(54) Title of the Invention: Method and device for the gravimetric and in-series distribution of solution
Abstract Title: Method and device for the gravimetric and in-series distribution of solution

(57) A device for the gravimetric and in-series distribution of a predetermined quantity of a solution comprises a means 202, such as a peristaltic pump, for delivering a solution, a weighing means 212 and a means for measuring an operating value, the setpoint value, of the delivery means 202 during a calibration step during which the weighing means 212 is used for the delivery of a predetermined quantity of solution. The device also comprises an actuating means 216 arranged to actuate the delivery means 202 with the setpoint value so as to carry out one or more distribution steps carrying out the delivery of the predetermined quantity of solution without using the weighing means. The invention also relates to a method for the gravimetric and in-series distribution of a predetermined quantity of a solution.
Fig. 1

1. Start delivery of product
2. Measurement of weight of product present in the container
3. Comparison of measured weight with desired weight
   - Less than! → Continue to deliver the product
   - Equal! → Stop delivery of product
4. Measurement and storage of an operating setpoint of the delivery means
5. Actuation of delivery means with setpoint value for a new distribution step
6. End in-series distribution?
   - No → Continue
   - Yes → End
“Method and device for the gravimetric and in-series distribution of solution”

The present invention relates to a method and a device for the gravimetric in-series distribution of a given quantity of liquid solution.

The field of the invention is the field of the in-series distribution of liquid or viscous solution, in particular in the field of dilution. The invention relates more particularly to the gravimetric in-series distribution of solution.

By “gravimetric distribution” is meant a distribution of solution into a container to which the solution is conveyed by one or more delivery means to a point situated above the container at a non-zero distance from the bottom of the container or from a filling opening of the container, the solution then flowing into the container by gravity.

Prior art

Several devices for the gravimetric distribution of a predetermined quantity of a solution are currently known.

In most of these devices, the distribution is carried out as follows. The solution is conveyed by a delivery means to a point situated above a container, the solution then flows by gravity into the container. The delivery means is governed by a control means actuating its operation.

During the pouring of the solution into the container, a weighing means monitors the quantity of solution poured into the container by measuring, in real time or at a predetermined frequency, the weight of the solution present in the container.

As a function of the measured weight and the weight of the desired total quantity the actuating means actuates the operation of the delivery means.

When the weight measured by the weighing means is equal to the weight of the desired total quantity of solution, the control means stops the delivery means.

The fact of controlling the delivery of the solution and more generally the distribution of solution by a weight measurement slows down the distribution of solution. In fact, it is necessary to leave enough time for the weighing means to give an accurate indication of the weight then to control the delivery means as a function of this accurate indication.
Moreover, in the known systems, when the weight measured by the weighing means approaches the weight of the desired quantity of solution, the control means slows down the delivery carried out by the delivery means to improve the accuracy of the distribution. This slows down the distribution still further.

Such slowing down is particularly detrimental and causes a significant loss of time in the case of in-series distribution.

Moreover, the fact of modifying the operation of the delivery means reduces the service life of this means.

A purpose of the present invention is to remedy the abovementioned drawbacks.

Another purpose of the invention is to propose a device and a method for the gravimetric in-series distribution of solution which is more rapid than the devices of the state of the art.

Yet another purpose of the invention is to propose a device and a method for the gravimetric in-series distribution of solution with a lower energy consumption.

Finally, another purpose of the invention is to propose a device and a method for the gravimetric in-series distribution of solution making it possible to increase the service life of the means used.

**Summary of the invention**

The invention proposes achieving at least one of the abovementioned purposes with a device for the gravimetric and in-series distribution of a predetermined quantity of a solution, said device comprising:

- at least one means of delivering said solution into a container,

- at least one measuring means supplying a so-called measurement data, relating to the quantity of solution delivered into said container, and

- at least one control means arranged to carry out several iterations of the following steps during a, so-called calibration, delivery step:
  - receiving, from the measuring means, said measurement data, and
  - controlling said delivery means as a function of said measurement data,
so as to deliver said predetermined quantity of solution into said container during said delivery step; said device being characterized in that it also comprises:

- at least one means for measuring at least one so-called setpoint value relating to the operation of said delivery means during said calibration step, and
- at least one means for actuating said delivery means or an identical delivery means, as a function of said setpoint value, so as to carry out at least one other, so-called distribution, delivery step.

The gravimetric distribution device according to the invention carries out a first calibration step utilizing a weighing means to measure an operating setpoint of the delivery means and then to use this operating setpoint to carry out the distribution steps without using the weighing means.

Thus, the device according to the invention makes it possible to carry out more rapid in-series distribution than the devices of the state of the art.

Moreover, not using the weighing means for the distribution steps, the distribution device according to the invention consumes less energy than the distribution devices which use the weighing means during all the distribution steps.

Furthermore, with the distribution device according to the invention it is possible to achieve smooth operation of the delivery means, which makes it possible to increase the service life of the delivery means.

Finally, it is possible with the device according to the invention to carry out a distribution independent of the empty weight of the containers since the quantity delivered is no longer linked to the weight of the container but directly dependent on an operating setpoint of the delivery means.

Advantageously, the device according to the invention can be presented in the form of a one-piece assembly making it easy to handle.

The device according to the invention can also comprise one or more display screens, optionally touch-screens, actuating means such as buttons, a keyboard or sensors or also visual or sound signalling means allowing a user to take note of information provided by the device and to enter data.
In a preferred embodiment of the invention, the measuring means can comprise a weight measuring means.

More particularly, the measuring means can comprise a weight measuring means comprising a strain gauge sensor, such as electronic scales.

The delivery means can comprise at least one component for delivery of the solution through a so-called delivery tube, said delivery component being in contact with the solution. Such a delivery component can for example comprise a volumetric pump or any other type of pump, a diaphragm pump, centrifugal pump or gear pump.

In an advantageous embodiment of the device according to the invention, the delivery means can comprise at least one component for the delivery of the solution through at least one so-called delivery tube, said delivery component not coming into contact with said solution.

This embodiment has the advantage of not having to clean, sterilize or maintain the delivery component under strict hygiene conditions since it is not in contact with the solution.

Advantageously, a delivery component can be a peristaltic pump, through which the delivery tube passes.

According to the invention, the delivery means can comprise several peristaltic pumps arranged in parallel, the delivery tube comprising a branch associated with each of said pumps. The use of several peristaltic pumps makes it possible to increase the speed of distribution of the solution.

In this case, an operating setpoint associated with each of the pumps is measured and each of the pumps is actuated by the setpoint associated with this pump.

The delivery means can also comprise at least two peristaltic pumps, mounted in parallel, and arranged to operate out of phase.

The out-of-phase operation of the peristaltic pumps makes it possible to obtain greater continuity of delivery of the solution so that the solution pours into the container more smoothly.

The delivery means can moreover comprise at least one component modifying the flow of the solution in the delivery tube by a pressure exerted on said tube.
The pressure can be exerted by clamping the tube between two parts of the delivery component constituting the two parts of a clamp for example.

In this case, the distributed solution can flow either by gravity from a reservoir positioned high up with respect to the delivery means or because it is put under pressure in the tube upstream or downstream of the delivery means.

The device according to the invention can also comprise at least one storage means for storing the setpoint value. The setpoint value can for example be stored in association with a given tube, a solution of a given viscosity and for a given delivery means, so that this value can be retrieved for a future distribution of solution or can be communicated to an external solution distribution device, with a view to repeating the accurate distribution of solution as desired.

The setpoint value can comprise at least one value or any combination of the following values:
- a rotation or a number of rotations,
- an operating time,
- an opening/closing time,
- power consumed,
- a distance and/or angle through which a rotating component passes,
- a number of pulses for a flap valve pump or two-way pump,
- etc.

In a particular embodiment, the actuating means actuating the delivery means as a function of the setpoint value can be incorporated into the control means.

In this case, the actuating means can be an actuating means located in the control means. Thus, during the calibration phase the control means is used to actuate the delivery means as a function of the measurement data provided by the weighing means and during a distribution phase the same control means actuates the delivery means as a function, no longer of a measurement data, but of the setpoint value.

According to a particular version of the device according to the invention, the actuating means can be arranged to be activated manually by an operator in order to carry out a distribution step.
The actuating means can alternatively or also be programmable in order to carry out several distribution steps over time according to programmed timing.

The programming can be carried out either with data entry means incorporated in or connected to the device according to the invention, or by transfer of executable instructions from another device via a wireless connection, a wired connection or means for reading from data storage equipment, such as for example means for reading from storage means via a USB connection.

The timing can be regular over time or not.

In a particularly advantageous embodiment, the device according to the invention can comprise a support, said support being arranged to hold and move an opening for pouring the solution delivered by the delivery means into a container, in at least one spatial direction.

The support can be arranged to move the pouring opening in two or three spatial directions, perpendicular to each other or not.

The movement in each direction can be a rectilinear or linear translation and/or a rotation.

The pouring opening can for example be an open end of a delivery tube into which the solution flows.

The open end of the delivery tube can be equipped with a nozzle or another device.

Advantageously, the support can be equipped with motorization means arranged to be actuated by at least one, optionally programmable, actuating means.

Thus, it is possible to carry out an automated distribution series by indicating the movements to be accomplished by the support so that the pouring opening is located above each of the containers provided for receiving the distributed solution in turn.

In an advantageous embodiment, the motorization means of the support can be actuated by the actuating means of the delivery means.

Thus, the device according to the invention can comprise a single actuating means for actuating the delivery means during the calibration step and the distribution steps and the support during the distribution steps.
According to another aspect of the invention, a method is provided for the gravimetric and in-series distribution of a predetermined quantity of a solution, said method comprising,

- a first, so-called calibration phase, comprising:
  - a so-called calibration step of delivery of solution into a container by a delivery means, said calibration step comprising several iterations of the following operations:
    - measurement of a so-called measurement data, relating to the quantity of solution delivered into said container,
    - actuation of said delivery means as a function of said measurement data and of said predetermined quantity, so as to deliver said predetermined quantity of solution into said container during said calibration step;
  - a step of measurement of a so-called setpoint value, relating to the operation of said delivery means during said calibration step,

- a second, so-called in-series distribution, phase comprising several iterations of a delivery step by successive actuation of said delivery means with said setpoint value.

The device and the method according to the invention can be advantageously used for the dilution of liquid and/or solid products for chemical and/or biological and/or microbiological and/or bacteriological analyses.

Other advantages and characteristics will become apparent on examination of the detailed description of embodiments which are in no way limitative, and the attached drawings, in which:

- FIGURE 1 is a representation in the form of a diagram of an example of the method according to the invention;
- FIGURES 2 and 4 are exploded diagrammatic representations of two embodiments of a device according to the invention; and
- FIGURES 3 and 5 are diagrammatic representations of two examples of a device according to the invention.

In the figures and in the remainder of the description, the components common to several figures retain the same reference number.
FIGURE 1 is a representation in the form of a diagram of an example of the method according to the invention.

The method 100 comprises a so-called calibration phase 102, followed by a so-called in-series distribution phase 104.

The calibration phase 102 commences with a step 106 beginning the delivery of the solution to be distributed into a container. Specifically, this step consists of the actuation of the delivery means, which can be a peristaltic pump.

During delivery of the solution, a step 108 consists of measurement of the quantity of solution, for example the weight of the solution, present in the container. This measurement step 108 requires the use of a measuring means for example a weighing means.

The quantity measured, for example the weight, is then compared with the desired quantity of product, for example to the desired weight, during a step 110.

If the measured quantity is less than the desired quantity with a small margin of error, the delivery is continued during a step 112 and the steps 108 and 110 are repeated.

If the measured quantity is equal to the desired quantity with a small margin of error, the delivery is stopped during a step 114. Specifically, this step consists of stopping the delivery means.

A setpoint value describing the operation of the delivery means from the start of the delivery until the stopping of the delivery, is then measured and stored during a step 116. This setpoint value can for example be a number of rotation(s) made by a peristaltic pump, if the delivery means is a peristaltic pump. This setpoint value can be any data which can be accurately measured and repeated, accurately describing the operation of the delivery means.

The in-series distribution phase 104 comprises several iterations of a so-called distribution step 118, consisting of actuating the delivery means so that it carries out an operation according to the setpoint value without measuring the quantity of product present in the container.

At the end of each distribution step, a step 120 of pausing/stopping the means of operation is carried out to determine whether the distribution phase has been completed. If so, the method 100 is completed. If not, the method provides for a pause in distribution allowing the user or an automated mobile support to change
the container into which the solution is poured. A new distribution step is then carried out, without being concerned about measuring the delivered quantity, and only actuating the delivery means in order to reach the operating setpoint of the delivery means.

Thus, during the calibration phase 102, the weighing means is used whereas during the distribution phase the weighing means is not used. The distribution phase is an iteration of a step of operating the delivery means according to the setpoint value.

FIGURE 2 is an exploded diagrammatic representation of a first embodiment of a device according to the invention.

The device 200 comprises at least one non-contact delivery means 202 carrying out the delivery of a solution from a reservoir 204 as far as a container 206 through a delivery tube 208. The delivery means 202 comprises one or more peristaltic pumps.

One of the ends of the delivery tube 208 is connected to the reservoir 204 and the other end is arranged on a support 210 which positions it over the container 206.

The device 200 comprises scales 212 on which the container 206 is arranged.

The device 200 also comprises a module 214 connected to the scales 212 and receiving from the scales 212 a weight value corresponding to the weight of the solution present in the container 206. The module 214 is moreover arranged in order to compare the measured weight value with a desired weight value corresponding to the predetermined quantity of solution to be delivered into the container 206.

The module 214 is connected to a so-called actuating module 216, which controls the operation of the delivery means 202.

The device 200 also comprises a module 218 for determining an operating setpoint value of the delivery means during the calibration phase. The setpoint value can for example be a rotation or a number of rotations made by the peristaltic pump to deliver the predetermined quantity of solution.

The device 200 comprises moreover a storage module 220, for example a flash memory, in which the setpoint value determined by the module 218 is stored.
The device 200 also comprises a so-called planning module 222, allowing a user to enter a process for the in-series distribution of solution by means of, for example a touch screen 224 or an alphanumeric keyboard 226.

During the calibration phase, the actuation module 216 receives the result of the comparison carried out by the module 214 and actuates the delivery means as a function of this comparison.

During the distribution phase, the actuation module 216 receives from the storage means 220 the setpoint value determined by the module 218 and the data relating to the distribution process from the planning module 222 and actuates the delivery means as a function of these data in order to carry out one or more solution distribution steps, each of the steps being carried out by actuating the delivery means 202 in order to reach the operating setpoint.

The device 200 can also comprise a manual activation means, such as a button 228, allowing a user to carry out and control the in-series distribution without having to enter planning data. In this case, each time the button 228 is pressed, the control means accesses the storage means in order to read the setpoint value and actuates the delivery means 202 in order to reach the operating setpoint.

The end 230 of the delivery tube 208 beside the container 206, also called the pouring end, is equipped with a nozzle/tip 232 improving the pouring of the solution into the container 206.

In the embodiment in Figure 2, the support 210 is not motorized. The delivery tube 208 is detachably connected to the support and the user can manually position the pouring end 232 on a particular container and start a solution distribution step, for example by pressing on the button 228.

FIGURE 3 is a diagrammatic representation of a first example of a device according to the invention, according to the embodiment in Figure 2.

The device 300 is presented in the form of a one-piece assembly comprising a body 302 in which the modules 214 to 222 are arranged.

The device 300 comprises three peristaltic pumps 202₁, 202₂, and 202₃ mounted in parallel and delivering a solution through one or more delivery tubes 208 having a branch associated with each of the pumps 202, namely the branches 208₁, 208₂ and 208₃. It is possible with the pumps 202 to carry out the distribution of the same solution, or of two or three solutions in parallel. In the example shown, the
pumps 202₁ and 202₂ carry out the distribution of the same solution originating from a first reservoir (not shown) and the pump 202₃ carries out the distribution of a second solution originating from a second reservoir (not shown). The device 300 comprises a first delivery tube comprising the branches 208₁ and 208₂ opening at a first pouring end 230₁ and a second delivery tube, independent of the first delivery tube, comprising the branch 208₃ opening at a second pouring end 230₂ both equipped with a pouring nozzle/tip.

The support 210 is made up of a holding element 304 for the pouring ends 230₁ and 230₂ that is arranged on an arm 306 held by two uprights 308 and 310 parallel to each other and substantially perpendicular to the arm 306. The uprights 308 and 310 join the body 302 of the device behind the container 206 with respect to the user. The uprights 308 and 310 are mobile in rotation with respect to the body 302, about an axis 312 substantially parallel to the arm 306 so that the support 210 is mobile in rotation about the axis 312 which is moreover parallel to the front face of the device 302.

FIGURE 4 is an exploded diagrammatic representation of a second embodiment of a device according to the invention.

The device 400 shown in Figure 4 comprises all the components of the device 200 in Figure 2.

In the device 400, the support 210 is mounted mobile in the three spatial directions and the device 400 also comprises motorization means which can be actuated, represented by the component 402. The motorization means 402 can comprise one or more motors, for example stepper motors and one or more belts or slides, moving a holding element for the pouring end in two/three spatial dimensions in order to position it over a particular container in turn.

The motorization means 402 are connected to the actuation module 216 which actuates these means 402 as a function of data received by the planning module 222.

FIGURE 5 is a diagrammatic representation of a second example of a device according to the invention, according to the embodiment in Figure 4.

The device 500 shown in Figure 5 is presented in the form of a one-piece assembly comprising a body 502 in which the modules 214 to 222 are arranged.
The device 500 comprises two peristaltic pumps 202, mounted in parallel and delivering the solution through a delivery tube having a branch associated with each of the pumps 202, namely the branches 208, opening at a pouring end 230 equipped with a nozzle or tip 232.

The device 500 comprises a support 210 comprising a holding element 504 for the pouring end 230, arranged in mobile manner on an arm 506. The element 504 is mobile in translation with respect to the arm 506 in the direction defined by the arm, represented by the axis 508, for example along or about the arm 506, over substantially the entire length of the arm 506 as represented by the arrow 510.

The arm 506 is mobile in translation along an axis 512 perpendicular to the axis 508, on or around two guides 514 and 516 parallel to each other and perpendicular to the arm 506. The guides 514 and 516 are held by uprights 518, high enough for a receptacle 520 comprising a plurality of containers 206 to be arranged between the arm 506 and the weighing means 212, and more particularly on the weighing means 212.

The holding element 504 is moved over/about the mobile arm 506 by one or more motors (not shown), for example stepper motors, optionally using belts.

The mobile arm 506 is moved over/around the guides 514 and 516 by one or more motors (not shown), for example stepper motors, optionally using belts.

The motors are connected to the actuation module 216, by wires or wirelessly.

As a function of the previously indicated position of each of the containers 206, the actuation module:

- actuates the motors in order to position the pouring end 230 above the container 206,
- actuates the delivery means in order to deliver the predetermined quantity of product by reaching the operating setpoint,
- stops the delivery means in order to move the pouring end over another container.

Each module 214 to 222 can be a software module or a set of instructions executed by an electronic or computer component, or also a physical module, such as an integrated circuit, an electronic chip or a processor such as an EEPROM.
Although presented separately for greater clarity, the modules 214-222 can be utilized in the same assembly or the same processor or also in the same set of executable instructions.

Of course the invention is not limited to the examples which have just been described.
CLAIMS

1. Device for the gravimetric and in-series distribution of a predetermined quantity of a solution, said device (200, 300, 400, 500) comprising:
   - at least one means (202) for delivering said solution into a container (206);
   - at least one measuring means (212) supplying a so-called measurement data relating to the quantity of solution delivered into said container (206);
   - at least one control means (214, 216) arranged to carry out several iterations of the following steps during a, so-called calibration, delivery step:
     o receiving said measurement data from the measuring means (212) and
     o actuating said delivery means as a function of said measurement data;
   so as to deliver said predetermined quantity of solution into said container (206) during said delivery step;
   - at least one means (218) for measuring at least one so-called setpoint value, relating to the operation of said delivery means (202) during said calibration step; and
   - at least one means (216) for actuating said delivery means (202) or an identical delivery means, as a function of said setpoint value, so as to carry out at least one other, so-called distribution, delivery step;
   said device being characterized in that it also comprises a support (210) arranged to hold and move an opening for pouring the solution delivered by the delivery means into a container (206), in at least one spatial direction.

2. Device according to claim 1, characterized in that it is presented in the form of a one-piece assembly.

3. Device according to any one of the previous claims, characterized in that the measuring means (212) comprises a weight measuring means.
4. Device according to any one of the previous claims, characterized in that the delivery means (202) comprises at least one component for delivering said solution through at least one so-called delivery tube (208) said delivery component not coming into contact with said solution.

5. Device according to claim 4, characterized in that a delivery component is a peristaltic pump (202).

6. Device according to any one of claims 4 or 5, characterized in that the delivery means comprises at least one component modifying the flow of the solution in the delivery tube by a pressure exerted on said tube.

7. Device according to any one of the previous claims, characterized in that it comprises at least one means (220) for storing the setpoint value.

8. Device according to any one of the previous claims, characterized in that the actuating means is incorporated into the control means.

9. Device according to any one of the previous claims, characterized in that the actuating means (216) is arranged to be manually activated by an operator in order to carry out a distribution step.

10. Device according to any one of the previous claims, characterized in that the actuating means (216) can be programmed to carry out several distribution steps over time according to programmed timing.

11. Device according to any one of the previous claims, characterized in that the support (304, 504) is equipped with motorization means arranged to be actuated by at least one programmable actuating means.

12. Device according to claim 11, characterized in that the motorization means of the support are actuated by the means (216) for actuating the delivery means (202).
13. Use of the device according to any one of the previous claims for the dilution of products.
Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

<table>
<thead>
<tr>
<th>Category</th>
<th>Relevant to claims</th>
<th>Identity of document and passage or figure of particular relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>1-13</td>
<td>WO2012/069925 A1 (ANDREW ALLIANCE) See especially page 34 lines 5-17 and figure 1</td>
</tr>
<tr>
<td>X</td>
<td>1-13</td>
<td>EP0810438 A2 (PACKARD INSTRUMENT CO) See col 12 line 45-col 13 line 18 and figure 1</td>
</tr>
<tr>
<td>A</td>
<td>-</td>
<td>US2006/134598 A1 (KENNEY) See abstract and figure 1</td>
</tr>
</tbody>
</table>

Categories:

| X | Document indicating lack of novelty or inventive step |
| Y | Document indicating lack of inventive step if combined with one or more other documents of same category. |
| & | Member of the same patent family |
| A | Document indicating technological background and/or state of the art. |
| P | Document published on or after the declared priority date but before the filing date of this invention. |
| E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC:

Worldwide search of patent documents classified in the following areas of the IPC

B01L; G01F; G01N

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI
### International Classification:

<table>
<thead>
<tr>
<th>Subclass</th>
<th>Subgroup</th>
<th>Valid From</th>
</tr>
</thead>
<tbody>
<tr>
<td>G01F</td>
<td>0025/00</td>
<td>01/01/2006</td>
</tr>
<tr>
<td>B01L</td>
<td>0003/02</td>
<td>01/01/2006</td>
</tr>
<tr>
<td>G01N</td>
<td>0035/10</td>
<td>01/01/2006</td>
</tr>
</tbody>
</table>