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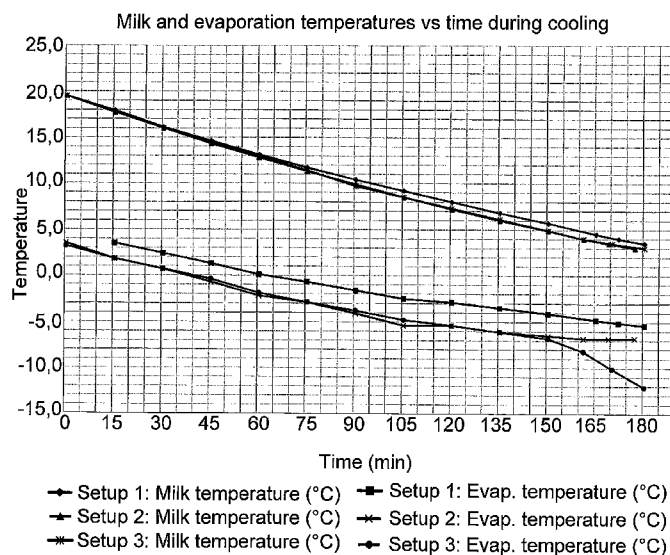


Fig. 3

(57) Abstract: A system (11) for storing and cooling milk comprises a cooling tank (12) provided to store milk (13), and a cooling arrangement for cooling the milk in the cooling tank comprising a cooling device (16), a sensor (17), and a control device (18). The cooling device comprises an evaporator (19), a compressor (20) connected with its suction side (20a) to the evaporator, a condenser (21) connected to the high pressure side (20b) of the compressor, and an expansion valve (22) interconnected between the condenser and the evaporator, thereby forming a closed circuit, in which a refrigerant can be circulated. The evaporator is in heat exchange contact with at least a portion of the bottom surface (12a) of the cooling tank, the sensor is provided to monitor a parameter indicative of the pressure (P) or temperature at the suction side of the compressor or in the evaporator, and the control device is operatively connected to the sensor and the compressor. The control device is configured to (i) control the compressor to run at full capacity during a first part of the cooling of milk in the cooling tank, and control (ii) the capacity of the compressor such that the pressure or temperature at the suction side of the compressor or in the evaporator is regulated towards a desired value (P_{TH}) during a second part of the cooling of milk in the cooling tank, which follows after said first part.

SYSTEM FOR STORING AND COOLING MILK, MILKING SYSTEM, AND METHOD FOR COOLING MILK

TECHNICAL FIELD

The technical field relates generally to cooling of milk and particularly to systems for storing and cooling milk, milking systems, and methods for cooling milk.

RELATED ART

In dairy farming animals are milked and their milk is stored in a milk storage tank for collection on a regular time basis, e.g. every second day. In order to maintain the quality of the milk, and to minimize the bacterial growth and contents of free fatty acids (FFA) in the milk, it is cooled to temperatures around 4 °C as quickly as possible. It is necessary to be careful during cooling of the milk because freezing of milk will have a detrimental effect on the milk quality.

At a dairy farm provided with a batch wise milking system, wherein a plurality of milking animals are milked at a time, the milk usually enters the milk storage tank in large amounts, compared to a dairy farm with an automatic milking system, where the milk usually enters the milk storage tank in small amounts spread during the day and night. Therefore, such batch wise milking systems have to be equipped with a powerful cooling device, which cools the milk to around 4 °C fastly and maintains this temperature in a filled milk storage tank.

Problems that may occur in such systems are too slow cooling of the milk in the milk storage tank resulting in deteriorated milk quality or too fast cooling of the milk in the milk storage tank resulting local freezing of milk, which also leads to deteriorated milk quality.

SUMMARY

It is an aim of this document to reveal novel systems for storing and cooling milk and methods for cooling milk, which are safe, fast, accurate, precise, efficient, and reliable. The milk ought to be cooled soon after milking and fastly down to temperatures around 4 °C, while the risk for locally freezing milk should be eliminated, or at least minimized.

A first aspect refers to a system for storing and cooling milk comprising a cooling tank provided to store milk and a cooling arrangement for cooling the milk in the cooling tank comprising a cooling device, a sensor, and a control device.

The cooling device comprises an evaporator, a compressor connected with its suction side to the evaporator, a condenser connected to the high pressure side of the compressor, and an expansion valve interconnected between the condenser and the evaporator, thereby forming a closed circuit, in which a refrigerant can be circulated, wherein the evaporator is in heat exchange contact with at least a portion of the bottom surface of the cooling tank.

The compressor has a varying capacity, which can be controlled. For instance, the compressor may be a capacity modulated scroll compressor, wherein the capacity can be controlled by means of controlling the modulation of the compressor. The capacity modulated scroll compressor may have two scroll members and a biasing chamber which contains a pressurized fluid. The pressurized fluid within the chamber can bias the two scroll members together. When such biasing load is removed, the two scroll members separate, creating a leakage path between discharge and suction to reduce the capacity of the scroll compressor. Such kind of scroll compressor is commercially available from Copeland Corporation/Emerson.

Typically, the scroll compressor can be modulated by means of modulating the operation of the valve assembly controlling the biasing load of the two scroll members as exerted by the pressurized fluid such that the scroll compressor is operated with alternating high biasing load and no biasing load in a cyclic manner. When the biasing load is high, the two scroll members are biased together, and the capacity of the scroll pump is at its maximum. When the biasing load is removed, the two scroll members separate, and the capacity of the scroll pump is at its minimum. The modulation level controls the time period, at which the biasing load is high, relative the time period, at which the biasing load is removed. If the modulation is increased, the time period, at which the biasing load is high, is increased relative the time period, at which the biasing load is removed, and correspondingly, if the modulation is decreased, the time period, at which the biasing load is high, is decreased relative the time period, at which the biasing load is removed. As a result, the modulation level controls the capacity of the scroll pump.

The sensor, which may be a pressure sensor or a temperature sensor, is provided to monitor a parameter indicative of the pressure or temperature at the suction side of the compressor or in the evaporator. The control device is operatively connected to the sensor and to the compressor.

The control device is configured to control the compressor to run at full capacity during a first part of the cooling of milk in the cooling tank, and to control the capacity of the compressor such that the pressure or temperature at the suction side of the compressor or in the evaporator is regulated towards a desired value during a second part of the cooling of milk in the cooling tank, which follows after the first part.

The desired value may be a pressure, at which the refrigerant has a boiling temperature of between about -10 and 0 °C, preferably between about -8 and -2 °C, and most preferably between about -6 and -4 °C. The desired value may be a pressure or temperature, at which the refrigerant has a heat exchange capacity, which ensure that milk in the cooling tank does not freeze locally in the bottom of the cooling tank during the second part of the cooling of the milk in the cooling tank. Thus, the desired value may be determined through experiments.

The system may comprise an agitator arrangement within the cooling tank provided for agitating the milk therein during the first and second parts of the cooling of the milk in the cooling tank.

By the system disclosed, it can be assured that the most effective cooling will be obtained at each instant. In the beginning, when the temperature of the milk in the cooling tank is warm, the cooling device can be run at full capacity, whereas in the end, when the milk in the cooling tank is cooler and the evaporation temperature of the refrigerant in the evaporator is lower, a set point of the evaporation pressure or temperature is set, and the compressor capacity is controlled to hold the evaporation temperature at the set point to avoid local freezing of milk. The control device may comprise a PID (proportional-integral-derivative) controller for regulating the pressure or temperature at the suction side of the compressor or in the evaporator towards the desired set point during the second part of the cooling of the milk in the cooling tank.

As compared to prior art cooling systems, the system disclosed above may use a compressor having a higher capacity, which means that the milk in the cooling tank is cooled down to about 4 °C faster. At a certain point, the cooling is altered such that the capacity of the compressor is controlled such that the pressure or temperature at the suction side of the compressor or in the evaporator is regulated towards the desired value to avoid local freezing of milk in the cooling tank, which would otherwise be happening given the higher capacity of the compressor.

In one embodiment, the control device is configured to determine the start of the second part of the cooling of the milk in the cooling tank in response to the monitored pressure or temperature at the suction side of the compressor or in the evaporator. In particular, the control device may be configured to determine that the start of the second part of the cooling of the milk in the cooling tank is when the monitored pressure or temperature at the suction side of the compressor or in the evaporator has reached the desired value.

In an alternative embodiment, the system comprises a timer for measuring a time lapsed since the start of the first part of the cooling of the milk in the cooling tank, wherein the control device is configured to determine the start of the second part of the cooling of the milk in the cooling tank in response to the sensed temperature.

In yet an alternative embodiment, the system comprises a temperature sensor for sensing a temperature of the milk in the cooling tank, wherein the control device is configured to determine the start of the second part of the cooling of the milk in the cooling tank in response to the sensed temperature.

The control device may be configured to control the compressor, such that the compressor is alternately switched on and switched off during a third part of the cooling of the milk in the cooling tank, which follows after the second part, wherein the compressor is run with a constant capacity when it is switched on. The compressor may typically be switched on and switched off with at least a minute between each switching. The switching may be controlled by a thermostat. When the compressor is switched on, it is constantly run with a constant capacity such as full capacity. If the compressor is a capacity modulated scroll compressor, the biasing load is kept constant during the operation thereof in the third part of the cooling.

The control device may be configured to determine the start of the third part of the cooling of the milk in the cooling tank in response to the sensed temperature, e.g. that the third part of the cooling of the milk in the cooling tank starts when the sensed temperature has reached a temperature, at which the milk in the cooling tank should be kept.

A second aspect refers to a milking system comprising a milking device for milking animals and any embodiment of the system for storing and cooling milk of the first aspect connected to the milking device to collect milk as milked by the milking device. The milking system may be a batch wise milking system, in which a plurality of milking animals is milked simultaneously e.g. two or three times per day.

A third aspect refers to a method for cooling milk in a cooling tank provided to store milk by a cooling device comprising an evaporator, a compressor connected with its suction side to the evaporator, a condenser connected to the high pressure side of the compressor, and an expansion valve interconnected between the condenser and the evaporator, thereby forming a closed circuit, in which a refrigerant can be circulated, wherein the evaporator is in heat exchange contact with at least a portion of the bottom surface of the cooling tank and the compressor has a varying capacity, which can be controlled.

According to the method, a parameter indicative of the pressure or temperature at the suction side of the compressor or in the evaporator is monitored, and the compressor is controlled to run at full capacity during a first part of the cooling of milk in the cooling tank, whereas the capacity of the compressor is controlled such that the pressure or temperature at the suction side of the compressor or in the evaporator is regulated towards a desired value during a second part of the cooling of milk in the cooling tank, which follows after the first part.

The compressor may be provided as a capacity modulated scroll compressor, wherein the capacity can be controlled by means of changing the modulation of the compressor.

Such a method for cooling milk down to temperatures around 4 °C is safe, fast, accurate, precise, efficient, and reliable, while the risk for local freezing of milk is eliminated, or at least minimized.

The features disclosed with respect to the first aspect are equally applicable to the second and third aspects.

Further characteristics and advantages will be evident from the detailed description of embodiments given hereinafter, and the accompanying Figs. 1-4, which are given by way of illustration only.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates, schematically, in side view, main parts of a system for storing and cooling milk according to an embodiment.

Fig. 2 illustrates, schematically, in a block scheme, a milking system comprising the system for storing and cooling milk of Fig. 1.

Fig. 3 is a diagram of milk and evaporation temperatures vs time during cooling by the system of Fig. 1 as compared to two prior art systems.

Fig. 4 is a schematic flow scheme of a method for cooling milk in a cooling tank according to a respective embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

Fig. 1 illustrates, schematically, in side view, main parts of a system 11 for storing and cooling milk according to an embodiment.

The system 11 for storing and cooling milk comprises a cooling tank 12 provided to store milk 13, an optional first sensor 15 provided to monitor the filling level L of milk in the cooling tank 12, and a cooling arrangement for cooling the milk in the cooling tank 12 comprising a cooling device 16, a second sensor 17, and a control device 18.

The first sensor 15 may be a sensor provided to measure the filling level L of milk in the cooling tank 12 indirectly, e.g. by means of measuring the amount of milk transferred to the cooling tank 12. The first sensor 15 may e.g. be a milk flow sensor (e.g. arranged upstream of the cooling tank), a level sensor, a threshold level sensor, or a float switch. It may be provided to monitor the exact filling level L of milk in the cooling tank 12 at each instance to provide a reading at each instance, or it may be

provided to only check whether the filling level exceeds a threshold or not. In the latter case, the first sensor 15 may be implemented as fixedly located optical sensor.

The cooling device comprises an evaporator 19, a compressor 20 connected with its suction side 20a to the evaporator 19, a condenser 21 connected to the high pressure side 20b of the compressor 20, and an expansion valve 22 interconnected between the condenser 21 and the evaporator 19, thereby forming a closed circuit, in which a refrigerant can be circulated.

The evaporator 19 is in heat exchange contact with at least a portion of the bottom surface 12a of the cooling tank 12.

The compressor 20 has a controllable varying capacity. It may be a capacity modulated scroll compressor, wherein the capacity can be controlled by means of controlling the modulation of the compressor 20. A higher modulation corresponds to a higher pump capacity, and a lower modulation corresponds to a lower pump capacity.

The scroll compressor 20 may have two scroll members and a biasing chamber which contains a pressurized fluid. The pressurized fluid within the chamber biases the two scroll members together. A valve assembly is in communication with this biasing chamber and releases the pressurized fluid on demand to bias the two scroll members together. When the biasing load is removed, the two scroll members separate, creating a leakage path between discharge and suction to reduce the capacity of the scroll compressor. Such kind of scroll compressor is commercially available from Copeland Corporation and is patented through US 6,821,092 B1, the contents of which being hereby incorporated by reference.

The second sensor 17 is provided to monitor a parameter indicative of the pressure P at the suction side 20a of the compressor 20. In one version, the second sensor 17 is a pressure sensor.

The control device 18 is operatively connected at least to the second sensor 17 to receive the monitored parameter indicative of the pressure P at the suction side 20a of the compressor 20, and to the compressor 20 to control the capacity thereof. The control device 18 is configured to control the compressor 20 to run at full capacity during a first part of the cooling of milk in the cooling tank 12, and to control the

capacity of the compressor 20, e.g. by means of changing the modulation of the compressor 20, such that the pressure at the suction side 20a of the compressor 20 is regulated towards a desired value P_{TH} during a second part of the cooling of milk in the cooling tank 12, which follows after the first part.

The desired value P_{TH} of the pressure may be a pressure, at which the refrigerant has a boiling temperature of between about -10 and 0 °C, preferably between about -8 and -2 °C, and most preferably between about -6 and -4 °C. In particular, the desired value P_{TH} of the pressure may be a pressure, at which the refrigerant has a heat exchange capacity, which ensure that milk in the cooling tank 12 does not freeze locally in the bottom 12 the cooling tank 12.

The system may comprise an agitator arrangement 14 within the cooling tank 12 provided for agitating the milk therein during the first and second parts of the cooling of the milk in the cooling tank 12.

The control device 18 may be configured to determine the start of the second part of the cooling of the milk in the cooling tank 12 in response to the monitored pressure at the suction side of the compressor. For instance, the control device 18 may be configured to determine that the second part of the cooling of the milk in the cooling tank 12 starts when the monitored pressure P at the suction side 20a of the compressor 20 has reached the desired value.

Alternatively, the system may comprise a timer for measuring a time lapsed since the start of the first part of the cooling of the milk in the cooling tank 12, wherein the control device 18 is configured to determine the start of the second part of the cooling of the milk in the cooling tank 12 in response to the measured time lapsed.

Yet alternatively, the control device 18 may be configured to determine the start of the second part of the cooling of the milk in the cooling tank 12 in response to a temperature of milk in the cooling tank 12 as sensed by a temperature sensor (not illustrated).

Further, the control device 18 may be configured to control the compressor 20, such that the compressor 20 is alternately switched on and switched off, during a third part of the cooling of the milk in the cooling tank 12, which follows after the second part, wherein the compressor is run with a constant capacity when being switched on.

The compressor may typically be switched on and switched off with at least a minute between each switching. The switching may be controlled by a thermostat. The control device 18 may be configured to determine the start of the third part of the cooling of the milk in the cooling tank 12 in response to the temperature of milk in the cooling tank 12 as sensed by the temperature sensor. In particular, the control device 18 may be configured to determine that the third part of the cooling of the milk in the cooling tank 12 starts when the sensed temperature has reached a temperature, at which the milk in the cooling tank should be kept, that is e.g. around 4 °C.

Fig. 2 illustrates, schematically, in a block scheme, a milking system 31 comprising the system for storing and cooling milk of Fig. 1. The milking system may be a batch wise milking system, in which a plurality of milking animals is milked at a time.

The milking system 31 comprises a milking device 32 for milking animals and any embodiment of the system 11 for storing and cooling milk as disclosed herein connected to the milking device 32 to collect milk as milked by the milking device 32.

Fig. 3 is a diagram of milk and evaporation temperatures vs time during cooling by the system of Fig. 1 as compared to two prior art systems and illustrates clearly the benefits of the system of Fig. 1.

Setup 1 uses a prior art system with a cooling capacity adapted to the size of the cooling tank, wherein the system is run at full capacity. Setup 3 uses a prior art system with a cooling capacity which is over-dimensioned for the size of the cooling tank, wherein the system is run at full capacity. Fig. 3 shows that the milk in the cooling tank reaches 4 °C after 161 minutes with setup 3 and after 172 minutes with setup 1. That is, the system with over-dimensioned cooling system is 11 minutes faster in reaching a milk temperature of 4 °C. Generally, over-dimensioning cooling could improve the quality of the milk since the cooling is faster. However, when studying the evaporation temperatures, it can be noted that the evaporation temperature of setup 3 using the over-dimensioned cooling system drops heavily in the end of the cooling process to about - 12 °C, whereas the evaporation temperature of setup 1 using the correctly dimensioned cooling system drops in the end of the cooling process only to about - 5.5 °C. The evaporation temperatures result in local freezing of milk in the bottom of the cooling tank for setup 3, but not for setup 1, which means

that the improvement in the speed of cooling is counterweighted by too low evaporation temperature in the end of the cooling process resulting in local freezing of milk in the bottom of the cooling tank.

Setup 2 uses the system disclosed with reference to Fig. 1 having the cooling capacity as the system in setup 3. It can be noted, that during the first part of the cooling of milk in the cooling tank using setup 2, the milk temperature drops just as fast as when setup 3 is used. However, at a certain instant, here after about 150 minutes, when the milk temperature has dropped to about 4.9 °C, the capacity of the compressor in setup 3 is controlled by means of changing the modulation of the compressor such that the pressure at the suction side of the compressor is regulated towards a desired value, here about - 6.8 °C. As a result the evaporation temperature does not drop further, and local freezing of milk in the bottom of the cooling tank is thus avoided. Still, the milk temperature reaches 4 °C after 161 minutes, which means that setup 2 has similar speed of cooling as setup 3, but avoids local freezing of milk.

It shall be appreciated that the second sensor 17 may instead be provided to monitor a parameter indicative of the pressure P in the evaporator 19 wherein the control device 18 is configured to control the capacity of the compressor 20 in response to the monitored parameter indicative of the pressure P in the evaporator 19 instead.

Yet alternatively, the second sensor 17 may be a temperature sensor provided to monitor a parameter indicative of the temperature at the suction side 20a of the compressor 20 or in the evaporator 19 wherein the control device 18 is configured to control the capacity of the compressor 20 in response to the monitored parameter indicative of the temperature at the suction side 20a of the compressor 20 or in the evaporator 19.

These embodiments may in other respects be similar to any of the embodiments disclosed with reference to Figs. 1-3.

Fig. 4 is a schematic flow scheme of an embodiment of a method for cooling milk in a cooling tank by a cooling device as disclosed above, e.g. one which comprises a capacity modulated scroll compressor, wherein the capacity can be controlled by means of changing the modulation of the compressor.

According to the method, a parameter indicative of the pressure P or temperature at the suction side of the compressor or in the evaporator is, in a step 41, monitored and the monitored parameter indicative of the pressure P at the suction side of the compressor is, in a step 42, repeatedly compared with a threshold or desired level P_{TH} . When the monitored parameter indicative of the pressure P or temperature is above the threshold or desired level P_{TH} the capacity of the compressor is, in a step 43, controlled in a first cooling scheme, and when the monitored parameter indicative of the pressure P or temperature falls below the threshold or desired level P_{TH} , the capacity of the compressor is, in a step 44, controlled in a second cooling scheme different from the first cooling scheme.

In the first cooling scheme, the compressor is controlled to run at full capacity and in the second cooling scheme, the capacity of the compressor is controlled, e.g. by means of changing the modulation of the compressor, such that the pressure or temperature at the suction side of the compressor or in the evaporator is regulated towards a value such as the above threshold or desired value P_{TH} .

The method can be generalized to a method wherein the compressor is controlled to run at full capacity during a first part of the cooling of milk in the cooling tank, whereas the capacity of the compressor is controlled, e.g. by means of changing the modulation of the compressor, such that the pressure or temperature at the suction side of the compressor or in the evaporator is regulated towards a desired value P_{TH} during a second part of the cooling of milk in the cooling tank, which follows after the first part. The shifting of the control of the compressor may be triggered in a plurality of manners. If the monitored parameter indicative of the pressure P or temperature is not used, the step 41, i.e. monitoring the parameter indicative of the pressure P or temperature, is only needed to be performed during the second part, as it is used in the control of the capacity of the compressor.

The above embodiments are not limiting, but exemplifying, the scope of the appended claims.

CLAIMS

1. A system (11) for storing and cooling milk comprising a cooling tank (12) provided to store milk (13), and a cooling arrangement for cooling the milk in the cooling tank comprising a cooling device (16), a sensor (17), and a control device (18), wherein

- the cooling device comprises an evaporator (19), a compressor (20) connected with its suction side (20a) to the evaporator, a condenser (21) connected to the high pressure side (20b) of the compressor, and an expansion valve (22) interconnected between the condenser and the evaporator, thereby forming a closed circuit, in which a refrigerant can be circulated,

- the evaporator is in heat exchange contact with at least a portion of the bottom surface (12a) of the cooling tank,

- the compressor has a varying capacity, which can be controlled,

- the sensor is provided to monitor a parameter indicative of the pressure (P) or temperature at the suction side of the compressor or in the evaporator, and

- the control device is operatively connected to the sensor and to the compressor, **characterized in** that

- the control device is configured to (i) control the compressor to run at full capacity during a first part of the cooling of milk in the cooling tank, and (ii) control the capacity of the compressor such that the pressure or temperature at the suction side of the compressor or in the evaporator is regulated towards a desired value (P_{TH}) during a second part of the cooling of milk in the cooling tank, which follows after said first part.

2. The system of claim 1 wherein the compressor is a capacity modulated scroll compressor, wherein the capacity is controllable by means of changing the modulation of the compressor.

3. The system of claim 1 or 2 wherein the desired value (P_{TH}) is a pressure, at which the refrigerant has a boiling temperature of between about -10 and 0 °C, preferably between about -8 and -2 °C, and most preferably between about -6 and -4 °C.
4. The system of claim 1 or 2 wherein the desired value (P_{TH}) is a pressure or a temperature, at which the refrigerant has a heat exchange capacity, which ensure that milk in the cooling tank does not freeze locally in the bottom of the cooling tank.
5. The system of any of claims 1-4 comprising an agitator arrangement (14) within the cooling tank provided for agitating the milk therein during said first and second parts of the cooling of the milk in the cooling tank.
6. The system of any of claims 1-5 wherein the control device is configured to determine the start of said second part of the cooling of the milk in the cooling tank in response to the monitored pressure or temperature at the suction side of the compressor or in the evaporator.
7. The system of claim 6 wherein the control device is configured to determine that said second part of the cooling of the milk in the cooling tank starts when the monitored pressure or temperature at the suction side of the compressor or in the evaporator has reached said desired value.
8. The system of any of claims 1-5 comprising a timer for measuring a time lapsed since the start of said first part of the cooling of the milk in the cooling tank, wherein the control device is configured to determine the start of said second part of the cooling of the milk in the cooling tank in response to said measured time lapsed.
9. The system of any of claims 1-5 comprising a temperature sensor for sensing a temperature of the milk in the cooling tank, wherein the control device is configured to determine the start of said second part of the cooling of the milk in the cooling tank in response to said sensed temperature.
10. The system of any of claims 1-9 wherein the control device is configured to control the compressor, such that the compressor is alternately switched on and switched off, during a third part of the cooling of the milk in the cooling tank, which follows after said second part, wherein the compressor is run with a constant capacity while being switched on.

11. The system of claim 10 comprising a temperature sensor for sensing a temperature of the milk in the cooling tank, wherein the control device is configured to determine the start of said third part of the cooling of the milk in the cooling tank in response to said sensed temperature.

12. The system of claim 11 wherein the control device is configured to determine that said third part of the cooling of the milk in the cooling tank starts when said sensed temperature has reached a temperature, at which the milk in the cooling tank should be kept.

13. A milking system (31) comprising a milking device (32) for milking animals and the system (11) for storing and cooling milk of any of claims 1-12 connected to the milking device to collect milk as milked by the milking device.

14. The milking system of claim 13 wherein the milking system is a batch wise milking system, in which a plurality of milking animals are milked at a time.

15. A method for cooling milk in a cooling tank (12) provided to store milk (13) by a cooling device (16) comprising an evaporator (19), a compressor (20) connected with its suction side (20a) to the evaporator, a condenser (21) connected to the high pressure side (20b) of the compressor, and an expansion valve (22) interconnected between the condenser and the evaporator, thereby forming a closed circuit, in which a refrigerant can be circulated, wherein the evaporator is in heat exchange contact with at least a portion of the bottom surface (12a) of the cooling tank and the compressor has a varying capacity, which can be controlled, the method being **characterized by** the steps of:

- monitoring (36) a parameter indicative of the pressure (P) or temperature at the suction side of the compressor or in the evaporator;
- controlling the compressor to run at full capacity during a first part of the cooling of milk in the cooling tank; and
- controlling the capacity of the compressor such that the pressure or temperature at the suction side of the compressor or in the evaporator is regulated towards a desired value (P_{TH}) during a second part of the cooling of milk in the cooling tank, which follows after said first part.

16. The method of claim 15 wherein the compressor is provided as a capacity modulated scroll compressor, wherein the capacity is controlled by means of changing the modulation of the compressor.
17. The method of claim 15 or 16 wherein the desired value (P_{TH}) is set to a pressure, at which the refrigerant has a boiling temperature of between about -10 and 0 °C, preferably between about -8 and -2 °C, and most preferably between about -6 and -4 °C.
18. The method of claim 15 or 16 wherein the desired value (P_{TH}) is set to a pressure or a temperature, at which the refrigerant has a heat exchange capacity, which ensure that milk in the cooling tank does not freeze locally in the bottom of the cooling tank.
19. The method of any of claims 15-18 comprising agitating the milk in the cooling tank during said first and second parts of the cooling of the milk in the cooling tank.
20. The method of any of claims 15-19 wherein said second part of the cooling of the milk in the cooling tank is determined to start in response to the monitored pressure or temperature at the suction side of the compressor or in the evaporator.
21. The method of claim 20 wherein said second part of the cooling of the milk in the cooling tank is determined to start when the monitored pressure at the suction side of the compressor has reached said desired value.
22. The method of any of claims 15-21 wherein the compressor is controlled, such that the compressor is alternately switched on and switched off, during a third part of the cooling of the milk in the cooling tank, which follows after said second part, wherein the compressor is run with a constant capacity while being switched on.
23. The method of claim 22 wherein a temperature of the milk in the cooling tank is sensed and said third part of the cooling of the milk in the cooling tank is determined to start in response to said sensed temperature.
24. The method of claim 23 wherein said third part of the cooling of the milk in the cooling tank is determined to start when said sensed temperature has reached a temperature, at which the milk in the cooling tank should be kept.

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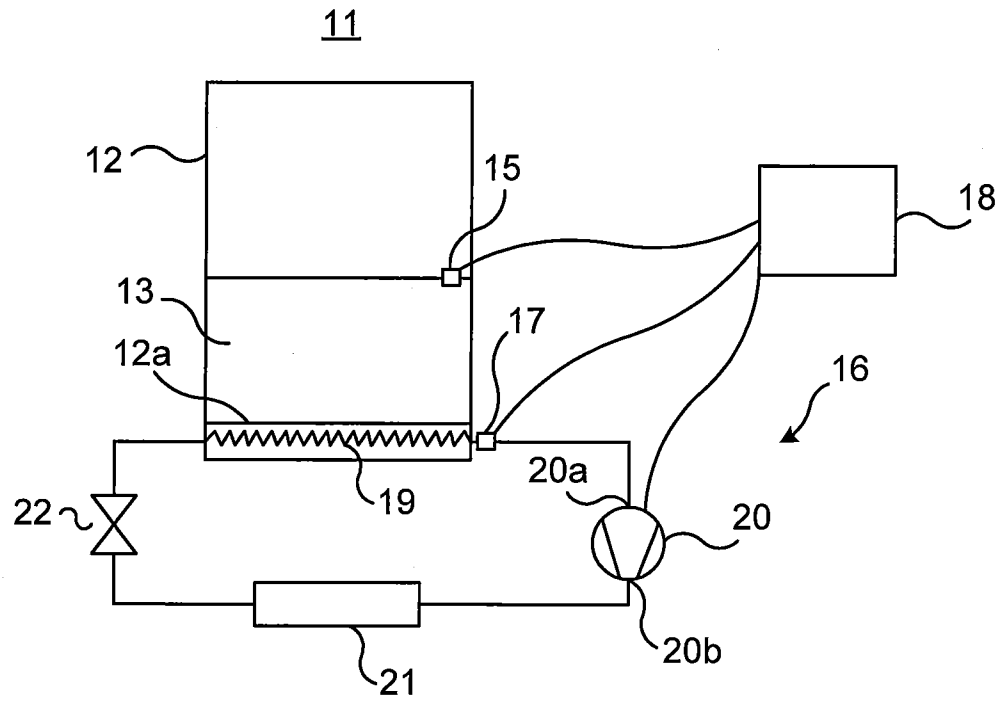


Fig. 1

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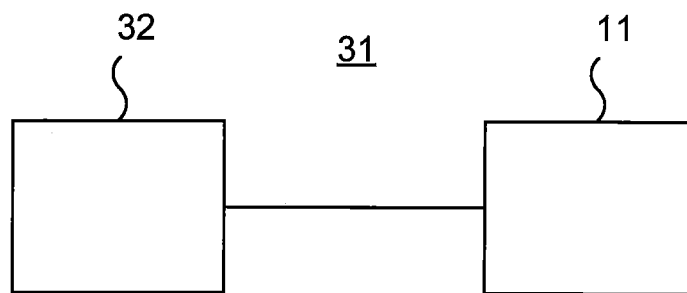


Fig. 2

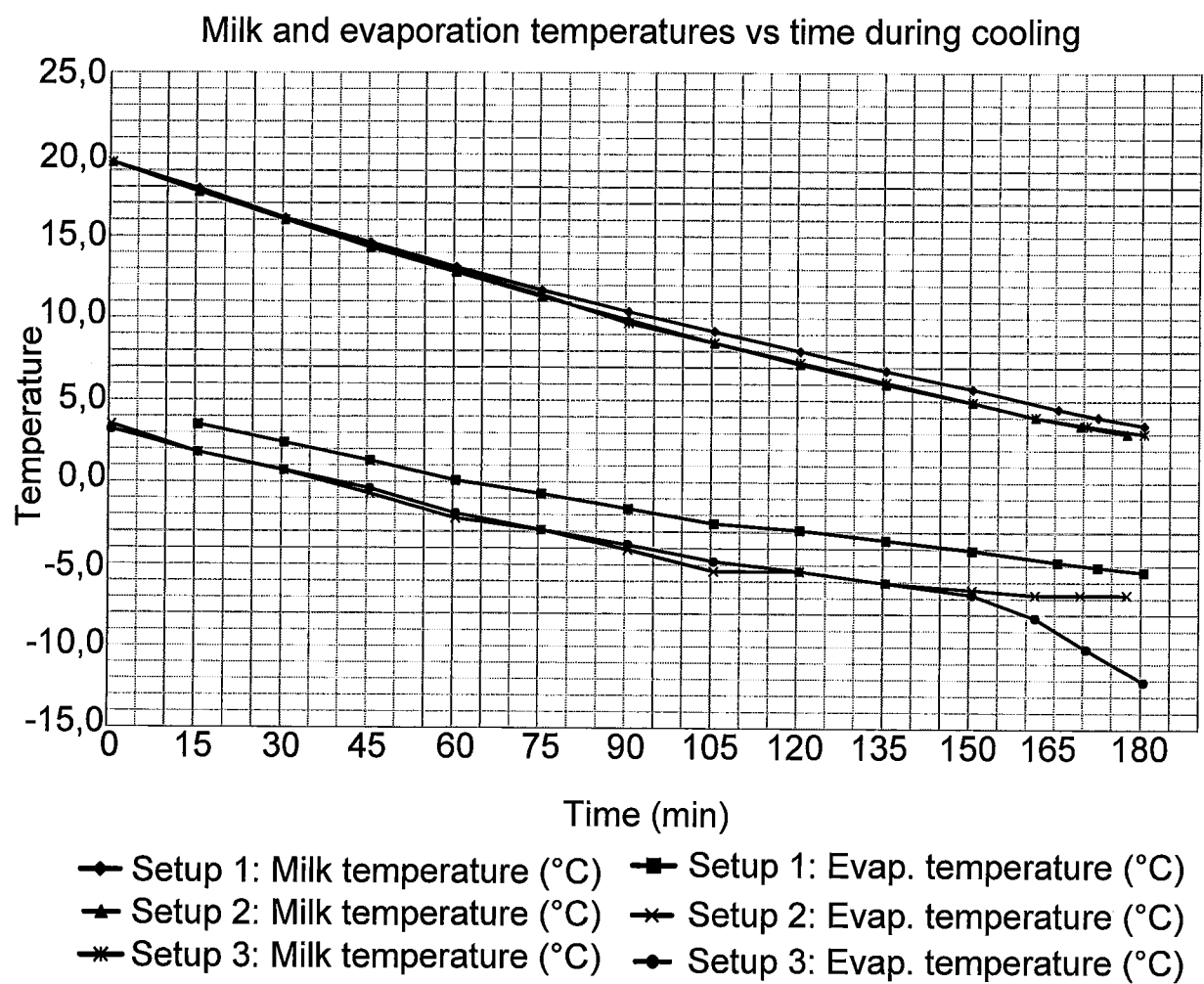


Fig. 3

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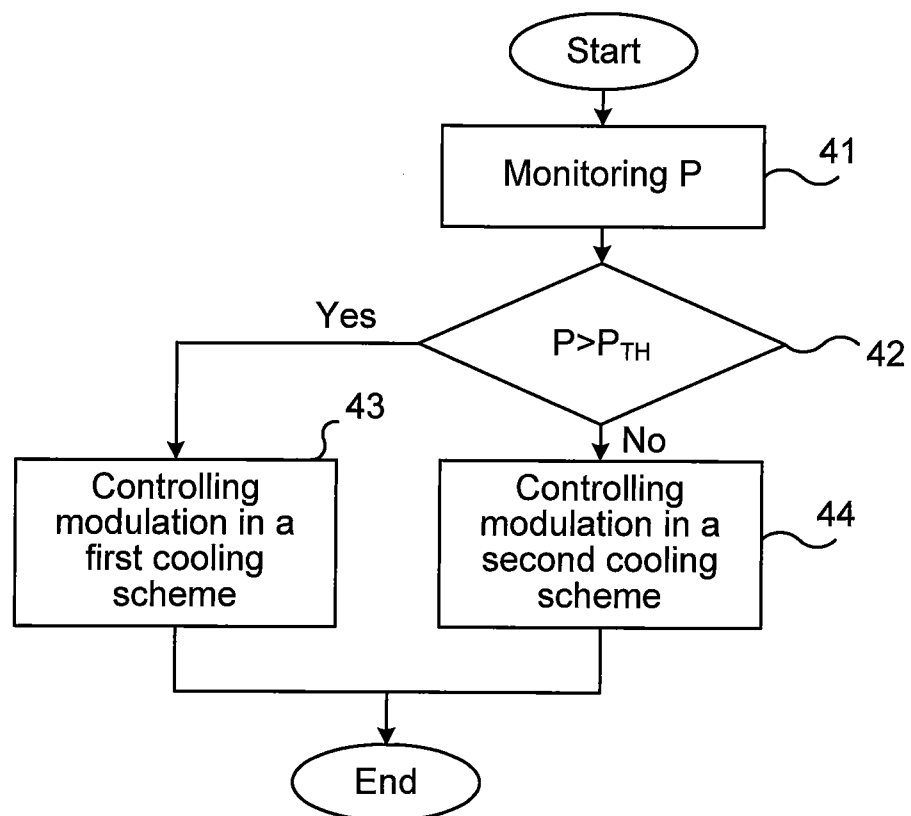


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No

PCT/SE2015/051338

A. CLASSIFICATION OF SUBJECT MATTER

INV. A01J9/04 F25B49/02 F25D31/00 B65D81/20 B67D1/04
ADD.

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 F25B F25D

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 practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2003/131619 A1 (LIDMAN MAGNUS [SE] ET AL) 17 July 2003 (2003-07-17) the whole document -----	1-24
Y	US 2008/034772 A1 (CHUMLEY EUGENE K [US] ET AL) 14 February 2008 (2008-02-14) the whole document -----	1-24
A	US 2 494 512 A (KAFFER CLARE H ET AL) 10 January 1950 (1950-01-10) the whole document -----	1-24
A	EP 1 260 777 A1 (MEKO HOLLAND B V [NL]) 27 November 2002 (2002-11-27) the whole document -----	1-24

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

1 March 2016

Date of mailing of the international search report

08/03/2016

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/SE2015/051338

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