(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 531 045 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
28.08.2019 Bulletin 2019/35

(21) Application number: **17861512.6**

(22) Date of filing: **19.10.2017**

(51) Int Cl.:
F25B 47/02 *(2006.01)* ***F24F 11/42*** *(2018.01)*
F24F 11/61 *(2018.01)* ***F25B 13/00*** *(2006.01)*
F25B 49/02 *(2006.01)* ***F24F 110/22*** *(2018.01)*
F24F 110/12 *(2018.01)*

(86) International application number:
PCT/CN2017/106842

(87) International publication number:
WO 2018/072727 (26.04.2018 Gazette 2018/17)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **20.10.2016 CN 201610915879**
21.04.2017 CN 201710269632

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(54) **METHOD AND DEVICE FOR DEFROSTING AIR CONDITIONER**

(57) A method and device for defrosting an air conditioner. The method comprises the following steps: detecting a refrigerant pressure of a heat exchange; obtaining, according to the detected refrigerant pressure of the heat exchange, a corresponding saturation temperature; obtaining an ambient dew point temperature; and when the corresponding saturation temperature is less than 0°C and less than the ambient dew point temperature, controlling the air conditioner to enter a defrost mode. The method can ensure timely defrosting when frost is formed, prevent defrosting when no frost is formed, extending a service life of an air conditioner.

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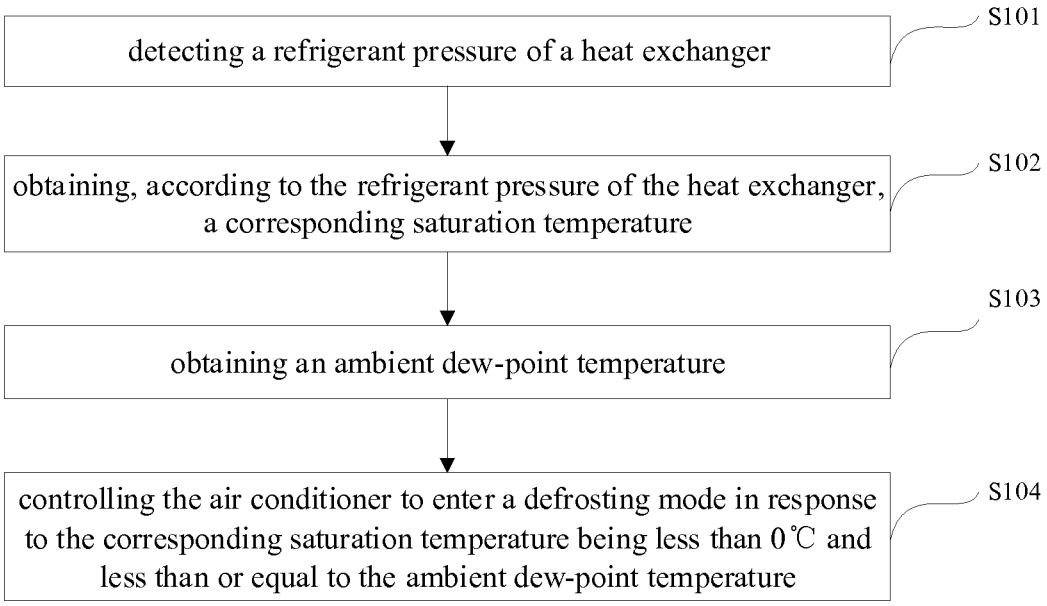

detecting a refrigerant pressure of a heat exchanger
S101
obtaining, according to the refrigerant pressure of the heat exchanger, a corresponding saturation temperature
S102
obtaining an ambient dew-point temperature
S103
controlling the air conditioner to enter a defrosting mode in response to the corresponding saturation temperature being less than 0℃ and less than or equal to the ambient dew-point temperature
S104

FIG. 1

Description

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and benefits of Chinese Patent Application No. 201710269632.1 filed on April 21, 2017 and titled with "method for controlling defrosting of air conditioner, air conditioner and computer-readable storage medium", and Chinese Patent Application No. 201610915879.1 filed on October 20, 2016 and titled with "method and device for controlling defrosting of air conditioner", both of which are filed by GD MIDEA HEATING & VENTILATING EQUIPMENT CO., LTD. and MIDEA GROUP CO., LTD., and the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure generally relates to the field of air conditioners, and more particularly, to a method and a device for controlling a defrosting of an air conditioner.

BACKGROUND

[0003] With the improvement of people's living standard, there are more and more home appliances. The air conditioner is one of the essential household appliances in people's live. However, when the air conditioner in the related art operates, it is often accompanied by frosting in a heat exchanger. Once the frosting occurs in the heat exchanger, the heat transfer efficiency of the air conditioner will be reduced, and it will hinder the improvement of heating capacity of the air conditioner. In order to solve the problem of capacity attenuation after frosting, the air conditioner needs to switch to a defrosting mode. However, excessive defrosting sacrifices the heating capacity of the air conditioner, and consumes more energy.

SUMMARY

[0004] The main objective of the present disclosure is to provide a method and a device for controlling a defrosting of an air conditioner, aiming at solving defects of high energy consumption caused by excessive defrosting in the air conditioner in the related art.

[0005] To achieve the above objectives, a method for controlling a defrosting of an air conditioner proposed by the present disclosure includes:

detecting a refrigerant pressure of a heat exchanger;
obtaining, according to the refrigerant pressure of the heat exchanger, a corresponding saturation temperature;
obtaining an ambient dew-point temperature; and
controlling the air conditioner to enter a defrosting mode in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature.

[0006] The obtaining, according to the refrigerant pressure of the heat exchanger, the corresponding saturation temperature includes:
obtaining, according to the refrigerant pressure of the heat exchanger, the corresponding saturation temperature by query or calculation.

[0007] Preferably, the obtaining the ambient dew-point temperature includes:

detecting an ambient temperature and an ambient wet-bulb temperature; and
obtaining, according to the ambient temperature and the ambient wet-bulb temperature, the ambient dew-point temperature by query or calculation.

[0008] Preferably, after the obtaining, according to the ambient temperature and the ambient wet-bulb temperature, the ambient dew-point temperature by query or calculation, the method further includes:

obtaining, according to the ambient temperature and the ambient wet-bulb temperature, a corresponding frosting critical temperature by query; and
determining whether the corresponding saturation temperature is less than 0°C and less than or equal to the ambient dew-point temperature in response to the ambient dew-point temperature being less than or equal to the frosting critical temperature.

[0009] Preferably, the controlling the air conditioner to enter the defrosting mode in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature includes:

determining that the air conditioner starts frost in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature;
accumulating a frosting duration of the air conditioner; and
controlling the air conditioner to enter the defrosting mode in response to the frosting duration being greater than a predetermined duration.

[0010] In addition, to achieve the above objectives, the present disclosure further provides a device for controlling a defrosting of an air conditioner. The device includes:

a first detecting module, configured to detect a refrigerant pressure of a heat exchanger;
an obtaining module, configured to, according to the refrigerant pressure of the heat exchanger, obtain a corresponding saturation temperature;
the obtaining module, further configured to obtain an ambient dew-point temperature; and
a control module, configured to control the air conditioner to enter a defrosting mode in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature.

[0011] Preferably, the obtaining module is configured to, according to the refrigerant pressure of the heat exchanger, obtain the corresponding saturation temperature by query or calculation.

[0012] Preferably, the device further includes: a second detecting module, configured to detect an ambient temperature and an ambient wet-bulb temperature;
in which the obtaining module is configured to, according to the ambient temperature and the ambient wet-bulb temperature, obtain the ambient dew-point temperature by query or calculation.

[0013] Preferably, the obtaining module, is further configured to, according to the ambient temperature and the ambient wet-bulb temperature, obtain a corresponding frosting critical temperature by query;
the device further includes a performing module, configured to, determine whether the corresponding saturation temperature is less than 0°C and less than or equal to the ambient dew-point temperature in response to the ambient dew-point temperature being less than or equal to the frosting critical temperature.

[0014] Preferably, the control module includes:

a frost determining unit, configured to, determine that the air conditioner starts frost in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature;
a time accumulating unit, configured to accumulate a frosting duration of the air conditioner; and
a control unit, configured to control the air conditioner to enter the defrosting mode in response to the frosting duration being greater than a predetermined duration.

[0015] The present disclosure, through detecting the refrigerant pressure of the heat exchanger, obtaining the corresponding saturation temperature according to the refrigerant pressure of the heat exchanger, and comparing the corresponding saturation temperature with the ambient dew-point temperature, controls the air conditioner to enter the defrosting mode when the corresponding saturation temperature is less than 0°C and less than or equal to the ambient dew-point temperature, thereby ensuring timely defrosting when frost is formed, preventing defrosting when no frost is formed, reducing energy consumption, and extending a service life of the air conditioner.

[0016] To achieve the above objectives, the present disclosure further provides an air conditioner. The air conditioner is coupled to one or more humidity detecting elements configured to detect outdoor humidity or outdoor relative humidity and one or more temperature detecting elements configured to detect outdoor temperature and temperature of an outdoor heat exchanger. The air conditioner includes: a memory, a processor and a program for controlling a defrosting of the air conditioner. The program is stored on the memory and operable on the processor. The program, when executed by the processor, is configured to implement the acts of any one of the methods for controlling a defrosting of an air conditioner described above.

[0017] To achieve the above objectives, the present disclosure further provides a computer-readable storage medium, configured to store a program for controlling a defrosting of an air conditioner, in which the acts of any one of the methods for controlling a defrosting of an air conditioner described above are implemented when the program is executed by a processor.

[0018] The main objective of the present disclosure is to provide a method for controlling a defrosting of an air conditioner, aiming at realizing reasonable defrosting control for the air conditioner.

[0019] To achieve the above objectives, the method for controlling a defrosting of an air conditioner proposed by the

present disclosure includes:

obtaining, a current outdoor relative humidity, a current outdoor temperature and a current temperature of an outdoor heat exchanger;
detecting a continuous operating duration of the air conditioner under the current outdoor relative humidity;
determining, according to the current outdoor relative humidity, the current outdoor temperature, the current temperature of the outdoor heat exchanger and the continuous operating duration, whether the outdoor heat exchanger meets a predetermined defrosting condition; and
defrosting the outdoor heat exchanger in response to the outdoor heat exchanger meeting the predetermined frosting condition.

[0020] Preferably, the determining, according to the current outdoor relative humidity, the current outdoor temperature, the current temperature of the outdoor heat exchanger and the continuous operating duration, whether the outdoor heat exchanger meets the predetermined defrosting condition, includes:

determining, according to the current outdoor relative humidity, the current outdoor temperature, and the current temperature of the outdoor heat exchanger, whether the outdoor heat exchanger meets a predetermined frosting condition;
determining, according to the current outdoor relative humidity and the current temperature of the outdoor heat exchanger, a current frosting period of the outdoor heat exchanger in response to the outdoor heat exchanger meeting the predetermined frosting condition; and
determining, according to the continuous operating duration and the current frosting period , whether the outdoor heat exchanger meets the predetermined defrosting condition.

[0021] Preferably, the defrosting the outdoor heat exchanger in response to the outdoor heat exchanger meeting the predetermined frosting condition, includes:
defrosting the outdoor heat exchanger in response to the continuous operating duration reaching the current frosting period.

[0022] Preferably, before the obtaining the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger, the method further includes:

obtaining, a predetermined data obtaining period;
when obtaining the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger, starting timing; and
obtaining an outdoor relative humidity in a next period, an ambient temperature in the next period and a temperature of the outdoor heat exchanger in the next period in response to a timing duration reaching the data obtaining period.

[0023] Preferably, before the detecting the continuous operating duration of the air conditioner under the current outdoor relative humidity, the method further includes:

determining, whether the outdoor relative humidity in the next period is equal to an outdoor relative humidity in a previous period;
continuously detecting the continuous operating duration of the air conditioner under the current outdoor relative humidity in response to the outdoor relative humidity in the next period being equal to the outdoor relative humidity in the previous period; and
detecting a continuous operating duration of the air conditioner under the outdoor relative humidity in the next period in response to the outdoor relative humidity in the next period being not equal to the outdoor relative humidity in the previous period.

[0024] Preferably, before the determining, according to the continuous operating duration and the current frosting period, whether the outdoor heat exchanger meets the predetermined defrosting condition, the method further include:

obtaining, a frosting period corresponding to each outdoor relative humidity and a continuous operating duration corresponding to each outdoor relative humidity of a current data obtaining period and before the current data obtaining period;
the determining, according to the continuous operating duration and the current frosting period, whether the outdoor heat exchanger meets the predetermined defrosting condition, includes:
determining, according to the continuous operating duration corresponding to each outdoor relative humidity and

the frosting period corresponding to each outdoor relative humidity, whether the outdoor heat exchanger meets the predetermined defrosting condition.

[0025] Preferably, the determining, according to the continuous operating duration corresponding to each outdoor relative humidity and the frosting period corresponding to each outdoor relative humidity, whether the outdoor heat exchanger meets the predetermined defrosting condition, includes:

obtaining, a ratio of the continuous operating duration and the frosting period, corresponding to the same outdoor relative humidity;
obtaining, a sum of the ratio corresponding to each outdoor relative humidity; and
determining, according to whether the sum reaches 1, whether the outdoor heat exchanger meets the predetermined defrosting condition.

[0026] Preferably, the determining, according to the current outdoor relative humidity, the current outdoor temperature, and the current temperature of the outdoor heat exchanger, whether the outdoor heat exchanger meets the predetermined frosting condition, includes:

determining, according to the current outdoor relative humidity and the outdoor heat exchanger, a current frosting critical temperature of the outdoor heat exchanger; and
determining, according to the current frosting critical temperature and the current temperature of the outdoor heat exchanger, whether the outdoor heat exchanger meets the predetermined defrosting condition.

[0027] Preferably, before the obtaining, the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger, the method further includes:

obtaining a current operating state of the air conditioner and determining whether the current operating state of the air conditioner is a heating state; and
obtaining the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger in response to the current operating state of the air conditioner being the heating state.

[0028] To achieve the above objectives, the present disclosure further provides an air conditioner. The air conditioner is coupled to one or more humidity detecting elements configured to detect outdoor humidity or outdoor relative humidity and one or more temperature detecting elements configured to detect outdoor temperature and temperature of an outdoor heat exchanger. The air conditioner includes: a memory, a processor and a program for controlling a defrosting of the air conditioner. The program is stored on the memory and operable on the processor. The program, when executed by the processor, is configured to implement the acts of any one of the methods for controlling a defrosting of an air conditioner described above.

[0029] To achieve the above objectives, the present disclosure further provides a computer-readable storage medium, configured to store a program for controlling a defrosting of an air conditioner, in which the acts of any one of the methods for controlling a defrosting of an air conditioner described above are implemented when the program is executed by a processor.

[0030] In the technical solutions of the present disclosure, parameters related to the frosting of the outdoor heat exchanger in the operation process of the air conditioner may be determined via obtaining the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger. Therefore, based on these parameters and the continuous operating duration of the air conditioner under the current outdoor relative humidity, it may be determined whether the outdoor heat exchanger meets the predetermined defrosting condition. When the outdoor heat exchanger meets the predetermined frosting condition, the operation of defrosting the outdoor heat exchanger may be started. It is helpful to realize reasonable defrosting control of the air conditioner, by determining whether to defrost the outdoor heat exchanger based on parameters related to the frosting of the outdoor heat exchanger in the operation process of the air conditioner and the continuous operating duration of the air conditioner under the current outdoor humidity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] In order to clearly illustrate embodiments of the present disclosure or technical solutions in the related art, a brief description of drawings used in embodiments or in the related art descriptions is given below. Obviously, the drawings in the following descriptions are only part embodiments of the present disclosure, and for those skilled in the art, other drawings can be obtained according to these drawings without creative labor.

FIG. 1 is a flow chart illustrating a method for controlling a defrosting of an air conditioner according to a first embodiment of the present disclosure;
FIG. 2 is a flow chart illustrating a method for controlling a defrosting of an air conditioner according to a second embodiment of the present disclosure;
FIG. 3 is a flow chart illustrating a method for controlling a defrosting of an air conditioner according to a third embodiment of the present disclosure;
FIG. 4 is a flow chart illustrating acts in block S40 in a method for controlling a defrosting of an air conditioner according to an embodiment of the present disclosure;
FIG. 5 is a block diagram illustrating a device for controlling a defrosting of an air conditioner according to a first embodiment of the present disclosure;
FIG. 6 is a block diagram illustrating a device for controlling a defrosting of an air conditioner according to a second embodiment of the present disclosure;
FIG. 7 is a block diagram illustrating a device for controlling a defrosting of an air conditioner according to a third embodiment of the present disclosure;
FIG. 8 is a block diagram illustrating a control module in a device for controlling a defrosting of an air conditioner according to an embodiment of the present disclosure;
FIG. 9 is a flow chart illustrating a method for controlling a defrosting of an air conditioner according to a first embodiment of the present disclosure;
FIG. 10 is a flow chart illustrating a method for controlling a defrosting of an air conditioner according to a second embodiment of the present disclosure;
FIG. 11 is a flow chart illustrating a method for controlling a defrosting of an air conditioner according to a seventh embodiment of the present disclosure;
FIG. 12 is a flow chart illustrating a method for controlling a defrosting of an air conditioner according to an eighth embodiment of the present disclosure;
FIG. 13 is a flow chart illustrating a method for controlling a defrosting of an air conditioner according to a ninth embodiment of the present disclosure;
FIG. 14 is a schematic diagram illustrating an outdoor unit system of an air conditioner according to an embodiment of the present disclosure;
FIG. 15 is a block diagram illustrating an air conditioner according to an embodiment of the present disclosure.

Reference signs in the drawings:

reference	name	reference	name
1	liquid-side shutoff valve	2	gas-side shutoff valve
3	temperature detecting element	4	humidity detecting element
5	four-way valve	6	high pressure sensor
7	low pressure sensor	8	compressor
9	one-way valve	10	oil-water separator
11	gas-liquid separator	12	outdoor heat exchanger
13	expansion valve		

[0032] The realization, functional characteristics and advantages of the purpose of the present disclosure will be described in detail below with reference to the accompanying drawings and the embodiments.

DETAILED DESCRIPTION

[0033] It will be appreciated that, embodiments described herein are explanatory, serve to explain the present disclosure, and are not construed to limit embodiments of the present disclosure.

[0034] The present disclosure provides a method for controlling a defrosting of an air conditioner. As illustrated in FIG. 1, in an embodiment, the method may include acts in the following blocks.

[0035] At block S101, a refrigerant pressure of a heat exchanger is detected.

[0036] There are an indoor heat exchanger and an outdoor heat exchanger in the air conditioner. In a refrigeration operation, the outdoor heat exchanger acts as a condenser for condensation and the indoor heat exchanger acts as an evaporator for evaporation; in a heating operation, the outdoor heat exchanger acts as an evaporator for evaporation

and the indoor heat exchanger acts as a condenser for condensation. When refrigerating, it needs to defrost an indoor machine and the refrigerant pressure of the indoor heat exchanger is detected. When heating, it needs to defrost an outdoor machine and the refrigerant pressure of the outdoor heat exchanger is detected. In detail, since a drop of the refrigerant pressure on the heat exchanger is not large, one or more pressure sensors may be employed to detect one of an inlet refrigerant pressure, an outlet refrigerant pressure and an intermediate refrigerant pressure of the heat exchanger.

[0037] At block S101, a corresponding saturation temperature is obtained according to the refrigerant pressure of the heat exchanger.

[0038] The saturation temperature refers to the temperature at which liquid and vapor are in a state of dynamic equilibrium, i.e., a state of saturation. At the state of saturation, the temperature of liquid is equal to that of vapor. When the saturation temperature is constant, a saturation pressure is constant; conversely, when the saturation pressure is constant, the saturation temperature is constant. As the pressure increases, a new dynamic equilibrium will be formed at a new temperature. In this embodiment, the corresponding saturation temperature is obtained according to the actually detected refrigerant pressure of the heat exchanger. Compared with directly detecting the temperature of the heat exchanger, the refrigerant pressure of the heat exchanger is less affected by the ambient temperature. Thus, the obtained corresponding saturation temperature is more accurate by detecting the refrigerant pressure of the heat exchanger. The saturation temperature is close to the temperature of the heat exchanger, which may be employed to replace the temperature of the heat exchanger. In detail, when the air conditioner is operating for refrigeration, the indoor corresponding saturation temperature may be obtained according to the detected refrigerant pressure of the indoor heat exchanger; when the air conditioner is operating for heating, the outdoor corresponding saturation temperature may be obtained according to the detected refrigerant pressure of the outdoor heat exchanger.

[0039] At block S103, an ambient dew-point temperature is obtained.

[0040] The ambient dew-point temperature refers to the temperature at which the air cools to saturation under the condition that the water vapor content and pressure do not change, that is, the temperature at which the water vapor in the air changes into dewdrops. When the water vapor in the air has reached saturation, the temperature is the same as the ambient dew-point temperature; when the water vapor does not reach saturation, the temperature is higher than the ambient dew-point temperature, in which the temperature drops to below the dew-point temperature is necessary for condensation. In the embodiment, the current ambient dew-point temperature is obtained to determine whether the water vapor meets a condensation condition. In detail, when the air conditioner is operating for refrigeration, an indoor dew-point temperature is obtained; when the air conditioner is operating for heating, an outdoor dew-point temperature is obtained.

[0041] At block S104, the air conditioner is controlled to enter a defrosting mode in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature.

[0042] After obtaining the saturation temperature and the ambient dew-point temperature, the two are compared, and it is also determined, whether the saturation temperature is less than 0°C. Only when the saturation temperature is less than 0°C, and simultaneously less than or equal to the ambient dew-point temperature, it means that frost phenomenon appear in the heat exchanger of the air conditioner, and the air conditioner is controlled to enter the defrosting mode. Otherwise, the air conditioner is controlled to operate normally, ensuring timely defrosting when frost is formed, preventing defrosting when no frost is formed, reducing energy consumption and extending a service life of the air conditioner.

[0043] It should be noted that, in the embodiments of the present disclosure, the corresponding saturation temperature is obtained according to the refrigerant pressure of the heat exchanger as follows. According to the detected refrigerant pressure of the heat exchanger, the corresponding saturation temperature is obtained by query or calculation.

[0044] From the above, the pressure varies with the saturation temperature. According to the change of the pressure, new equilibrium of liquid and vapor will be formed at a new temperature. In the embodiment, a plurality of saturation temperatures corresponding to a plurality of refrigerant pressures of the heat exchanger may be predetermined. The corresponding saturation temperature may be inquired according to the detected refrigerant pressure of the heat exchanger. Also, a corresponding formula for pressures and saturation temperatures may be set. The corresponding saturation temperature may be calculated according to the detected refrigerant pressure of the heat exchanger.

[0045] Further, as illustrated in FIG. 2, based on the first embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, in a second embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, the act in block S103 includes acts in the following blocks.

[0046] At block S1031, an ambient temperature and an ambient wet-bulb temperature are detected.

[0047] At block S1032, according to the ambient temperature and the ambient wet-bulb temperature, a corresponding ambient dew-point temperature is obtained by query or calculation.

[0048] In the embodiment, the wet-bulb temperature refers to an air temperature when the water vapor in the air reaches saturation under the air state of same enthalpy value. The amount of water vapor in the air is related to the temperature, and the corresponding ambient dew-point temperature may be obtained according to the detected ambient temperature and ambient wet-bulb temperature. In detail, a plurality of ambient dew-point temperatures corresponding

to a plurality of ambient temperatures and a plurality of ambient wet-bulb temperatures may be predetermined. When necessary, the corresponding ambient dew-point temperature may be queried according to the detected ambient temperature and ambient wet-bulb temperature. Also, a corresponding formula of ambient temperatures, ambient wet-bulb temperatures and ambient dew-point temperatures may also be set. The corresponding ambient dew-point temperature may be calculated according to the detected ambient temperature and ambient wet-bulb temperature. When the air conditioner is operating for refrigeration, the indoor temperature and the indoor wet-bulb temperature are detected, and the corresponding indoor dew-point temperature may be obtained by query or calculation according to the detected indoor temperature and indoor wet-bulb temperature; when the air conditioner is operating for heating, the outdoor temperature and the outdoor wet-bulb temperature are detected, and the corresponding outdoor dew-point temperature may be obtained by query or calculation according to the detected outdoor temperature and outdoor wet-bulb temperature.

[0049] Further, as illustrated in FIG. 3, based on the second embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, in a third embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, the method may include acts in the following blocks after the act in block S1032.

[0050] At block S1033, a corresponding frosting critical temperature may be obtained by query according to the ambient temperature and the ambient wet-bulb temperature.

[0051] At block S1034, it is determined whether the corresponding saturation temperature is less than 0°C and less than or equal to the ambient dew-point temperature in response to the ambient dew-point temperature being less than or equal to the frosting critical temperature.

[0052] In the embodiment, after obtaining the corresponding ambient dew-point temperature by query or calculation according to the detected ambient temperature and ambient wet-bulb temperature, the corresponding frosting critical temperature is also obtained by query according to the two temperature values. In detail, a plurality of frosting critical temperatures corresponding to a plurality of ambient temperatures and a plurality of ambient wet-bulb temperatures may be predetermined. When necessary, the corresponding frosting critical temperature may be queried according to the detected ambient temperature and ambient wet-bulb temperature. When the air conditioner is operating for refrigeration, the indoor temperature and the indoor wet-bulb temperature may be detected, and the corresponding indoor frosting critical temperature may be obtained by query according to the detected indoor temperature and indoor wet-bulb temperature. When the air conditioner is operating for heating, the outdoor temperature and the outdoor wet-bulb temperature are detected, and the corresponding outdoor frosting critical temperature may be obtained by query according to the detected outdoor temperature and outdoor wet-bulb temperature. When the ambient dew-point temperature is lower than the frosting critical temperature, it indicates that the frosting condition is reached, and then it is determined a size between the saturation temperature and the ambient dew-point temperature.

[0053] As illustrated in FIG. 4, as a preferred embodiment of the act in block S104 in the method for controlling a defrosting of an air conditioner proposed by the present disclosure, the act in block S104 may include the acts in the following blocks.

[0054] At block S1041, it is determined that the air conditioner starts frost in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature.

[0055] At block S1042, a frosting duration of the air conditioner is accumulated.

[0056] At block S1043, the air conditioner is controlled to enter the defrosting mode in response to the frosting duration being greater than a predetermined duration.

[0057] In the embodiment, the predetermined duration is set. When the saturation temperature is less than 0 °C, and less than or equal to the ambient dew-point temperature, it indicates that the air conditioner begins to frost, and the frosting duration is accumulated. When the frosting duration is greater than the predetermined duration, it indicates that the frosting reaches a certain thickness, and the air conditioner is controlled to enter the defrosting mode, thereby avoiding defrosting as soon as it starts to frost, reducing energy consumption and extending a service life of the air conditioner.

[0058] The present disclosure further provides a device for controlling a defrosting of an air conditioner. As illustrated in FIG. 5, in an embodiment, the device for controlling a defrosting of an air conditioner proposed by the present disclosure includes a first detecting module 10, an obtaining module 20 and a control module 30.

[0059] The first detecting module 10 is configured to detect a refrigerant pressure of a heat exchanger.

[0060] There are an indoor heat exchanger and an outdoor heat exchanger in the air conditioner. In a refrigeration operation, the outdoor heat exchanger acts as a condenser for condensation and the indoor heat exchanger acts as an evaporator for evaporation; in a heating operation, the outdoor heat exchanger acts as an evaporator for evaporation and the indoor heat exchanger acts as a condenser for condensation. When refrigerating, it needs to defrost an indoor machine and the refrigerant pressure of the indoor heat exchanger is detected. When heating, it needs to defrost an outdoor machine and the refrigerant pressure of the outdoor heat exchanger is detected. In detail, since a drop of the refrigerant pressure on the heat exchanger is not large, one or more pressure sensors may be employed to detect one of an inlet refrigerant pressure, an outlet refrigerant pressure and an intermediate refrigerant pressure of the heat

exchanger.

[0061] The obtaining module 20 is configured to, according to the refrigerant pressure of the heat exchanger, obtain a corresponding saturation temperature.

[0062] The saturation temperature refers to the temperature at which liquid and vapor are in a state of dynamic equilibrium, i.e., a state of saturation. At the state of saturation, the temperature of liquid is equal to that of vapor. When the saturation temperature is constant, a saturation pressure is constant; conversely, when the saturation pressure is constant, the saturation temperature is constant. As the pressure increases, a new dynamic equilibrium will be formed at a new temperature. In this embodiment, the corresponding saturation temperature is obtained according to the actually detected refrigerant pressure of the heat exchanger. Compared with directly detecting the temperature of the heat exchanger, the refrigerant pressure of the heat exchanger is less affected by the ambient temperature. Thus, the obtained corresponding saturation temperature is more accurate by detecting the refrigerant pressure of the heat exchanger. The saturation temperature is close to the temperature of the heat exchanger, which may be employed to replace the temperature of the heat exchanger. In detail, when the air conditioner is operating for refrigeration, the indoor corresponding saturation temperature may be obtained according to the detected refrigerant pressure of the indoor heat exchanger; when the air conditioner is operating for heating, the outdoor corresponding saturation temperature may be obtained according to the detected refrigerant pressure of the outdoor heat exchanger.

[0063] The obtaining module 20 is further configured to obtain an ambient dew-point temperature.

[0064] The ambient dew-point temperature refers to the temperature at which the air cools to saturation under the condition that the water vapor content and pressure do not change, that is, the temperature at which the water vapor in the air changes into dewdrops. When the water vapor in the air has reached saturation, the temperature is the same as the ambient dew-point temperature; when the water vapor does not reach saturation, the temperature is higher than the ambient dew-point temperature, in which the temperature drops to below the dew-point temperature is necessary for condensation. In the embodiment, the current ambient dew-point temperature is obtained to determine whether the water vapor meets a condensation condition. In detail, when the air conditioner is operating for refrigeration, an indoor dew-point temperature is obtained; when the air conditioner is operating for heating, an outdoor dew-point temperature is obtained.

[0065] The control module 30 is configured to, control the air conditioner to enter a defrosting mode in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature.

[0066] After obtaining the saturation temperature and the ambient dew-point temperature, the two are compared, and it is also determined, whether the saturation temperature is less than 0°C. Only when the saturation temperature is less than 0°C, and simultaneously less than or equal to the ambient dew-point temperature, it means that frost phenomenon appear in the heat exchanger of the air conditioner, and the air conditioner is controlled to enter the defrosting mode. Otherwise, the air conditioner is controlled to operate normally, ensuring timely defrosting when frost is formed, preventing defrosting when no frost is formed, reducing energy consumption and extending a service life of the air conditioner.

[0067] It should be noted that, the obtaining module 20 in the present disclosure, is configured to, according to the refrigerant pressure of the heat exchanger, obtain a corresponding saturation temperature by query or calculation.

[0068] From the above, the pressure varies with the saturation temperature. According to the change of the pressure, new equilibrium of liquid and vapor will be formed at a new temperature. In the embodiment, a plurality of saturation temperatures corresponding to a plurality of refrigerant pressures of the heat exchanger may be predetermined. The corresponding saturation temperature may be inquired according to the detected refrigerant pressure of the heat exchanger. Also, a corresponding formula for pressures and saturation temperatures may be set. The corresponding saturation temperature may be calculated according to the detected refrigerant pressure of the heat exchanger.

[0069] Further, as illustrated in FIG. 6, based on the second embodiment of the device for controlling a defrosting of an air conditioner proposed by the present disclosure, in a third embodiment of the device for controlling a defrosting of an air conditioner proposed by the present disclosure, the device further includes a second detecting module 40. The second detecting module 40 is configured to detect the ambient temperature and the ambient wet-bulb temperature.

[0070] The obtaining module 20 is configured to obtain, according to the ambient temperature and the ambient wet-bulb temperature, a corresponding ambient dew-point temperature by query or calculation.

[0071] In the embodiment, the wet-bulb temperature refers to an air temperature when the water vapor in the air reaches saturation under the air state of same enthalpy value. The amount of water vapor in the air is related to the temperature, and the corresponding ambient dew-point temperature may be obtained according to the detected ambient temperature and ambient wet-bulb temperature. In detail, a plurality of ambient dew-point temperatures corresponding to a plurality of ambient temperatures and a plurality of ambient wet-bulb temperatures may be predetermined. When necessary, the corresponding ambient dew-point temperature may be queried according to the detected ambient temperature and ambient wet-bulb temperature. Also, a corresponding formula of ambient temperatures, ambient wet-bulb temperatures and ambient dew-point temperatures may also be set. The corresponding ambient dew-point temperature may be calculated according to the detected ambient temperature and ambient wet-bulb temperature. When the air

conditioner is operating for refrigeration, the indoor temperature and the indoor wet-bulb temperature are detected, and the corresponding indoor dew-point temperature may be obtained by query or calculation according to the detected indoor temperature and indoor wet-bulb temperature; when the air conditioner is operating for heating, the outdoor temperature and the outdoor wet-bulb temperature are detected, and the corresponding outdoor dew-point temperature may be obtained by query or calculation according to the detected outdoor temperature and outdoor wet-bulb temperature.

[0072] Further, as illustrated in FIG. 7, based on the second embodiment of the device for controlling a defrosting of an air conditioner proposed by the present disclosure, in a third embodiment of the device for controlling a defrosting of an air conditioner proposed by the present disclosure, the obtaining module 20 is further configured to, obtain a corresponding frosting critical temperature by query according to the ambient temperature and the ambient wet-bulb temperature.

[0073] The device further includes a performing module 50. The performing module 50 is configured to, determine whether the corresponding saturation temperature is less than 0°C and less than or equal to the ambient dew-point temperature in response to the ambient dew-point temperature being less than or equal to the frosting critical temperature.

[0074] In the embodiment, after obtaining the corresponding ambient dew-point temperature by query or calculation according to the detected ambient temperature and ambient wet-bulb temperature, the corresponding frosting critical temperature is also obtained by query according to the two temperature values. In detail, a plurality of frosting critical temperatures corresponding to a plurality of ambient temperatures and a plurality of ambient wet-bulb temperatures may be predetermined. When necessary, the corresponding frosting critical temperature may be queried according to the detected ambient temperature and ambient wet-bulb temperature. When the air conditioner is operating for refrigeration, the indoor temperature and the indoor wet-bulb temperature may be detected, and the corresponding indoor frosting critical temperature may be obtained by query according to the detected indoor temperature and indoor wet-bulb temperature. When the air conditioner is operating for heating, the outdoor temperature and the outdoor wet-bulb temperature are detected, and the corresponding outdoor frosting critical temperature may be obtained by query according to the detected outdoor temperature and outdoor wet-bulb temperature. When the ambient dew-point temperature is lower than the frosting critical temperature, it indicates that the frosting condition is reached, and then it is determined a size between the saturation temperature and the ambient dew-point temperature.

[0075] Further, as illustrated in FIG. 8, the control module 30 of the device for controlling a defrosting of an air conditioner proposed by the present disclosure, includes: a frost determining unit 31, a time accumulating unit 32 and a control unit 33.

[0076] The frost determining unit 31 is configured to, determine that the air conditioner starts frost in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature.

[0077] The time accumulating unit 32 is configured to accumulate a frosting duration of the air conditioner.

[0078] The control unit 33 is configured to control the air conditioner to enter the defrosting mode in response to the frosting duration being greater than a predetermined duration.

[0079] In the embodiment, the predetermined duration is set. When the saturation temperature is less than 0 °C, and less than or equal to the ambient dew-point temperature, it indicates that the air conditioner begins to frost, and the frosting duration is accumulated. When the frosting duration is greater than the predetermined duration, it indicates that the frosting reaches a certain thickness, and the air conditioner is controlled to enter the defrosting mode, thereby avoiding defrosting as soon as it starts to frost, reducing energy consumption and extending a service life of the air conditioner.

[0080] It will be appreciated that, embodiments described herein are explanatory, serve to explain the present disclosure, and are not construed to limit embodiments of the present disclosure.

[0081] As illustrated in FIG. 9, to achieve the above objectives, the method for controlling a defrosting of an air conditioner is proposed by the present disclosure, which includes acts in the following blocks.

[0082] At block S201, a current outdoor relative humidity, a current outdoor temperature and a current temperature of an outdoor heat exchanger are obtained.

[0083] At block S202, a continuous operating duration of the air conditioner under the current outdoor relative humidity is detected.

[0084] At block S203, according to the current outdoor relative humidity, the current outdoor temperature, the current temperature of the outdoor heat exchanger and the continuous operating duration, it is determined whether the outdoor heat exchanger meets a predetermined defrosting condition.

[0085] At block S204, the outdoor heat exchanger is defrosted in response to the outdoor heat exchanger meeting the predetermined frosting condition.

[0086] In the technical solutions of the present disclosure, parameters related to the frosting of the outdoor heat exchanger in the operation process of the air conditioner may be determined via obtaining the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger. Therefore, based on these parameters and the continuous operating duration of the air conditioner under the current outdoor relative humidity, it may be determined whether the outdoor heat exchanger meets the predetermined defrosting condition. When the outdoor heat exchanger meets the predetermined frosting condition, the operation of defrosting the outdoor heat

exchanger may be started. It is helpful to realize reasonable defrosting control of the air conditioner, by determining whether to defrost the outdoor heat exchanger based on parameters related to the frosting of the outdoor heat exchanger in the operation process of the air conditioner and the continuous operating duration of the air conditioner under the current outdoor humidity.

[0087] The outdoor relative humidity may be measured by a relative humidity detecting element, or by conversion or table look-up based on the humidity measured by a humidity measuring device. The outdoor temperature and the temperature of the outdoor heat exchanger may be measured by setting corresponding temperature detection elements. In the embodiment, a wet-bulb temperature and a dry-bulb temperature may be measured by a psychrometer, the dry-bulb temperature refers to the outdoor temperature, and the outdoor relative humidity may be obtained through the outdoor temperature and the wet-bulb temperature.

[0088] In the mode of heating, the temperature of the outdoor heat exchanger of the air conditioner is usually below 0°C, and in the mode of refrigeration, the temperature of the outdoor heat exchanger of the air conditioner is usually above 30°C. Therefore, it may be determined whether the air conditioner is in the mode of heating according to the current temperature of the outdoor heat exchanger. If the air conditioner is in the mode of heating, it is necessary to further determine whether the outdoor heat exchanger should be defrosted, in which the determining may be based on: the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger. The above three parameters may be employed to determine whether the outdoor heat exchanger has reached the frosting condition, and further according to the continuous operating duration to determine whether it is necessary to defrost the outdoor heat exchanger.

[0089] It is easy to understand that, the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger all meet the certain frosting condition, and it lasts for a certain duration, which will lead to a frosting result of the outdoor heat exchanger. Therefore, detecting the continuous operating duration of the air conditioner under the current outdoor relative humidity is helpful to determine the duration appropriate to frost. According to the appropriate frosting condition and the continuous operating duration of the frosting condition, it may be determined whether it is necessary to defrost the outdoor heat exchanger.

[0090] As illustrated in FIG. 10, based on the first embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, in a second embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, the act in block S203 includes the acts in the following blocks.

[0091] At block S2031, it is determined, according to the current outdoor relative humidity, the current outdoor temperature, and the current temperature of the outdoor heat exchanger, whether the outdoor heat exchanger meets a predetermined frosting condition.

[0092] At block S2032, it is determined, according to the current outdoor relative humidity and the current temperature of the outdoor heat exchanger, a current frosting period of the outdoor heat exchanger in response to the outdoor heat exchanger meeting the predetermined frosting condition.

[0093] At block S2033, it is determined, according to the continuous operating duration and the current frosting period, whether the outdoor heat exchanger meets the predetermined defrosting condition.

[0094] According to the outdoor temperature, the outdoor relative humidity and the current temperature of the outdoor heat exchanger, the possibility of frosting of the outdoor heat exchanger may be determined. For instance, when the temperature of the outdoor heat exchanger is more than 0 °C, it may be considered that the outdoor heat exchanger does not reach the frosting condition. When the temperature of the outdoor heat exchanger is below 0 °C, further combining with the outdoor temperature and the outdoor relative humidity, it may be determined whether the outdoor heat exchanger reaches the frosting condition.

[0095] The current frosting period of the outdoor heat exchanger may be determined according to the current outdoor relative humidity and the current temperature of the outdoor heat exchanger. Under the condition that the temperature of the outdoor heat exchanger is suitable for frosting, the higher the outdoor relative humidity is, the shorter the frosting period is, whereas, the lower the outdoor relative humidity is, the longer the frosting period is. A mapping table may be stored in the system, in which there is a one-to-one correspondence between the outdoor relative humidity and the frosting period. After obtaining the outdoor relative humidity, the corresponding frosting period may be determined according to the mapping relation table.

[0096] It is easy to understand that, it is determined whether the outdoor heat exchanger is frosted by comparing the continuous operating duration of the outdoor heat exchanger under the frosting condition with the frosting period, which is helpful to determine whether it is necessary to start defrosting the outdoor heat exchanger.

[0097] Based on the second embodiment of the method for defrosting an air conditioner of the present disclosure, in a third embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, the act in block S204 further includes acts in the following blocks.

[0098] At block S2041, the outdoor heat exchanger is defrosted in response to the continuous operating duration reaching the current frosting period.

[0099] For instance, between 12:00 and 12:15, the system operates at 90% relative humidity, and the frosting period

T1 corresponding to the relative humidity is 45min. Due to the continuous operating duration is 15min, it does not reach the frosting period. Therefore, it is determined that the system is not frosting, and defrosting control cannot be performed. At this point, the continuous operating duration of the air conditioner under the current outdoor relative humidity is detected unceasingly. When the continuous operating duration reaches 45min, defrosting is controlled to start.

[0100] Certainly, defrosting the outdoor heat exchanger when the continuous operating duration does not reach the current frosting period is also included in the protection scope of the present disclosure.

[0101] Based on the second embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, in a fourth embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, before the act in block S204, the method further includes acts in the following blocks.

[0102] At block S205, a predetermined data obtaining period is obtained.

[0103] When the act in block S201 is performed, the act in block S206 is performed, and it starts timing.

[0104] At block S206, an outdoor relative humidity in a next period, an ambient temperature in the next period and a temperature of the outdoor heat exchanger in the next period are obtained as the act in block S101, in response to a timing duration reaching the data obtaining period.

[0105] The previous period and the next period in this disclosure refer to two adjacent data obtaining periods. As the outdoor temperature and the temperature of the outdoor heat exchanger are constantly changing, the frosting period will also be constantly changing. Therefore, defrosting control may not achieve the optimal effect by only measuring the outdoor temperature and the temperature of the outdoor heat exchanger one time and detecting the continuous operating duration of the air conditioner under the two parameters. In order to improve the accuracy of defrosting control, the outdoor relative humidity, the outdoor temperature and the temperature of the outdoor heat exchanger may be obtained periodically. Thus, the system may detect the change of frosting conditions in time and quickly adjust the timing of defrosting control.

[0106] It is easy to understand that, a short data obtaining period is conducive to timely sensing the changes in frost conditions, so as to perform defrosting control timely and effectively. For instance, the data obtaining period may be less than 5min. Of course, the data obtaining period should not be too short.

[0107] Based on the fourth embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, in a fifth embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, before the act in block S202, the method further includes acts in the following blocks.

[0108] At block S208, it is determined, whether the outdoor relative humidity in the next period is equal to an outdoor relative humidity in a previous period.

[0109] At block S2081, the act in block S202 is performed continuously in response to the outdoor relative humidity in the next period being equal to the outdoor relative humidity in the previous period.

[0110] At block S2082, a continuous operating duration of the air conditioner under the outdoor relative humidity in the next period is detected as the act in block S202 in response to the outdoor relative humidity in the next period being not equal to the outdoor relative humidity in the previous period.

[0111] It may be determined whether it is necessary to accumulate the operating duration of the air conditioner under the previous outdoor relative humidity by determining whether the outdoor relative humidity in the next period is equal to the outdoor relative humidity in the previous period. When the outdoor relative humidity data in two adjacent periods are equal, the continuous operating period under the relative humidity data may be accumulated. When the outdoor relative humidity data in two adjacent periods are not equal, the continuous operating duration under the outdoor relative humidity in the previous period is stored, and the continuous operating duration of the air conditioner in the next period under the outdoor relative humidity in the next period may start to detect.

[0112] Certainly, this is only one implementation of detecting the continuous operating period of the air conditioner under the current outdoor relative humidity. In this implementation, the accumulated amount in time is the length of the data obtaining period.

[0113] In practical applications, a timer may be employed for data obtaining control, and another timer is employed to detect the continuous operating duration of the air conditioner under the current outdoor relative humidity.

[0114] Based on the fifth embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, in a sixth embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, before the act in block S2033, the method further includes acts in the following blocks.

[0115] At block S209, a frosting period corresponding to each outdoor relative humidity and a continuous operating duration corresponding to each outdoor relative humidity of a current data obtaining period and before the current data obtaining period are obtained.

[0116] The act in block S2033 includes the act in the following block.

[0117] At block S2033a, according to the continuous operating duration corresponding to each outdoor relative humidity and the frosting period corresponding to each outdoor relative humidity, it is determined whether the outdoor heat exchanger meets the predetermined defrosting condition.

[0118] Obtaining the outdoor relative humidity, the outdoor temperature and the temperature of the outdoor heat

exchanger according to the predetermined data obtaining period, it is helpful to determine the frosting period corresponding to the outdoor relative humidity according to the outdoor relative humidity obtained in each data obtaining period.

[0119] For instance, when the data obtaining period t is 5min, data obtaining is entered from 12:00. At 12:00-12:15, the system operates at 90% relative humidity, and the frosting period T1, corresponding to this relative humidity, is 45min. When the timing duration reaches the second data obtaining period (this time is 12:05), the continuous operating duration t1 of the system is only 5min, which does not reach the frosting period T1 corresponding to the relative humidity. Thus, defrosting control is not performed and data in the second round are obtained directly. Due to the outdoor relative data obtained in the second round remain unchanged, the continuous operating duration t1 may be continued to be accumulated until the fourth data obtaining period (this time is 12:15) is reached. The system detects that the relative humidity data has changed (at this time, the relative humidity data is 80%), and the accumulation of the continuous operating duration t1 may be stopped. The continuous operating duration t2 of the air conditioner under 80% relative humidity is accumulated.

[0120] At 12:15-12:35, the system operates at 80% relative humidity, which corresponds to the frosting period T2 of 60min. In order to continuously determine whether the air conditioner meets the defrosting condition, the first frosting period T1 and the continuous operating duration t1 under 90% relative humidity need to be obtained and stored, and the second frosting period T2 and the continuous operating duration t2 under 80% relative humidity need to be obtained and stored.

[0121] Based on the sixth embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, in a seventh embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, the act in block S2033a includes acts in the following blocks.

[0122] At block S2033b, a ratio of the continuous operating duration and the frosting period, corresponding to the same outdoor relative humidity, is obtained.

[0123] At block S2033c, a sum of the ratio corresponding to each outdoor relative humidity is obtained.

[0124] At block S2033d, it is determined, according to whether the sum reaches 1, whether the outdoor heat exchanger meets the predetermined defrosting condition.

[0125] It should be noted that, since the air conditioner has reached the frosting condition, if the continuous operating duration of the air conditioner under a certain outdoor relative humidity reaches the corresponding frosting period, the defrosting control of the outdoor heat exchanger should be started.

[0126] When the continuous operating duration under the relative humidity does not reach the frosting period, and the relative humidity changes, the system detects the continuous operating duration under the new relative humidity, and also obtain the sum of the ratio corresponding to the each outdoor relative humidity, and determine whether the outdoor heat exchanger meets the predetermined defrost condition according to whether the sum reaches 1. Once the sum reaches 1, the defrosting control of the outdoor heat exchanger needs to be started.

[0127] For instance, assuming that the data obtaining period is 5min, the data is acquired from 12:00 at the first time. At 12:00-12:15, the system operates at 90% relative humidity, and the frosting period T1 corresponding to the relative humidity is 45min. At 12:15-12:35, the system operates at 80% relative humidity, and the frosting period T2 corresponding to the relative humidity is 60min.

[0128] The sum is obtained at the first time as follows:

$5/45=1/9\leq 1$, which does not meet the predetermined defrost condition.

[0129] The sum is obtained at the second time as follows:

$10/45=2/9\leq 1$, which does not meet the predetermined defrost conditions.

[0130] The sum is obtained at the third time as follows:

$15/45=1/3\leq 1$, which does not meet the predetermined defrost condition.

[0131] Since the sum of the first period (12:00-12:15) is not equal to 1, the data obtaining process continues to the second period (12:15-12:35), and the sums are continuously counted.

[0132] The sum is obtained at the fourth time as follows:

$15/45+5/60=5/12\leq 1$, which does not meet the predetermined defrost condition.

...

[0133] The sum is obtained at the eighth time as follows:

$15/45+20/60=2/3 \leq 1$, which still does not meet the predetermined defrost condition.

[0134] Thus, it is necessary to continue to obtain the outdoor relative humidity, the outdoor temperature, the temperature of the outdoor heat exchanger and the continuous operating duration of the next period.

[0135] As illustrated in FIG. 12, based on any one of the second embodiment to the seventh embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, in an eighth embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, the act in block S2031 includes acts in the following blocks.

[0136] At block S2031a, according to the current outdoor relative humidity and the outdoor heat exchanger, a current frosting critical temperature of the outdoor heat exchanger is determined.

[0137] At block S2031b, according to the current frosting critical temperature and the current temperature of the outdoor heat exchanger, it is determined whether the outdoor heat exchanger meets the predetermined defrosting condition.

[0138] The current dew-point temperature may be determined according to the outdoor temperature and the outdoor relative humidity. As long as the temperature of the outdoor heat exchanger is below the dew-point temperature, frosting is possible. The reason why frosting is only possible is that whether frosting or not refers to the continuous operating period of the system under the appropriate frosting condition. In the embodiment, the frosting critical temperatures under different outdoor temperatures and outdoor relative humidity values are stored in the system so that the system may more accurately determine that the outdoor heat exchanger reaches the frosting condition. In the embodiment, preferably, the frosting critical temperature is less than or equal to the dew-point temperature. When the temperature of the outdoor heat exchanger is less than or equal to the critical frosting temperature, it is considered that the outdoor heat exchanger meets the predetermined frosting condition and begins to frost.

[0139] As illustrated in FIG. 13, based on any one of the first embodiment to the seventh embodiment of the method for defrosting an air conditioner proposed by the present disclosure, in a ninth embodiment of the method for controlling a defrosting of an air conditioner proposed by the present disclosure, before the act in block S2031, the method further includes the acts in the following blocks.

[0140] At block S2010, a current operating state of the air conditioner is obtained and it is determined whether the current operating state of the air conditioner is a heating state.

[0141] If the current operating state of the air conditioner is the heating state, the act in block S201 is performed.

[0142] According to the temperature of the outdoor heat exchanger, it may be determined whether the air conditioner is in the heating state. Only when the air conditioner is in the heating state, there is the possibility of frosting of the outdoor heat exchanger, and it is necessary to determine whether defrosting is needed.

[0143] In the embodiment, the current operating state of the air conditioner is obtained. When the current operating state of the air conditioner is the heating state, it is determined whether to start the defrosting control, which makes the method have simple logic and more intuitive. Because of the simple and accurate acts to determine the operating state of the air conditioner, it is not easy to lead to misjudgment.

[0144] The act in block S2010 may set in any sequence prior to the act in block S203. In the embodiment, the act in block S2010 is set before the act in block S201, which is helpful to avoid unnecessary data collection and analysis in refrigeration mode.

[0145] Furthermore, in order to achieve the above objectives, a first embodiment of the present disclosure provides an air conditioner. The air conditioner is connected with a humidity detecting element 4 configured to detect outdoor humidity or outdoor relative humidity, and a temperature detecting element 3 configured to detect outdoor temperature and temperature of an outdoor heat exchanger. The air conditioner also includes a memory, a processor and a program for controlling a defrosting of the air conditioner. The program is stored on the memory and operable on the processor. When the program is executed by the processor, acts of any one of the methods for controlling a defrosting of an air conditioner mentioned above may be implemented.

[0146] As illustrated in FIG. 14, it is a schematic diagram of an embodiment of an outdoor unit system of the air conditioner. The outdoor unit system of the air conditioner includes a liquid-side shutoff valve 1, a gas stop valve 2, a temperature detecting element 3, a humidity detecting element 4, a four-way valve 5, a high pressure sensor 6, a low pressure sensor 7, a compressor system, a one-way valve 9, an oil-water separator 10, a gas-liquid separator 11, an outdoor heat exchanger 12 and an expansion valve 13. Components may be deleted or added on the outdoor unit system of the air conditioner as required.

[0147] The compressor system may be combined by any number of variable frequency compressors and/or constant frequency compressors, to realize the combination of all variable frequency compressors, all constant frequency compressors, or the combination of variable frequency and constant frequency compressors. In the embodiment, the compressor system adopts a constant frequency compressor and a variable frequency compressor in parallel.

[0148] As illustrated in FIG. 15, in some concrete implementations, the air conditioner may include: a processor 1001, such as CPU (Central Processing Unit), a network interface 1004, a user interface 1003, a memory 1005, and a communication bus 1002. The communication bus 1002 is configured to implement connection and communication between these components. The user interface 1003 may include a display, an input unit such as keyboard. An optional user interface 1003 may also include standard wired and wireless interfaces. When in use, the front end obtains data through the user interface 1003. The network interface 1004 optionally may include standard wired interfaces or wireless interfaces (such as Wi-Fi interfaces). The memory 1005 may be either high-speed RAM memory or non-volatile memory, such as disk memory. The memory 1005 optionally may also be a storage device independent of the processor 1001 described above.

[0149] It would be appreciated by those skilled in the art, the terminal is not limited to the structure illustrated in FIG. 7, and it may include more or less parts than is illustrated in the diagram, or may incorporate some parts, or may include different parts arrangements.

[0150] Since the technical solutions of the air conditioner in the embodiment includes at least all the technical solutions

of the above embodiments of the method for controlling a defrosting of an air conditioner, at least all the technical effects of the above embodiments are available, which will not be repeated here.

[0151] It should be noted that herein, the terms "include," "contain," or any other variation thereof, are intended to cover non-exclusive inclusion, thus, a process, a method, an object or a system that includes a series of elements includes not only those elements, but also other elements not explicitly listed, or include elements inherent in the process, method, object, or system. Without more limits, an element limited by a statement of 'including a ...', is not excluded that there are other identical elements in the process, method, object or system that include this element.

[0152] The serial numbers of embodiments of the present disclosure are for the purpose of description only and do not represent the merits or demerits of the embodiments.

[0153] Through the implementation described above, it is appreciated to those skilled in the art that, the above embodiment method may be implemented by means of software plus a required common hardware platform, it can also be done through hardware, but in many cases the former is a better implementation. Based on this understanding, the technical solutions of the present disclosure, in essence, or the part that contributes to the existing technology, can be reflected in the form of software products, the computer software product is stored in a storage medium (such as ROM/RAM, magnetic disk, optical disk) as described above, and includes instructions to enable a terminal device to enter the method described in each embodiment of the disclosure.

[0154] Furthermore, to achieve the above objectives, the present disclosure further provides a computer readable storage medium, configured to store the air conditioner defrosting control program that, when executed by the processor, implement any one of the acts of the method for defrosting an air conditioner described above. Since the technical solutions of the computer readable storage medium in the embodiment includes at least all the technical solutions of the embodiments of the above method for defrosting an air conditioner, therefore at least all the technical effects of the above embodiments are available, which will not be repeated here.

[0155] Embodiments described above are only preferred embodiments of the present disclosure, the scope of the present disclosure should not be limited thereby, the equivalent structure or equivalent process transformation made by using the contents of the specification and the appended drawings of the present disclosure, or directly or indirectly applied in other relevant technical fields, shall be similarly included in the scope of patent protection of the present disclosure.

Claims

1. A method for controlling a defrosting of an air conditioner, comprising:

   detecting, a refrigerant pressure of a heat exchanger or a tube temperature of a heat exchanger;
   obtaining, according to the refrigerant pressure of the heat exchange, a corresponding saturation temperature;
   obtaining an ambient dew-point temperature; and
   controlling the air conditioner to enter a defrosting mode in response to the corresponding saturation temperature or the tube temperature of the heat exchanger being less than 0°C and less than or equal to the ambient dew-point temperature.

2. The method of claim 1, wherein, the obtaining, according to the refrigerant pressure of the heat exchanger, the corresponding saturation temperature, comprises:
   obtaining, according to the refrigerant pressure of the heat exchanger, the corresponding saturation temperature by query or calculation.

3. The method of claim 1 or 2, wherein, the obtaining the ambient dew-point temperature comprises:

   detecting an ambient temperature and an ambient wet-bulb temperature; and
   obtaining, according to the ambient temperature and the ambient wet-bulb temperature, the ambient dew-point temperature by query or calculation.

4. The method of any one of claims 1 to 3, after the obtaining, according to the ambient temperature and the ambient wet-bulb temperature, the ambient dew-point temperature by query or calculation, further comprising:

   obtaining, according to the ambient temperature and the ambient wet-bulb temperature, a corresponding frosting critical temperature by query; and
   determining whether the corresponding saturation temperature is less than 0°C and less than or equal to the ambient dew-point temperature in response to the ambient dew-point temperature being less than or equal to

the frosting critical temperature.

5. The method of any one of claims 1 to 4, wherein, the controlling the air conditioner to enter the defrosting mode in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature, comprises:

determining that the air conditioner starts frost in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature;
accumulating a frosting duration of the air conditioner; and
controlling the air conditioner to enter the defrosting mode in response to the frosting duration being greater than a predetermined duration.

6. A device for controlling a defrosting of an air conditioner, comprising:

a first detecting module, configured to detect a refrigerant pressure of a heat exchanger;
an obtaining module, configured to, according to the refrigerant pressure of the heat exchanger, obtain a corresponding saturation temperature;
the obtaining module, further configured to obtain an ambient dew-point temperature; and
a control module, configured to control the air conditioner to enter a defrosting mode in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature.

7. The device of claim 6, wherein, the obtaining module is configured to, according to the refrigerant pressure of the heat exchanger, obtain the corresponding saturation temperature by query or calculation.

8. The device of claim 6 or 7, further comprising:

a second detecting module, configured to detect an ambient temperature and an ambient wet-bulb temperature;
wherein the obtaining module is configured to, according to the ambient temperature and the ambient wet-bulb temperature, obtain the ambient dew-point temperature by query or calculation.

9. The device of any one of claims 6 to 8, wherein,
the obtaining module, is further configured to, according to the ambient temperature and the ambient wet-bulb temperature, obtain a corresponding frosting critical temperature by query;
the device further comprises:
a performing module, configured to, determine whether the corresponding saturation temperature is less than 0°C and less than or equal to the ambient dew-point temperature in response to the ambient dew-point temperature being less than or equal to the frosting critical temperature.

10. The device of any one of claims 6 to 9, wherein, the control module comprises:

a frost determining unit, configured to, determine that the air conditioner starts frost in response to the corresponding saturation temperature being less than 0°C and less than or equal to the ambient dew-point temperature;
a time accumulating unit, configured to accumulate a frosting duration of the air conditioner; and
a control unit, configured to control the air conditioner to enter the defrosting mode in response to the frosting duration being greater than a predetermined duration.

11. A method for controlling a defrosting of an air conditioner, comprising:

obtaining, a current outdoor relative humidity, a current outdoor temperature and a current temperature of an outdoor heat exchanger;
detecting a continuous operating duration of the air conditioner under the current outdoor relative humidity;
determining, according to the current outdoor relative humidity, the current outdoor temperature, the current temperature of the outdoor heat exchanger and the continuous operating duration, whether the outdoor heat exchanger meets a predetermined defrosting condition; and
defrosting the outdoor heat exchanger in response to the outdoor heat exchanger meeting the predetermined frosting condition.

12. The method of claim 11, wherein, the determining, according to the current outdoor relative humidity, the current outdoor temperature, the current temperature of the outdoor heat exchanger and the continuous operating duration , whether the outdoor heat exchanger meets the predetermined defrosting condition, comprises:

determining, according to the current outdoor relative humidity, the current outdoor temperature, and the current temperature of the outdoor heat exchanger, whether the outdoor heat exchanger meets a predetermined frosting condition;
determining, according to the current outdoor relative humidity and the current temperature of the outdoor heat exchanger, a current frosting period of the outdoor heat exchanger in response to the outdoor heat exchanger meeting the predetermined frosting condition; and
determining, according to the continuous operating duration and the current frosting period, whether the outdoor heat exchanger meets the predetermined defrosting condition.

13. The method of claim 11 or 12, wherein, the defrosting the outdoor heat exchanger in response to the outdoor heat exchanger meeting the predetermined frosting condition, comprises:
defrosting the outdoor heat exchanger in response to the continuous operating duration reaching the current frosting period.

14. The method of any one of claims 11 to 13, before the obtaining, the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger, further comprising:

obtaining, a predetermined data obtaining period;
when obtaining the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger, starting timing; and
obtaining an outdoor relative humidity in a next period, an ambient temperature in the next period and a temperature of the outdoor heat exchanger in the next period in response to a timing duration reaching the data obtaining period.

15. The method of any one of claims 11 to 14, before the detecting the continuous operating duration of the air conditioner under the current outdoor relative humidity, further comprising:

determining, whether the outdoor relative humidity in the next period is equal to an outdoor relative humidity in a previous period;
continuously detecting the continuous operating duration of the air conditioner under the current outdoor relative humidity in response to the outdoor relative humidity in the next period being equal to the outdoor relative humidity in the previous period; and
detecting a continuous operating duration of the air conditioner under the outdoor relative humidity in the next period in response to the outdoor relative humidity in the next period being not equal to the outdoor relative humidity in the previous period.

16. The method of any one of claims 11 to 15, wherein, before the determining, according to the continuous operating duration and the current frosting period, whether the outdoor heat exchanger meets the predetermined defrosting condition, the method further comprises:

obtaining, a frosting period corresponding to each outdoor relative humidity and a continuous operating duration corresponding to each outdoor relative humidity, of a current data obtaining period and before the current data obtaining period;
the determining, according to the continuous operating duration and the current frosting period, whether the outdoor heat exchanger meets the predetermined defrosting condition, comprises:
determining, according to the continuous operating duration corresponding to each outdoor relative humidity and the frosting period corresponding to each outdoor relative humidity, whether the outdoor heat exchanger meets the predetermined defrosting condition.

17. The method of claim 16, wherein, the determining, according to the continuous operating duration corresponding to each outdoor relative humidity and the frosting period corresponding to each outdoor relative humidity, whether the outdoor heat exchanger meets the predetermined defrosting condition, comprises:

obtaining, a ratio of the continuous operating duration and the frosting period, corresponding to the same outdoor

relative humidity;
obtaining, a sum of the ratio corresponding to each outdoor relative humidity; and
determining, according to whether the sum reaches 1, whether the outdoor heat exchanger meets the predetermined defrosting condition.

18. The method of any one of claims 12 to 17, wherein, the determining, according to the current outdoor relative humidity, the current outdoor temperature, and the current temperature of the outdoor heat exchanger, whether the outdoor heat exchanger meets the predetermined frosting condition, comprises:

determining, according to the current outdoor relative humidity and the outdoor heat exchanger, a current frosting critical temperature of the outdoor heat exchanger; and
determining, according to the current frosting critical temperature and the current temperature of the outdoor heat exchanger, whether the outdoor heat exchanger meets the predetermined defrosting condition.

19. The method of any one of claims 11 to 17, before the obtaining, the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger, further comprising:

obtaining a current operating state of the air conditioner and determining whether the current operating state of the air conditioner is a heating state; and
obtaining the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger in response to the current operating state of the air conditioner being the heating state.

20. An air conditioner, coupled to, one or more humidity detecting elements configured to detect outdoor humidity or outdoor relative humidity and one or more temperature detecting elements configured to detect outdoor temperature and temperature of an outdoor heat exchanger; and comprising: a memory, a processor and a program for controlling a defrosting of the air conditioner, the program being stored on the memory and operable on the processor; the program, when executed by the processor, for implementing the method for controlling a defrosting of an air conditioner according to any one of claims 1 to 5.

21. A computer-readable storage medium, configured to store a program for controlling a defrosting of an air conditioner, wherein when the program is executed by a processor, the method for controlling a defrosting of an air conditioner according to any one of claims 1 to 5 is implemented.

22. An air conditioner, coupled to, one or more humidity detecting elements configured to detect outdoor humidity or outdoor relative humidity and one or more temperature detecting elements configured to detect outdoor temperature and temperature of an outdoor heat exchanger; and comprising: a memory, a processor and a program for controlling a defrosting of the air conditioner, the program being stored on the memory and operable on the processor; the program, when executed by the processor, for implementing the method for controlling a defrosting of an air conditioner according to any one of claims 11 to 19.

23. A computer-readable storage medium, configured to store a program for controlling a defrosting of an air conditioner, wherein when the program is executed by a processor, the method for controlling a defrosting of an air conditioner according to any one of claims 11 to 19 is implemented.

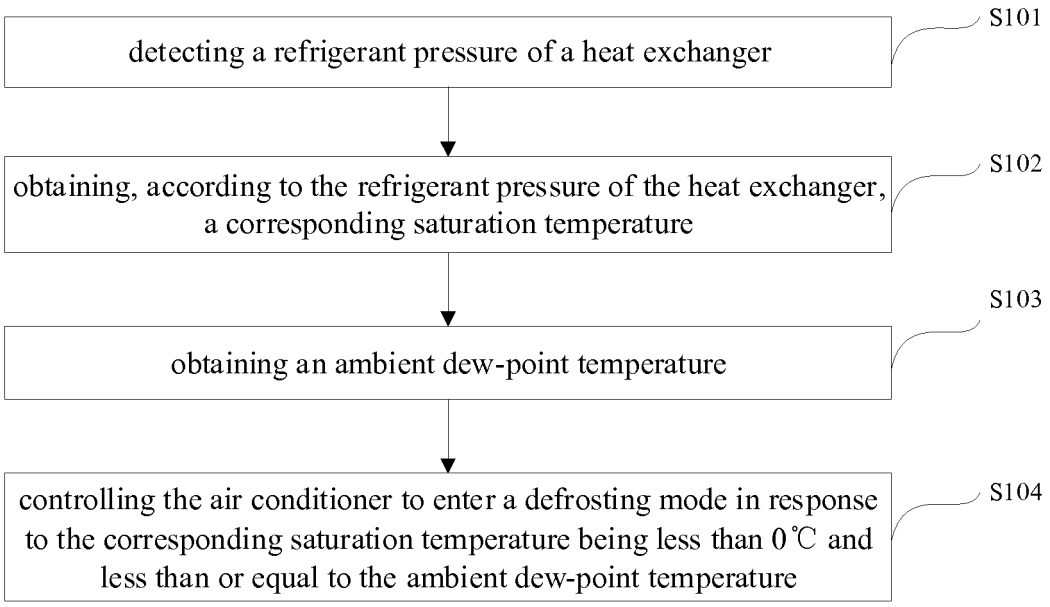

detecting a refrigerant pressure of a heat exchanger
S101
obtaining, according to the refrigerant pressure of the heat exchanger, a corresponding saturation temperature
S102
obtaining an ambient dew-point temperature
S103
controlling the air conditioner to enter a defrosting mode in response to the corresponding saturation temperature being less than 0℃ and less than or equal to the ambient dew-point temperature
S104

FIG. 1

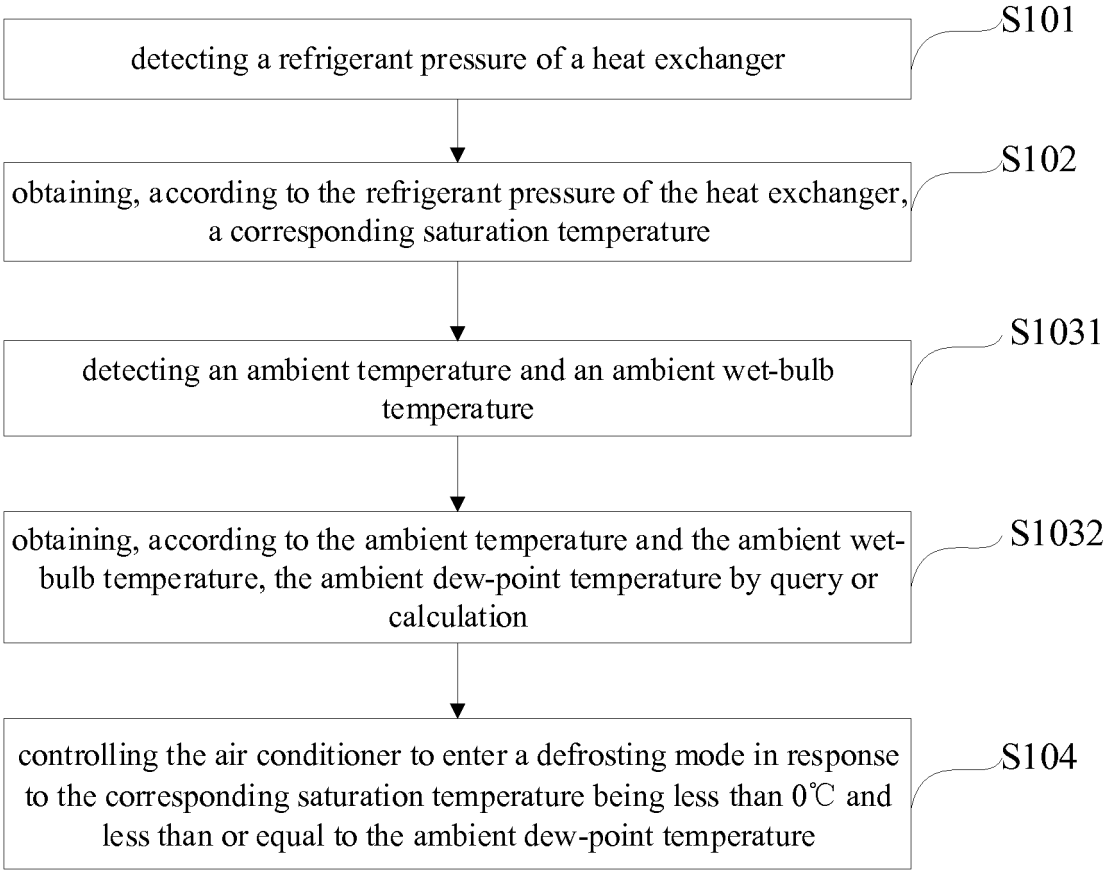

detecting a refrigerant pressure of a heat exchanger
S101
obtaining, according to the refrigerant pressure of the heat exchanger, a corresponding saturation temperature
S102
detecting an ambient temperature and an ambient wet-bulb temperature
S1031
obtaining, according to the ambient temperature and the ambient wet-bulb temperature, the ambient dew-point temperature by query or calculation
S1032
controlling the air conditioner to enter a defrosting mode in response to the corresponding saturation temperature being less than 0℃ and less than or equal to the ambient dew-point temperature
S104

FIG. 2

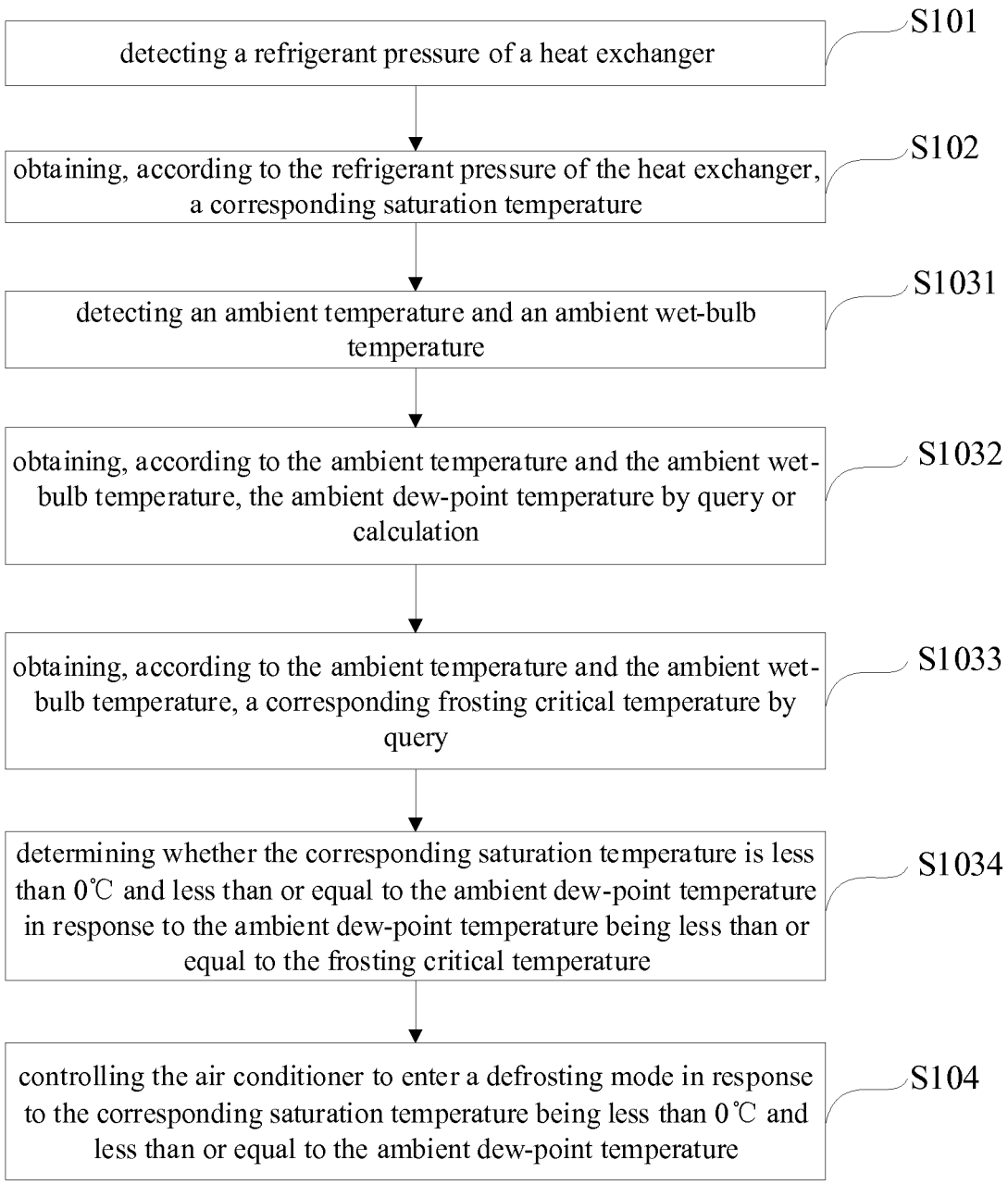

detecting a refrigerant pressure of a heat exchanger
S101
obtaining, according to the refrigerant pressure of the heat exchanger, a corresponding saturation temperature
S102
detecting an ambient temperature and an ambient wet-bulb temperature
S1031
obtaining, according to the ambient temperature and the ambient wet-bulb temperature, the ambient dew-point temperature by query or calculation
S1032
obtaining, according to the ambient temperature and the ambient wet-bulb temperature, a corresponding frosting critical temperature by query
S1033
determining whether the corresponding saturation temperature is less than 0℃ and less than or equal to the ambient dew-point temperature in response to the ambient dew-point temperature being less than or equal to the frosting critical temperature
S1034
controlling the air conditioner to enter a defrosting mode in response to the corresponding saturation temperature being less than 0℃ and less than or equal to the ambient dew-point temperature
S104

FIG. 3

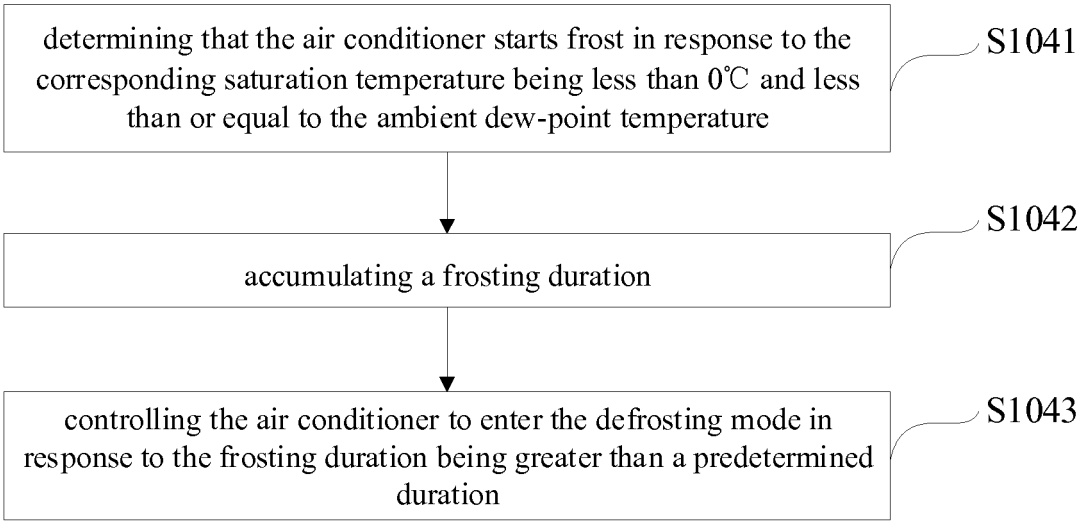

determining that the air conditioner starts frost in response to the corresponding saturation temperature being less than 0℃ and less than or equal to the ambient dew-point temperature
S1041
accumulating a frosting duration
S1042
controlling the air conditioner to enter the defrosting mode in response to the frosting duration being greater than a predetermined duration
S1043

FIG. 4

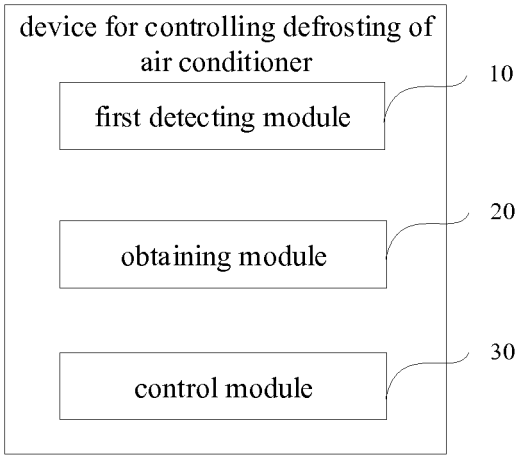

device for controlling defrosting of air conditioner
first detecting module
10
obtaining module
20
control module
30

FIG. 5

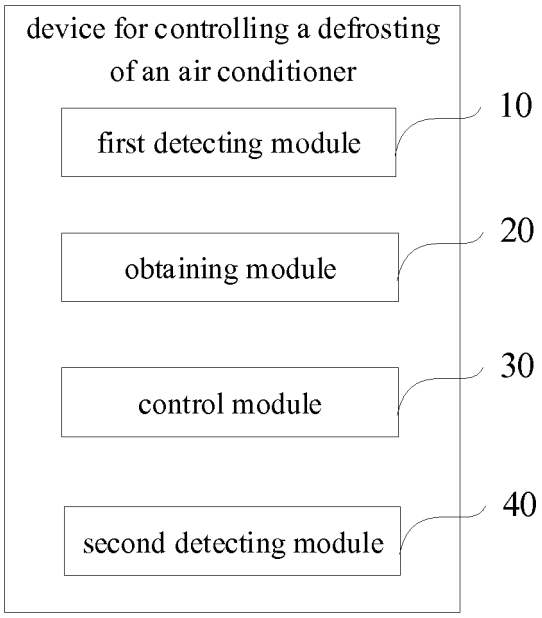

device for controlling a defrosting of an air conditioner
first detecting module
10
obtaining module
20
control module
30
second detecting module
40

FIG. 6

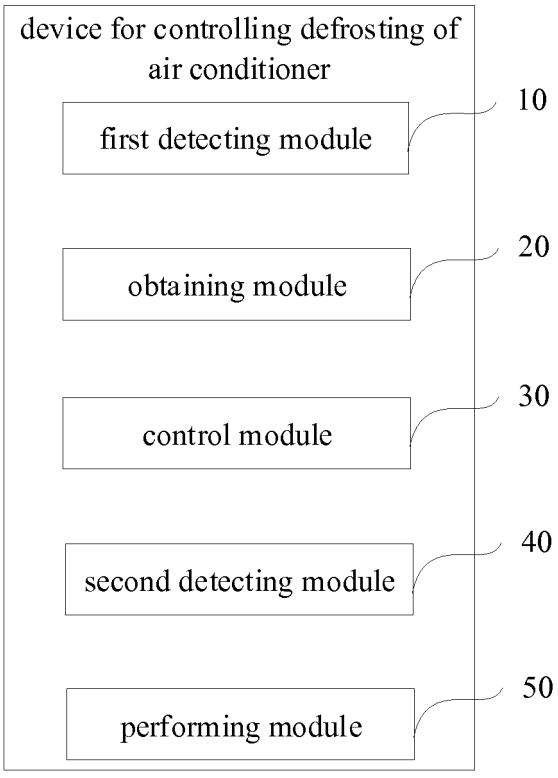

device for controlling defrosting of air conditioner
first detecting module
10
obtaining module
20
control module
30
second detecting module
40
performing module
50

FIG. 7

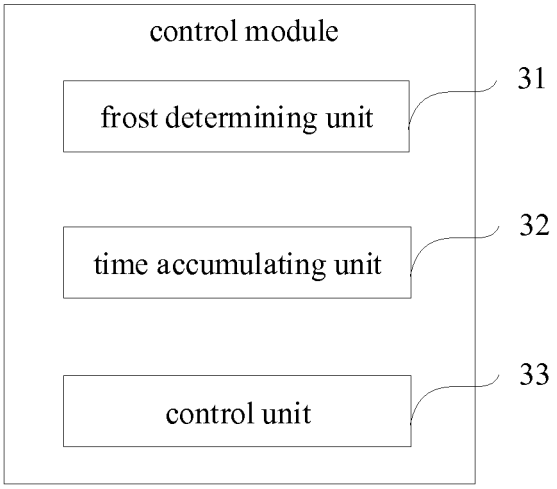

control module
frost determining unit
31
time accumulating unit
32
control unit
33

FIG. 8

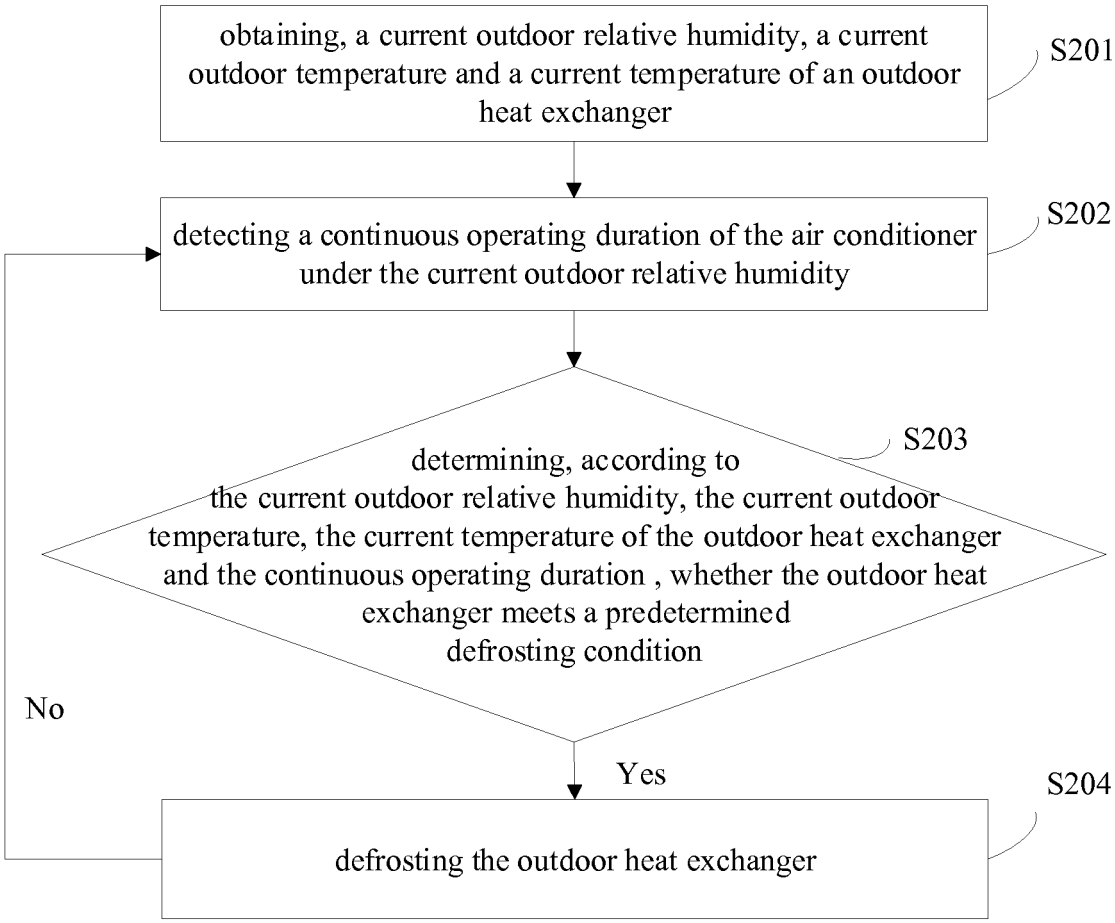

obtaining, a current outdoor relative humidity, a current outdoor temperature and a current temperature of an outdoor heat exchanger
S201
detecting a continuous operating duration of the air conditioner under the current outdoor relative humidity
S202
determining, according to the current outdoor relative humidity, the current outdoor temperature, the current temperature of the outdoor heat exchanger and the continuous operating duration , whether the outdoor heat exchanger meets a predetermined defrosting condition
S203
No
Yes
defrosting the outdoor heat exchanger
S204

FIG. 9

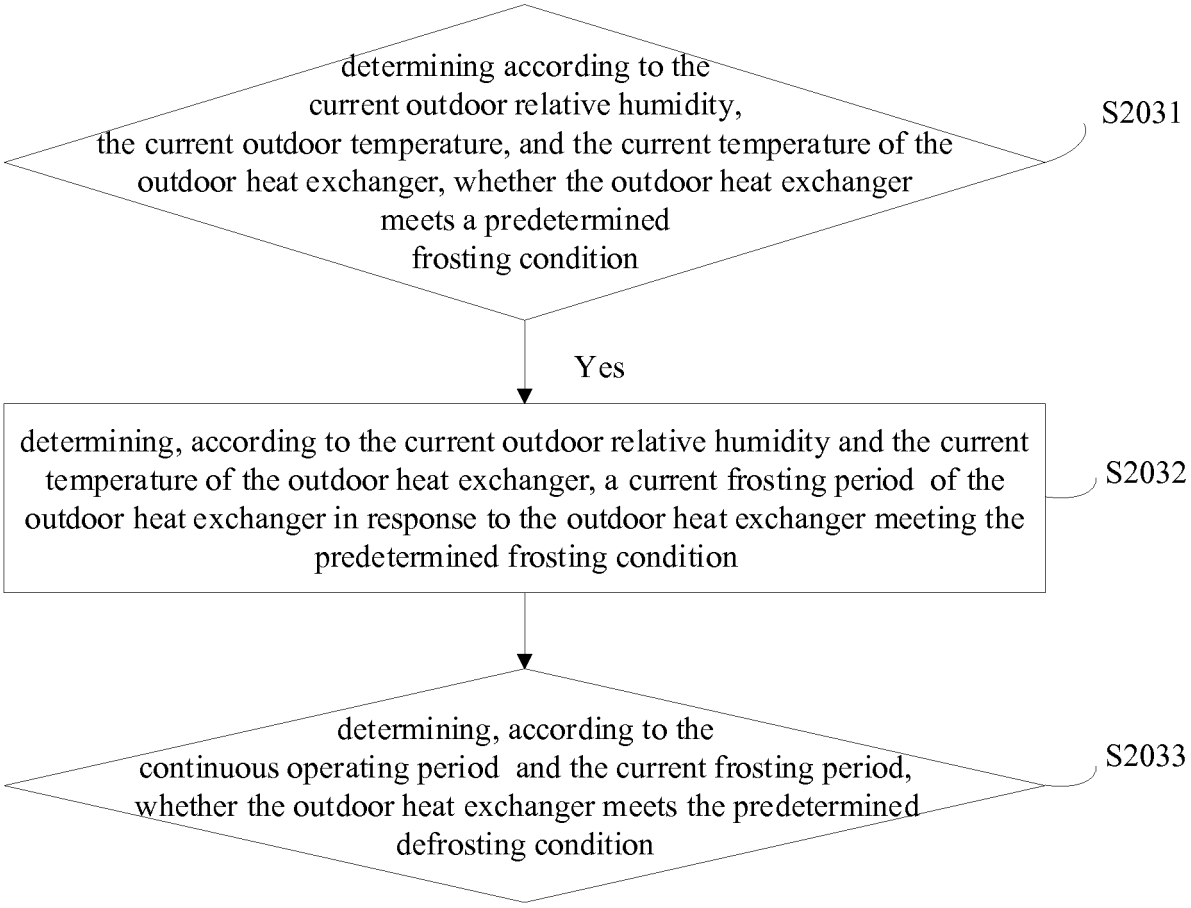

determining according to the current outdoor relative humidity, the current outdoor temperature, and the current temperature of the outdoor heat exchanger, whether the outdoor heat exchanger meets a predetermined frosting condition
S2031
Yes
determining, according to the current outdoor relative humidity and the current temperature of the outdoor heat exchanger, a current frosting period of the outdoor heat exchanger in response to the outdoor heat exchanger meeting the predetermined frosting condition
S2032
determining, according to the continuous operating period and the current frosting period, whether the outdoor heat exchanger meets the predetermined defrosting condition
S2033

FIG. 10

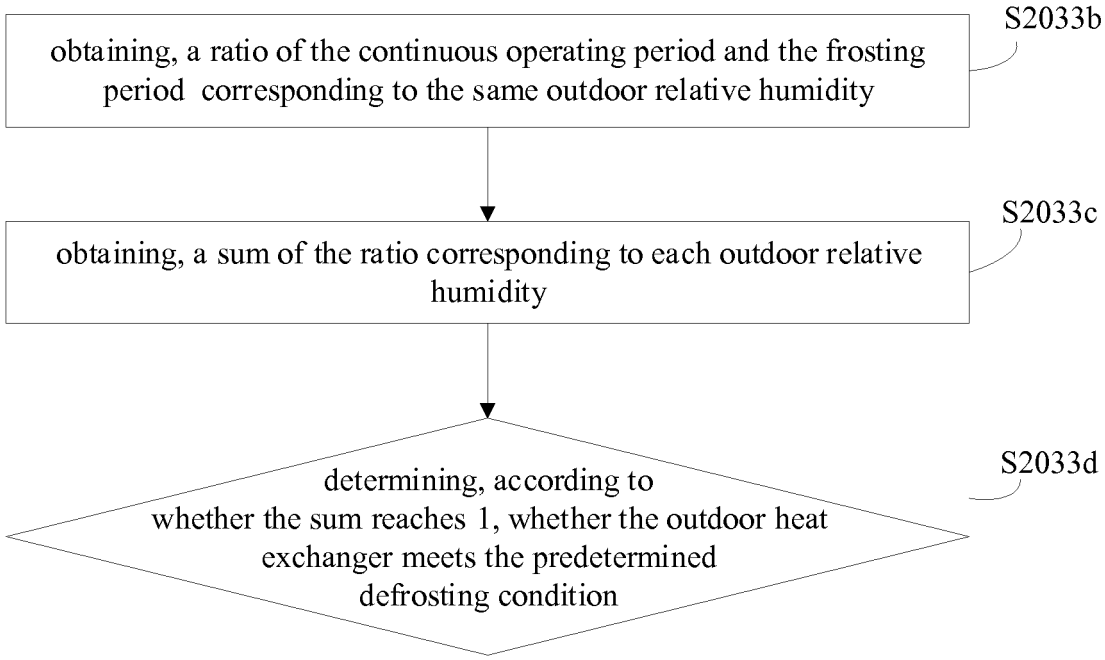

obtaining, a ratio of the continuous operating period and the frosting period corresponding to the same outdoor relative humidity
S2033b
obtaining, a sum of the ratio corresponding to each outdoor relative humidity
S2033c
determining, according to whether the sum reaches 1, whether the outdoor heat exchanger meets the predetermined defrosting condition
S2033d

FIG. 11

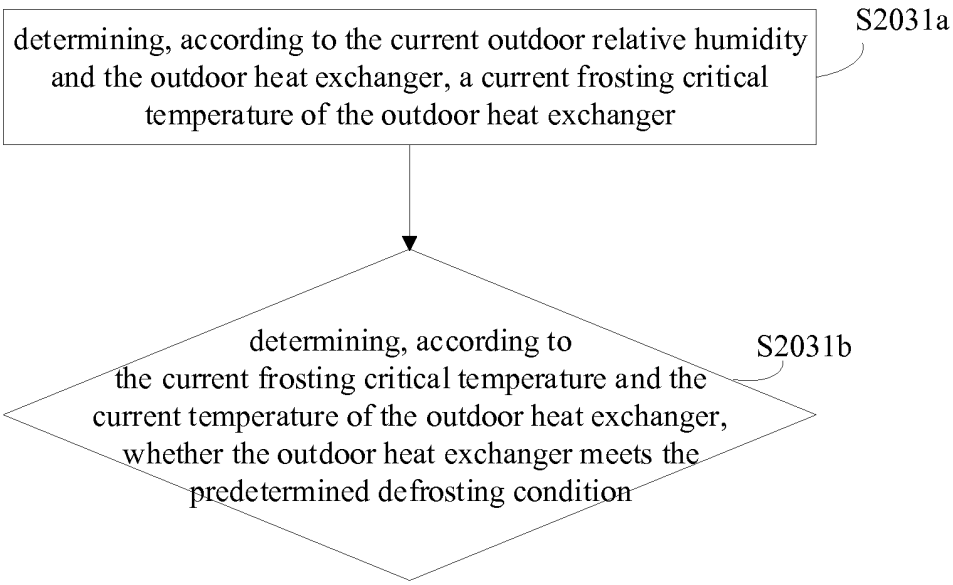

determining, according to the current outdoor relative humidity and the outdoor heat exchanger, a current frosting critical temperature of the outdoor heat exchanger
S2031a
determining, according to the current frosting critical temperature and the current temperature of the outdoor heat exchanger, whether the outdoor heat exchanger meets the predetermined defrosting condition
S2031b

FIG. 12

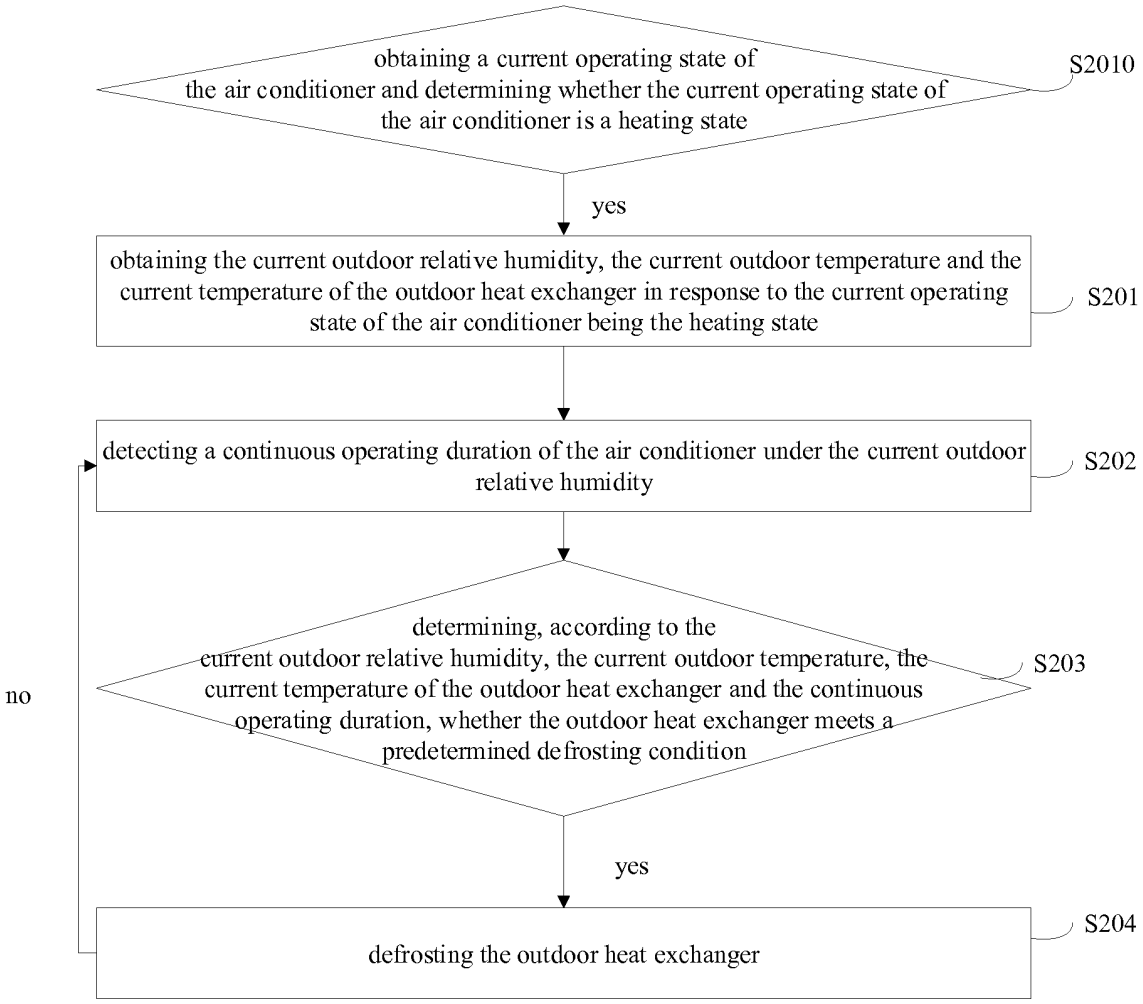

obtaining a current operating state of the air conditioner and determining whether the current operating state of the air conditioner is a heating state
S2010
yes
obtaining the current outdoor relative humidity, the current outdoor temperature and the current temperature of the outdoor heat exchanger in response to the current operating state of the air conditioner being the heating state
S201
detecting a continuous operating duration of the air conditioner under the current outdoor relative humidity
S202
determining, according to the current outdoor relative humidity, the current outdoor temperature, the current temperature of the outdoor heat exchanger and the continuous operating duration, whether the outdoor heat exchanger meets a predetermined defrosting condition
S203
no
yes
defrosting the outdoor heat exchanger
S204

FIG. 13

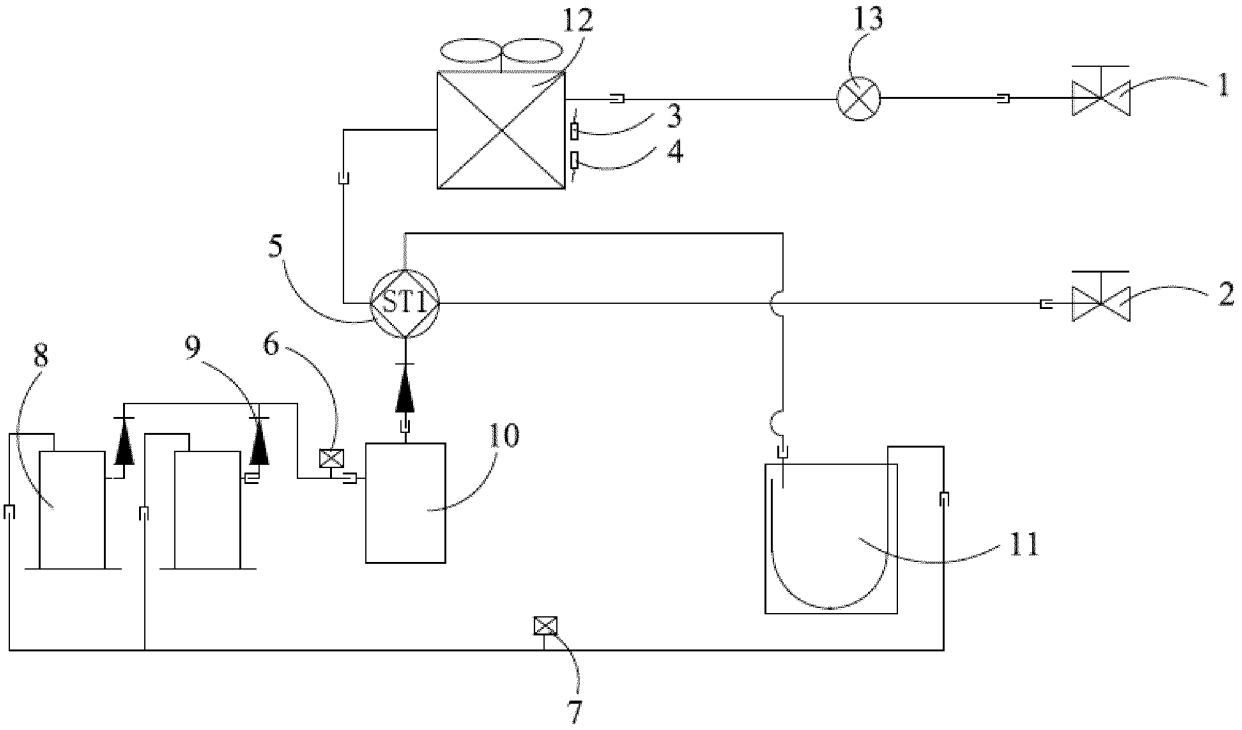

12
13
1
3
4
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ST1
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6
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11
7

FIG. 14

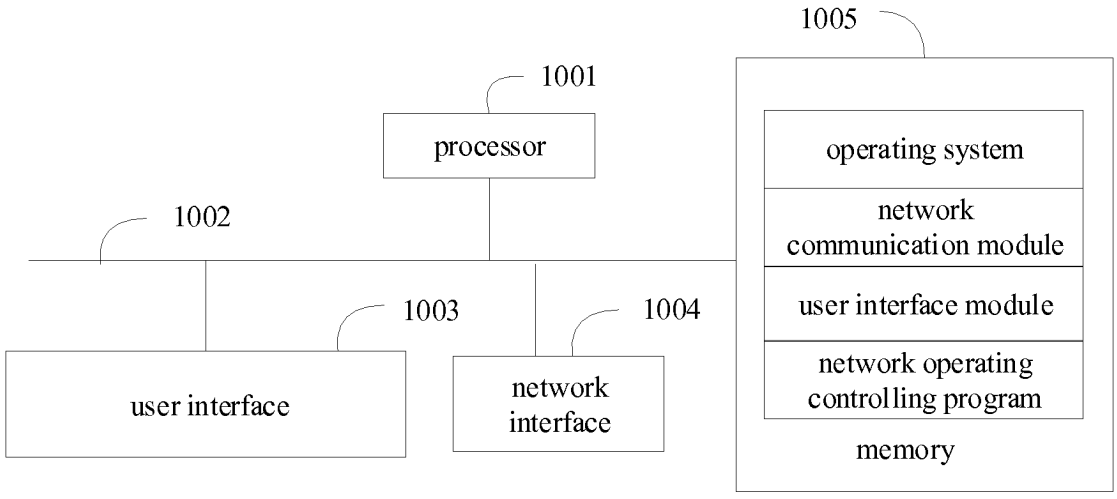

1005
1001
processor
operating system
network communication module
1002
user interface module
1003
1004
network operating controlling program
user interface
network interface
memory

FIG. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/106842

A. CLASSIFICATION OF SUBJECT MATTER

F25B 47/02 (2006.01) i

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)

F25B 47, F24F

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)

CNTXT; SIPOABS; VEN; CNKI: 露点, 环境温度, 饱和温度, 湿度, 除霜, 化霜, defrost, dew, enviroment, temperature, humidity

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP H0278844 A (HOKKAIDO ELECTRIC POWER et al.), 19 March 1990 (19.03.1990), description, page 3, upper left-hand column, lines 11-19	1-5, 20-21
Y	JP H0278844 A (HOKKAIDO ELECTRIC POWER et al.), 19 March 1990 (19.03.1990), description, page 3, upper left-hand column, lines 11-19	6-10
Y	CN 204301351 U (MITSUBISHI ELECTRIC CORPORATION), 29 April 2015 (29.04.2015), description, paragraph [0056]	6-10
X	JP S61250438 A (SAGINOMIYA SEISAKUSHO INC.), 07 November 1986 (07.11.1986), description, page 2, upper left-hand column, line 2 to page 5, upper right-hand column, line 4	11-13, 18-19, 22-23
PX	CN 106288243 A (GUANGDONG MIDEA HEATING & VENTILATION EQUIPMENT CO., LTD. et al.), 04 January 2017 (04.01.2017), claims 1-10	1-10, 20-21
PX	CN 107044716 A (GUANGDONG MIDEA HEATING & VENTILATION EQUIPMENT CO., LTD. et al.), 15 August 2017 (15.08.2017), claims 1-11	11-19, 22-23
A	CN 102022872 A (LOTUS AC (JIANGSU) CO., LTD.), 20 April 2011 (20.04.2011), entire document	1-23

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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	Date of mailing of the international search report
02 January 2018	12 January 2018

Name and mailing address of the ISA	Authorized officer
State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	YANG, Fei Telephone No. (86-10) 62084199

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/106842

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 0278844 A	19 March 1990	JP H0278844 A	19 March 1990
CN 204301351 U	29 April 2015	JP 2015098981 A	28 May 2015
		JP 5988953 B2	07 September 2016
JP 61250438 A	07 November 1986	JP H0443173 B2	15 July 1992
CN 106288243 A	04 January 2017	None	
CN 107044716 A	15 August 2017	None	
CN 102022872 A	20 April 2011	CN 102022872 B	07 December 2011

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201710269632 **[0001]**
- CN 201610915879 **[0001]**