

Description

The present invention relates to a method and apparatus for improving quality and increasing syrup yields within a beverage blending system. In particular, the present invention relates to a method and apparatus for controlling the proportional blending of two or more components of a carbonated beverage by means of the mass flow of the components.

The preparation of beverages, particularly carbonated beverages, includes the mixture or blending in exact proportion of a flavor syrup with water. The proportion standards for a particular beverage are typically set by the owner of the syrup recipe and the associated trademarks of the beverage. These proportion standards are a fixed operational requirement for the bottler who is a licensee of the recipe owner.

Typically, the conformity of the blended beverage to the proportion standards is determined after the beverage has been prepared. This determination is made by a downstream analyzer system or by lab analysis. If it is found that the already blended beverage does not fall within the required standards, the batch is disposed of at substantial cost to the bottler.

There are a number of blending and proportioning systems found in the prior art. There is shown in Figure 1 a typical blending and proportioning system including a proportion analyzer at the discharge end. For purposes of the present invention this typical blending system need not be described in complete detail. Reference is hereby made to U.S. Pat. No. 4,801,471 to Mojonner which describes a blending and proportioning system similar to those typically found in existing bottling plants.

The typical blending and portioning system shown in Figure 1 herein includes a water input 10 which feeds a cooler 12. The cooler 12 feeds one portion of a proportioner 14. A syrup supply 16 feeds a separate portion of the proportioner 14. Filtered water from inlet 10 or syrup from supply 16 may pass through scrubbing units (not shown) or other apparatus as desired prior to input into proportioner 14. The input flow into the proportioner 14 from both the water line 18 and syrup line 20 is controlled by means of valves 22 and 24, respectively. Valves 22, 24 receive control signals from floating control members (not shown) within the storage tanks 26 and 28 of the proportioner 14.

Storage tanks 26 and 28 feed lines 32, 34, respectively, which exhaust into blending tank 30. Water line 32 into tank 30 includes a micrometer or similar type control valve 36. Valve 36 is used to make minute adjustments in the relative proportion of the water flowing into blending tank 30. Syrup line 34 may also include a control valve (not shown). However, due to the large proportion of water in a typical beverage, as compared to the syrup, minute control of the relative proportion of the components is more easily

accomplished by adjustment at the water input. A total flow control valve 38 is also provided at the inlet to blending tank 30.

Blending tank 30 includes a float member 40 similar to that used along with valves 22 and 24. The signals from the float member 40 is used to control the downstream flow of the blended beverage. The blended beverage from blending tank 30 is input into a carbonator 42. After carbonation, the beverage flow is directed towards a bottling apparatus (not shown).

The actual proportion of syrup and water within the blended beverage is determined by a downstream beverage analyzer 44. The analyzer 44 takes samples from the flow into the bottling apparatus. The samples are used to determine the accuracy of the blend as performed by the proportioner 14 and compare it to the fixed standards. If an on-line analyzer 44 is not provided, periodically samples are manually withdrawn from the flow and lab analysis is conducted to determine the proportion result.

Typically, sugar based beverages are analyzed by making a brix determination of the sugar within the overall blend. In the case of diet soda, the analyzer typically uses a titrated acidity determination. Methods of analyzing the beverage include internal reflection spectroscopy and infrared absorption.

Upon a finding that the blended beverage is outside of the standards set by the recipe owner, adjustment of the proportioning is made at valve 36 or at some other position within the system. Analyzer 44 may also serve to control the blend. Such an analyzer/controller typically includes an external water valve which inputs additional water into the flow at the position of the analyzer. The system compensates for errors of the proportional blending by operating the proportioner on the "high" or rich end of the blending standards. The addition of water downstream of the proportioner adjusts the proportion of the blend. However, if the analyzer fails to adjust the beverage into the proper proportion, the product will be outside of the fixed standards. This may occur, if the beverage blend moves into the "low" range. In this situation manual micrometer control must be made to realign the proportion into the desired range. The portion of the batch prepared outside of the fixed standards must then be disposed of prior to continuation of the blending and bottling process.

The present invention as defined in independent claims 1 and 14 is a method and apparatus for controlling the proportional blending of beverage components as a function of the mass flow of at least one of the components. The present invention preferably includes a Coriolis mass flow meter within the syrup input line. A Coriolis mass flow meter may also be included in the water input line of the blending system. The proportion of the water and syrup within the blend is calculated as function of the mass flow signal from the Coriolis meters. This calculated proportion value

is compared to the fixed standard for the particular beverage or from an actual density determination of the fluids. Adjustment of the proportional blending is automatically made as function of these calculated and fixed values and related comparisons. Furthermore, an overall efficiency of the blending and proportioning system may be determined.

Embodiments of the invention will now be described by way of example with reference to Figures 2 to 5 of the drawings, in which:

Figure 2 shows a beverage blending and proportioning apparatus,

Figures 3, 3A and 3B show a flow diagram of the method for adjusting the proportional blending of a beverage,

Figures 4 and 5 show flow diagrams for alternative methods of calculating the volumetric flow rate of the water and syrup for use within the method shown in Figures 3, 3A and 3B.

In the figures where like numerals indicate like elements, there is shown in Figure 2 a beverage blending and proportioning apparatus in accordance with the present invention. This apparatus generally includes a proportioner 50 similar to proportioner 14 shown in Figure 1. At the water inlet 52 to proportioner 50 is positioned a flow input into the filtered water storage tank 56. Similarly, at the syrup inlet 58, there is a second mass flow meter 60 which determines the mass flow rate of the syrup input into the syrup storage tank 62 of the proportioner 50. Flow meters 54 and 60 are preferably of the type known as a Coriolis mass flow meter. Coriolis-type mass flow meters are preferred because of their high accuracy in determining the mass flow rate and total mass flow of the fluid without reference to the temperature or viscosity of the fluid. The size and operational capabilities of meters 54, 60 will depend upon the flow rates into the proportioner 50 and the number of storage tanks therein. The flow meters as generally preferred for use with the present invention are those manufactured by the K-Flow Corporation of Millville, New Jersey.

At the inlet side of water storage tank 56 is a flow control valve 64. The inlet to syrup tank 62 includes a similar valve 66. These valves 64, 66 are controlled by a float sensors (not shown) within tanks 56 and 62, respectively. A fixed orifice valve 76 is positioned at the outlet 78 of the syrup tank 62. A micrometer control valve 72 is located at the outlet 74 of water storage tank 56. Outlets 74 and 78 feed blending tank 80. The outlet 82 of blending tank 80 feeds carbonator 84. The carbonator 84 feeds pump 86 which directs the flow into a bottling or container filling apparatus (not shown). A float control (not shown) within the blending tank 80 outputs a signal which may be utilized downstream of the proportioner 50 by pump 86 to control the overall flow rate or speed of the system.

The signals from the flow meters 54, 60 are fed to a controller 68. Signals from the carbonator 84 are also fed into controller 68. Controller 68 in turn sends a signal to an electronic actuator 70. Actuator 70 is used to adjust micrometer control valve 72 at the outlet 74 of water storage tank 56. The actuator 70 controls the throttling or shut off of the valve 72 by a rotary motion based upon a remote control signal from controller 68. Actuator 70 as contemplated by the present invention may take any form as desired, such as geared electronic actuator. Adaptation of the actuator 70 to operate valve 72 may require a yoke bracket (not shown) or the like to be fit between the torque output of the actuator and the rotational knob of the micrometer.

Controller 68 may also be used to adjust the blending performed by variable speed pumps at the outlet of the proportioner storage tanks. Controller 68 operates under the following preferred method for adjusting the proportional blending of a beverage. Figures 3, 3A, 3B, 4 and 5 show flow charts for this preferred method.

As particularly shown in Figure 3, at start-up, the controller 68 reviews certain controls within the system. First, the controller 68 determines whether or not the mix or lift pumps (not shown) within the system are operating. If the pumps are not operating, the control program will not continue. If the pumps are operating, the controller 68 proceeds to the next step. There is a initial period at start-up where the signals from the flow meters 56, 60 and from other elements in the system may be unstable. A time delay is input into the system to permit stability to be achieved prior to making the initial flow meter readings. Upon exceeding the delay time, controller 68 moves to the next step. The final preliminary step taken is to determine whether or not the end run remote switch (not shown) has been actuated. This end run switch will prevent further operation of the control program at any time during the blending operation. Upon completing the start-up procedure, the signals output from the flow meters 54, 60 are zeroed to indicate the start of a new batch. Also, the memory of the previous batch calculations is cleared.

A proportioning and blending system is required at different times to produce many different types of beverages under different blending recipes. The appropriate fixed data related to a particular beverage to be blended must be identified to properly instruct the controller 68 during further operation. The particular beverage to be run through the system will be selected at start-up. This selection actuates the retrieval of data from stored memory for the particular beverage. Thereafter, the syrup and water flow meter signals are read and the batch is initiated.

As particularly shown in Figure 4, the first determination made by the controller 68 during a batch run is whether or not the drink is a sugared drink or wheth-

er or not such is a diet or other non-sugar sweetened drink. This determination particularly relates to the density of the syrup.

The first calculation for a sugar-free syrup by the controller uses the mass flow signal from flow meter 60 to determine the volumetric flow rate of the syrup. The volumetric flow of the sugar-free syrup can be determined from the following equation:

$$(1) \quad \text{GPMS}_{\text{sf}} = M_{\text{s}} / (8.333 \cdot D_{\text{sf}})$$

(GPMS_{sf} = gallons per minute of the sugar-free syrup; M_s = the mass flow rate of the syrup; and D_{sf} = the density of the sugar-free syrup.) Typically, the density of the sugar-free syrup can be estimated to be one, i.e. substantially the same as water at 20°C. However, controller 68 may be set to read a different density value for the sugar-free syrup (D_{sf}) as determined by the bottler or as set by the drink recipe owner.

The determination of the volumetric flow rate of a sugared syrup as a function of the mass flow is also a function of its density. This density value for a sugared syrup may be calculated as a function of published brix values. Curves providing this information are published by the National Bureau of Standards at Table No. 113. The brix value for a particular beverage syrup changes during the blending operation. Therefore, the density for each particular drink must be calculated. This density value is calculated by the resultant equation of a least squares regression on the published curves. This equation is as follows:

$$(2) \quad D_{\text{su}} = D_{\text{su}} + K_{(x+1)} \cdot (DN_{\text{std}} \cdot R_i)^x$$

(D_{su} = density of the sugared syrup; K = a constant corresponding to the least squares calculation; x = the coefficient value within the calculation; DN_{std} = the standard drink number for the particular beverage being prepared; and R_i = the ideal ratio for mixing the particular syrup with water.) The calculation using this equation includes the following constant (K) values:

$$K_{(1)} = .9987881$$

$$K_{(2)} = .003715599$$

$$K_{(3)} = .00002321195$$

$$K_{(4)} = -.0000002270948$$

$$K_{(5)} = .000000003156378$$

$$K_{(6)} = -.0000000001398131$$

The series of calculations start at x = 5 and D_{su} = K₍₁₎ with each subsequent calculation being made for x - 1.

From this density calculation (D_{su}), the flow rate of the sugared syrup can be determined as a function of the mass flow signal from flow meter 60 by the following equation:

$$(3) \quad \text{GPMS}_{\text{su}} = M_{\text{s}} / (8.333 \cdot D_{\text{su}})$$

In the same manner the output of water flow meter 54 is used to calculate the volumetric flow rate of the water as a function of its mass flow. This volumetric flow rate is determined from the following equation:

$$(4) \quad \text{GPMW} = M_{\text{w}} / (8.333 \cdot .998234)$$

In this equation, a fixed value for the density of the

water at 20°C is used.

The advantage of using Coriolis type mass flow meters as part of the present invention is due to the accuracy of the mass flow determination made therefrom. This mass flow determination is made without reference to the viscosity or temperature of the fluid. Thus, the volumetric determinations made by equations (1), (3) and (4) are essentially free of fluid temperature and viscosity considerations. Ultimately the accuracy of the blending control by the present invention is checked against laboratory analysis by the bottler. Further, calculations made by the controller 68 require lab analysis input, such as the standard drink number (DN_{std}). This data and the density values used to calculate the volumetric flow for the water and the syrup (sugar and sugar free) and other calculations within the system are made on the assumption that the fluid is at 20°C. Since the signal from the mass flow meter is not temperature dependent, this assumption provides accurate results.

The density value for a sugared syrup, as well as the sugar-free syrup and the mixing water, may also be determined by utilizing the mass flow meters 54 and 60. Typically, Coriolis type flow meters are capable of determining the density of a fluid as well as its mass flow rate. Thus, the actual brix value of the syrup may be used to determine the volumetric flow rate into proportioner 50.

As particularly shown in Figure 5 the calculation of the volumetric flow of the sugar-free syrup uses the mass flow signal from flow meter 60 as well as the density signal therefrom. Thus, the density of the sugar-free syrup (D_{sf}) in equation (1), above, is an actual value rather than an assigned value.

The determination of the volumetric flow rate of a sugared syrup as a function of the mass flow and density flow readings is somewhat more complicated than for the sugar free syrup calculation. This calculation generally involves substituting an actual drink number for the syrup (DN_{sy}) within equation (2). The temperature of the sugared syrup becomes a significant factor in determining of the drink number value. The variation in temperature in the sugar-free syrup is not considered significant for purposes of determining a volumetric flow. Thus, the measured density readings from the densitometer portion of the Coriolis meter requires correction to 20°C.

The temperature correction factor is calculated by the resulting equation of a least squares regression duplicating the curves at National Bureau of Standards Table No. 120. The resultant equation based upon this regression is as follows:

$$(2a) \quad T_{\text{cor}} = T_{\text{cor}} + KT_{(xt+1)} \cdot D_{\text{mea}}^{xt}$$

(T_{cor} = temperature correction variable factor; KT = a constant corresponding to the least squares regression; xt = the coefficient value within the regression; and D_{mea} = the measured density value from the flow meter 60.) The regression for this equation includes

the following constant (KT) values:

$$KT_{(1)} = -.004109494$$

$$KT_{(2)} = .007006943$$

$$KT_{(3)} = -.00194279$$

$$KT_{(4)} = -.001908077$$

$$KT_{(5)} = .001467323$$

$$KT_{(6)} = -.0002886857$$

The calculation starts at $xt = 5$ and $T_{cor} = KT_{(1)}$ with each subsequent calculation being made for $xt - 1$.

The measured density is corrected to 20°C by the following equation:

$$(2b) \quad D_{cor} = ((T_{syr} - 20) \cdot T_{cor}) + D_{mea}$$

(D_{cor} = the corrected value of the measured density and T_{syr} = the actual temperature of the syrup.)

From this corrected density value (D_{cor}), the weight percent sugar or brix of the sugared syrup can be determined by a least fit squares regression of National Bureau of Standards Table No. 113. This regression equation is as follows:

$$(2c) \quad DN_{act} = DN_{act} + KD_{(xd + 1)} \cdot D_{cor}^{xd}$$

(DN_{act} = the actual syrup drink number (brix) for the specific syrup; KD = a constant corresponding to the least squares regression; and xd = the coefficient value within the regression). The regression for this equation includes the following constant (KD) values for the density to brix conversion:

$$KD_{(1)} = -241.5639$$

$$KD_{(2)} = 183.5383$$

$$KD_{(3)} = -16.72519$$

$$KD_{(4)} = 289.5726$$

$$KD_{(5)} = -293.833$$

$$KD_{(6)} = 79.9125$$

The calculation starts with $DN_{act} = KD_{(1)}$ and $xd = 5$ with each subsequent calculation being made for $xd - 1$.

Typically, a correction factor is used by bottlers for the individual syrup formulas to correct the true brix value after the solution is diluted to the ideal ratio for the drink output. This correction factor can be included into the actual calculations as follows:

$$(2d) \quad DN_{std} = DN_{act}/SYP$$

(SYP = the syrup correction factor variable.) From this point the standard drink number (DN_{std}) can be input into the original equation (2) so as to continuously calculate the density of the syrup and the corresponding volumetric flow rate of the syrup via equation (3).

In the same manner, the output of water flow meter 54 can be used to calculate the volumetric flow rate as a function of its mass flow and its density flow rate. This volumetric flow rate is determined from the following equation:

$$(4a) \quad GPMW = M_w/(8.33 \cdot D_w)$$

(D_w = the density of the water from the meter 54.)

The result of each of these equations is to provide a volumetric flow rate which is fixed at a 20°C temperature factor. As particularly shown in Figure 3A and 3B, from the volumetric flow rate values a calculated ratio for the beverage being blended within

blending tank 80 may be determined as well as other aspects of the blending process.

The ratio of the blend is determined by the following equation:

$$(5) \quad \text{RATIO} = \text{GPMW/GPMS}$$

(GPMS = either the calculated volumetric flow of the sugar-free (GPMS_{sf}) or the sugared (GPMS_{su}) syrup.)

The blending of a particular beverage is typically determined as a function of its target drink number. This target drink number is the proper brix value for the sugar in the blended beverage as set by the beverage recipe owner. The bottler must conform to this fixed value in preparing the beverage. However, in preparing each batch of syrup (prior to blending), the "standard" drink number (DN_{std}) for the syrup batch may not conform to the target value. A standard drink number for the batch is determined by the bottler through lab analysis by mixing the syrup with water in the exact proportion desired by the beverage owner at a controlled 20°C. The standard and target drink numbers are typically part of the data read by the controller 68 from stored memory at the start of the batch. The difference between the target drink number and the standard drink number for the batch of syrup provides the bottler with an indication of the original setting of the micrometer in order to produce a beverage in conformance with the target value.

Adjustments to the blend during operation of the proportioner require a determination of the drink number for the beverage at the time of the adjustment. This actual drink number can be calculated as a function of the standard drink number for the syrup batch and the ideal blend ratio for the particular beverage:

$$(6) \quad DN_{cal} = ((R/\text{RATIO}) \cdot DN_{std}) + B_{off}$$

(DN_{cal} = calculated drink number and B_{off} = adjustment value.) The offset adjustment value may be set by a bottler or by the beverage recipe owner in order to adjust the equation in view of past calculations to arrive at the target. This value may typically be equal to zero (0).

For sugared drinks the calculation of the drink number can be linearized as part of the standard drink number calculation. This variation is calculated by the following equation:

$$(6a) \quad DN_{cal} = ((\text{Log}(R)/\text{Log}(\text{RATIO})) \cdot DN_{std}) + B_{off}$$

The same equation can be used to calculate the drink number for the sugar-free drink. However, the standard control drink number (DN_{std}) input by the operator is used rather than the calculated standard drink of equation (2d).

The bottler is typically permitted by a beverage recipe owner to produce the beverage within a certain percentage range of the target, such as between 100% and 102% of the target drink number. Due to the accuracy of the present invention in determining the actual drink number and controlling the blend, a bot-

tler may identify a set point within this target range. This set point will likely be the lowest possible consistently obtainable value in the target range. The calculated drink number (DN_{cal}) may be compared to the target and set points by the following equations:

$$(7) \quad TGT\% = (DN_{cal}/TGT) \cdot 100$$

$$(8) \quad SET\% = (DN_{cal}/SET) \cdot 100$$

($TGT\%$ = percentage of the calculated drink number to the targeted drink number; TGT = the target drink number; $SET\%$ = percentage of the calculated drink number to the set point value; and SET = the set point for a particular bottler.) From these percentage values a determination can be made as to whether or not an adjustment of the blend is required. Adjustment will be discussed in further detail below.

The volumetric flow rate determinations of equations (1), (3) and (4) may be used to calculate the total flow rate out of the proportioner 50 by the following equation:

$$(9) \quad GPM_{tot} = GPMS + GPMW$$

Further, the total flow for the particular batch at any particular time can be determined from the total mass flow signal received from the flow meters 54, 60:

$$(9a) \quad FLOW_{tot} = MS_{tot}/(8.333 \cdot D_{syr}) + MW_{tot}/(8.333 \cdot .998)$$

(MS_{tot} = the total mass of the syrup; MW_{tot} = the total mass of the water; and D_{syr} = the density of the syrup- D_{sf} for sugar-free syrup or D_{su} for sugared syrup.)

One variation in the blending of a beverage is the solubility of the CO_2 input into the beverage by the carbonator 84. This variable is determined as a function of the temperature and pressure within the carbonator 84. Published curves for these determinations in graph format are produced by the American Bottling Association. This variable is typically reported in volumes of CO_2 .

A least squares method may again be utilized to calculate the temperature factor of the carbonation as a function of the changing conditions in carbonator 84. The least squares regression for this temperature component is as follows:

$$(10) \quad T_{CO2} = T_{CO2} + KC_{(xc+1)} \cdot T_{carb} \cdot XC$$

(T_{CO2} = the temperature coefficient for carbonator; KC = the coefficient value within the calculation; xc = the position within the regression; and T_{carb} = the temperature in $^{\circ}F$ in the carbonator.) The constants within this regression are as follows:

$$KC_{(1)} = .3529254$$

$$KC_{(2)} = .008671118$$

$$KC_{(3)} = -.000007131652$$

$$KC_{(4)} = .000002720279$$

$$KC_{(5)} = -.00000003849611$$

$$KC_{(6)} = .000000000177644$$

The calculation starts at $xc = 5$ and $T_{CO2} = KC_{(1)}$ with each subsequent calculation being made for $xc - 1$.

An additional factor must be determined prior to calculating the volumes of CO_2 added to the beverage. This factor is a result of the pressure in the car-

bonator 84 and can be determined by the following equation:

$$(11) \quad P_{fac} = (P_{CO2}/13.7) + .075$$

(P_{CO2} = the pressure within the carbonator system.)

The constant values within this equation 11 have been determined from the same published sources of the American Bottling Association as for equation (10).

From the determination of the temperature coefficient and the pressure factor in the carbonator 84, the volumes percent of carbonation can be determined as follows:

$$(12) \quad VOL_{CO2} = (P_{fac}/T_{CO2}) + C_{off}$$

(C_{off} = offset adjustment value.) Typically, the volumes of CO_2 is determined by a shake test outside of the carbonator. The present calculations are being performed in line. Therefore, the readings made by in line sensors may not provide an accurate value. This determination may be adjusted (C_{off}) to provide a value that is within the desired specifications of the bottler. The offset value is provided so as to account for the standard variations in the calculation from the normal mode of testing.

The total volumetric flow determination ($FLOW_{tot}$) can be used to predict the number of cases which should be produced by a particular run.

(13) $CASE_{proj} = (FLOW_{tot} \cdot 128)/CONT_{vol}/CASE_{size}$
($CONT_{vol}$ = the volume in each particular container and $CASE_{size}$ = the number of containers to be input into a case.)

The controller 68 may be set to receive a pulse signal for each bottle or container passing through the bottling apparatus. From this pulse count, the actual total number of cases produced is determined by the following equation:

$$(14) \quad CASE_{Tot} = P / CASE_{size}$$

(P = the number of pulses received from the bottler.)

An efficiency estimate may be made by using the volumetric calculations for the projected case total and comparing this value to the actual number of cases which have been produced:

$$(15) \quad CASE_{lost} = CASE_{Proj} - CASE_{Tot}$$

Also, an efficiency determination for the entire system can be made by evaluating the run time and the maximum obtainable cases per minute. This efficiency calculation is as follows:

$$(16) \quad EFF = ((P/T_{run})/CPM) \cdot 100$$

(T_{run} = the time of the batch run and CPM = the determined maximum cases per minute value seen during the particular batch run.) The maximum cases per minute during the run and the comparison to the overall output of the run are values which are usually desired by the bottler.

All values calculated can be displayed on a screen for observation during the run. These calculated values can be averaged over a number of cycles by the controller 68 and may also be displayed as a function of the average over a specific period of time

such as 1 minute. The time averages can also be charted on a graph and displayed accordingly.

The controller 68 may be used to evaluate various other operating functions of the system. By connecting the sensors within the system to the controller 68, certain alarm signals may be defined to determine whether a critical error exists in the system. With a critical alarm, an acknowledge signal may be required in order to continue the operation or calculations of the system.

From the calculated values, a determination can be made of the adjustment required by the valve 72 in order for the proportioner 50 to blend the beverage in line with the set point of the bottler. The first determination is the variation of the calculated drink number from the set point:

$$(17) \quad \text{ERROR} = \text{DN}_{\text{cal}} - \text{SET}$$

If there is a variation between these two values, an adjustment is required. From the error value a control signal may be directed to actuator 70 for appropriate adjustment of the micrometer valve 72 to bring the blended beverage into line with the set point and, thus, the recipe owner's target. This adjustment may be determined by the following equation:

$$(18) \quad M_{\text{adj}} = ((\text{ERROR} \cdot \text{GAIN}) + (\text{ERROR} \cdot T_E / T_K)) / 100$$

(GAIN = a multiplication factor for the ERROR signal; T_K = an integral time constant in repeats per minute; and T_E = the elapsed time from the last adjustment.) The value for the integral time constant is discretionary and is contemplated to be set as part of the programming of controller 68, rather than being set by the bottler. Therefore, this value would not be changed after installation.

As can be seen from the equations, a calculated drink number (DN_{cal}) which is greater than the set point (SET) will result in a positive error (ERROR) signal. This positive error will be converted into a positive value for the adjustment (M_{adj}) of valve 72. This positive value will increase the amount of water within the blend and decrease the resulting drink number (e.g., for a sugared beverage, reduces the brix value for the sugar in the blended beverage). Thus, the next calculation made for the error (ERROR) signal will be decreased. If this newly calculated drink number is not equal to the set point and, thus, the error signal is not equal to zero, the micrometer will be adjusted again. A calculated drink number that is less than the set point will approach a zero error value in the same manner, but from the opposite direction.

The micrometer adjustment calculation of equation (18) would produce a change in the setting of the valve 72. The setting value for a micrometer-type valve is typically expressed in mils over the total length of the valve movement. A calibration factor may be required to direct the actuator 70 to adjust the micrometer within the proper proportions. Further, a different calibration may be required to provide a read-

out of the mil position of the micrometer in the bottler's normal units.

Upon initial start-up of the system, the bottler would manually or through the controller 68 open the valve 72 to a recommended value for the drink specification. Thereafter, it is also possible to manually adjust this valve for any additional changes other than those made by the actuator 70 in response to the control signals from controller 68. The most common error (ERROR) will be the result of the start-up position of the valve 72. The setting of this valve 72 at start-up is typically an estimate. Once the blended beverage has been adjusted to the target range, the only changes that would be required to maintain the blend within that range and at the set point would be initiated by the actuator 70 via the calculations and control signals of controller 68.

The adjustment of the valve 72 by controller 68 preferably includes a range limit. This range would prevent the controller from adjusting the valve 72 at too great a variation without further authorization from the bottler. It is contemplated that a plus or minus 2% variation in the micrometer setting would be a sufficient limit for this purpose. If a greater value were calculated by the controller 68, such may be the result of an unusual error within the system. An audible alarm would then initiate a warning to the bottler that a significant change has occurred within the system. The bottler will be required to cancel the calculated result or approve the change and initiate a new 2% control limit. This scheme ensures a quality control with limitations. This will confirm that the variations are a normal fluctuation within the system rather than a miscalculation or unusual error. If the user does not agree with the value change, the product will not deviate off specification without further proof that such is required.

The system in accordance with the present invention has been found to be highly accurate in controlling the operation of the proportioner and for maintaining the blend within the standard set by the beverage owner. It is contemplated that the present invention can be adapted to existing bottling systems of bottlers throughout the world. The present invention will incorporate into the existing bottling system a highly accurate means for automatically controlling the proportional blending of the beverage. The ultimate accuracy of the control initiated by the present invention may continue to be determined as a function of an analyzer which is either downstream in the system or which is performed in the lab. However, by the application of the present invention into the existing bottling plant, it is contemplated that the need for disposal of already blended beverage which is not made in accordance with the requirements of the recipe owner will be eliminated after achieving a consistent setting for the control valve in the proportioner.

Claims

1. A method of proportioning and blending a beverage comprising the steps of:

(a) providing a flow of water,
 (b) providing a flow of beverage syrup,
 (c) determining the volumetric flow rate of the water,
 (d) measuring the mass flow rate of the syrup,
 (e) calculating a volumetric flow rate for the syrup as a function of the mass flow determination, and
 (f) mixing the water and syrup flows,
 (g) adjusting the mixed proportion of the water flow to the syrup flow as a function of the calculated and determined flow values for the blended beverage compared to a previously set value for the beverage.

2. A method as claimed in claim 1, wherein the mass flow rate of the water is measured simultaneously with the mass flow rate of the syrup and the volumetric flow rate determination is made as a calculation of the measured mass flow.

3. A method as claimed in claim 2, wherein the mass flow rate of the water and the syrup are determined by Coriolis-type mass flow meters.

4. A method as claimed in any preceding claim, including the step of determining whether the syrup is sweetened by sugar or a sugar substitute.

5. A method as claimed in any preceding claim, wherein the volumetric calculation step includes calculating the density of the syrup as a function of the standard brix value for the sugar in the syrup.

6. A method as claimed in claim 5, wherein the brix value of the blended water and syrup is determined according to the following formula:

$$DN_{cal} = (\text{Log}(R_i) / \text{Log}(\text{RATIO})) \cdot DN_{std} + B_{off}$$

where R_i is the ideal ratio of the water/syrup blend, RATIO is the determined value of the water/syrup blend, DN_{std} is the standard brix value for the ideal blend, and B_{off} is a preselected offset value for the calculation.

7. A method as claimed in claim 5 or 6, wherein the volumetric calculation step includes determining the density flow rate of the syrup.

8. A method as claimed in claim 7, wherein the density flow rate of the syrup is determined by a Coriolis-type mass flow meter.

9. A method as claimed in claim 7, wherein the pro-

portion adjustment is performed by an incremental value for each calculation of the volumetric flow rate.

10. A method as claimed in claim 7, including the step of correcting the determined density flow rate to a value corresponding to a density at 20°C.

11. A method as claimed in claim 10, including the steps of calculating a ratio of the volumetric flow of the water to that of the syrup, calculating a brix value for the blended beverage from the calculated ratio and the set and determined values for the beverage, and comparing the calculated brix value to the fixed proportional requirements for the beverage.

12. A method as claimed in claim 1, including the steps of calculating a ratio of the volumetric flow of the water to that of the syrup, calculating a brix value for the blended beverage from the calculated ratio and the set values for the beverage, and comparing the calculated brix value to the fixed proportional requirements for the beverage.

13. A method as claimed in claim 12, including the steps of calculating the total flow rate and total flow of the blended beverage; determining the volumes of CO_2 input into the blended beverage by a carbonator; averaging the calculated results over a fixed period of time; and calculating a line efficiency of the system as a function of total volume output.

14. An apparatus for controlling the proportional blending of a beverage comprising:

means for receiving a flow of water,
 means for receiving a flow of beverage syrup,

means for determining the mass flow rate of the syrup,

means for determining the volumetric flow rate of the syrup as a function of the mass flow determination,

means for determining the volumetric flow rate of the water,

means for adjusting the flow of water and of the syrup as a function of the volumetric flow rate determinations, and

means for blending the adjusted flows of water and syrup.

15. An apparatus as claimed in claim 14, including means for determining the mass flow rate of the water, the means for determining the volumetric flow rate of the water being a function of the mass flow determination of the water.



16. An apparatus as claimed in claim 14 or 15, wherein the mass flow determining means include Coriolis-type mass flow meters.

17. An apparatus as claimed in claim 15, including means for calculating a volumetric flow rate for the water and the syrup as a function of the mass flow rate and for comparing the ratio of the volumetric flow rate of the water to that of the syrup to a set ratio value.

18. An apparatus as claimed in any of claims 14 to 17, including means for calculating the density of the syrup as a function of its brix content for the sugar in the syrup.

19. An apparatus as claimed in claim 18, wherein the density calculating means determines the brix value of the blended water and syrup according to the following formula:

$DN_{cal} = (\text{Log } (R_i) / \text{Log } (\text{RATIO})) \cdot DN_{std} + B_{off}$
where R_i is the ideal ratio of the water/syrup blend, RATIO is the determined value of the water/syrup blend, DN_{std} is the standard brix value for the ideal blend, and B_{off} is a preselected offset value for the calculation.

20. An apparatus as claimed in claim 18 or 19, including means for determining the actual density of the syrup and adjusting the density to a value at 20°C.

21. An apparatus as claimed in any of claims 18 to 20, wherein the volumetric flow rate calculating means operates as a function of the density of the syrup.

22. An apparatus as claimed in any of claims 14 to 21, including means for carbonization of the blended beverage and means for determining the volumes of CO₂ input into the blended beverage as a function of the carbonization pressure and temperature.

Patentansprüche

1. Verfahren zum Proportionieren und Mischen eines Getränkes, das folgende Schritte enthält:

- (a) Erzeugen eines Wasserzuflusses,
- (b) Erzeugen eines Getränkesirupzuflusses,
- (c) Bestimmen des volumetrischen Durchsatzes des Wassers,
- (d) Messen des Massendurchsatzes des Sirups,
- (e) Berechnen eines volumetrischen Durchsatzes des Sirups als Funktion der Massendurchsatz-Bestimmung,

(f) Mischen der Wasser- und Sirupmengen,
(g) Einstellen des Mischungsverhältnisses des Wasserzuflusses zum Sirupzufluß als Funktion der berechneten und bestimmten Flußwerte für das Mischgetränk im Vergleich zu einem Soll-Wert für das Getränk.

2. Verfahren nach Anspruch 1, bei dem der Massendurchsatz des Wassers gleichzeitig mit dem Massendurchsatz des Sirups gemessen wird und die Bestimmung des volumetrischen Durchsatzes durch Berechnen des gemessenen Massendurchsatzes erfolgt.

3. Verfahren nach Anspruch 2, bei dem der Massendurchsatz von Wasser und Sirup durch Massenströmungsmesser des Coriolis-Typs bestimmt wird.

4. Verfahren nach einem der vorhergehenden Ansprüche einschließlich des Schrittes der Feststellung, ob der Sirup durch Zucker oder einen Zuckerersatz gesüßt ist.

5. Verfahren nach einem der vorhergehenden Ansprüche, bei dem der volumetrische Berechnungsschritt das Berechnen der Sirupdichte als Funktion des Standard-Brix-Wertes für den im Sirup enthaltenen Zucker einschließt.

6. Verfahren nach Anspruch 5, bei dem der Brix-Wert des Wasser-Sirup-Gemisches gemäß der folgenden Formel bestimmt wird:

$DN_{cal} = (\text{Log } (R_i) / \text{Log } (\text{RATIO})) \cdot DN_{std} + B_{off}$
wobei R_i das ideale Verhältnis der Wasser/Sirup-Mischung, RATIO der bestimmte Wert der Wasser/Sirup-Mischung, DN_{std} der Standard-Brix-Wert für die ideale Mischung und B_{off} ein vorbestimmter Korrektur-Wert für die Berechnung ist.

7. Verfahren nach einem der Ansprüche 5 oder 6, bei dem der volumetrische Berechnungsschritt das Bestimmen des Dichtedurchsatzes des Sirups einschließt.

8. Verfahren nach Anspruch 7, bei dem der Dichtedurchsatz des Sirups durch einen Massenströmungsmesser des Coriolis-Typs bestimmt wird.

9. Verfahren nach Anspruch 7, bei dem die Proportionseinstellung durch einen Inkrementalen Wert für jede Berechnung des volumetrischen Durchsatzes durchgeführt wird.

10. Verfahren nach Anspruch 7, das den Schritt der Korrektur des bestimmten Dichte-Durchsatzes auf einen Wert einschließt, der einer Dichte bei 20° C entspricht.



11. Verfahren nach Anspruch 10, das die Schritte der Berechnung eines Verhältnisses des volumetrischen Wasserzuflusses zu dem des Sirups, der Berechnung eines Brix-Wertes für das gemischte Getränk aus dem errechneten Verhältnis und den vorgegebenen und bestimmten Werten für das Getränk und des Vergleichs des berechneten Brix-Wertes mit den feststehenden Proportional-Erfordernissen für das Getränk einschließt.
12. Verfahren nach Anspruch 1, das die Schritte der Berechnung eines Verhältnisses des volumetrischen Wasserzuflusses zu der des Sirups, der Berechnung eines Brix-Wertes für das gemischte Getränk aus dem berechneten Verhältnis und den vorgegebenen Werten für das Getränk und des Vergleichs des berechneten Brix-Wertes mit den feststehenden Proportional-Erfordernissen für das Getränk einschließt.
13. Verfahren nach Anspruch 12, das die Schritte der Berechnung des Gesamtdurchsatzes und des Gesamtflusses des Mischgetränkes, des Bestimmens der Volumina der CO₂-Eingabe in das Mischgetränk durch einen Carbonisierer, der Durchschnittsbildung der berechneten Ergebnisse über einen festgelegten Zeitabschnitt und der Berechnung eines Leitungswirkungsgrades des Systems als Funktion des Gesamt-Volumenausstoßes einschließt.
14. Vorrichtung zum Prüfen der proportionalen Mischung eines Getränkes enthaltend:
 - Mittel zum Erzeugen eines Wasserzuflusses,
 - Mittel zum Erzeugen eines Getränkesirupzuflusses,
 - Mittel zum Bestimmen des Massendurchsatzes des Sirups,
 - Mittel zum Bestimmen des volumetrischen Durchsatzes des Sirups als Funktion der Massendurchsatz-Bestimmung,
 - Mittel zum Bestimmen des volumetrischen Durchsatzes des Wassers,
 - Mittel zum Einstellen der Wasser- und Sirupzuflüsse als Funktion der bestimmten volumetrischen Durchsätze und
 - Mittel zum Mischen der eingestellten Wasser- und Sirup-Zuflüsse.
15. Vorrichtung nach Anspruch 14, die Mittel zum Bestimmen des Massendurchsatzes des Wassers aufweist, wobei die Mittel zum Bestimmen des volumetrischen Durchsatzes des Wassers eine Funktion des ermittelten Massendurchsatzes des Wassers sind.
16. Vorrichtung nach Anspruch 14 oder 15, bei welcher

die Mittel zum Bestimmen des Massendurchsatzes Massenstrommesser des Coriolis-Typs aufweisen.

17. Vorrichtung nach Anspruch 15, die Mittel zum Berechnen eines volumetrischen Durchsatzes für Wasser und Sirup als Funktion des Massendurchsatzes und zum Vergleichen des Verhältnisses des volumetrischen Durchsatzes des Wassers und dem des Sirups mit einem Soll-Verhältniswert aufweist.
18. Vorrichtung nach einem der Ansprüche 14 - 17, die Mittel zum Berechnen der Dichte des Sirups als Funktion seines Brix-Gehaltes für den Zucker im Sirup aufweist.
19. Vorrichtung nach Anspruch 18, bei welcher das die Dichte berechnende Mittel den Brix-Wert von gemischtem Wasser und Sirup gemäß folgender Formel bestimmt:

$$DN_{\text{cal}} = (\text{Log}(R_i) / \text{Log}(\text{RATIO})) \cdot DN_{\text{std}} + B_{\text{off}}$$
 wobei R_i das ideale Verhältnis der Wasser/Sirup-Mischung, RATIO der bestimmte Wert der Wasser/Sirup-Mischung, DN_{std} der Standard-Brix-Wert für die ideale Mischung und B_{off} ein vorbestimmter Korrekturwert für die Berechnung ist.
20. Vorrichtung nach Anspruch 18 oder 19, die Mittel zum Bestimmen der tatsächlichen Dichte des Sirups und zum Einstellen der Dichte auf einen Wert bei 20° C aufweist.
21. Vorrichtung nach einem der Ansprüche 18 - 20, bei welcher das Rechenmittel für den volumetrischen Durchsatz als Funktion der Dichte des Sirups arbeitet.
22. Vorrichtung nach einem der Ansprüche 14 - 21, die Mittel zum Carbonisieren des Mischgetränkes und Mittel zur Bestimmung der Volumina der CO₂-Eingabe in das Mischgetränk als Funktion des Kohlensäuredrucks und der Temperatur aufweist.

Revendications

1. Procédé de dosage et de mélange d'une boisson, comprenant les étapes consistant à :
 - (a) fournir un débit d'eau,
 - (b) fournir un débit de sirop pour boisson,
 - (c) déterminer le débit volumétrique de l'eau,
 - (d) mesurer le débit de masse du sirop,
 - (e) calculer un débit volumétrique pour le sirop en fonction de la détermination du débit de masse, et
 - (f) mélanger les débits d'eau et de sirop,



- (g) régler la proportion de mélange du débit d'eau au débit de sirop en fonction des valeurs de débit calculées et déterminées pour la boisson mélangée, comparativement à une valeur préalablement réglée pour la boisson.
2. Procédé selon la revendication 1, caractérisé en ce que le débit de masse de l'eau est mesuré exactement en même temps que le débit de masse du sirop, et en ce que la détermination du débit volumétrique est effectuée sous la forme d'un calcul du débit de masse mesuré.
 3. Procédé selon la revendication 2, caractérisé en ce que les débits de masse de l'eau et du sirop sont déterminés par des débitmètres de masse du type Coriolis.
 4. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce qu'il comprend l'étape consistant à déterminer si le sirop est adouci par du sucre ou par un produit de substitution du sucre.
 5. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que l'étape de calcul volumétrique comprend le calcul de la densité du sirop en fonction d'une valeur de Brix standard pour le sucre dans le sirop.
 6. Procédé selon la revendication 5, caractérisé en ce que la valeur de Brix de l'eau et du sirop mélangés, est déterminée par la formule suivante :

$$DN_{cal} = (\text{Log } (R_i) / \text{Log } (\text{RATIO})) \cdot DN_{std} + B_{off}$$
 dans laquelle R_i est le rapport idéal du mélange eau/sirop, RATIO est la valeur déterminée du mélange eau/sirop, DN_{std} est la valeur de Brix standard pour le mélange idéal, et B_{off} est une valeur de décalage présélectionnée pour le calcul.
 7. Procédé selon la revendication 5 ou 6, caractérisé en ce que l'étape de calcul volumétrique comprend la détermination du débit de densité du sirop.
 8. Procédé selon la revendication 7, caractérisé en ce que le débit de densité du sirop est déterminé par un débitmètre de masse du type Coriolis.
 9. Procédé selon la revendication 7, caractérisé en ce que le réglage de proportion est effectué par une valeur d'augmentation pour chaque calcul du débit volumétrique.
 10. Procédé selon la revendication 7, caractérisé en ce qu'il comprend l'étape consistant à corriger le débit de densité déterminé pour l'amener à une valeur correspondant à une densité à 20°C.
 11. Procédé selon la revendication 10, caractérisé en ce qu'il comprend les étapes consistant à calculer un rapport du débit volumétrique de l'eau à celui du sirop, à calculer une valeur de Brix pour la boisson mélangée à partir du rapport calculé et des valeurs réglées et déterminées pour la boisson, et à comparer la valeur de Brix calculée aux exigences de proportions fixées pour la boisson.
 12. Procédé selon la revendication 1, caractérisé en ce qu'il comprend les étapes consistant à calculer un rapport du débit volumétrique de l'eau à celui du sirop, à calculer une valeur de Brix pour la boisson mélangée à partir du rapport calculé et des valeurs de réglage pour la boisson, et à comparer la valeur de Brix calculée avec les exigences de proportions pour la boisson.
 13. Procédé selon la revendication 12, caractérisé en ce qu'il comprend les étapes consistant à calculer le débit total et l'écoulement total de la boisson mélangée ; à déterminer les volumes de CO_2 introduits dans la boisson mélangée par un gazéificateur ; à former la moyenne des résultats calculés sur une période de temps fixée ; et à calculer un rendement de série du système en fonction du volume de sortie total.
 14. Appareil pour commander le mélange dosé d'une boisson, comprenant :
 - des moyens pour recevoir un débit d'eau,
 - des moyens pour recevoir un débit de sirop pour boisson,
 - des moyens pour déterminer le débit de masse du sirop,
 - des moyens pour déterminer le débit volumétrique du sirop en fonction de la détermination du débit de masse,
 - des moyens pour déterminer le débit volumétrique de l'eau,
 - des moyens pour régler le débit de l'eau et le débit du sirop en fonction des déterminations de débit volumétrique, et
 - des moyens pour mélanger les débits réglés d'eau et de sirop.
 15. Appareil selon la revendication 14, caractérisé en ce qu'il comprend des moyens pour déterminer le débit de masse de l'eau, les moyens pour déterminer le débit volumétrique de l'eau étant fonction de la détermination de l'écoulement de masse de l'eau.
 16. Appareil selon la revendication 14 ou 15, caractérisé en ce que les moyens de détermination de débit de masse comprennent des débitmètres de masse du type Coriolis.



17. Appareil selon la revendication 15, caractérisé en ce qu'il comprend des moyens pour calculer un débit volumétrique de l'eau et du sirop en fonction du débit de masse, et pour comparer à une valeur de rapport réglée, le rapport du débit volumétrique de l'eau à celui du sirop. 5
18. Appareil selon l'une quelconque des revendications 14 à 17, caractérisé en ce qu'il comprend des moyens pour calculer la densité du sirop en fonction de sa teneur de Brix en sucre dans le sirop. 10
19. Appareil selon la revendication 18, caractérisé en ce que les moyens de calcul de densité déterminent la valeur de Brix de l'eau et du sirop mélangés, par la formule suivante :

$$DN_{cal} = (\text{Log}(R_i) / \text{Log}(\text{RATIO})) \cdot DN_{std} + B_{off}$$
dans laquelle R_i est le rapport idéal du mélange eau/sirop, RATIO est la valeur déterminée du mélange eau/sirop, DN_{std} est la valeur de Brix standard pour le mélange idéal, et B_{off} est une valeur de décalage présélectionnée pour le calcul. 15 20
20. Appareil selon la revendication 18 ou 19, caractérisé en ce qu'il comprend des moyens pour déterminer la densité réelle du sirop et pour régler cette densité à une valeur correspondant à 20°C. 25
21. Appareil selon l'une quelconque des revendications 18 à 20, caractérisé en ce que les moyens de calcul du débit volumétrique fonctionnent comme une fonction de la densité du sirop. 30
22. Appareil selon l'une quelconque des revendications 14 à 21, caractérisé en ce qu'il comprend des moyens pour gazéifier la boisson mélangée, et des moyens pour déterminer les volumes de CO_2 introduits dans la boisson mélangée, en fonction de la pression et de la température de gazéification. 35 40

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