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(54) **SYSTEM AND METHOD FOR FILLING CONTAINERS WITH A CARBONATED PRODUCT, HAVING IMPROVED EFFICIENCY**

SYSTEM UND VERFAHREN ZUM BEFÜLLEN VON BEHÄLTERN MIT EINEM KOHLENSÄUREHALTIGEN PRODUKT, MIT VERBESSERTER EFFIZIENZ

SYSTÈME ET PROCÉDÉ DE REMPLISSAGE DE CONTENANTS AVEC UN PRODUIT GAZÉIFIÉ, PRÉSENTANT UNE EFFICACITÉ AMÉLIORÉE

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Description

[0001] The present invention relates to a system and to a corresponding method for filling containers with a carbonate product, having an improved efficiency.

[0002] In general, the present solution may be implemented in filling machines for any type of containers or receptacles, such as containers made of glass, plastics (PET), aluminum, steel and composites, and with any type of carbonated product, such as sparkling water, soft drinks, etc.; the present solution is, however, particularly designed for filling cans with beer or a similar carbonated product.

[0003] Rotary-type filling machines are known, comprising a rotary conveyor (so called "carousel") rotatable around a vertical axis, a reservoir containing a pourable product and a plurality of filling units (or "filling valves"). The filling units are peripherally carried by the carousel, are connected to the reservoir by means of respective ducts and are carried by the carousel along a circumferential transfer path.

[0004] A typical filling machine also comprises input and output container conveying means, in particular an inlet conveyor for feeding a succession of empty containers to the carousel and an outlet conveyor receiving the filled containers from the carousel and configured to feed the filled containers to further processing devices, such as a capping device or a labeler device.

[0005] Each filling unit is configured to feed a predetermined

[0006] volume of pourable product into a respective container at a time, while being advanced along the transfer path due to the rotary motion imparted by the carousel; filling occurs according to a desired plan or "recipe", including a number of recipe phases, envisaging respective operations to be performed on the container.

[0007] The filling recipe may for example envisage one or more of the following operations, performed in a preset sequence: air-extraction, removing air from the container, e.g. by fluidically coupling the container to an air-suction device; pressurizing, raising the pressure within the container; fast or slow filling, feeding a "fast" or "slow" stream of filling liquid into the container; "sniffing", slowly depressurizing the filled container via an orifice.

[0008] The filling recipe defines the sequence of operations to be performed, the respective time length and the relevant operating parameters of the filling units.

[0009] In particular, filling machines for filling cans or similar containers with beer envisage, in the filling recipe, one or more "flushing" phases, feeding a stream of carbon dioxide (CO₂) into the container and at the same time removing the mixture of air and carbon dioxide from the same container via a discharge path, in order to remove air (mainly O₂) from the container, before the actual filling operations occur.

[0010] EP0697369A1 describes a system in accordance with the preamble of claim 1, for filling containers with a carbonated product by a container filling machine comprising a number of filling units configured to perform filling operations according to a filling recipe comprising a flushing phase for flushing the container with a stream of carbon dioxide.

[0011] As it is known, stringent requirements have to be met concerning the amount of oxygen (O₂) in the filled containers, both in terms of dissolved oxygen and in terms of oxygen remaining in the head space of the container; the total percentage of oxygen is often defined as TPO, Total Package Oxygen. Indeed, oxygen is a known factor causing degradation of the beer product over time.

[0012] The filling recipe, in particular the above discussed flushing operations, is thus properly designed in order to meet the TPO requirements for the filled containers.

[0013] A common problem of known filling machines is the difficulty to guarantee the oxygen concentration requirements in the filled containers, in all possible operating conditions.

[0014] The present Applicant has realized that a common cause of oxygen concentration increase is the modification of the rotating speed of the filling machine carousel, in particular a decrease of this rotating speed. Indeed, particularly in stand-alone filling machines, i.e. filling machines whose operation is not combined with other container processing machines (such as a labeler machine), the speed of the carousel is related to the speed of the input and/or output container conveying means; it is therefore a common occurrence that the speed of the carousel is increased/decreased in order to match the speed of the input or output conveyors.

[0015] A decrease of the rotating speed entails a longer stay of the filled containers (which are open to the external atmosphere) on the output conveyor, before the same filled containers are transferred to a capping machine, with a consequent increase of the amount of oxygen entering the containers.

[0016] As a consequence, the present Applicant has verified that both the TPO and the dissolved oxygen increase in the filled containers, although with a different rate. For example, the Applicant has verified that a speed reduction from a nominal speed of 96000 cph (container per hour) to a reduced speed of 50000 cph may entail an increase of the TPO count by 200 PPB (parts per billion) and of the dissolved amount by 40/50 PPB.

[0017] Such increase of the oxygen amount may entail the impossibility to meet the desired quality requirements for the filled containers and the filled product.

[0018] A possible solution to the above problem could envisage a modification of the filling recipe, to take into account the possible increase of oxygen concentration; this solution, however, entails a decrease of efficiency, since the filling

recipe would not be optimized for the actual or nominal operating conditions.

[0019] The aim of the present solution is to solve, at least in part, the problem previously highlighted, and in general to provide a container filling machine having an improved efficiency.

[0020] According to the present solution, a system and a method are provided, as defined in the independent claims.

[0021] For a better understanding of the present invention, preferred embodiments thereof are now described, purely by way of non-limiting examples, with reference to the attached drawings, wherein:

- Figure 1 is a schematic representation of a filling machine;
- Figure 2 is a diagrammatic representation of a filling recipe implemented by the filling machine of Figure 1; and
- Figure 3 is a flow chart of operations implemented in the filling machine of Figure 1.

[0022] Figure 1 schematically shows a filling machine (or "filler") 1, configured for filling containers 2, in particular cans, with a filling fluid, in particular a carbonated pourable food product, more particularly beer (it is however again underlined that other types of containers and carbonated liquids may as well be envisaged).

[0023] Filling machine 1 comprises a conveying device, including a rotating conveyor (or carousel) 4, which is mounted to rotate continuously (e.g. anticlockwise in Figure 1) about a substantially vertical longitudinal axis A.

[0024] The carousel 4 receives a succession of empty containers 2 from an input wheel 7 (or other suitable input conveyor), which is coupled thereto at a first transfer station and is mounted to rotate continuously about a respective vertical longitudinal axis A', parallel to axis A.

[0025] The carousel 4 releases a succession of filled containers 2 to an output conveyor 8 (a linear belt conveyor, as shown in Figure 1, or another suitable output conveyor), which is coupled thereto at a second transfer station and is configured to transfer the filled containers 2 towards a capping machine configured to cap the same filled containers 2 (or towards another processing machine).

[0026] Filling machine 1 comprises a number of filling units 5, which are equally spaced about axis A, are mounted along a peripheral edge of the carousel 4, and are moved by the same carousel 4 along a path P extending about axis A and through the above transfer stations.

[0027] Each filling unit 5 is designed to receive at least one container 2 to be filled, and to perform, during its rotation along path P, filling operations according to a desired plan, the so called filling "recipe", in order to fill the container 2 with the carbonated product.

[0028] In a manner not shown in detail, each filling unit 5 includes a main body, for example with a tubular configuration, having a vertical extension along a longitudinal axis that is substantially parallel to axis A of carousel 4, and mechanically coupled to the same carousel 4. The main body includes, at a bottom portion thereof, a container receiving part, designed to engage a top portion of a respective container 2 that is to be filled during the filling operations, and generally includes one or more fluidic conduits and flow regulators (here not shown), including valves that are designed to selectively couple the container 2 to one or more feed devices or product tanks (also not shown), of the filling machine 1, via respective filling ducts 6.

[0029] Operation of the filling units 5 is controlled by a machine control unit 12 (shown schematically), generally including an industrial PLC (Programmable Logic Controller) or any other suitable digital processing unit, for example a computer running a PLC software application, designed to control general operation of the filling machine 1 according to the desired filling recipe.

[0030] Moreover, each filling unit 5 is provided with its own intelligence, i.e. with a respective local control unit 12' (shown schematically), e.g. a processor or similar computing unit, programmed to manage the filling operations of the same filling unit 5 according to the recipe and operatively coupled to the machine control unit 12.

[0031] Local control units 12' are communicatively coupled to the machine control unit 12 of the filling machine 1, e.g. via a data communication bus 14, so as to receive control signals from the machine control unit 12 and provide feedback signals to the same machine control unit 12, while filling operations are performed. Data communication bus 14 may be a real-time bus, in particular an Ethernet-based real-time communication bus, such as the Powerlink bus, Ethercat, Ethernet Realtime, or Profinet, or any other bus capable to offer data communication capability, even not in real time (e.g. a RS-485 bus). Local control units 12' may be coupled to the machine control unit 12 according to a master/slave operating relation (the machine control unit 12 acting as "master" and the local control units 12' acting as "slaves").

[0032] The machine control unit 12 may moreover be coupled to a central supervising unit (here not shown), including a respective PLC or any other suitable computing and processing unit, e.g. located remotely with respect to the filling machine 1, via a cabled or remote wireless link; central supervising unit may supervise and manage operation of various processing machines in a same processing plant, in addition to filling machine 1 (e.g. a capping machine, a labelling machine and so on, all cooperating in processing of the containers 2), and may receive feedback information from the various machines of the processing plant.

[0033] As schematically shown in Figure 2, the filling recipe envisages a number n of recipe phases or steps 20, with corresponding operations performed by the flow regulators, valves and actuators of the filling units 5, that are executed

in a temporal sequence.

[0034] In a possible embodiment, that is particularly designed for filling a can with beer, the recipe phases 20 may include:

- 5 a first recipe phase 20 of flushing of the container 2, feeding a stream of carbon dioxide (CO₂) into the container 2 and at the same time removing the mixture of air and carbon dioxide from the same container 2 via a discharge path (in order to "saturate" the inside of the container 2 with CO₂);
 a second recipe phase 20 of pressurization of the container 2;
 a third recipe phase 20 of filling the container 2 with the carbonated product, in particular beer;
 10 a fourth recipe phase 20 of "sniffing" (i.e. slowly depressurizing) the filled container 2, before the same filled container 2 is transferred to the output conveyor 8.

[0035] The number and type of the actual recipe phases 20 of the filling recipe may vary, according to the specific needs and requirements; in any case, the filling recipe includes at least one recipe phase of flushing of the container 2, which precedes a recipe phase of actual filling of the same container 2.

[0036] In a possible embodiment, two or more distinct recipe phases of flushing are envisaged (which are subsequent in time and may or may not be consecutive), for example a first flushing recipe phase, followed by a pressurization recipe phase, in turn followed by a second flushing recipe phase.

[0037] As will be discussed in detail in the following, in order to solve the problem of possible increase of the oxygen amount in the filled containers 2 that are transferred at the output of the filling machine 1, a particular aspect of the present solution envisages an increase of duration of at least one flushing phase of the filling recipe, without any further modification of the same filling recipe (which remains therefore optimized for the particular product and operating conditions).

[0038] In particular, the increase of the flushing duration is implemented dynamically, i.e. in real-time during the filling operations, while the filling recipe is being executed.

[0039] The increase of the flushing duration allows to further saturate the inside of the container 2 with carbonated dioxide, before the filling operations are performed, thereby opposing and limiting subsequent introduction of oxygen within the same container 2 and allowing to satisfy the oxygen concentration requirements for the filled containers 2 (e.g. in terms of the TPO and/or the quantity of dissolved oxygen).

[0040] In further detail, and as shown schematically in Figure 3, an aspect of the present solution therefore envisages the following operations:

determining, at step 30, a disturbance cause affecting the filling machine 1 that may lead to increase of the oxygen concentration in the filled containers 2 (as discussed in the following, this disturbance cause may be a reduction of the rotating speed of the carousel 4 of the filling machine or an increase of oxygen concentration in the product tank) ;
 35 in response to the above determination of the disturbance cause, at step 31, determining a dynamic increase of a duration of the flushing operation in the filling recipe, as a function of the determined disturbance;
 implementing, at step 32, the filling recipe with the determined increased duration of the flushing operation, until it is determined that the disturbance cause has been removed or is no more affecting operation of the filling machine
 40 1, as shown at step 33. Afterwards, in a manner not shown, filling operations continue with the original filling recipe (with the nominal duration envisaged for the flushing operation).

[0041] In particular, according to a further aspect of the present solution, it is determined which one is the last flushing phase of the filling recipe (in case a number of flushing phases are present), and only the duration of this last flushing phase is dynamically increased, as a function of the disturbance cause.

[0042] According to a possible embodiment, the determination of the cause of disturbance envisages assessing that the speed of the carousel 4 is lower than a design (or nominal) rotating speed S_N, in particular that an actual speed S_{ACT} of the carousel 4 is lower than a threshold speed S_{TH}, that is lower than (or equal to) the nominal rotating speed S_N of the same carousel 4. For example, in case the nominal speed S_N of the carousel 4 is 96000 cph, the above threshold speed TH may be set equal to 50000 cph.

[0043] If the actual speed S_{ACT} of the carousel 4 is lower than the threshold speed S_{TH}, the nominal flushing duration is increased of an additional duration ΔT that is a function of the speed difference ΔS between the threshold speed S_{TH} and the actual rotating speed S_{ACT} of the carousel 4:

$$\Delta T = f(\Delta S) = f(S_{TH} - S_{ACT}) .$$

[0044] In a possible embodiment, the additional duration ΔT (that is added to the duration originally envisaged by the filling recipe) is a linear function of this speed difference ΔS .

[0045] In particular, a time offset Off may be set, e.g. equal to 100 ms, corresponding to a given interval of the speed difference ΔS , e.g. equal to 10000 cph: in other words, the value of the additional duration ΔT is increased of the time offset Off for every interval of the speed difference ΔS .

[0046] The following Table shows the dynamic increase of the flushing duration in the above example, for a number of possible values of the speed difference ΔS , considering again a threshold speed S_{TH} equal to 50000 cph for the activation of the dynamic modification of the flushing duration:

S_{ACT} (cph)	ΔS (cph)	Dynamic increase of flushing duration active?	ΔT (ms)
70000	-	No	0
60000	-	No	0
50000	-	No	0
49000	1000	Yes	10
47000	3000	Yes	30
45000	5000	Yes	50
40000	10000	YEs	100
30000	20000	YEs	200
28000	22000	YEs	220
...

[0047] According to a possible embodiment, the local control unit 12' of each filling unit 5 is configured (having suitable program instructions stored in a non-volatile memory coupled to the corresponding computing unit) to determine the additional duration ΔT for the above discussed increase of the flushing duration, upon the occurrence of a disturbance cause leading to a possible increase of the oxygen amount in the filled containers 2.

[0048] In this case, local control unit 12' of the filling unit 5 is configured to receive the filling recipe (including all the recipe phases 20) and a start command of the filling operations from the machine control unit 12.

[0049] Upon the occurrence of the cause of disturbance, e.g. when the actual rotating speed S_{ACT} of the carousel 4 falls below the threshold speed S_{TH} , the same local control unit 12' is configured to determine which is the last flushing phase in the filling recipe and to dynamically increase the duration thereof, e.g. adding an additional duration ΔT being a function of the speed difference ΔS between the threshold speed S_{TH} and the actual rotating speed S_{ACT} of the carousel 4.

[0050] According to an alternative embodiment, it is the same machine control unit 12 that determines the increase of the flushing duration, upon the occurrence of a disturbance cause leading to a possible increase of the oxygen amount in the filled containers 2.

[0051] In this case, the machine control unit 12 is configured to determine which is the last flushing phase of the filling recipe and to dynamically increase the duration thereof; the machine control unit 12 is further configured to communicate the filling recipe, with the flushing phase having the suitably increased duration, to the local control unit 12' of the filling units 5, so that they may execute the same filling recipe.

[0052] The advantages that the described solution allows to achieve are clear from the foregoing description.

[0053] In particular, it is again underlined that the proposed solution allows to improve the efficiency of the filling machine 1, without requiring a change of the filling recipe, except for an increase of duration of the flushing operation (in particular, of a last flushing phase in the filling recipe).

[0054] The present solution allows to avoid undesired increase of the oxygen amount (the dissolved oxygen amount and/or the total package amount) in the filled containers 2, that could cause a degradation of the quality of the filled product, in particular beer.

[0055] The discussed solution allows to modify the filling recipe dynamically during the filling operations, and cope with possible variations of the external conditions (that are not controlled by the filling machine 1), in an automated manner, without requiring intervention by human personnel.

[0056] Therefore, downtime of the filling machine 1 is reduced, as well as non-conformity of the filled products, efficiency and flexibility are increased and costs and wastes reduced.

[0057] Finally, it is clear that modifications and variations may be applied to the solution described and shown, without

departing from the scope of the appended claims.

[0058] In particular, it is again underlined that the discussed solution is configured to dynamically react to the mentioned causes of disturbance that could cause an increase of the oxygen amount in the filled containers 2.

[0059] Moreover, the dynamic determination of the increased duration of the flushing operation could even be performed by a further processing module, that could be implemented externally to the machine control unit 12 of the filling machine 1 and to the local control units 12', for example by the central supervising unit of the processing plant or by a further, dedicated, processing unit properly arranged at the filling machine 1 or externally thereto.

Claims

1. A system for filling containers (2) with a carbonated product by a container filling machine (1) comprising a number of filling units (5), coupled to a rotating conveyor (4) designed to rotate around a rotation axis (A) and configured to perform filling operations on a respective container (2) according to a filling recipe; wherein the filling recipe comprises at least one flushing phase for flushing of the container (2) with a stream of carbon dioxide (CO₂), preceding a filling phase for filling the container (2) with the carbonated product, **characterized by** the system comprising a processing module (12; 12'), configured to:

determine a disturbance cause affecting the filling machine (1) that would lead to an increase of oxygen amount in the filled containers (2); and
 in response to determining the disturbance cause, cause a dynamic increase of a duration of the at least one flushing phase of the filling recipe, as a function of the determined disturbance;
 wherein the disturbance cause is a reduction of the rotating speed of the rotating conveyor (4) or an increase of oxygen concentration in a product tank.

2. The system according to claim 1, wherein the processing module (12; 12') is configured to determine the disturbance cause and cause the dynamic increase of the duration of the at least one flushing phase in real-time, while the filling operations are being performed by the filling machine (1).

3. The system according to claim 1 or 2, wherein the filling recipe comprises a number of flushing phases for flushing of the container (2) with a stream of carbon dioxide (CO₂), which are subsequent in time and precede the filling phase for filling the container (2) with the carbonated product; wherein said at least one flushing phase is a last phase among said flushing phases.

4. The system according to any of the preceding claims, wherein the system is configured to cause said increase of duration, until it is determined that the disturbance cause has been removed or is no more affecting operation of the filling machine (1).

5. The system according to any of the preceding claims, wherein said disturbance cause is a reduction of the rotating speed of the rotating conveyor (4) below a threshold speed (S_{TH}) that is lower than, or equal to, a nominal speed (S_N) of said rotating conveyor (4); and wherein the increase of duration is a function of said reduction of the rotating speed.

6. The system according to claim 5, wherein the duration of the at least one flushing phase is increased of an additional duration (ΔT) that is a linear function (f) of the speed difference (ΔS) between the threshold speed (S_{TH}) and an actual rotating speed (S_{ACT}) of the rotating conveyor (4):

$$\Delta T = f(\Delta S) = f(S_{TH} - S_{ACT}) .$$

7. The system according to claim 5 or 6, wherein a time offset (Off) is set, corresponding to a given interval of the speed difference (ΔS), and an additional duration (ΔT) is added to the duration of the at least one flushing phase, the additional duration (ΔT) being increased of said time offset (Off) for every interval of the speed difference (ΔS).

8. The system according to any of the preceding claims, wherein the filling machine (1) includes a machine control unit (12) and each of said filling units (5) is provided with a respective local control unit (12'), coupled to the machine control unit (12) to receive said filling recipe; wherein said processing module is implemented in said local control

unit (12').

- 5 9. The system according to any of claims 1-7, wherein the filling machine (1) includes a machine control unit (12) and each of said filling units (5) is provided with a respective local control unit (12'), coupled to the machine control unit (12) to receive said filling recipe; wherein said processing module is implemented in said machine control unit (12).
10. A filling machine (1), provided with the system according to any of the preceding claims.
- 10 11. The filling machine according to claim 10, wherein the containers (2) are cans and the carbonated product is beer.
- 15 12. A method for filling containers (2) with a carbonated product by a container filling machine (1) comprising a number of filling units (5) coupled to a rotating conveyor (4) designed to rotate around a rotation axis (A) and configured to perform filling operations on a respective container (2) according to a filling recipe; wherein the filling recipe comprises at least one flushing phase for flushing of the container (2) with a stream of carbon dioxide (CO₂), preceding a filling phase for filling the container (2) with the carbonated product, the method comprising:
- determining a disturbance cause affecting the filling machine (1) that would lead to an increase of an oxygen amount in the filled containers (2); and
- 20 in response to determining the disturbance cause, causing a dynamic increase of a duration of the at least one flushing phase of the filling recipe, as a function of the determined disturbance; wherein the disturbance cause is a reduction of the rotating speed of the rotating conveyor (4) or an increase of oxygen concentration in a product tank.
- 25 13. The method according to claim 12, wherein said filling recipe comprises a number of flushing phases for flushing of the container (2) with a stream of carbon dioxide (CO₂), which are subsequent in time and precede the filling phase for filling the container (2) with the carbonated product; wherein said at least one flushing phase is a last phase among said flushing phases.
- 30 14. The method according to claim 12 or 13, wherein said disturbance cause is a reduction of the rotating speed of the rotating conveyor (4) below a threshold speed (S_{TH}) that is lower than, or equal to, a nominal speed (S_N) of said rotating conveyor (4); and wherein the increase of duration is a function of said reduction of the rotating speed.
- 35 15. A computer program product comprising instructions to cause the system according to any one of claims from 1 to 11 to execute the method according to any one of claims from 12 to 14.

Patentansprüche

- 40 1. System zum Befüllen von Behältern (2) mit einem kohlendioxidhaltigen Produkt durch eine Behälterbefüllungsmaschine (1), umfassend eine Anzahl von Befüllungseinheiten (5), die an einen Rotationsförderer (4) gekoppelt sind, der vorgesehen ist, um sich um eine Rotationsachse (A) zu drehen, und ausgestaltet ist, um Befüllungsoperationen an einem jeweiligen Behälter (2) gemäß einem Befüllungsrezept durchzuführen; wobei das Befüllungsrezept mindestens eine Spülphase zum Spülen des Behälters (2) mit einem Strom aus Kohlendioxid (CO₂) umfasst, die einer Befüllungsphase zum Befüllen des Behälters mit dem kohlendioxidhaltigen Produkt vorausgeht,
- 45 **dadurch gekennzeichnet, dass**
das System ein Verarbeitungsmodul (12; 12') umfasst, das ausgestaltet ist zum:
- Ermitteln einer Störungsursache, welche die Befüllungsmaschine (1) beeinflusst, die zu einer Erhöhung der Sauerstoffmenge in den befüllten Behältern (2) führen würde; und
- 50 in Reaktion auf das Ermitteln der Störungsursache Bewirken eines dynamischen Anstiegs der Dauer der mindestens einen Spülphase des Befüllungsrezepts als Funktion der ermittelten Störung; wobei die Störungsursache eine Reduktion der Rotationsgeschwindigkeit des Rotationsförderers (4) oder ein Anstieg der Sauerstoffkonzentration in einem Produkttank ist.
- 55 2. System nach Anspruch 1, wobei das Verarbeitungsmodul (12, 12') ausgestaltet ist, um die Störungsursache zu ermitteln und den dynamischen Anstieg der Dauer der mindestens einen Spülphase in Echtzeit zu bewirken, während die Befüllungsoperationen durch die Befüllungsmaschine (1) durchgeführt werden.

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3. System nach Anspruch 1 oder 2, wobei das Befüllungsrezept eine Anzahl von Spülphasen zum Spülen des Behälters (2) mit einem Strom aus Kohlendioxid (CO₂) umfasst, die zeitlich aufeinander folgen und der Befüllungsphase zum Befüllen des Behälters (2) mit dem kohlenensäurehaltigen Produkt vorausgehen; wobei die mindestens eine Spülphase eine letzte Phase innerhalb der Spülphasen ist.

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4. System nach einem der vorhergehenden Ansprüche, wobei das System ausgestaltet ist, um den Anstieg der Dauer zu bewirken, bis ermittelt wird, dass die Störungsursache entfernt worden ist oder den Betrieb der Befüllungsmaschine (1) nicht länger beeinflusst.

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5. System nach einem der vorhergehenden Ansprüche, wobei die Störungsursache eine Reduktion der Rotationsgeschwindigkeit des Rotationsförderers (4) unter eine Schwellengeschwindigkeit (S_{TH}) ist, die niedriger als oder gleich einer Nenngeschwindigkeit (S_N) des Rotationsförderers (4) ist; und wobei der Anstieg der Dauer eine Funktion der Reduktion der Rotationsgeschwindigkeit ist.

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6. System nach Anspruch 5, wobei die Dauer der mindestens einen Spülphase um eine Zusatzdauer (ΔT) erhöht wird, die eine lineare Funktion (f) der Geschwindigkeitsdifferenz (ΔS) zwischen der Schwellengeschwindigkeit (S_{TH}) und einer tatsächlichen Rotationsgeschwindigkeit (S_{ACT}) des Rotationsförderers (4) ist:

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$$\Delta T = f(\Delta S) = f(S_{TH} - S_{ACT}) .$$

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7. System nach Anspruch 5 oder 6, wobei ein Zeitversatz (Off) festgelegt wird, der einem gegebenen Intervall der Geschwindigkeitsdifferenz (ΔS) entspricht, und eine Zusatzdauer (ΔT) zu der Dauer der mindestens einen Spülphase addiert wird, wobei die Zusatzdauer (ΔT) für jedes Intervall der Geschwindigkeitsdifferenz (ΔS) um den Zeitversatz (Off) erhöht wird.

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8. System nach einem der vorhergehenden Ansprüche, wobei die Befüllungsmaschine (1) eine Maschinensteuereinheit (12) einschließt und jede der Befüllungseinheiten (5) mit einer jeweiligen lokalen Steuereinheit (12') ausgestattet ist, die an die Maschinensteuereinheit (12) gekoppelt ist, um das Befüllungsrezept zu empfangen; wobei das Verarbeitungsmodul in der lokalen Steuereinheit (12') implementiert wird.

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9. System nach einem der Ansprüche 1 bis 7, wobei die Befüllungsmaschine (1) eine Maschinensteuereinheit (12) einschließt und jede der Befüllungseinheiten (5) mit einer jeweiligen lokalen Steuereinheit (12') ausgestattet ist, die an die Maschinensteuereinheit (12) gekoppelt ist, um das Befüllungsrezept zu empfangen; wobei das Verarbeitungsmodul in der Maschinensteuereinheit (12) implementiert wird.

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10. Befüllungsmaschine (1), die mit dem System gemäß einem der vorhergehenden Ansprüche ausgestattet ist.

11. Befüllungsmaschine nach Anspruch 10, wobei die Behälter (2) Dosen sind und das kohlenensäurehaltige Produkt Bier ist.

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12. Verfahren zum Befüllen von Behältern (2) mit einem kohlenensäurehaltigen Produkt durch eine Behälterbefüllungsmaschine (1), umfassend eine Anzahl von Befüllungseinheiten (5), die an einen Rotationsförderer (4) gekoppelt sind, der vorgesehen ist, um sich um eine Rotationsachse (A) zu drehen, und ausgestaltet ist, um Befüllungsoperationen an einem jeweiligen Behälter (2) gemäß einem Befüllungsrezept durchzuführen; wobei das Befüllungsrezept mindestens eine Spülphase zum Spülen des Behälters (2) mit einem Strom aus Kohlendioxid (CO₂) umfasst, der einer Befüllungsphase zum Befüllen des Behälters (2) mit dem kohlenensäurehaltigen Produkt vorausgeht, wobei das Verfahren umfasst:

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Ermitteln einer Störungsursache, welche die Befüllungsmaschine (1) beeinflusst, die zu einer Erhöhung einer Sauerstoffmenge in den gefüllten Behältern (2) führen würde; und
in Reaktion auf das Ermitteln der Störungsursache Bewirken eines dynamischen Anstiegs der Dauer der mindestens einen Spülphase des Befüllungsrezepts als Funktion der ermittelten Störung;
wobei die Störungsursache eine Reduktion der Rotationsgeschwindigkeit des Rotationsförderers (4) oder ein Anstieg der Sauerstoffkonzentration in einem Produkttank ist.

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13. Verfahren nach Anspruch 12, wobei das Befüllungsrezept eine Anzahl von Spülphasen zum Spülen des Behälters

(2) mit einem Strom aus Kohlendioxid (CO₂) umfasst, die zeitlich aufeinander folgen und der Befüllungsphase zum Befüllen des Behälters (2) mit dem kohlenstoffhaltigen Produkt vorausgehen; wobei die mindestens eine Spülphase eine letzte Phase innerhalb der Spülphasen ist.

- 5 14. Verfahren nach Anspruch 12 oder 13, wobei die Störungsursache eine Reduktion der Rotationsgeschwindigkeit des Rotationsförderers (4) unter eine Schwellengeschwindigkeit (S_{TH}) ist, die niedriger als oder gleich einer Nenn-
geschwindigkeit (S_N) des Rotationsförderers (4) ist; und wobei der Anstieg der Dauer eine Funktion der Reduktion
der Rotationsgeschwindigkeit ist.
- 10 15. Computerprogrammprodukt, umfassend Anweisungen zum Bewirken, dass das System gemäß einem der Ansprüche 1 bis 11 das Verfahren gemäß einem der Ansprüche 12 bis 14 durchführt.

Revendications

- 15 1. Système pour remplir des contenants (2) avec un produit carboné par une machine de remplissage de contenant
(1) comprenant un nombre d'unités de remplissage (5), couplées à un transporteur rotatif (4), conçu pour entrer en
rotation autour d'un axe de rotation (A), et configurées pour réaliser des opérations de remplissage sur un contenant
respectif (2) selon une recette de remplissage ; dans lequel la recette de remplissage comprend au moins une
20 phase de rinçage pour le rinçage du contenant (2) avec un courant de dioxyde de carbone (CO₂), précédant une
phase de remplissage pour remplir le contenant (2) avec le produit carboné,
caractérisé en ce que le système comprend un module de traitement (12 ; 12'), configuré pour :

déterminer une cause de dérangement affectant la machine de remplissage (1) qui occasionnerait une aug-
25 mentation de quantité d'oxygène dans les contenants remplis (2) ; et
en réponse à la détermination de la cause de dérangement, entraîner une augmentation dynamique d'une
durée de l'au moins une phase de rinçage de la recette de remplissage, en fonction du dérangement déterminé ;
dans lequel la cause de dérangement est une réduction de la vitesse de rotation du transporteur rotatif (4) ou
une augmentation de concentration en oxygène dans un réservoir de produit.

- 30 2. Système selon la revendication 1, dans lequel le module de traitement (12 ; 12') est configuré pour déterminer la
cause de dérangement et entraîner l'augmentation dynamique de la durée de l'au moins une phase de rinçage en
temps réel, alors que les opérations de remplissage sont en train d'être réalisées par la machine de remplissage (1).
- 35 3. Système selon la revendication 1 ou 2, dans lequel la recette de remplissage comprend un nombre de phases de
rinçage pour le rinçage du contenant (2) avec un courant de dioxyde de carbone (CO₂), qui sont subséquentes en
temps et précèdent la phase de remplissage pour remplir le contenant (2) avec le produit carboné ; dans lequel
ladite au moins une phase de rinçage est une dernière phase parmi lesdites phases de rinçage.
- 40 4. Système selon l'une quelconque des revendications précédentes, dans lequel le système est configuré pour entraîner
ladite augmentation de durée, jusqu'à ce qu'il soit déterminé que la cause de dérangement a été éliminée ou n'affecte
plus le fonctionnement de la machine de remplissage (1).
- 45 5. Système selon l'une quelconque des revendications précédentes, dans lequel ladite cause de dérangement est
une réduction de la vitesse de rotation du transporteur rotatif (4) jusqu'en dessous d'une vitesse seuil (S_{TH}) qui est
inférieure ou égale à une vitesse nominale (S_N) dudit transporteur rotatif (4) ; et dans lequel l'augmentation de durée
est une fonction de ladite réduction de la vitesse de rotation.
- 50 6. Système selon la revendication 5, dans lequel la durée de l'au moins une phase de rinçage est augmentée selon
une durée supplémentaire (ΔT) qui est une fonction linéaire (f) de la différence de vitesse (ΔS) entre la vitesse seuil
(S_{TH}) et une vitesse de rotation réelle (S_{ACT}) du transporteur rotatif (4) :

$$\Delta T = f(\Delta S) = f(S_{TH} - S_{ACT})$$

- 55 7. Système selon la revendication 5 ou 6, dans lequel un décalage temporel (Off) est réglé, correspondant à un
intervalle donné de la différence de vitesse (ΔS), et une durée supplémentaire (ΔT) est ajoutée à la durée de l'au

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moins une phase de rinçage, la durée supplémentaire (ΔT) étant augmentée selon ledit décalage temporel (Off) pour chaque intervalle de la différence de vitesse (ΔS).

- 5
8. Système selon l'une quelconque des revendications précédentes, dans lequel la machine de remplissage (1) inclut une unité de commande de machine (12) et chacune desdites unités de remplissage (5) est pourvue d'une unité de commande locale respective (12'), couplée à l'unité de commande de machine (12) pour recevoir ladite recette de remplissage ; dans lequel ledit module de traitement est mis en œuvre dans ladite unité de commande locale (12').
- 10
9. Système selon l'une quelconque des revendications 1 à 7, dans lequel la machine de remplissage (1) inclut une unité de commande de machine (12) et chacune desdites unités de remplissage (5) est pourvue d'une unité de commande locale respective (12'), couplée à l'unité de commande de machine (12) pour recevoir ladite recette de remplissage ; dans lequel ledit module de traitement est mis en œuvre dans ladite unité de commande de machine (12).
- 15
10. Machine de remplissage (1), pourvue du système selon l'une quelconque des revendications précédentes.
11. Machine de remplissage selon la revendication 10, dans laquelle les contenants (2) sont des cannettes et le produit carboné est de la bière.
- 20
12. Procédé pour remplir des contenants (2) avec un produit carboné par une machine de remplissage de contenant (1) comprenant un nombre d'unités de remplissage (5) couplées à un transporteur rotatif (4), conçu pour entrer en rotation autour d'un axe de rotation (A), et configurées pour réaliser des opérations de remplissage sur un contenant respectif (2) selon une recette de remplissage ; dans lequel la recette de remplissage comprend au moins une phase de rinçage pour le rinçage du contenant (2) avec un courant de dioxyde de carbone (CO_2), précédant une phase de remplissage pour remplir le contenant (2) avec le produit carboné, le procédé comprenant :
- 25
- la détermination d'une cause de dérangement affectant la machine de remplissage (1) qui occasionnerait une augmentation d'une quantité d'oxygène dans les contenants remplis (2) ; et
- 30
- en réponse à la détermination de la cause de dérangement, l'entraînement d'une augmentation dynamique d'une durée de l'au moins une phase de rinçage de la recette de remplissage, en fonction du dérangement déterminé ;
- 35
- dans lequel la cause de dérangement est une réduction de la vitesse de rotation du transporteur rotatif (4) ou une augmentation de concentration en oxygène dans un réservoir de produit.
13. Procédé selon la revendication 12, dans lequel ladite recette de remplissage comprend un nombre de phases de rinçage pour le rinçage du contenant (2) avec un courant de dioxyde de carbone (CO_2), qui sont subséquentes en temps et précèdent la phase de remplissage pour remplir le contenant (2) avec le produit carboné ; dans lequel ladite au moins une phase de rinçage est une dernière phase parmi lesdites phases de rinçage.
- 40
14. Procédé selon la revendication 12 ou 13, dans lequel ladite cause de dérangement est une réduction de la vitesse de rotation du transporteur rotatif (4) jusqu'en dessous d'une vitesse seuil (S_{TH}) qui est inférieure ou égale à une vitesse nominale (S_N) dudit transporteur rotatif (4) ; et dans lequel l'augmentation de durée est une fonction de ladite réduction de la vitesse de rotation.
- 45
15. Produit programme d'ordinateur, comprenant des instructions pour faire en sorte que le système selon l'une quelconque des revendications 1 à 11 exécute le procédé selon l'une quelconque des revendications 12 à 14.
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- 55

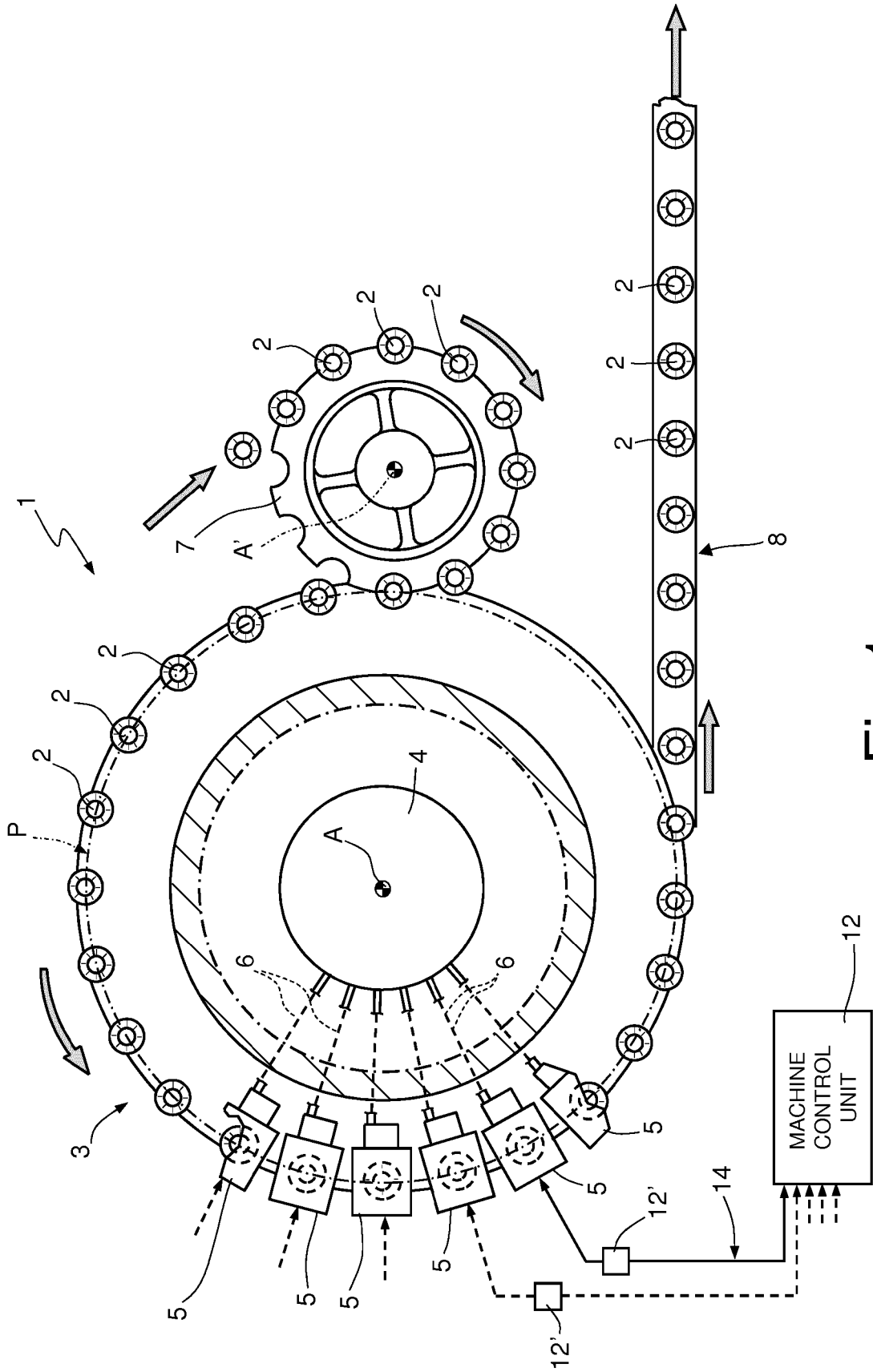


Fig.1

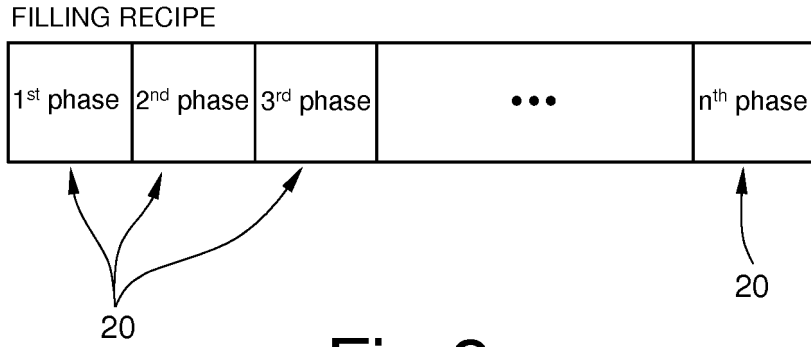


Fig.2

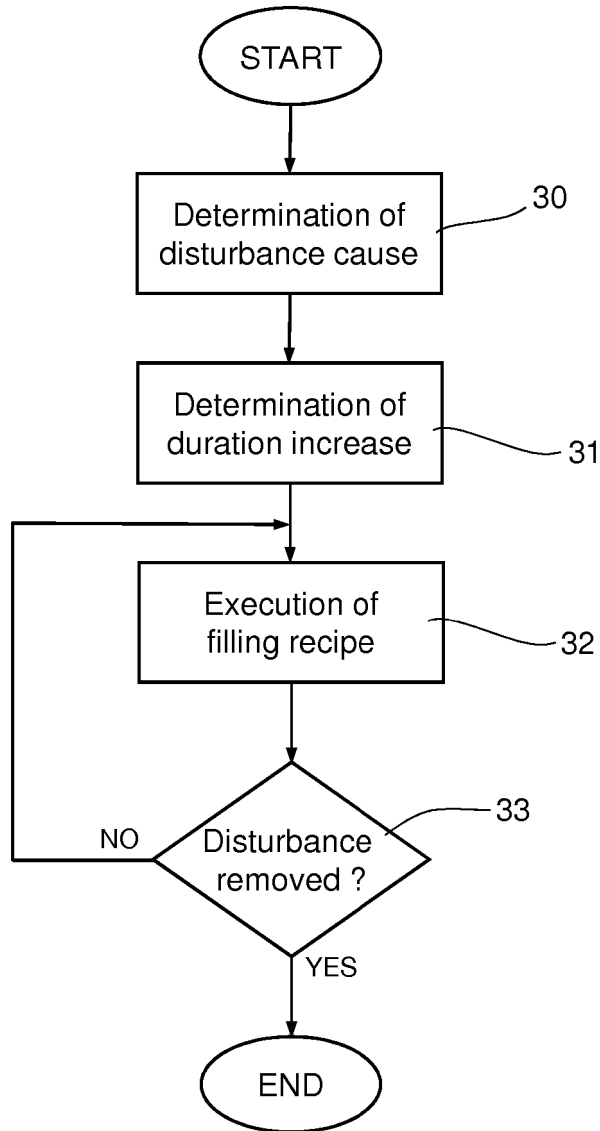


Fig.3

REFERENCES CITED IN THE DESCRIPTION

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