Abstract:
The invention relates to a measuring device to be provided in a milk reservoir, comprising one or more sensors (10, 11) for monitoring of the milk reservoir and/or of a liquid present in the milk reservoir. The invention is characterized in that the measuring device is a measuring device which floats in or on milk, and in that the measuring device comprises at least one motion sensor and/or a position sensor.
The invention relates to a measuring device to be provided in a milk reservoir, comprising one or more sensors for monitoring of the milk reservoir and/or of a liquid present in the milk reservoir.

Such a measuring device is known for example from European patent application EP 1 317 880. In an embodiment according to this patent publication a measuring probe is provided on a float. The float floats on the milk present in the tank. Data transmission between the measuring probe and a measuring station provided at the inside of the milk tank can take place in a wireless manner. EP 1 317 880 does not disclose further characteristics of the measuring probe provided on a float.

The invention aims at providing an alternative measuring device for monitoring of the milk reservoir and/or of a liquid present in the milk reservoir.

This object is achieved by means of a measuring device according to the preamble of claim 1, wherein the measuring device is characterized in that the measuring device is a measuring device which floats in or on milk, and in that the measuring device comprises at least one motion sensor and/or a position sensor.

By providing a motion sensor and/or a position sensor on a measuring device which floats in milk, it is possible to determine the motion and/or the position of the floating measuring device. This motion and/or position may provide information regarding the milk reservoir or the liquid present in the milk reservoir.

For example, it is possible that, by detecting oscillatory motions of the measuring device, it is possible to determine a motion of the liquid present in the milk reservoir. This motion indicates, for example, that the liquid has been set in motion by the agitator present in the milk reservoir. It is then possible for the motion sensor to replace a separate monitoring sensor of the agitator or to control same.

Another motion that can be determined by the motion sensor may, for example, be an indication of new milk flowing in. This motion, too, may be an oscillatory motion of the measuring device but may also be a motion in which the
measuring device floats away from the inflow aperture of the milk. In an embodiment, the measuring device is arranged to distinguish motions caused by different flows in the liquid.

As it is desirable to perform certain measurements in relation to the motion and/or position of the measuring device in the milk, it is necessary for the measuring device to float in or on milk. If it is desirable also to perform measurements in another liquid present in the milk reservoir, for example in a cleaning liquid, it is also desirable that the measuring device floats in or on the cleaning liquid. In general, a measuring device which floats in or on milk will also float on a cleaning liquid.

In an embodiment, the position sensor is arranged to determine an absolute position of the measuring device relative to the milk tank. It may be advantageous to know the position of the floating measuring device. For example, if the measuring device freely floats in the milk, it is possible for the measuring device to come close to the agitator, which may result in possible damage. If this is determined by the position sensor, it is possible to take appropriate measures, for example switching off the agitator or switching on means for moving the measuring device away from the agitator by causing a flow in the milk in the direction away from the agitator or by means of a magnetic field.

In an alternative embodiment, there may be provided a motion limiting device which limits the freedom of movement of the measuring device but does not impede the latter from floating in or on the milk and from moving as a result of the motions of the milk. For example, the measuring device may be attached to the wall of the milk tank by means of a flexible element, or the milk tank may be divided into two parts by means of a partition or the like, the measuring device and the agitator each being positioned in a separate part. Owing to this, it is no longer possible for the measuring device to come in the vicinity of the agitator, and the risk of the measuring device being damaged as a result of the motion of the agitator is considerably reduced.

In an embodiment, the measuring device comprises a battery and a charging mechanism for the battery. The charging mechanism is capable of converting the mechanical energy of the motions of the measuring device into electrical energy, and of charging the battery therewith. In an alternative embodiment, the charging mechanism may be chargeable in a wireless manner,
for example by means of (magnetic) induction. By providing such a battery comprising a charging mechanism, it is possible for the measuring device to function permanently, without the necessity of being taken from the milk reservoir for the purpose of charging or replacing the battery.

In an embodiment, the position sensor comprises a depth sensor for determining a depth position of the measuring device in the liquid present in the milk reservoir. If the shape, the weight and the depth of the measuring device are known, it is possible to determine the density of the liquid present in the milk reservoir.

This density may be an indication of the freezing point of the milk. For an even more accurate determination of the freezing point, it is possible to use additional quality parameters of the milk, such as fat content and protein content.

In an embodiment, the measuring device comprises one or more quality sensors for determining one or more quality factors of milk present in the milk reservoir. These quality parameters may comprise protein content or fat content in the milk, which may, for example, be determined by means of a colour sensor. There may further be provided a conductivity sensor which is capable of providing a measure for the cell count of the milk and the health of the dairy animals from which the milk has been obtained. Other quality parameters that could be measured are the acidity of the milk, the cell count, the cleanliness of the milk, and the presence of antibiotics.

In an embodiment, the measuring device comprises a temperature sensor for determining the temperature of the liquid present in the milk reservoir. In order to maintain an optimum milk quality, it is important that the milk is cooled to the correct temperature, which is typically lower than 4 degrees Celsius. By providing the measuring device with a temperature sensor, it is possible to monitor the temperature of the milk.

In an embodiment, the measuring device is designed so as to have a preferred orientation when floating. By means of such a design it may be ensured that the measuring device will substantially occupy one and the same position when floating. This ensures that, in the case of measurements requiring a certain orientation of the measuring device, for example a depth measurement, this orientation has been guaranteed to a great extent.
In a further embodiment, the measuring device is further designed so as not to assume the preferred orientation when lying or standing on a flat ground. If the liquid level in the milk reservoir comes below a certain minimum, the measuring device will leave the preferred orientation and assume another position.

In this manner it is possible to determine, by means of the motion sensor and/or the position sensor, whether a minimum amount of milk is present in the milk reservoir. This determination may be combined with a second measurement, for example by means of a conductivity sensor. For, if no liquid is present, there will be no conductivity.

Advantageously, the measuring device is included in a measuring arrangement in a milk tank. In an embodiment, the measuring arrangement comprises a measuring station which is attached to the inside of the milk reservoir, wherein data obtained in the measuring device are communicated to the measuring station. The communication between the measuring device and the measuring station is preferably wireless, but may also take place by means of a data transmission cable. In an embodiment, the data transmission cable may also be used as a motion limiting device for the measuring device.

The communication between the measuring station and the measuring device may be mono-directional, in which case only transmission of measurement data from the measuring device to the measuring station takes place, but may also be bi-directional, in which case also transmission of data from the measuring station to the measuring device takes place, for example for calibration of the sensors of the measuring device.

In an embodiment, the measuring arrangement comprises a tank guard, wherein data obtained in the measuring device are transmitted directly or via the measuring station to the tank guard. A tank guard is a registration device, the use of which is often required by the buyer of the milk. Important milk related data, such as temperature and quality, are registered in the tank guard.

The invention further relates to a method of monitoring a milk reservoir and/or an amount of milk present in a milk reservoir, comprising the steps of:
- providing a measuring device which is floatable in or on milk, comprising at least one motion sensor and/or a position sensor,
- providing the measuring device in the milk reservoir,
determining a motion and/or a position of the measuring device.

The invention will be elucidated hereinafter with reference to an exemplary embodiment shown in the drawing, in which:

Figure 1 is a diagrammatic side view of a measuring device and a measuring arrangement according to the invention.

Figure 1 shows a diagrammatic view of a milking system which is denoted as a whole by reference numeral 1. The milking system comprises a milking device 2 known per se, of which the different components are not shown in more detail, and a milk tank 3. The milking device 2 is arranged to milk dairy animals. The milking device 2 may be provided with a milking robot by means of which the dairy animals are milked fully automatically. The milking device 2 and the milk tank 3 are interconnected by means of a milk line 4. The milk obtained by the milking device 2 is stored in the milk tank 3 via the milk line 4. This milk is regularly collected by a milk collecting service or the like, for example once per two or three days.

The milk tank 3 comprises a cooling device for cooling the liquid present in the milk tank 3 and an agitator 7 for keeping the milk in motion so that the milk is prevented from freezing onto the wall of the milk tank 3 as a result of the cooling.

A measuring device 6 floats in the milk 5 present in the milk tank 3, which measuring device 6 has a number of sensors 10, 11 for determining a number of characteristics of the milk and/or the functions of the milk tank 3. In the embodiment shown, the measuring device 6 freely floats in the milk.

In order to prevent the measuring device 6 from being damaged by the agitator 7, there may be provided a motion limiting device which limits the freedom of movement of the measuring device 6. For example, the measuring device 6 may be attached to a wall of the milk tank 3 by means of a flexible element, for example a data cable, or the milk tank 3 may be divided into two parts by means of a partition or the like, the measuring device 6 and the agitator 7 each being positioned in a separate part.

As an alternative, it is also possible to keep the measuring device 6 away from the agitator 7 by means of a magnetic field.
The measuring device 6 communicates in a wireless manner (indicated by a dashed line) with a measuring station 8 which, in the embodiment shown, is positioned at a lower side of a cover in the milk tank 3. The measuring station 8 collects the data and transmits them itself to a tank guard 9. It is further possible that the measuring station 8 is provided with a number of sensors, for example a sensor for determining the liquid level in the milk tank 3, or a sensor which is arranged to measure the cleanliness of the milk tank 3.

The tank guard 9 is a registration device which records relevant data in relation to the quality of the milk. The buyer of the milk often requires that the measurement data of the milk are recorded in the milk tank in a tank guard 9 prescribed by the buyer. By means of such a tank guard 9 the buyer of the milk, for example the dairy factory, monitors the quality of the milk, in particular whether the milk has been kept at the correct temperature.

In the embodiment of Figure 1, the measuring station 8 and the tank guard 9 are interconnected by means of a data transmission cable. It is also possible that the transmission between the measuring station 8 and the tank guard 9 is a wireless one. It is also possible that the tank guard 9 directly communicates with the measuring device 6.

The measuring device 6 comprises a battery and a charging mechanism for the battery. The charging mechanism converts -motions of the measuring device into electrical energy with which the battery is charged. In this manner the battery is automatically charged and the measuring device need not be taken from the milk tank 3 for the purpose of charging or replacing the battery. In an alternative embodiment, a charging mechanism is capable of charging the battery in a wireless manner, for example by means of magnetic induction.

The measuring device 6 is shown in a preferred orientation which is obtained by bringing the centre of gravity at the lower side of the measuring device 6 by providing relatively heavy components, such as for example sensors, the battery and the charging mechanism, in the lower part of the measuring device 6. In the preferred orientation, the measuring device 6 has a pointed end which extends upwardly and a pointed end which extends downwardly.

The advantage of the upwardly extending pointed end is that part of the measuring device will always be located above the milk. This makes it possible
inter alia to keep certain components, for example the sensor 11, above the liquid level.

The advantage of the downwardly extending pointed end is that, if the measuring device 6 is standing or lying on the bottom of the milk tank, the measuring device 6 will not be in the preferred orientation. It is thus possible, by determining the orientation of the measuring device 6, to determine whether a minimum amount of liquid is present in the milk tank.

In the measuring device 6 there are provided a number of sensors 10, 11 which are diagrammatically shown in Figure 1. Said sensors are provided to monitor the functioning of the milk tank 3 and the amount of milk 5 present in the milk tank 3. The sensors 10, 11 which are provided in the measuring device 6 shown will now be described.

The measuring device comprises a motion sensor which is capable of determining a motion of the measuring device 6. By means of such a motion sensor it is, for example, possible to detect oscillatory motions of the measuring device 6. These oscillatory motions may be an indication of motion in the milk of the milk tank as a result of driving of the agitator 7 or new milk flowing in from the milk line 4.

The measuring station 8 comprises a device for recognizing and distinguishing the different motions, so that the device, on the basis of the determined motion, is capable of determining by which of the two reasons the oscillatory motions are caused. On the basis of the measured motions it is thus possible to determine whether the agitator 7 is being driven and/or whether new milk is flowing into the milk tank 3.

The measuring device 6 further comprises a position sensor by means of which it is possible to determine an absolute position of the measuring device 6 relative to the milk tank 3. This position determination may be used to determine whether the measuring device comes too close to the agitator 7, or as additional information upon distinguishing the oscillatory motions. If, for example, the measuring device 6 is situated close to the connection of the milk line 4 to the milk tank 3, a great amplitude in the oscillations may be an indication of new milk flowing in, while the same great amplitude may be an indication of agitator activity if the measuring device 6 is situated close to the agitator 7.
The absolute position sensor may also be used to determine the liquid level in the milk tank 3.

The measuring device further comprises a temperature sensor for determining the temperature of the liquid present in the milk tank. It is important that the milk is cooled below a maximum temperature of typically 4 degrees Celsius in order to maintain an optimum milk quality. By providing the measuring device 6 with a temperature sensor, it is possible to monitor the temperature of the milk. This information will typically also be registered in the tank guard 9.

The measuring device 6 also comprises one or more quality sensors 10 for determining one or more quality factors of milk in the milk tank 3.

The quality sensors comprise a colour sensor for determining the protein content and the fat content of the milk, a conductivity sensor for monitoring whether the milk comes from healthy dairy animals, and a cleanliness sensor for controlling the milk for the presence of foreign elements.

The temperature sensor and the quality sensors are provided in the lower part of the measuring device 6, so that the sensors, in as far as required, are in contact with the milk.

The measuring device 6 further comprises a depth sensor for determining a depth position of the measuring device 6 in the milk. On the basis of the shape, the weight and the depth of the measuring device 6, it is possible to determine the density of the milk 5. This density is an indication of the freezing point of the milk. The freezing point may be estimated even better if the measurements of the quality sensors are taken into consideration in the determination of the freezing point.

Advantageously, the upper end of the measuring device 6 is an upwardly extending pointed end with a relatively small cross-section. As a result, a relatively small change of the density of the milk will effect a relatively great change of the depth position of the measuring device 6. This makes it possible better to determine the depth position of the measuring device 6 in the milk.

On the upper end of the upwardly extending pointed end of the measuring device 6 there is situated a sensor 11 for determining the cleanliness of the inner surface of the wall of the milk tank 6. Said sensor 11 may in particular be used after cleaning of the milk tank 6 in order to determine whether the milk tank 3 is sufficiently clean.
It is possible that, at a given moment, other liquid than milk is present in the milk tank 3, for example cleaning liquid during cleaning of the milk tank 3. It may be desirable, during cleaning of the milk tank 3, also to measure certain parameters of said liquid, for example the temperature and cleanliness of the cleaning liquid. For this purpose, the measuring device 6 may be applied. In general, a measuring device which floats in or on milk will also float in or on cleaning liquid.

The above-described measuring device 6 comprises a number of sensors which are known per se. In the measuring device according to the invention, there is provided at least one motion sensor and/or a position sensor. The other sensors may be provided, according to one’s needs, in further embodiments of the measuring device.

The measuring device 6 has been described above during use in a milk tank 3. It should be noted that such a measuring device may also be applied in other milk reservoirs, such as for example a buffer tank, a transport reservoir, in particular a trailer, or a milk storage vessel in a dairy factory.
CLAIMS

1. Measuring device (6) to be provided in a milk reservoir (3), comprising one or more sensors (10, 11) for monitoring of the milk reservoir and/or of a liquid (5) present in the milk reservoir, characterized in that the measuring device (6) is a measuring device which floats in or on milk, and in that the measuring device comprises at least one motion sensor and/or a position sensor.

2. Measuring device (6) according to claim 1, wherein the measuring device comprises a battery and a charging mechanism for the battery.

3. Measuring device (6) according to claim 1 or 2, wherein the measuring device comprises a wireless data transmission device.

4. Measuring device (6) according to any one of the preceding claims, wherein the measuring device comprises a motion limiting device by means of which the measuring device is kept in a particular part of the milk reservoir (3).

5. Measuring device (6) according to claim 4, wherein the motion limiting device comprises a flexible connecting element by means of which the measuring device is connected to the milk reservoir (3), wherein the connecting element is preferably suitable for transmission of data from the one or more sensors.

6. Measuring device (6) according to any one of the preceding claims, wherein the position sensor comprises a depth sensor for determining a depth position of the measuring device in the liquid present in the milk reservoir.

7. Measuring device (6) according to any one of the preceding claims, wherein the measuring device comprises one or more quality sensors for determining one or more quality factors of liquid present in the milk reservoir.

8. Measuring device (6) according to claim 7, wherein the one or more quality sensors comprises/comprise a conductivity sensor, a cleanliness sensor and/or a colour sensor.

9. Measuring device (6) according to any one of the preceding claims, wherein the measuring device comprises a cleanliness sensor (11) for measuring the cleanliness of an inner surface of the milk reservoir (3).

10. Measuring device (6) according to any one of the preceding claims, wherein the measuring device comprises a temperature sensor for determining the temperature of the liquid present in the milk reservoir.
11. Measuring device (6) according to any one of the preceding claims, wherein the measuring device is designed so as to have a preferred orientation when floating.

12. Measuring device (6) according to claim 11, wherein the measuring device is further designed so as not to assume the preferred orientation when lying or standing on a flat ground.

13. Assembly of a measuring arrangement and a milk reservoir (3), wherein the measuring arrangement comprises a measuring device (6) according to any one of the preceding claims.

14. Assembly according to claim 13, wherein the measuring arrangement further comprises a measuring station (8) which is attached to the inside of the milk reservoir, wherein data obtained in the measuring device (6) are communicated to the measuring station.

15. Assembly according to claim 13 or 14, wherein the measuring arrangement comprises a tank guard (9), wherein data obtained in the measuring device (6) are transmitted directly or via the measuring station to the tank guard (9).

16. Method of monitoring a milk reservoir (3) and/or an amount of milk (5) present in a milk reservoir, comprising the steps of:

- providing a measuring device (6) which is floatable in or on milk, comprising at least one motion sensor and/or a position sensor,
- providing the measuring device in the milk reservoir,
- determining a motion and/or a position of the measuring device.

17. Method according to claim 16, wherein the detection of oscillatory motions of the measuring device (6) indicates a motion of the liquid present in the milk reservoir (3).

18. Method according to claim 16 or 17, wherein the position sensor comprises a depth sensor for determining a depth position of the measuring device (6) in the liquid present in the milk reservoir (3), wherein the density is determined on the basis of the depth of the measuring device.

19. Method according to claim 18, wherein the density is used for estimating the freezing point of the liquid present in the milk reservoir (3).
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. G01F23/68 A01J9/00 G01N9/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A01J G01F G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C

See patent family annex

Date of the actual completion of the international search

28 April 2009

Date of mailing of the international search report

08/05/2009

Name and mailing address of the ISA/

European Patent Office, P B 5818 Patentlaan 2

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Merckx, Alain
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