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(54) Benævnelse: **APPARAT OG METODE TIL OPVARMNING AF LUFT I EN LUFTBEHANDLINGS ANORDNING**

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None

DESCRIPTION

Technical field

[0001] Present invention relates to a device and a method for heating of air at an air treatment device comprising an air handling unit, provided with a heat exchanger, and in combination with a heat pump for further heating of supply air in addition to what the heat exchanger provides. The heat pump is arranged with an extra injection circuit for gas/fluid injection directly in connection to the suction side of the compressor, which provides an extra cooling of the compressor and thereby a possibility to balance the discharge super heat in the system.

Background of the invention

[0002] Within the field of air handling it is well known to decrease costs for heating, by recovery of heat energy from the exhaust air and transfer this energy to the supply air in an air handling unit. In normal cases, at least for Nordic countries and countries with cold climate, the installation also must be complemented with an additional heater, to be able of keeping sufficiently high temperature of the supply air, for example by an electric heating coil or liquid coupled heating coil, arranged in the supply air. It is further known to combine the air handling unit with a heat pump to recover even more energy from the extract air, i.e. to arrange an evaporator in the extract air, after the heat exchanger, and as well a condenser in the supply air. By the heat pump technique more energy is collected from the extract air by evaporation of refrigerant, and this energy is delivered to the supply air by condensation of the refrigerant in the condenser. At a heat pump the relation between added input driving energy and recovered energy is described as the COP-value. Normally this value is between COP 2-5, i.e. the recovered energy is 2-5 times bigger than the added electric energy for the operation of the heat pump. A known problem with heat pumps is that when the temperature of the air passing through the evaporator becomes too low, the operation is inefficient and there is a high wear in the heat pump compressor at these low temperatures. Usually, For Nordic climate, it is recommended switching off the heat pump at a temperature around - 15°C. When the heat pump cannot be used, the entire heat pump's contribution to the heat of the supply air must be replaced with additional heating, whereby an auxiliary heater then usually is arranged, as described above, in the supply air after the heat exchanger. The applicant has a solution to this problem, by an international application - WO2014098724 disclosing a device according to the preamble of claim 1, whereby, instead of placing an auxiliary heater in the supply air to manage the heating demand when the heat pump is switched off, has complemented the facility with an auxiliary electric heater in the extract air, before the evaporator, to thereby heat in this position and extend the operation time of the heat pump. By this is supplied just enough heat to maintain the operation of the heat pump, so as not to lose the entire heat pump contribution for the heating of supply air. One problem is that one in different ways has to add external energy by at least one additional heating coil, which provides extra costs for

installation and operation, and also the air handling physical dimensions may be affected.

Disclosure of the invention

[0003] With the present invention the object to solve the above mentioned problems is achieved in an alternative way, compared to WO2014098724, from the first aspect, by an air treatment device according to claim 1, where the refrigerant recirculation circuit of the heat pump comprises an extra circuit - an injection circuit comprising an injection valve, which is arranged to redirect at least a subset of the refrigerant from high pressure side to low pressure side, whereby the subset of the refrigerant doesn't pass through the expansion valve and the evaporator, for lowering of the - so called - Discharge Super Heat (DSH) in the system, by gas/liquid injection in connection to the suction side of the compressor. The DSH is defined as the difference between the condensing temperature and the hot gas temperature in the system, which is well known terminology in heat pump systems. If it will be gas or liquid injection varies depending on operating conditions and how much the injection valve opens. Initially and at a small opening of the injection valve it is typically gaseous refrigerant that arrives to the suction side, whereas gradually at a need for further reduction of the hot gas temperature, and thus a more open injection valve, the injection gradually tends to involve more liquid droplets. Through the device a lowering of the discharge super heat is possible, whereby the compressor also has a possibility to operate "outside" its normal operating range (also called envelop). The DSH normally increases when the compressor operates in the outskirts of its envelop, for example while the outdoor temperature is very low. By controlling/lowering the DSH it is possible to keep the heat pump operation and extract heat from the extract air and completely skip the auxiliary heater in the supply air as well in the extract air and manage the complete heating of the supply air by means of the heat exchanger and the heat pump equipped with the injector circuit. In connection to ordinary, so-called air-to-air heat pumps, this technique occurs - and is called "liquid injection" technique - where by different solutions and coupling alternatives makes sure to lower the DSH and thereby allow operation down to lower outdoor temperatures than possible by conventional heat pump technology. In EP 1647783 B1 is among other things presented a solution for an air-to-air heat pump and where the technology is presented in more detail. However, it is not yet known to combine a heat pump according this technology with an air handling unit with some form of heat exchanger and thus fully be able to abolish all kinds of extra heaters, which is very beneficial from a cost, installation and operational point of view, compared to existing solutions.

[0004] According to the invention the circulation circuit comprises a pressure sensor, which is arranged to measure the pressure on the high pressure side of the circulation circuit, preferably after the condenser. This makes it possible to theoretically determine a condensation temperature of the refrigerant.

[0005] According to the invention the circulation circuit comprises a temperature sensor, which is arranged to measure the so called hot gas temperature, which is the temperature of the refrigerant after the compressor. Preferably, the temperature sensor is arranged to measure

the temperature on the so-called hot gas tube, which is arranged on the high pressure side after the compressor.

[0006] According to the invention the air treatment device comprises means for calculating the condensing temperature based of the measured pressure, measured with the pressure sensor according to the above. Furthermore, the device comprises means for calculating the so-called discharge super heat, which is the value that indicates the difference between the condensing temperature and the hot gas temperature. Preferably the calculations are handled through software provided in the control equipment which controls the device.

[0007] According to the invention the injection valve is arranged to control the amount of refrigerant flowing through the injection circuit based of the value of the discharge super heat, to control the discharge super heat. The discharge super heat normally increases when the compressor operation is getting close to the outskirts of its working range (envelop), i.e. when the outdoor temperature becomes very low, and the value thereby is a good indicator for the control of the injection valve. When the discharge super heat rises above a certain predetermined value, the injection valve is opened to lower the discharge super heat and thereby is - so to speak - the working area at the lower temperature areas. By this it is possible to run the compressor further, down to very low temperatures for this type of application, which means that the heat pump continuously can work and supply the extra heat needed to maintain the supply air temperature in the facility, without the need of extra heating coils or similar external heat sources in addition to the heat pump. The advantage is as mentioned above that the heat pump can be used for virtually most operation modes of the year, even in cold climates.

[0008] According to a preferred embodiment of the air treatment device the injection circuit opens at the suction pipe before the compressor, instead of directly into the suction chamber of the compressor. The advantage of this is that a conventional compressor without additional connections adapted for liquid injection can be used, even if the overall system is equipped with the optional cooling through the injection circuit. The injection circuit is thus not dependent on that the compressor is designed for this technology. In other words, it is then also possible to supplement the heat pump system with an injection circuit.

[0009] According to a alternative embodiment the injection circuit opens in a connection directly to the suction chamber of the compressor, which compressor then is adopted to be connected with an injection circuit.

[0010] According to the invention the heat pump circulation circuit comprises a heat exchanger, which is arranged with its first side between the second reservoir and the connection of the second end of the injection circuit to the suction side. The second side of the heat exchanger is a part of the injection circuit, i.e. the flow of the injection circuit flows through the second side of the heat exchanger, where the input to the heat exchanger connects to the expansion valve, i.e. to the liquid side, and the output from the second side of the heat exchanger connects to suction side of the compressor. The heat exchanger is in other words

arranged to make the subset of incoming liquid refrigerant to shift to gaseous refrigerant, by the heat exchange with the refrigerant coming from the second reservoir. The advantage with this is that it is easier to control the discharge super heat than just use an injection valve, which in some applications (mostly small systems) may be a somewhat rough control means. The tube dimension of the injection circuit is normally relatively small and if the heat pump system also is small, the injection valve can in certain operation modes be dominant, i.e. a small change in the valve opening gives a great impact on the refrigerant flow, which can lead to that drops of liquid arrives to the compressor. Compressors may normally be permitted to obtain a certain amount of refrigerant in liquid form (drops) but the ideal is gaseous refrigerant, so it is a further advantage to be able to influence the injection of refrigerant to the suction side of the compressor.

[0011] According to a preferred embodiment the injection valve is of electrical type. If it in the actual case is enough with a simple control of the valve, it is enough with a simple type of valve, like an electrical valve, for example a solenoid valve or the like, arranged to control the flow through the injection circuit.

[0012] According to another preferred embodiment the injection valve is of thermal type. To avoid electronic control it is instead possible to use a thermal valve that opens for flow through the injection circuit within a certain tested temperature range. Preferably, a so-called bulb alternatively an external pressure compensation control for temperature measurement thus arranged after the compressor in the high pressure side. This solution is sufficient for the case a relatively blunt regulation is sufficient or wanted.

[0013] According to a further preferred embodiment, the injection valve is of the type step motor valve. For cases where a more precise or fine control are required, it is preferred to use a step motor valve with a large number of steps, for precise control of the refrigerant amount through the injector circuit.

[0014] From the second aspect of the invention the object is achieved to solve the above mentioned problems by a method for heating of air according to claim 7, which method comprises that the discharge super heat is lowered by at least a subset of refrigerant is injected in connection to the suction side of the compressor. This becomes possible by that the refrigerant recirculation circuit comprises an injection circuit connected with one end at a suction pipe between the condenser and the expansion valve, i.e. in a position on the high pressure side of the refrigerant and where the refrigerant is a fluid, and further connected with the other end at the suction side of the compressor, i.e. at the low pressure side. The injection circuit comprises an injection valve which, at need of lowering the discharge super heat, opens for at least a subset of the refrigerant from high pressure side to low pressure side, why the subset of refrigerant thereby not passes the expansion valve and the evaporator, but instead is delivered to the suction side of the compressor. Conversely, at decreased or cessation need to reduce the discharge super heat, the injection valve closes. Such a method for heating of air at an air handling unit of the type indicated in the preamble of claim 12 is not yet known and has the advantage compared to prior art, that no extra heater is needed for heating of supply air or

maintained heat pump operation at the air handling unit, as earlier described in the background description of the patent application.

[0015] According to the second aspect of the invention a number of steps are performed to control the discharge super heat where a certain pressure on the high pressure side of the circulation circuit is measured with a pressure sensor, preferably in a position after the condenser. Based on the measured pressure the condensation temperature is calculated for the actual operation mode and further the hot gas temperature on the high pressure side of the compressor is measured. Based on the condensation temperature and the hot gas temperature the discharge super heat is calculated, which is the difference between the condensation temperature and the hot gas temperature for the actual operating condition. Based on the value of the discharge super heat, the injection valve opens when needed for a subset of refrigerant, which thereby flows through the injection circuit from high pressure side to low pressure side, such that the subset of the refrigerant thus not pass the expansion valve and the evaporator, but is transferred to suction side of the compressor, to control/reduce discharge super heat. The remaining refrigerant flows so to say, the usual way via the expansion valve and further to the evaporator.

[0016] According to the second aspect of the invention the subset of the refrigerant is led in the injection circuit through a heat exchanger to cause the liquid refrigerant, which arrive via the injection valve, to switch into gaseous refrigerant. The heat exchanger is connected with a first side to the low pressure side of the circulation circuit, in a position where the first side input of the heat exchanger is connected, after the other reservoir (in the heating case, the second reservoir is in the direction of flow after the evaporator), whereby the refrigerant flows from the second reservoir, and into heat exchanger, and an output from the first side of the heat exchanger is connected in a position before the other end of the injection circuit connects to the circulation circuit. The heat exchanger's second side, which shall exchange energy with the first side, is in turn connected to the injection circuit with its input after the injection valve and its output to the compressor suction side, whereby the heat exchanger exchanges energy between the high pressure side and low pressure side in the circulation circuit. The phase transformation occurs when heat exchange occurs between the refrigerant low and high pressure side in the heat exchanger. This makes it easier to control the injection of gaseous refrigerant to the suction side of the compressor, for lowering of discharge super heat.

[0017] From the third aspect the object is achieved to solve the above mentioned problems by use of an air handling unit according to claim 8. The combination of the air handling unit and the heat pump enables heating with the heat pump at outdoor temperatures down to -30°C without need of any additional heater in the system, which is very advantageous at use of the system in cold climates.

[0018] Through the invention is achieved a number of advantages compared to prior art:

- The combination of the air handling unit with heat pump provided with the injector circuit means that there is no need for an extra heater in the supply air or to provide an

extended heat pump operation by an additional heater in the exhaust air.
- Extended operating time of the heat pump down to very low temperatures.
- A standard compressor can be used for a particular embodiment.
- Heat exchange between low and high pressure side (via injection circuit) makes it possible to phase transfer liquid refrigerant in the injector circuit into gaseous refrigerant, which is beneficial for the compressor when the compressor operates outside normal working area.

Brief description of the drawings

[0019] Following schematic principle figures shows:

- Fig.1a shows a schematic sketch of an air treatment device according to an exemplary embodiment, with the injection circuit connected on a suction pipe before the compressor.
- Fig. 1b shows a schematic sketch of an air treatment device according to an exemplary embodiment, with the injection circuit connected directly to the suction chamber of the compressor.
- Fig.2 shows a schematic sketch of an air treatment device according to the invention with a heat exchanger as a part of the circulation circuit.
- Fig.3 shows a typical example of an operating condition of an air treatment device existing on the market, and the compressor working area for that operating condition.
- Fig.4 shows an example of an operating condition of an air treatment device according to the invention, where the compressor working area is extended because of the invention.

[0020] The structural design of the present invention are apparent in the following detailed description of a number of embodiments of the invention with reference to the accompanying figures which show preferred but not limiting embodiments of the invention.

Detailed description of the drawings

[0021] Fig.1a shows a schematic sketch of an air treatment device comprising an air handling unit 1 according to an exemplary embodiment. The air handling unit 1 comprises a heat exchanger 2, in this case a rotary heat exchanger, which is arranged to exchange energy between a first air stream 3 (exhaust side) and a second air stream 4 (supply air side). Further, the air handling unit 1 comprises a heat pump 5 with a circulation circuit 6 containing refrigerant 7. The figure shows the heat pump 5 in the heating case with the flow direction

according to the arrows in the figure. The circulation circuit 6 comprises a number of components all connected by refrigerant pipes and in order according to the flow direction of the heating case with starting at the compressor 10, which raises the pressure in the system, followed by a pressure side 12, a temperature sensor 25 disposed on the pressure side 12, further a condenser 9 arranged in the second air stream 4 and which leaves the heat energy in exchange with the second air stream 4. Thereafter, the refrigerant 7 flows further and passes a pressure sensor 24, which is arranged on refrigerant pipe after the condenser 9, and further to a first reservoir 13, which is used to balance the refrigerant quantity 7 of the system. After the reservoir 13 the liquid refrigerant 7 is directed through a liquid pipe 18 to an expansion valve 14, which reduces the pressure of the refrigerant which then flows further to an evaporator 8, arranged in the first air stream 3 and which absorbs heat energy from the first air stream 3. After the evaporator 8 follows a second reservoir 15, which acts as a liquid separator to the extent possible, ensure that only gaseous refrigerant 7 reaches the compressor 10, which follows after the second reservoir 15 and thus the circulation circuit 6 is closed. The second reservoir 15 and the compressor 10 are interconnected by a refrigerator pipe, here called suction conduit 21. Between the liquid pipe 18 and suction conduit 21 extends an injection circuit 16, in a flow-direction order having a first end 17 connected to the liquid pipe 18, followed by an injection valve 20, and ends with a second end 19, connected to the suction conduit 21. The injection valve 20 can be of different type, such as an electric valve (solenoid valve or similar), a step motor valve or a thermal valve. The variant with thermal valve is not shown in the figure. According to earlier description, the discharge super heat that occurs when the compressor is operating in the outskirts of its working area (se fig.3 and 4), is controlled by that the pressure sensor 24 registers the pressure after the condenser 9, and transforms this to a condensation temperature T1. With the temperature sensor 25 is the hot gas temperature T2 measured, and the discharge super heat (DSH) is calculated. On the basis of this the injection valve 20 opens at need, wherein a subset of the refrigerant 7 can start to flow directly from the high pressure side (before the expansion valve 14) to the low pressure side. Depending on the operating mode the refrigerant through the injection circuit 16 may be in gaseous or liquid form, it will vary with the particular case. While the injection circuit usually consists of a very thin tube, and a relatively small valve, will in the case of liquid arriving to the suction side, substantially liquid droplets be mixed with the gaseous refrigerant 7 from the second reservoir 15. Hereby is the discharge super heat lowered and compressor 10 can run down to lower temperatures, see also Figure 4.

[0022] Fig.1b shows another exemplary embodiment with the only difference that the second end 19 of the injection circuit 16 directly connects to a connection on the compressor 10, which connection has direct access to the suction chamber 22 (not visible) of the compressor 10. The function is the same as above, but the compressor 10 is in this case adopted for additional refrigerant injection.

[0023] Fig.2 shows an embodiment according to the invention which is broadly similar to the previous variants, but with the difference that a heat exchanger 23 is provided with a first side 26 connected to the circulation circuit 6 and a second side 29 connected to the injection circuit 16, with a purpose of, in appropriate cases, phase change the liquid refrigerant 7 in the

injection circuit 16, to gaseous refrigerant 7, before it arrives at the suction side 11 of the compressor 10. The first side 26 of the heat exchanger 23, is connected with a first input 27 connected towards the second reservoir 15, and with a first output 28 connected to the circulation circuit 6 in a position before the connection of the injection circuit's 16 second end 19 to the suction side 11. The second side 29 of the heat exchanger 23, is in turn connected to the injection circuit 16 with a second input 30 towards the injection valve 20, and a second output 31 towards the suction side 11 of the compressor 10, wherein the subset of the refrigerant 7 flows via the injection valve 20, through the second side 29 of the heat exchanger 23, and further to the suction side of the compressor 10. Hereby, the heat exchanger 23 is arranged to exchange energy between the high pressure side and low pressure side of the circulation circuit 6, for evaporation of the liquid refrigerant 7 in the injection circuit 16. Otherwise, the function is the same as in the above described embodiments.

[0024] Fig.3 shows an example of an operation condition at one, on the market existing, air handling unit 1 provided with a heat exchanger 2 and a conventional heat pump 5, which lacks the injection circuit according to the invention. The figure shows a diagram over the compressor working area (envelop) and the actual operating point at the operation condition, according to the temperatures in connection to the air handling unit 1. According to the example the temperatures are the following: outdoor temperature -20°C, exhaust temperature 25°C, temperature after the heat exchanger -13°C at the exhaust side and 14°C at the supply air side. In the diagram the x-axis shows evaporation temperature, which in the example is -24°C and the y-axis shows condensation temperature which in the example is 25°C, to keep a sufficient supply air temperature. As seen in the diagram, the compressor is working in the outskirts of its envelop which means that the discharge super heat rises and that the compressor thereby must operate at higher temperature than appropriate, at least for longer operation cycles, and with higher wear as result. The discharge super heat should be lowered alternatively the compressor operation time should be lowered or the compressor switched off, whereby other energy sources must be used to keep the correct supply air temperature.

[0025] Fig.4 shows an operating condition according to an example of an air treatment device according to the invention, comprising the air handling unit 1, with the heat exchanger 2 and the heat pump 5 comprising the injection circuit 16. This example shows the embodiment where the heat exchanger 23 is part of the circulation circuit 6 and the injection circuit 16. The example shows that the air treatment device can be run down to an outdoor temperature of -30°C instead of down to -20°C, compared with the previous example (Figure 3), which means a big difference for both installation cost and running cost. This becomes possible by, with the same compressor performance as in the example in Figure 3, using the injection circuit 16 to lower the discharge super heat, which normally rises in the outskirts of the normal envelop. By directing at least a subset of refrigerant through the injection circuit 16, by controlling the injection valve 20, and inject refrigerant in connection to the suction side of the compressor 10, the discharge super heat is lowered and the compressor envelop (working area) increases, whereby an operating point corresponding to a evaporation temperature of -35°C and a condensation temperature of 25°C is possible. As seen in the chart the operating range is considerably extended, whereby other operating points becomes available.

PARTS LIST

[0026]

1=
air handling unit
2=
heat exchanger
3=
first air stream
4=
second air stream
5=
heat pump
6=
circulation circuit
7=
refrigerant
8=
evaporator
9=
condenser
10=
compressor
11=
suction side
12=
pressure side
13=
first reservoir
14=
expansion valve
15=
second reservoir
16=
injection circuit
17=
first end
18=
liquid pipe
19=
second end

20=
injection valve
21=
suction conduit
22=
suction chamber
23=
heat exchanger
24=
pressure sensor
25=
temperature sensor
26=
first side (heat exchanger)
27=
first input
28=
first output
29=
second side (heat exchanger)
30=
second input
31=
second output

REFERENCES CITED IN THE DESCRIPTION

Cited references

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

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- WO2014098724A [0002] [0003]

- EP1647783B1 [0003]

APPARAT OG METODE TIL OPVARMNING AF LUFT I EN LUFTBEHANDLINGS ANORDNING

PATENTKRAV

1. Luftbehandlings anordning til opvarmning af luft, omfattende en luftbehandlings unit (1), hvilken luftbehandlings unit (1) omfatter en varmeveksler (2), indrettet til, i en opvarmnings tilstand, at genvinde varmeenergi fra en første luftstrøm (3) og overføre den til en anden luftstrøm (4), til opvarmning af den anden luftstrøm (4), og at luftbehandlings anordningen endvidere omfatter en varmepumpe (5), indrettet til, i en opvarmnings tilstand, at genvinde varmeenergi fra den første luftstrøm (3) og overføre den til en anden luftstrøm (4), til opvarmning af den anden luftstrøm (4), og hvilken varmepumpe (5) omfatter et cirkulations kredsløb (6) til kølemiddel (7), en fordamper (8) anbragt i den første luftstrøm (3), i luftstrøms retningen efter varmeveksleren (2), og en kondensator (9) anbragt i den anden luftstrøm (4), i luftstrøms retningen efter varmeveksleren (2), og at varmepumpen (5) endvidere omfatter en kompressor (10) med en sugeside (11) og en trykside (12) forbundet til cirkulations kredsløbet (6) og anbragt, i strøm retningen af kølemidlet (7) i den opvarmende tilstand, efter fordamperen (8) og inden kondensatoren (9), og endvidere omfatter cirkulations kredsløbet (6) en ekspansionsventil (14) og et første reservoir (13), som er anbragt, i strøm retningen af kølemidlet (7) i den opvarmende tilstand, efter kondensatoren (9) og inden fordamperen (9) på et væske rør (18) og et anden reservoir (15) anbragt mellem fordamperen (8) og kompressoren (10), kendetegnet ved at cirkulations kredsløbet (6) endvidere omfatter et indsprøjtnings kredsløb (16) med en første ende (17) forbundet mellem kondensatoren (9) og ekspansionsventilen (14) ved væske røret (18), og en anden ende (19) anbragt ved sugesiden (11) af kompressoren (10), og hvilket injektions kredsløb (16) omfatter en indsprøjtnings ventil (20) indrettet til at styre mindst en delmængde af kølemidlet (7) fra højtryks siden til lavtryks siden, således at delmængden af kølemidlet (7) dermed ikke passerer gennem ekspansionsventilen (14) og fordamperen (8), til reduktionen af varmepumpen (5) udleder overvarme, og at cirkulations kredsløbet (6) omfatter en tryksensor (24) indrettet til at måle et tryk (P) på højtryks siden af cirkulations kredsløbet (6) og en temperatursensor (25) indrettet til at måle en varm gas temperatur (T2) på højtryks siden efter kompressoren

(10),luftbehandlings anordningen omfatter virkemidler til beregning af en kondensations temperatur (T1) baseret på det målte tryk (P), og endvidere virkemidler til beregning af såkaldt udledt super varme (DSH), som er differencen mellem kondensations temperaturen (T1) og den varme gas temperatur (T2), og indsprøjtnings ventilen (20) er indrettet til at kontrollere mængden af kølemiddel (7) igennem indsprøjtnings kredsløbet (16) baseret på værdien af udledt super varme (DSH), for at kontrollere samme, hvori varmeveksleren (23) er indrettet med en første side (26) forbundet til cirkulations kredsløbet (6), med en første indgang (27) fra det andet reservoir (15) og med en første udgang (28) forbundet til cirkulations kredsløbet (6) inden forbindelsen af den anden ende (19) af indsprøjtnings kredsløbet (16), og varmeveksleren (23) er endvidere forsynet med en anden side (29) forbundet til indsprøjtnings kredsløbet (16) med en anden indgang (30) fra indsprøjtnings ventilen (20) og en anden udgang (31) til kompressorens sugeside (11), hvori varmeveksleren (23) er indrettet til at udveksle energi mellem højtryks siden og lavtryks siden af cirkulations kredsløbet (6), til fordampning af væske kølemiddel (7) i indsprøjtnings kredsløbet (16).

2. Luftbehandlings anordning i henhold til patentkrav 1, kendetegnet ved at den anden ende (19) af indsprøjtnings kredsløbet (16) er forbundet til en sugeledning (21) på sugesiden (11) af kompressoren (10).

3. Luftbehandlings anordning i henhold til patentkrav 1, kendetegnet ved at den anden ende (19) af indsprøjtnings kredsløbet (16) er forbundet til et sugekammer (22) i kompressoren (10).

4. Luftbehandlings anordning i henhold til et af de foregående patentkrav, kendetegnet ved at indsprøjtnings ventilen (20) er af elektrisk type.

5. Luftbehandlings anordning i henhold til et af patentkravene 1-3, kendetegnet ved at indsprøjtnings ventilen (20) er af termisk type.

6. Luftbehandlings anordning i henhold til et af patentkravene 1-3, kendetegnet ved at indsprøjtnings ventilen (20) er af stepmotor type.

7. Metode til opvarmning af luft i en luftbehandlings anordning omfattende en luftbehandlings unit (1) hvilken luftbehandlings unit (1) omfatter en varmeveksler (2), som i en opvarmnings

tilstand genvinder varmenergi fra en første luftstrøm (3) og overfører den til en anden luftstrøm (4), til opvarmning af en anden luftstrøm (4), og at luftbehandlings anordningen endvidere omfatter en varmepumpe (5), som i en opvarmnings tilstand genvinder varmeenergi fra den første luftstrøm (3) og overfører den til en anden luftstrøm (4), til opvarmning af den anden luftstrøm (4), og hvilken varmepumpe (5) omfatter et cirkulations kredsløb (6) til kølemiddel (7), en fordamper (8) anbragt i den første luftstrøm (3), i luftstrøms retningen efter varmeveksleren (2), og en kondensator (9) anbragt i den anden luftstrøm (4), i luftstrøms retningen efter varmeveksleren (2), og at varmepumpen (5) endvidere omfatter en kompressor (10) med en sugeside (11) og en trykside (12) forbundet til cirkulations kredsløbet (6) og anbragt, i strøm retningen af kølemidlet (7) i opvarmnings tilstanden, efter fordamperen (8) og inden kondensatoren (9), og endvidere omfatter cirkulations kredsløbet (6) en ekspansions-ventil (14) og et første reservoir (13), som er anbragt, i strøm retningen af kølemidlet (7) i opvarmnings tilstanden, efter kondensatoren (9) og inden fordamperen (8), og et anden reservoir (15) anbragt mellem fordamperen (8) og kondensatoren (10), kendetegnet ved at den udledte super varme (DSH) af kompressoren er reduceret ved at mindst en delmængde af kølemidlet (7) er indsprøjtet i forbindelse med sugesiden (11) af kompressoren (10), ved at cirkulations kredsløbet (6) omfatter et indsprøjtnings kredsløb (16) med en første ende (17) forbundet mellem konden-satoren (9) og ekspansionsventilen (14) af et væske rør (18), og en anden ende (19) anbragt ved sugesiden (11) af kompressoren (10), og indsprøjtnings kredsløbet (16) omfatter en indsprøjtnings ventil (20), og indsprøjtnings ventilen (20) styrer mindst en delmængde af kølemidlet (7) fra højtryks siden til lavtryks siden, således at delmængden af kølemidlet (7) dermed ikke passerer gennem ekspansionsventilen (14) og fordamperen (8), omfattende følgende trin:

- med en tryksensor (24) måle et tryk (P) på højtryks siden af cirkulations kredsløbet (6), fortrinsvis efter kondensatoren (9),
- baseret på det målte tryk (P) beregne en kondensations temperatur (T1),
- måle en varm gas temperatur (T2) på højtryks siden efter kompressoren (10),
- beregne en udledt super varme (DSH), som er differencen mellem kondensations temperaturen (T1) og den varme gas temperatur (T2),

- kontrol af mængden af kølemiddel (7) igennem indsprøjtnings kredsløbet (16) baseret på værdien af den udledte super varme (DSH), for at kontrollere samme, og

hvori delmængden af kølemiddel (7) igennem indsprøjtnings kredsløbet (16) er ført igennem en varmeveksler (23) som er anbragt med en første side (26) forbundet til cirkulations kredsløbet (6), med en første indgang (27) fra det andet reservoir (15) og med en første udgang (28) forbundet til cirkulations kredsløbet (6) inden forbindelsen af den anden ende (19) af indsprøjtnings kredsløbet (16), og varmeveksleren (23) er endvidere forsynet med en anden side (29) forbundet til indsprøjtnings kredsløbet (16) med en anden indgang (30) fra indsprøjtnings ventilen (20) og en anden udgang (31) til kompressorens sugeside (11), hvori varmeveksleren (23) er anbragt for at udveksle energi mellem højtryks siden og lavtryks siden af cirkulations kredsløbet (6), til fordampning af flydende kølemiddel (7) i indsprøjtnings kredsløbet (16).

8. Brug af en luftbehandlings unit (1) sammen med en varmepumpe (5) i henhold til et af patentkravene 1-6 i forbindelse med opvarmning af tilført luft til brug i bygninger.

DRAWINGS

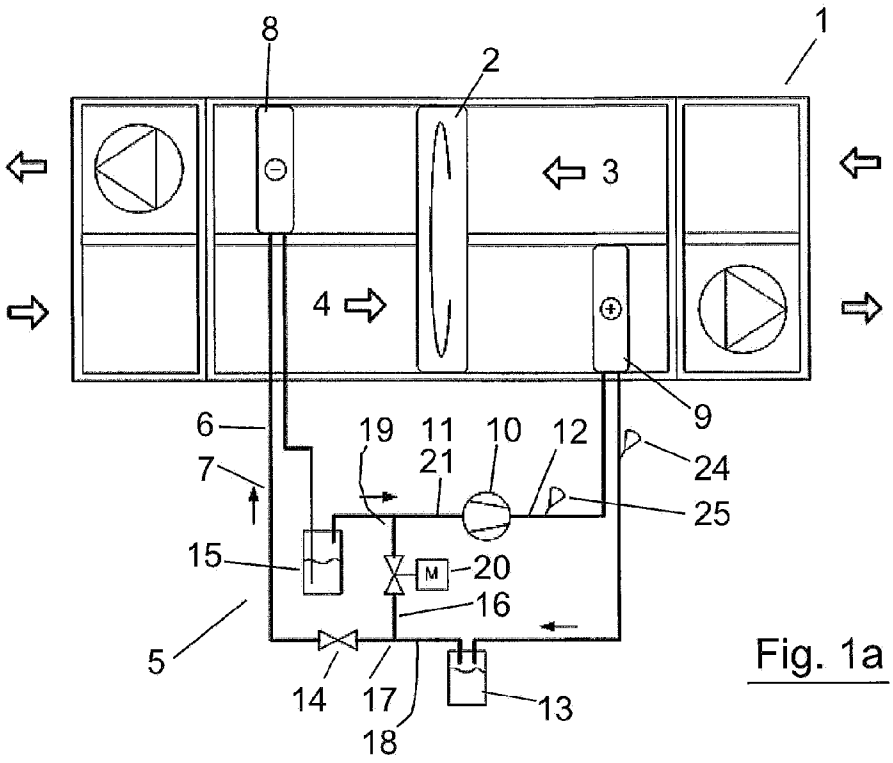


Fig. 1a

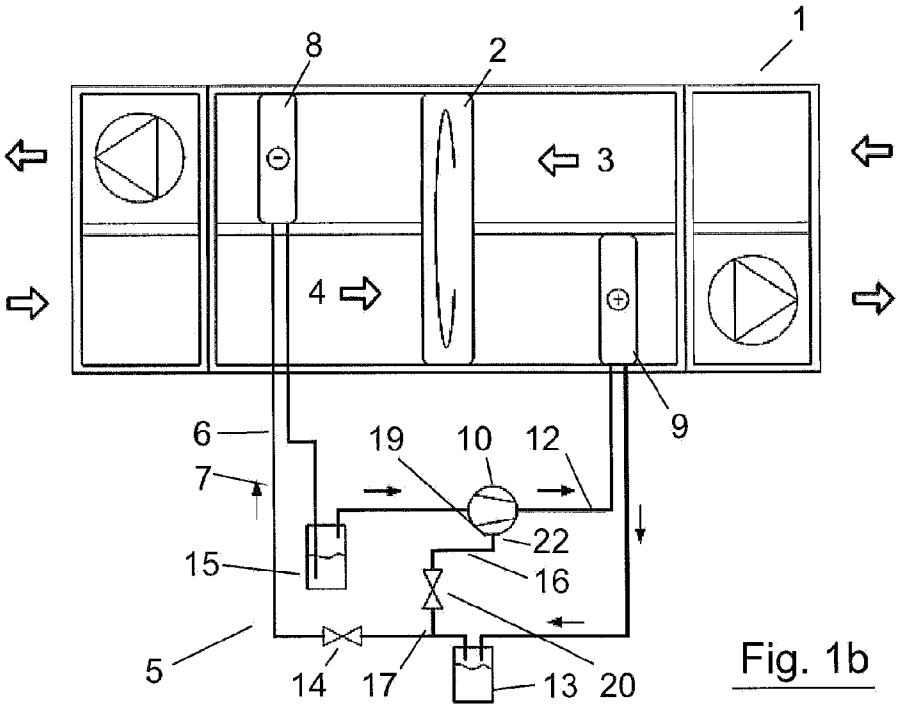


Fig. 1b

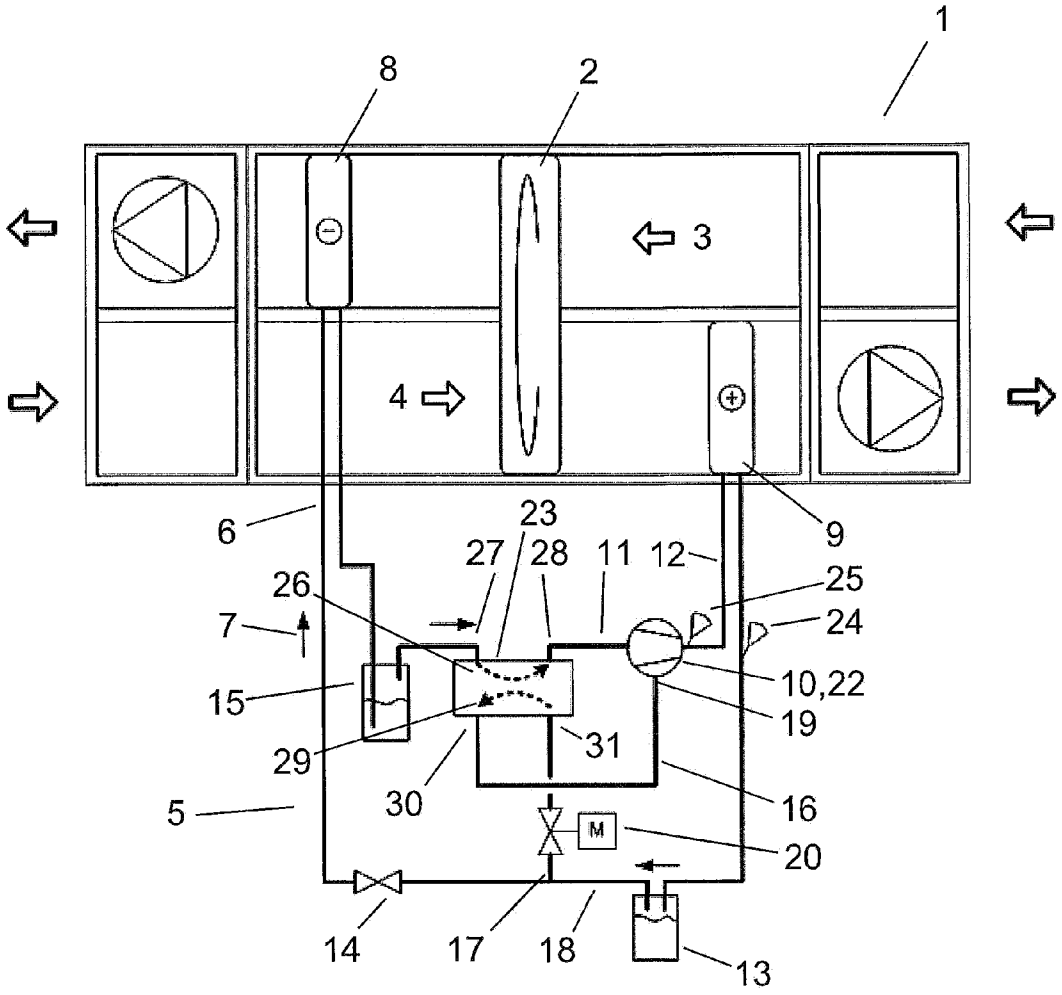
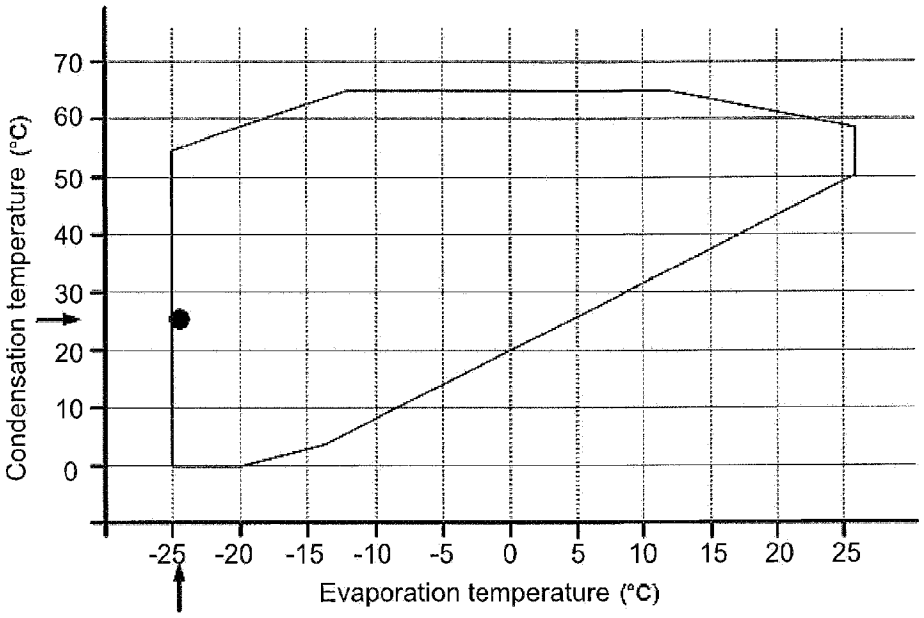

1
8
2
3
4
6
23
27
28
11
12
9
26
25
7
24
15
10,22
19
29
31
30
16
5
M
20
14
17
18
13

Fig. 2


Condensation temperature (°C)
70
60
50
40
30
20
10
0
-25
-20
-15
-10
-5
0
5
10
15
20
25
Evaporation temperature (°C)

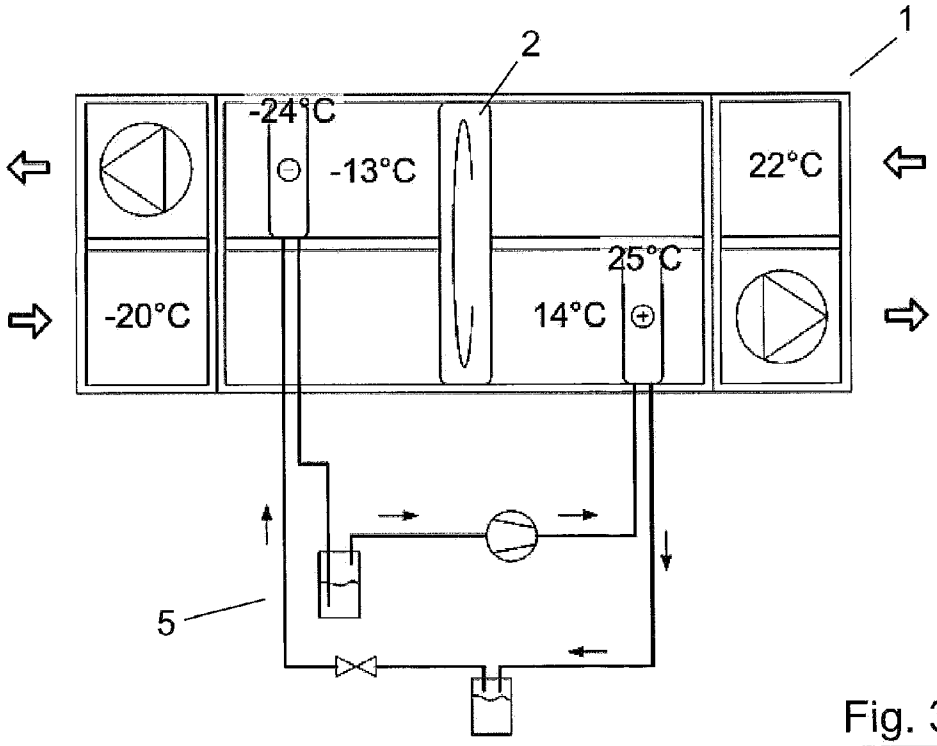
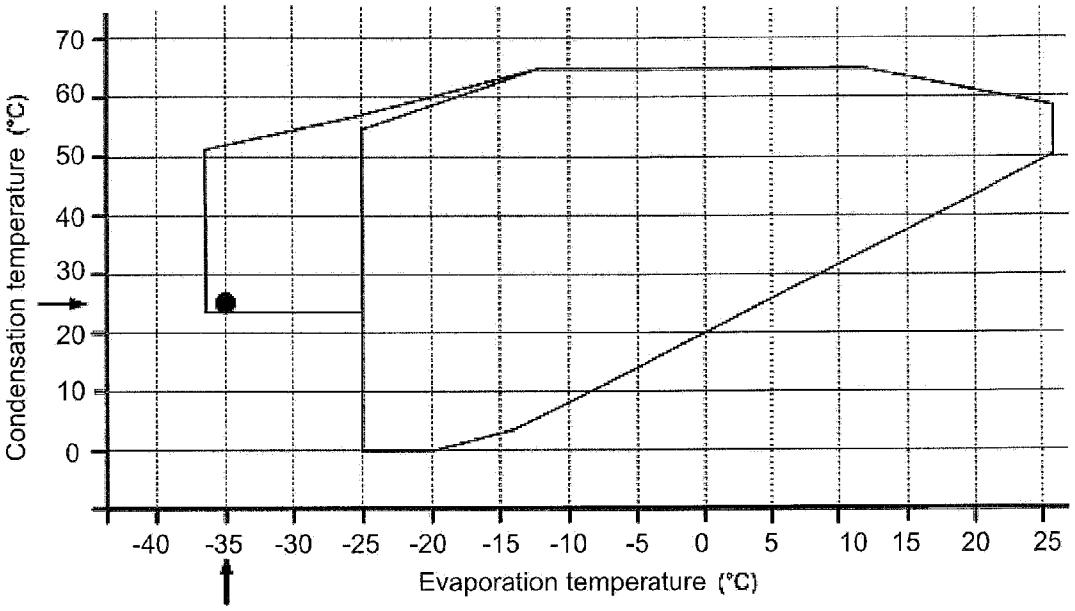

1
2
-24°C
-13°C
22°C
25°C
-20°C
14°C
5

Fig. 3


Condensation temperature (°C)
70
60
50
40
30
20
10
0
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
Evaporation temperature (°C)

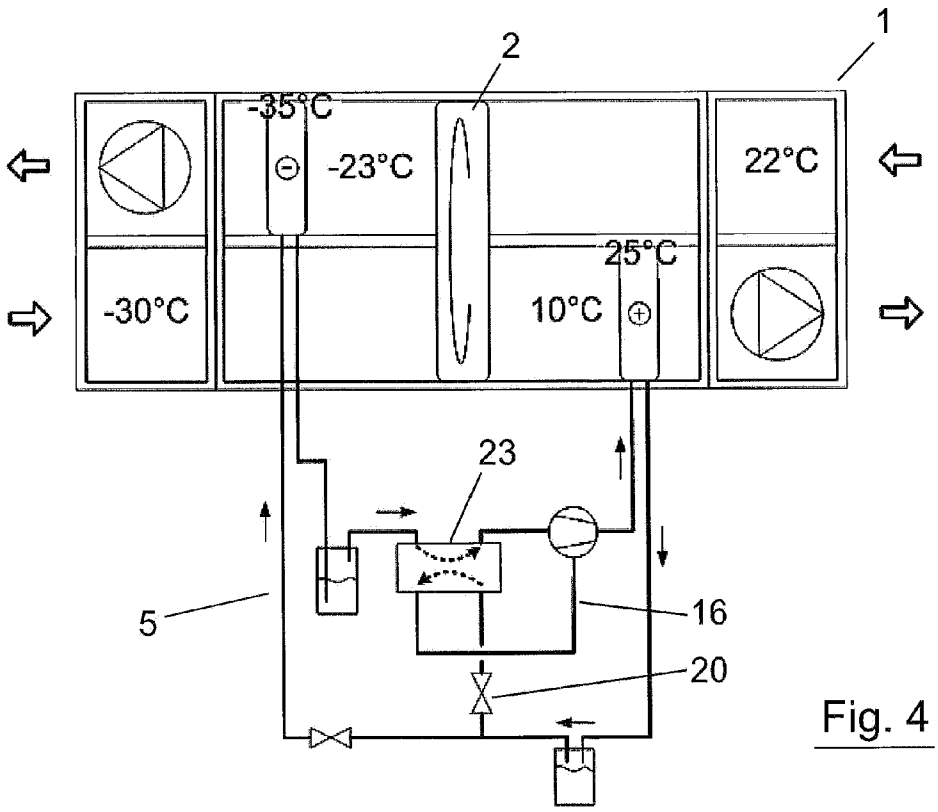

1
2
-35°C
-23°C
22°C
25°C
-30°C
10°C
23
5
16
20

Fig. 4