes.

(37) The sensor **126a** is used to provide the computer or controller **132** with a measure of the temperature of the liquid contained in the chamber of the tank **110**, so as to account for such temperature in the calculation of the Brix of the liquid. In one embodiment, the temperature sensor **126a** is operatively mounted to the tank **110** to measure the temperature of the liquid contained therein.

(38) In an alternate embodiment, the system **101**, like system **1**, could include a plurality of temperature sensors mounted at different locations in the system **101**, for instance three temperature sensors including one sensor **126b** in the inlet pipe, one sensor **126a** in the chamber of the tank **110** and/or one sensor **126c** in the outlet pipe, to provide a compensation of the Brix based on aggregated temperature data from these three locations.

(39) In other embodiments, the system **101** could be provided with a different number of sensors and/or temperature sensors at other locations. For instance, the system **101** could be provided with two temperature sensors, mounted to the inlet and outlet pipes (**126b**, **126c**) but no sensor mounted to the tank **110**. Alternatively, the system **101** could be provided with only one sensor, mounted either to the inlet pipe **126b** or to the outlet pipe **126c**.

(40) As it will be appreciated, various types of temperature sensors could be used to measure the temperature of the liquid in the chamber **114** of the tank **110**, including thermometers, negative temperature coefficient (NTC), thermistors, resistance temperature detectors (RTDs), semiconductor-based sensors, infrared sensors, bimetallic devices and the like.

(41) To provide the computer or controller **132** with the weight of the liquid contained in the tank **110**, the weighing system **128** is provided. In the illustrated embodiment, the weighing system **128** comprises a plurality of weight sensors such as load cells, onto which the tank **110** is supported. Such weight sensors could include, for instance, compression load cells, compression load modules, strain gauge load cells, single point load cells or any other type of electronic or digital weight sensors. Such weight sensors could include, for instance, compression load cells, compression load modules, strain gauge load cells, single point load cells or any other type of electronic or digital weight sensors. For instance, where a tank **110** having a square or rectangular base is used (as shown in FIG. 2), the tank **110** can rest on 4 compression load cells **140a-140d** (only load cells **140a-140d** being shown in FIG. 2), each load cell **140a-140d** being positioned at

one corner of the square or rectangular-shaped tank **110**. In such an embodiment, the load or weight sensed by each load cell **140a-140d** is sent and treated by the controller or computer **132**, to determine the weight of the liquid contained in the tank **110** and to account for such weight in the calculation or determination of the Brix measurement.

(42) As is will be apparent, the load cells **140a-140d** and/or computer or controller **132** can be configured to tare the weight of the empty tanks **110** and of the various components that can be attached thereto (e.g. pipes and the like) so that the weight of the liquid contained in the tank **110** is measured with precision and excludes any weight measurements not attributable to the liquid contained in the tank **110**.

(43) Further, in embodiments, the load cells **140a-140d** and/or computer or controller **132** can be configured to account for other factors that could affect the measurement of the weight, for instance the position of the various load cells relative to the floor or ground surface, as well as any irregularities on the floor or ground surface that could affect the measurements taken by the load cells. As it will be appreciated, the number and position of load cells can vary greatly depending on the configuration and shape of the reservoir or tank, the space and nature of the surface on which these load cells rest and other factors. Thus, in some embodiments, the tank **110** could be supported on, or suspended from a single load cell or weight sensor, while in other embodiments a plurality of load cells or weight sensors may be desirable.

(44) To correlate the weight of the liquid contained in the tank **110** with its volume, the volume measurement system **130** is provided. In one embodiment, the volume measurement system **130** comprises the tank **110**, for which the volume at various predetermined levels is known, as well as at least one level sensor **150** for measuring the level of liquid in the tank **110**. By determining the level of the liquid contained in the tank **110**, and knowing the volume of the tank **110** at the various predetermined levels (either as preset values or by calculation), it becomes possible to extrapolate the volume of liquid contained in the tank **110**, and to send the relevant information or data to the computer or controller **132**, to account for this information in the calculation or determination of the Brix measurement.

(45) As it will be appreciated, the volume of the tank **110** may itself be affected by the temperature of the liquid contained in the chamber **114** and or the external temperature, or the materials used in making the tank, as materials tend to expand under warm temperatures and to contract under colder temperatures. As it will further be appreciated, this variation of volume of the tank **110** would in turn affect the exact volume of liquid contained in the tank **110** and measured at a given level. As such, the volume of the tanks may be determined or calibrated at a standard temperature (e.g. the volume at 20 degrees Celsius), and a correction based on the temperature internal and/or external to the tank **110** can be applied to correct the volume of the tank **110** according to the temperature (and thus to the volume of liquid contained therein). Like the temperature sensor **126a** for measuring the temperature of the liquid contained in the chamber **114**, various types of temperature sensors could be used to determine the temperature external to the tank **110**, to provide a correction value for the volume of the tank.

(46) In one embodiment, the level sensor **150** is mounted to peripheral wall **112** of the tank **110**, either directly or via an intervening structure such as a bracket, to extend in the internal chamber **114** of the tank **110** and to measure the level of liquid contained therein. The level sensor **150** could be of any type suitable for such an application, including a level sensor such as optical level switches, capacitance level sensors, ultrasonic sensors, microwave sensors, radar sensors, vibrating sensors, turning fork sensors, conductive sensors, resistance sensors, float switches and the like.

(47) In an alternate embodiment, the system **101** could also comprises a Brix measurement apparatus such as an inline refractometer **124** operatively coupled to the chamber **114**, the inlet pipe **118** or the outlet pipe **122** for directly measuring the Brix of the liquid contained in the chamber **114** of the tank **110** or circulating in the inlet and/or outlet pipes (**118**, **122**).

(48) In this embodiment, the inline refractometer **124** is in communication with the computer **132**,

much like the temperature sensors **126a**, **126b**, **126c**, the weighing system **128** and the volume measurement system **130**. As such, the computer **132** receives inputs or data from the refractometer **124**, in addition to receiving data or inputs from the temperature sensors **126a**, **126b**, **126c**, the weighing system **128** and the volume measurement system **130**. In this embodiment, the computer or controller **132** is programmed to process the inputs or data received from the temperature sensors **126a**, **126b**, **126c**, the weighing system **128** and the volume measurement system **130** and the refractometer **124** either to apply a correction to the Brix measurement based on the weight (mass) of the liquid contained in the tank **110**, its volume and temperature as described above, to apply a correction to the Brix readings from the inline refractometer **124**, or to provide a comingled Brix measurement value otherwise based on the Brix measurement based on the weight (mass) of the liquid contained in the tank **110**, its volume and temperature as described above and the readings from the refractometer **124**.

(49) As it will be appreciated, various types of inline refractometers **124** could be used. Further, the inline refractometer **124** can be mounted to the piping system (e.g. the inlet pipe **118** or the outlet pipe **122**, inside the chamber **114** on the peripheral wall **112** of the tank **110**, or otherwise mounted in the chamber **114**.

(50) In one embodiment, the refractometer **124** is operatively coupled to a cleaning system (not shown) allowing a cleaning liquid to circulate and recirculate to clean the lens of the refractometer **124**. While in the above embodiment, the system **101** has been described in connection with a single optional refractometer **124**, it will be appreciated that the system could comprise multiple optional refractometers (not shown) (e.g. similar to refractometer **124**).

(51) In operation, the system **101** comprises the inlet pipe **118** which may be in fluid connection with a network of pipes (not shown) connected to a number of trees (not shown) for collecting the sap therefrom. In one embodiment, the outlet pipe **122** is connected to a number of maple trees (not shown) and the system **101** is configured for measuring Brix from maple sap, taffy and/or maple syrup, but it will be understood that the inlet pipe **118** could instead be connected to a different type of trees and the system **101** could be configured to measure the Brix of a different type of sap, taffy or liquid. In some embodiment, the network of pipes (not show) may be linked to intervening devices such as pumps **180**, to facilitate the transport of sap from the trees to the inlet pipe **118**.

(52) While the sap or liquid is conveyed in the inlet pipe, its temperature can be measured for a first time, when the system **101** is equipped with a temperature sensor in the inlet pipe **118**, and the temperature data is sent to the computer or controller **132**, either through a wired connection or a wireless connection, to be processed by the computer or controller **132**. The sap, taffy, or liquid then goes through the top opening **116**, to reach the chamber **114** of the tank **110**, until a volume of sap, taffy or liquid is contained in the tank **110**.

(53) While in operation, the temperature of the liquid contained in the tank **110** is measured with the temperature sensor **126a** mounted to the tank **110**, and the temperature data is sent to the computer or controller **132**, either through a wired connection or a wireless connection, to be processed. At that point, the weight of the liquid contained in the tank **110** is measured by the weighing system **128** and the volume of the liquid is determined by the volume measurement system **130**. The data obtained by the weighing system **128** and the volume measurement system **130** is sent to the computer or controller **132** by wired or wireless connection, also to be processed. At that point, when the system **101** is provided with an optional refractometer **124**, the refractometer **124** takes measurement of the Brix of the liquid contained in the tank **110** or at different points (e.g inlet pipe **118** or the outlet pipe **122**), and also sends the measurement to the computer or controller **132**, again by wired connection or wireless connection.

(54) When the liquid is allowed to exit the chamber **114** of the tank **110**, for instance by opening a valve (not shown), the liquid exits the chamber **114** through the outlet opening **120** to flow through the outlet pipe **122**. When the system **101** is equipped with a temperature sensor **126c** in the outlet pipe **122**, the temperature sensor measures the temperature of the liquid in the outlet pipe and sends

data to the computer or controller **132**, to be processed.

(55) Upon receipt of the temperature data from the temperature sensors **126a**, **126b** or **126c**, the weight of the liquid from the weighing system **128** and the volume of the liquid from the volume measurement system **130** (and, when applicable, Brix data from the optional refractometer **124**), the computer or controller **132** applies a preprogram algorithm accounting for the temperature of the liquid, its weight and volume to determine a Brix measurement (or to apply an appropriate correction or comingled Brix measurement value). For instance, in one embodiment, the computer or controller **132** is programmed with an algorithm correlating a Brix value of the liquid received in the tank **110** based on the volume, the weight and the temperature of the liquid received in the tank **110**, in order to determine the Brix measurement of the liquid received in the tank **110**. As it will be appreciated, such algorithm may take multiple forms, and can include preset tables correlating Brix measurement values to weight (mass), volume and temperature of the liquid (e.g. maple sap or syrup), or mathematical formulas for dynamically calculating the Brix based on weight, volume and temperature of the liquid contained in the tank **110**, data from the optional refractometer **124**, or from elsewhere in the system **101**.

(56) To facilitate the operation of the computer or controller **132** and of the system **101**, and the adjustment of the various parameters, the computer or controller can be provided with a graphical interface **134**. Such interface allows the control and monitoring of the various elements of the system (e.g. the temperature sensors (**126a**, **126b**, **126c**), the level sensor **150**, the weighing system **128**, etc.), and can be accessed directly from the computer or controller **132**, or remotely using internet or other type of connection, whether wired or wireless, using other computers or personal handheld electronic devices such a smart phones or tablets. Such interface **134** may be an input interface.

(57) As it will be appreciated, it may be desirable to use to system **101** to determine the Brix value of different types of liquids. For instance, the system **101** may be used to measure the Brix of maple syrup, maple sap, taffy or a different type of liquid. In such circumstances, when the same system **101** is used to process different types of liquids, the system **101** may be cleaned between the various Brix measurements, simply by circulating water and/or a cleaning agent in the inlet pipe **118**, tank **110**, outlet pipe **120** and any other relevant part of the system **101**.

(58) Referring now to FIG. 3, in embodiments, there is provided of a method and system **3001** for measuring the Brix of maple sap continuously (in real time) or not, wherein said method allows for the automatic calibration of the Brix by using a volume measurement and density calibration system **1030**, said method integrating a system **1000** for measuring the Brix of maple sap continuously (in real time) or not. As provided, the method for measuring Brix from a liquid comprises: providing the system **1000** comprising a tank **1010** for receiving therein a volume of the liquid, an inlet opening **1020** fluidly connected to the tank **1010** for conveying the liquid into the tank **1010**; an outlet opening **1016** fluidly connected to the tank for evacuating the liquid from the tank; a temperature reading apparatus (**1026a**, **1026b**, **1026c**) for measuring a temperature of the liquid prior to entering the tank **1010**, while received in the tank or after being evacuated from the tank; a weighing apparatus **1028** for measuring a weight of the volume of liquid received in the tank **1010**; volume measurement and density calibration system **1030** for measuring the volume of the liquid received in the tank and calibrating the Brix; a computer or controller **1032** operatively connected to the temperature reading apparatus (**1026a**, **1026b**, **1026c**), the weighing apparatus **1028** and the volume measurement and density calibration system **1030** and receiving data from same, the computer or controller **1032** being programmed to determine a Brix measurement based on the data received from the temperature reading apparatus (**1026a**, **1026b**, **1026c**), the weighing apparatus **1028** and volume measurement and density calibration system **1030** and receiving data from same; measuring the temperature of the liquid received in the tank **1010** using the temperature reading apparatus (**1026a**, **1026b**, **1026c**); measuring the weight of the liquid received in the tank **1010** using the weighing apparatus **1028**; measuring the volume of the liquid received in the tank

1010 using the volume measurement and density calibration system **1030**; receiving data from the temperature reading apparatus (**1026a**, **1026b**, **1026c**), the weighing apparatus **1028** and volume measurement and density calibration system **1030**; and using the computer to determine the Brix measurement based on the data received from the temperature reading apparatus (**1026a**, **1026b**, **1026c**), the weighing apparatus **1028** and the volume measurement and density calibration system **1030**. The computer or controller **1032** optionally being programmable for calibrating the Brix measurements thanks for the data received from the volume measurement and density calibration system **1030**.

(59) As it will be apparent, the controller or computer **1032** may be a programmable logic controller (PLC) or programmable controller, or a supervisory control and data acquisition (SCADA) system.

(60) Still referring to FIG. 3, it will be appreciated the reservoir or tank **1010** comprises a peripheral wall **1012** defining a chamber **1014** for receiving a liquid therein, an inlet opening **1016** fluidly coupled to an inlet pipe **1018**, for conveying the liquid into the chamber **1014** of the reservoir **1010**, an outlet end **1020** operatively coupled to an outlet pipe **1022**, for evacuating the liquid from the chamber **1014** of the reservoir **1010**.

(61) As it will be appreciated, the weighing system **1028** may be configured such that the tank **1010** is supported by or hang from a weight sensing sensor **1042**, for instance a tension load cell (e.g. a tension weight module). In such an embodiment, the tank **1010** is provided with a plurality of suspension cables **1044a** to **1044d** (only suspension cables **1044a** to **1044c** being shown in FIG. 3), or alternatively to frame members (not shown), allowing to tank **1010** to be hung from a lower hook of the weight sensor **1042**, which weight sensor **1042** also comprises an upper hook for attaching or suspending the weight sensor **1042** to a structure such a ceiling beam (not shown), a truss or any other type of structure (not shown) to which the tank **1010** can be suspended.

(62) As it is further appreciated in FIG. 3, the Brix measurement apparatus may also comprise an inline refractometer **1024a** operatively coupled to the chamber **1014**.

(63) Still referring to FIG. 3, in embodiments, it will be appreciated that an optional volume measurement and density calibration system **1030** may be fluidly coupled with the reservoir or tank **1010**, wherein the outlet pipe **1022** directs the liquid received from the tank **1010** towards the volume measurement and density calibration system **1030**.

(64) In embodiments, the volume measurement and density calibration system **1030** may comprise a top opening **1116**, to reach the chamber **1114** of the tank **1110**, until a volume of sap is contained in the tank **1110**. The volume measurement system may comprise a temperature reading apparatus **1026d**, an optional agitator **1190** for mixing the liquid, as well as at least one level sensor **1050**.

(65) In embodiments, the volume measurement and density calibration system **1030** may comprise an inline refractometer **1024b** operatively coupled to the chamber **1114** of the tank **1110**.

(66) Still referring to FIG. 3, in embodiments, it will be appreciated that the sap or the liquid may be directed from the volume measurement and density calibration system **1030** to a storing container or reservoir **2010** for storage or, alternatively, the sap or the liquid may be directed from volume measurement and density calibration system **1030** to the Brix measurement system **1000** for further analysis and measurements.

(67) It will be appreciated, in embodiments as shown in FIG. 3, the method and system for measuring the Brix of maple sap continuously (in real time) or not **3001** may comprise one or more storage tanks **2020** for storing the sap, taffy or liquid.

(68) Still referring to FIG. 3, in embodiments, the volume measurement and density calibration system **1030** or at least one of the storage tanks **2020** may comprise a heating device (**2030a**, **2030b**) for regulating the temperature of the sap, taffy or liquid.

(69) As it will be appreciated, still referring to FIG. 3, there is provided a cleaning system **2040** comprising a plurality of tanks (**2042**, **2044**) allowing a cleaning liquid to circulate and be recirculated to clean the system for measuring the Brix of maple sap continuously (in real time) or

not **3001**. The cleaning liquid may be a cleaning acid used in the food industry, preferably citric acid.

(70) In embodiments, as provided in FIG. 3, the method and system for measuring the Brix of maple sap continuously (in real time) or not **3001** maybe be fluidly coupled to a plurality of intervening devices such as pumps (**2050a**, **2050b**, **2050c**, **2050d**) to facilitate the transport of sap or liquid through the different systems and/or for the cleaning of system for measuring the Brix of maple sap continuously (in real time) or not **3001**.

(71) Now referring to FIG. 4, there is provided a system **4001** for an automated calibration of Brix in a liquid, the system may be fluidly coupled to a system similar to the one previously described. In particular, reference is made to the system **3001** previously described and the same reference numerals are used in FIG. 4 where appropriate to identify identical components or components performing a similar function in system **4001** as in system **3001**. The system **4001** may comprise: a tank for receiving therein a volume of the liquid; an inlet opening fluidly connected to the tank for conveying the liquid into the tank; an outlet opening fluidly connected to the tank for evacuating the liquid from the tank; a temperature reading apparatus for measuring a temperature of the liquid; a weighing apparatus for measuring a weight of the volume of liquid received in the tank; a volume measurement system for measuring the volume of the liquid received in the tank. The system comprises an evaporator **4010** fluidly connected to the tank, the reading apparatus, the weighing apparatus and the volume measurement system, the evaporator being configured to reduce the level of water in the liquid, the evaporator comprising a combustion chamber **4011** and a plurality of water injectors **4012** for spraying water to the liquid. The water injectors may be connected to an aqueduct feed **4013**. The evaporator may further comprise one or more temperature reading devices **4026** for reading the temperature of the liquid in the evaporator, as well as one or more valves **4027** in fluid communication with the injectors **4012**, the devices **4026** and valves **4027** being operatively connected to other components of the system in a manner similar to the operative connections described for the systems **1**, **101** and **3001**. A manifold **4015** evacuates liquid from the evaporator **4010**. The system **4001** further comprises a computer or an automated HMI **4036** operatively connected to the temperature reading apparatus, the weighing apparatus, the volume measurement system and the evaporator and receiving data from same, the computer or the automated HMI may be programmed to determine a Brix measurement based on the data received from the temperature reading apparatus, the weighing apparatus, the volume measurement system and the evaporator, the computer or automated HMI may be programmed to calibrate and adjust the Brix in the liquid to a predetermined value.

(72) Still referring to FIG. 4, in embodiments, the system for automated calibration of Brix in a liquid may be fluidly coupled to a pump such as pump **2050b** for recirculating the liquid in a closed-loop configuration between an end section of the evaporator and the tank. The system may comprise a drain **4016** and a pump **4017**, such as a peristaltic pump, configured to pump the liquid towards a tank **1110**, to storage means (not shown) or to a filtration system (not shown), drain **4016** and pump **4017** being in fluid communication with the manifold. The system **4001** may comprise one or more sampling ports **4060**.

(73) Recirculation pump **2050b** may be in fluid communication with a degassing system **4050**, wherein liquid or syrup comprising gas is fed through a pipe network comprising a pressure regularization column **4051**. The change in pressure causes the gas contained within the liquid or syrup to escape, the gas being vented or otherwise separated from the liquid or syrup stream through outlet **4052**. Liquid or syrup that enters or remains in the column **4051** may be recirculated into the evaporator **4010** or into a tank such as tank **2042**. The degassing system may comprise one or more drains **4053**.

(74) In embodiments, as shown in FIG. 4, the computer or the automated HMI may be programmed to action the plurality of water injectors for stabilizing the temperature of the evaporator.

(75) Still referring to FIG. 4, in embodiments, the computer or the automated HMI, may be

programmed with an algorithm correlating a Brix value of the liquid received in the tank based on the volume, the weight and the temperature of the liquid received in the tank to determine the Brix measurement of the liquid received in the tank.

(76) Still referring to FIG. 4, in embodiments, the evaporator may comprise a plurality of temperature sensors for reading the temperature of the liquid inside the evaporator. The temperature sensors may also be adapted to read the temperature inside the evaporator and transmit these temperature readings to the computer.

(77) Still referring to FIG. 4, in another embodiment, the plurality of water injectors may be independently actionable by the computer or the automated HMI. When the computer or the automated HMI receives data from the temperature sensors inside the evaporator, it may action the water injectors to adjust the temperature to a predetermined level and/or action the plurality of water injectors and spray water to the liquid. The water injectors may be actioned all at once, or may be independently actionable by the computer or the automated HMI.

(78) Still referring to FIG. 4, in embodiments, there is provided a system wherein the computer or the automated HMI is programmed to analyze the data received from the temperature reading apparatus, the weighing apparatus, the volume measurement system and the evaporator and calibrate the Brix of the liquid to a predetermined level by coordinating changes in the temperature in the evaporator and/or actioning the plurality of water injectors and spraying water to the liquid.

(79) The predetermined level of Brix in the liquid may be between 30 and 80%, preferably the Brix level of the liquid may measure 66 to 67%.

(80) Yet in another embodiment, and as illustrated in FIG. 4, according to another broad aspect, there is provided a method for calibrating Brix in a liquid, the method comprising: providing a system as described above; measuring the temperature of the liquid received in the tank using the temperature reading apparatus; measuring the weight of the liquid received in the tank using the weighing apparatus; measuring the volume of the liquid received in the tank using the volume measurement system; receiving data from the temperature reading apparatus, the evaporator, the weighing apparatus and the volume measurement system; and calibrating the Brix content of the liquid to a predetermined level based on the data received from the temperature reading apparatus, the weighing apparatus, the evaporator and the volume measurement system using the computer or the automate HMI.

(81) Still referring to FIG. 4, in embodiments, the computer or automated HMI may be a programmable logic controller (PLC) or programmable controller or a supervisory control and data acquisition (SCADA) system.

(82) As will be apparent, the computers, interfaces, HMIs and other control devices described herein may be configured to control one or several characteristics of the processes, such characteristics comprising flowrates, power, pump speeds, fuel feed, combustion intensity, heating intensity, agitator speeds and sampling rates.

(83) The above description of the variants, examples or embodiments should not be interpreted in a limiting manner since other variations, modifications and refinements are possible within the scope of the present invention. Accordingly, it should be understood that various features and aspects of the disclosed variants or embodiments can be combined with or substituted for one another in order to form varying modes of the disclosed invention. For example, and without limitation, any individual element of the described variants or embodiments may be replaced by alternative elements that provide substantially similar functionality or otherwise provide adequate operation. This includes, for example, presently known alternative elements, such as those that might be currently known to a skilled person in the art, and alternative elements that may be developed in the future, such as those that a skilled person in the art might, upon development, recognize as an alternative. The scope is defined in the appended claims and their equivalents.

Claims

1. A system for an automated calibration of Brix in a liquid, the system comprising: a tank for receiving therein a volume of the liquid; an inlet opening fluidly connected to the tank for conveying the liquid into the tank; an outlet opening fluidly connected to the tank for evacuating the liquid from the tank; a temperature reading apparatus for measuring a temperature of the liquid; a weighing apparatus for measuring a weight of the volume of liquid received in the tank; a volume measurement system for measuring the volume of the liquid received in the tank; an evaporator fluidly connected to the tank, the reading apparatus, the weighing apparatus and the volume measurement system, the evaporator being configured to reduce the level of water in the liquid, the evaporator comprising a plurality of water injectors for spraying water to the liquid; and A computer operatively connected to the temperature reading apparatus, the weighing apparatus, the volume measurement system and the evaporator and receiving data from same, the computer being programmed to determine a Brix measurement based on the data received from the temperature reading apparatus, the weighing apparatus, the volume measurement system and the evaporator, the computer being programmed to action at least one of the plurality of water injectors for stabilizing the temperature of the evaporator.

2. The system of claim 1, wherein the evaporator comprises a plurality of temperature reading sensors for reading the temperature of the liquid inside the evaporator.

3. The system of claim 1, wherein the computer is programmed with an algorithm correlating a Brix value of the liquid received in the tank based on the volume, the weight and the temperature of the liquid received in the tank to determine the Brix measurement of the liquid received in the tank.

4. The system of claim 3, wherein the computer is programmed with an algorithm to activate the plurality of water injectors to control the temperature of the evaporator.

5. The system of claim 4, wherein the computer is programmed to analyze the data received from the temperature reading apparatus, the weighing apparatus, the volume measurement system and the evaporator to calibrate the Brix of the liquid to a predetermined level.

6. The system of claim 5, wherein the predetermined Brix level is between 30 and 80%.

7. The system of claim 1, wherein the temperature reading apparatus comprises at least one temperature sensor selected from a group consisting of a thermometer, a negative temperature coefficient (NTC) thermistor, a resistance temperature detector (RTD), a thermocouple, a semiconductor-based sensor, an infrared sensor and a bimetallic device.

8. The system of claim 7, comprising: an inlet pipe fluidly connected to the inlet opening for conveying the liquid into the tank; an outlet pipe fluidly connected to the outlet opening for tank for evacuating the liquid from the tank; and wherein the temperature reading apparatus is mounted to at least one of the tank, the inlet pipe and the outlet pipe.

9. The system of claim 8, wherein the temperature reading apparatus comprises at least one temperature sensor mounted to at least one of the tank, the inlet pipe and the outlet pipe.

10. The system of claim 9, wherein the temperature reading apparatus comprises a first temperature sensor mounted to the tank, a second temperature sensor mounted to the inlet pipe and a third temperature sensor mounted to the outlet pipe.

11. The system of claim 1, wherein the weighing apparatus comprises at least one load cell operatively associated with the tank for measuring the weight of the volume of liquid received in the tank.

12. The system of claim 11, wherein the at least one load cell is supported on a floor surface, and the tank is supported onto the at least one load cell.

13. The system of claim 11, wherein the at least one load cell is suspended to a ceiling structure and the tank is suspended by the at least one load cell.

14. The system of claim 1, wherein the volume measurement system further comprises gas

removing means associated with the tank for removing gas present in the liquid contained in the tank.

15. The system of claim 1, wherein the volume measurement system comprises a level sensor operatively associated with the tank, the computer being configured for receiving data from the level sensor and extrapolating a volume of liquid contained in the tank for predetermined levels.

16. The system of claim 1, further comprising a Brix reading apparatus for measuring the Brix of the liquid prior to entering the tank, while received in the tank or after being evacuated from the tank, the computer being operatively connected to the Brix reading apparatus and receiving data from the same, the computer being programmed to account for the data received from the Brix reading apparatus to determine the Brix measurement.

17. The system of claim 1, wherein the plurality of water injectors are independently actionable by the computer.

18. The system of claim 1, wherein the liquid is selected from a group consisting of maple sap, maple taffy and maple syrup.

19. A method for calibrating Brix in a liquid, the method comprising: Providing a system according to claim 1; Measuring the temperature of the liquid received in the tank using the temperature reading apparatus; Measuring the weight of the liquid received in the tank using the weighing apparatus; Measuring the volume of the liquid received in the tank using the volume measurement system; Evaporating the water of the liquid using the evaporator; Receiving data from the temperature reading apparatus, the evaporator, the weighing apparatus and the volume measurement system; and Calibrating the Brix content of the liquid to a predetermined level based on the data received from the temperature reading apparatus, the weighing apparatus, the evaporator and the volume measurement system using the computer.

20. The method of claim 19, wherein the calibrating comprises actioning at least one of the water injectors to begin spraying, cease spraying, or modulate a rate of spraying of water to the liquid and wherein the computer stabilizes and controls the temperature of the evaporator by actioning the water injectors and/or injecting water to the liquid inside the evaporator.
