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(71) Applicant (for all designated States except US): ROCA SYSTEMS N.V. [BE/BE]; Esenstraat 29A, 8610 Zarren (BE).


Title: SYSTEM AND METHOD FOR ADDING A PRODUCT TO BE DOSED

Abstract: The present invention is related to a dosing system for adding a product to be dosed to a bulk product being discharged, comprising a dosing device (100) arranged for being supplied with the product to be dosed, a first weighing unit (250) comprising at least one weighing sensor arranged for weighing the product to be dosed, a second weighing unit (200) comprising at least one weighing sensor arranged for weighing the bulk product and a control device (300) arranged for receiving weighing data from the first weighing unit and from the second weighing unit and arranged for adjusting during the discharge operation the discharge rate of the dosing device, based on the received weighing data.
SYSTEM AND METHOD FOR ADDING A PRODUCT TO BE DOSED

Field of the invention
[0001] The present invention relates to a mobile dosing system for adding a product to be dosed into a bulk product. It also relates to an assembly of such a dosing system and a separate recipient containing the product to be dosed. The invention further relates to a method for adding a product to be dosed into a bulk product.

State of the art
[0002] In recent years there has been a growing interest at various levels (not in the least with both European and national authorities) in improving the safety of the food chain. Given this background there is also a growing need to better control e.g. the process of adding medical (pre)preparations or food supplements in a production line of compound feeds and to exclude as much as any abuse in such process. Issues like obtaining an accurate, precise predefined mix are of major importance. In any case an error tolerance below the GMP (Good Manufacturing Practice) requirements must be guaranteed.

In order to add a product to be dosed (e.g. vitamins, medical (pre)preparations or any product in powder) to a bulk product a dosing device is used. In prior art applications this is a device wherein a static mix of two products is realised. This operation is often performed when transporting feed from a bulk lorry to a silo. Typically the dosing device has a reservoir from which a component is mixed into a large amount of bulk product. The
dosing device is positioned between two parts of a transport tube and has at its upper side an open funnel shaped reservoir having at its bottom a rotatable axis provided with protrusions. However this approach has some serious drawbacks. During operation clouds of dust or powder can be released via the funnel. Weather conditions (e.g. humidity) can affect the performance. There is also a safety problem as all rotatable parts can be reached. Moreover it is difficult to control the dosing of the product into the bulk product.

[0004] Patent document BE1010363A4 discloses a dosing device for static mixing comprising a reservoir made as an airtight pressure chamber sealed from the outside environment. With 'static mixing' is meant that a predetermined amount of product to be dosed is added to a second product (bulk product) before discharging and that no further action is performed in order to adjust the parameters of the discharge process, like the discharge rate or the mixing ratio. The dosing device of BE1010363A4 forms a closed system under pressure such that the previously mentioned clouds of dust or powder are avoided. Further there is no pressure difference between the reservoir and the transport tube, which prevents the dosed product from being blown back. This facilitates the control of the dosing.

[0005] An important drawback of the above-described solution is that the system needs to be adjusted by an operator. This may give rise to deviations from the optimal mixing ratios or from the quality aspects of the mixing operation in general.

[0006] Patent document US-5718507 relates to a system for applying accurately metered, minute quantities of concentrated dry or liquid additives from bulk sources of supply to successive masses of material presented for
treatment. The dosifying system includes a pass-through chamber within which separate streams of a liquid carrier and the additive substance are merged together. When a truck arrives at the dispensing station, the contents of the container with bulk product is weighed using a scale that inputs the resulting information to a computer device. Information about the amount of additive to be dispensed for a certain weight of the bulk mass within the truck container has previously been stored within the computer device such that, when the weight of the contents is known, the computer can appropriately signal the rest of the system to release only the appropriate amount of additive from a hopper for that particular job. During the mixing operation no further control of the discharge rate is provided. The mixed substance of liquid carrier and additive is then loaded into the truck container.

Aims of the invention
[0007] The present invention aims to provide a dosing system and assembly for dynamically adding a product to be dosed to a bulk product with substantially enhanced accuracy and reliability. It further aims to provide a method for adding a product to be dosed to a bulk product.

Summary of the invention
[0008] The present invention relates to a dosing system for adding a product to be dosed to a bulk product being discharged, comprising
- a dosing device arranged for being supplied with the product to be dosed,
- a first weighing unit comprising at least one weighing sensor arranged for weighing the product to be dosed,
- a second weighing unit comprising at least one weighing sensor arranged for weighing the bulk product and
- a control device arranged for receiving weighing data from the first weighing unit and weighing data from the second weighing unit and arranged for dynamically adjusting the discharge rate of the dosing device during the discharge operation, based on the received weighing data.

[0009] In a preferred embodiment the at least one weighing sensor of the first weighing unit comprises load cells. The load cells are advantageously mounted in a chassis bearing the dosing device.

[0010] In a preferred embodiment the at least one weighing sensor of the second weighing unit comprises load cells and/or air pressure sensors. Advantageously the second weighing unit further comprises air transducers.

[0011] In a further embodiment the control device further comprises a memory device for storing weighing data and/or information related to the dosing and discharge process. Typically the control device comprises a processing unit.

[0012] Preferably the dosing device is further provided with a transparent pipe for injecting the product to be dosed into the bulk product.

[0013] Advantageously the control device further comprises first reading means for reading identification data of a silo into which the mix of the bulk product and the product to be dosed is to be discharged.

[0014] In an alternative embodiment the dosing device further comprises an integrated reservoir for containing said product to be dosed.

[0015] In a specific embodiment the invention also relates to a bulk truck or a bulk trailer on which a dosing
system as previously described is mounted. In such a bulk truck or a bulk trailer the dosing system is advantageously driven by the power supply of the bulk truck or of a truck to which the bulk trailer is coupled.

[0016] The invention also relates to a recipient for containing a product to be dosed, said recipient being provided with data for identifying the product to be dosed and arranged for co-operating with a dosing system as previously described.

[0017] In a preferred embodiment the invention relates to a dosing assembly, comprising a dosing system as previously described as well as a separate recipient containing the product to be dosed, said recipient being connectable to the dosing device. Advantageously the separate recipient is mountable on the dosing device.

[0018] Preferably the separate recipient comprises data for identifying the product to be dosed and the control device comprises second reading means for reading the data identifying the product to be dosed.

[0019] In another aspect the invention relates to a method for adding a product to be dosed to a bulk product. The method comprises the steps of

- determining the weight of the bulk product to be discharged and the weight of the product to be dosed,

- determining an initial discharge rate from the determined weights,

- initiating the discharge of the mix of the bulk product and the product to be dosed at said initial discharge rate,

- performing repeated weighing operations on the weight of the remaining bulk product and the remaining product to be dosed.
- adjusting dynamically the discharge rate of the product to be dosed based on data from the repeated weighing operations.

[0020] In a further embodiment the product to be dosed is contained in a separate recipient. The method then advantageously comprising the further steps of reading and checking identification data provided on the separate recipient before performing the step of initiating the discharge.

[0021] In a specific embodiment the method further comprises the step of reading and checking identification data provided on a silo into which the mix of said bulk product with the product to be dosed is to be discharged before performing the step of initiating the discharge.

Short description of the drawings

[0022] Fig. 1 represents the main parts of a dosing system according to the present invention.

[0023] Fig. 2 represents an embodiment wherein the dosing device of the dosing system comprises a reservoir containing the product to be dosed.

[0024] Fig. 3 represents an embodiment wherein the product to be dosed is supplied from a separate recipient containing the product to be dosed.

[0025] Fig. 4 represents a trailer provided with several compartments comprising bulk product.

[0026] Fig. 5 represents the dosing device and the chassis bearing it.

Detailed description of the invention

[0027] The present invention discloses a dosing system/dosing assembly allowing a very precise dosing that is dynamically adjustable to variable parameters like e.g. the volume and weight of the product to be dosed and the
discharge rate of the bulk lorry or bulk trailer. Moreover, it comprises features that allow increasing considerably the reliability and controllability of the whole process of adding a dosed product (e.g. a premix) to a bulk product like feed.

[0028] Fig.1 shows a general view of a dosing system/assembly according to the invention. The system comprises a dosing device (100) arranged for receiving the product to be dosed, a first weighing unit (250) comprising a plurality of weighing sensors for weighing that product to be dosed, a second weighing unit (200) with a plurality of weighing sensors for weighing the bulk product to which the product to be dosed is to be added, and a control device (300). In one embodiment the dosing device comprises a reservoir for containing the product to be dosed. In a second embodiment the dosing device is supplied with the product to be dosed from a separate recipient containing the product to be dosed and which is connectable to the dosing device. The separate recipient may be detachably mountable on the dosing device. The latter approach offers the advantage that any risk of contamination and abuse is excluded. The dosing system or assembly typically is applied for adding a product to be dosed into a bulk product from a bulk lorry or truck to a silo. The system is based on a volumetric dosing on a truck, a lorry or a trailer. Preferably the dosing system is mounted on the vehicle and operates with the power supply of the vehicle (24 V DC and air pressure).

[0029] In one embodiment the dosing device forming part of the dosing system according to the invention basically can be a dosing device like the one disclosed in BE1010363. A cog distributes and transports a product to be dosed (e.g. in powder) by bringing it into an air stream. After it has left the dosing device it is injected into the
stream of bulk product that has left the bulk lorry. In this way any risk of contamination is avoided.

[0030] Figure 2 shows a cross section of the cylindrical dosing device (100). A light (11) is hermetically sealed and put behind window glass. The bottom 1A of the reservoir 1, which is made as an airtight pressure chamber, has a W-shaped cross section. At the bottom there is also an outlet opening (1B). In the middle a drive shaft (14) (3 x supported on bearings to absorb axial and radial tensions) enters through the bottom into the reservoir. To the shaft (14) is attached at least one rotatable conic scraper (13) extending radially slightly above the bottom (1A). The scraper (13) is provided with brushes (13A) scraping across the base (1A). As further shown in Fig.2 the dosing means (7) is shaped by a cog-shaped rotor (16) in a rotor housing (7A) that is located under an outlet opening (1B) in the base (1A) of the reservoir (1). Preferably the rotor (16) is made of synthetic material, giving the rotor smooth surfaces in order to avoid sticking and contamination. The rotor is mounted on a drive shaft (15). The product to be dosed radially ends up between the cogs in the rotor casing (7A) via the outlet opening (1B). Subsequently it is transported axially in the rotor casing and the opposite discharge opening (19) and injected into the bulk product by means of a pipe. Advantageously, this pipe is transparent such that it allows a visual inspection of the dosing process. The quantity of dosed product depends on the rotor speed and the space between the cogs in the rotor. The rotor’s profile is such that it contributes as much as possible in keeping the flow of the product to be dosed constant. The dosing means (7) is driven by a continuously variable impulse control driving electro-motor (6) with high
precision. The dosing device is typically driven by a 24 V DC motor.

[0031] As already mentioned, in another embodiment of the invention the product to be dosed is supplied from a separate recipient containing said product (Fig.3). The recipient is preferably provided with a secured seal. In this case the dosing device of course does not need the reservoir as in Fig.2. Fig.3 shows the dosing device (100) on which a separate container (400) with the product to be dosed is mounted. The dosing device and the recipient (400) with the product to be dosed are arranged for being connected to one another. Both the dosing device and the recipient are equipped with a suitable system (404) for opening/closing. The assembly of dosing system and separate container with the product to be dosed considered in this embodiment offers several additional advantages as discussed below.

[0032] In the solution according to the present invention, the discharge rate of the product to be dosed is dynamically determined based on measurement data obtained by applying a weighing procedure on both the bulk product and the product to be dosed. The dosing system according to the invention thereto comprises not only a dosing device as previously described, but also a first weighing unit to weigh the product to be dosed, a second weighing unit to weigh the bulk product in either the truck or the trailer and a control device, preferably all mounted on the bulk truck/trailer. The control device advantageously comprises a processing unit, that can be implemented as a (plurality of) microprocessor(s) or a PLC (Programmable Logic Controller). Alternatively, an application specific integrated circuit (ASIC) can be implemented for this purpose. The weighing functionality is provided by means of sensors developed to absorb the radial and axial forces (g-
forces) on the truck when driving and stopping and yet to maintain good weighing properties. The whole system comprising the dosing device, the weighing units and the control device can advantageously be mounted anywhere on the vehicle (for example on the side).

[0033] In a first step the weight is determined of the truck or trailer comprising the bulk product, to which a product to be dosed is to be added. The bulk product is typically divided over one or more compartments of the truck or trailer (see Fig. 4).

[0034] First the case of a truck is considered. The weighing unit of the dosing system comprises at least one and preferably a plurality of weight sensors called load cells. The load cells are connected to the truck in order to perform the weighing. Typically six load cells are implemented. The load cells preferably are mounted between the chassis of the truck and the bulk. Load cell signals are amplified, possibly compensated for potential vibrations and a possibly tilted position of the truck. The resulting signals from the load cells are subsequently fed to the control device (300). The signals are transmitted to the processing unit in the control device. The weighing operation yields the gross weight of the bulk construction + the bulk product stored in the various compartments of the bulk construction. The net weight of the bulk product can then easily be derived. The acquired measurement data can be stored and processed in the control device.

[0035] In case of a trailer, a different approach is followed. Typically each axle with air suspension on a trailer is provided with two air buffers, in which air transducers may be mounted. Alternatively, load cells are used. Weighing is then performed on one, two or three different axles by sensing the air pressure in the suspension air line or by processing of the load cell
signal(s). Then the output signal of the weighing operation is converted into an electrical signal, which may also be compensated. In combination with the weighing on the different axes, a weighing operation can be performed on the fifth wheel (i.e. the heavy duty coupling device to couple the trailer). The resulting signals from the load cells are subsequently applied to the control device (300) and further processed by the processing unit. The signal is protected against external influences from e.g. magnetic fields etc... The acquired data are subsequently transmitted to the control device. All measurement data is visualised on a display connected to the processing unit. After installing the weighing sensors on the truck or trailer a calibration is required in order to obtain a properly functioning weighing system. Not only the truck or trailer carrying the bulk product is subject to a weighing procedure, but also the dosing device. A second weighing unit equipped with at least one and preferably a plurality of sensors is provided for that purpose. The weighing is for example performed with a three-point weighing on load cells. In a preferred embodiment the load cells are integrated into the chassis that bears the dosing device (see Fig.4). Before filling the reservoir of the dosing device or connecting a separate recipient with the product to be dosed a first weighing is performed. This gives information on the tare weight of the dosing device. Next the dosing device can be filled or the recipient connected, after which another weighing operation is performed. Also all the weighing data relating to the dosing device is compensated for vibrations and a possible tilted position of the truck, converted into serial signals and finally transmitted to the control device. At the installation of the system some ‘fixed’ parameters are entered into the system, like the
total number of compartments in the vehicle and the maximum weight of the product inside each of the compartments. This information allows detecting errors before or while discharging. Before starting a particular dosing and discharging operation several other parameters can or have to be entered into the system. The operator enters into the control device from which compartment there is to be discharged and how much product that compartment actually contains. In a further embodiment it is provided that when a weight is entered exceeding the allowed maximum weight, an alarm signal is triggered and the dosing operation is not initiated. Several more alarm functions may be provided, e.g. in case the required weight of product to be dosed into an amount of bulk product exceeds the maximum capacity of the dosing device. In another scenario the discharge rate of the bulk product may be too low. This may happen when the pipe through which the bulk product is transported, is obstructed or when the silo is full. Also the discharge rate of the product to be dosed may be too low, which may occur when a tube is blocked or due to any unforeseen, exceptional circumstances. Further an emergency stop function and a secured seal to make sure that the system cannot operate when the seal is not closed, may be provided.

[0039] The initial discharge rate (i.e. during the first 10 seconds) of the dosing device is set at an initial value, for example a value calculated from the average bulk discharge rate during the previous two discharging operations. The average bulk discharge rate is determined by repeatedly weighing. During operation an average bulk discharge rate is determined 10 times per second. Every 2 seconds an average value is calculated to determine the discharge rate during the next 2 seconds. Also the dosing device with the product to be dosed is weighed repeatedly.
The discharge rate of the dosing device is adjusted accordingly by the processing unit by regulating the rotor speed. The evolution of the discharging process can be visualised on a display connected to the control device. This may help the operator to timely discover any malfunction.

The discharge rate, which is influenced by the position of the compartment, by the pressure in the pipe, distance to the silo, kind of bulk product being discharged, is continuously measured and the control device continuously controls the dosing device, such that the product to be dosed is always spread homogeneously over the bulk product, irrespective of the bulk discharge rate.

As already mentioned the embodiment with a separate container of product to be dosed allows for several additional advantageous features.

The containers comprising the product to be dosed are preferably provided with an identification label or electronic data carrier comprising useful identification data such as the composition of the product to be dosed, the destination, weight, weight of bulk product it is intended for, ... The control device (300) of the dosing system then further comprises a first reading means for reading said identification data and a memory device for data storage. Data relating to a container with product to be dosed are also entered into the control device’s storage means. Before starting a mixing/discharging operation the identification data on the container with product to be dosed is read with the first reading means. In the control device the read information is next checked with the data found in the memory to see if the container was indeed meant for use with the dosing system in question. In a more specific embodiment the control device may further even be arranged for controlling the opening of the container with
product to be dosed such that it only becomes operable after a positive identification of the container is performed. In such an embodiment it is impossible to open the container without damaging it if no positive identification signal is given.

[0043] The memory device of the control device can further advantageously be used for storing other data, e.g. data related to the dosing or discharge process or any other data may typically be stored on a board computer of a transport vehicle. Storing data regarding the identification of the silo into which it is allowed discharging the resulting mix of bulk product and product to be dosed, can be advantageous for further increasing the safety aspects of the whole system.

On arrival of the truck near a silo, the operator can use a second reading means provided on the control device to read identification information present on the silo (e.g. in an identification chip). Optionally said second reading means is the same as the first reading means, which is intended for reading identification information present on the container with product to be dosed. Alternatively, the second reading means can be provided in a separate identification apparatus that is mountable on the pipe transporting the bulk product to the silo, preferably near the free end of the pipe, close to the silo. This identification apparatus is in that case further arranged for communicating with the control device, e.g. over a wireless connection. Only when the control device observes a positive match between the identification data previously stored in the control device and the data on the silo, the discharge operation can be started. In that way it is assured that the mix of a quantity of product to be dosed in a quantity of bulk product was actually meant for being delivered to that particular silo. A further processing of
the stored data, like transmitting certain data to other computers, linking the stored data to client related data, making graphics of discharging parameters, etc… can be performed within the control device.

5 [0044] The same principle can be applied to all kinds of bulk vehicles, high and low pressure bulk trucks, skip cars. The dosing system/assembly as presented can be used in all applications where a product to be dosed is to be added dynamically while discharging a bulk lorry or bulk trailer.

[0045] The dosing assembly provided with the additional features of control and security offers a total solution with very strong guarantee for production of animal feed, of crucial importance for safe and healthy human food. Due to the dynamic characteristics of the dosing process, a homogeneous feed can be dosed at the location of consumption, with control and traceability over who produced what feed delivered securely to the correct silo. Abuses in production of animal feed are further strongly eliminated through usage of the proposed assembly and its total application, for the benefit of higher safety and quality in production of human foods. Healthy feed for healthy animals is a big step towards a safe food supply chain.

25 [0046] Further advantages of the invention lie in the fact that the power supply of the truck is reused, that means for extensive data registration is provided, that an improved control over the discharging operation is possible,… The solution according to the invention also avoids the need for heavy investments in modifications of the production line at the premises of the feed manufacturers.
CLAIMS

1. Dosing system for adding a product to be dosed to a bulk product being discharged, comprising
   - a dosing device (100) arranged for being supplied with said product to be dosed,
   - a first weighing unit (250) comprising at least one weighing sensor arranged for weighing said product to be dosed
   - a second weighing unit (200) comprising at least one weighing sensors arranged for weighing said bulk product and
   - a control device (300) arranged for receiving weighing data from said first weighing unit and weighing data from said second weighing unit and arranged for dynamically adjusting the discharge rate of said dosing device during the discharge operation, based on said received weighing data.

2. Dosing system as in claim 1, wherein said at least one weighing sensor of said first weighing unit (250) comprises load cells.

3. Dosing system as in claim 2, wherein said load cells are mounted in a chassis bearing said dosing device (100).

4. Dosing system as in any of claims 1 to 3, wherein said at least one weighing sensor of said second weighing unit (200) comprises load cells and/or air pressure sensors.

5. Dosing system as in any of claims 1 to 4, wherein said second weighing unit (200) further comprises air transducers.

6. Dosing system as in any of the previous claims, wherein said control device (300) further comprises
a memory device for storing weighing data and/or information related to the dosing and discharge process.

7. Dosing system as in any of the previous claims, wherein said dosing device (100) is further provided with a transparent pipe for injecting said product to be dosed into said bulk product.

8. Dosing system as in any of the previous claims, wherein said control device (300) comprises a processing unit.

9. Dosing system as in any of the previous claims, wherein said control device (300) further comprises first reading means for reading identification data of a silo into which the mix of said bulk product and said product to be dosed is to be discharged.

10. Dosing system as in any of the previous claims, wherein said dosing device (100) further comprises an integrated reservoir for containing said product to be dosed.

11. Bulk truck or a bulk trailer on which a dosing system as in any of claims 1 to 10 is mounted.

12. Bulk truck or a bulk trailer as in claim 11, wherein said dosing system is driven by the power supply of said bulk truck or of a truck to which said bulk trailer is coupled.

13. Recipient (400) for containing a product to be dosed, said recipient being provided with data for identifying said product to be dosed and arranged for cooperating with a dosing system as in any of claims 1 to 10.

14. Dosing assembly comprising a dosing system as in any of claims 1 to 9 and further comprising a separate recipient (400) containing said product to be dosed, said recipient being connectable to said dosing device (100).
15. Dosing assembly as in claim 14, wherein said separate recipient (400) comprises data for identifying said product to be dosed, and wherein said control device comprises second reading means for reading said data for identifying said product to be dosed.

16. Method for adding a product to be dosed to a bulk product, comprising the steps of
   - determining the weight of said bulk product to be discharged and the weight of said product to be dosed,
   - determining an initial discharge rate from said determined weights,
   - initiating the discharge of the mix of said bulk product with said product to be dosed at said initial discharge rate,
   - performing repeated weighing operations on the weight of the remaining bulk product and the remaining product to be dosed,
   - adjusting dynamically the discharge rate of said product to be dosed based on data from said repeated weighing operations.

17. Method for adding a product to be dosed to a bulk product as in claim 16, wherein said product to be dosed is contained in a separate recipient (400).

18. Method as in claim 17, further comprising the steps of reading and checking identification data provided on said separate recipient (400) before performing said step of initiating the discharge.

19. Method as in any of claims 15 to 17, further comprising the step of reading and checking identification data provided on a silo into which said mix of said bulk product with said product to be dosed is to be discharged before performing said step of initiating the discharge.