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

(11) **EP 4 379 289 A1**

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

(43) Date of publication:
05.06.2024 Bulletin 2024/23

(21) Application number: **22871350.9**

(22) Date of filing: **22.03.2022**

(51) International Patent Classification (IPC):
F25B 30/06 *(2006.01)*

(86) International application number:
PCT/CN2022/082270

(87) International publication number:
WO 2023/045285 (30.03.2023 Gazette 2023/13)

(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:
KH MA MD TN

(30) Priority: **27.09.2021 CN 202111135796**

(71) Applicant: **GD Midea Air-Conditioning Equipment Co., Ltd.**
Foshan, Guangdong 528311 (CN)

(72) Inventors:
- **TAO, Kui**
  Foshan, Guangdong 528311 (CN)
- **ZHONG, Wenchao**
  Foshan, Guangdong 528311 (CN)
- **ZHANG, Dengke**
  Foshan, Guangdong 528311 (CN)
- **MA, Chao**
  Foshan, Guangdong 528311 (CN)

(74) Representative: **RGTH Patentanwälte PartGmbB**
Neuer Wall 10
20354 Hamburg (DE)

(54) **CONTROL METHOD, SYSTEM AND APPARATUS FOR AIR SOURCE HEAT PUMP, AND STORAGE MEDIUM**

(57) A control method, system and apparatus for an air source heat pump, and a computer-readable storage medium, which relate to household appliance technology. The air source heat pump includes a water outlet (221), a compressor (130) and a heat exchanger (210). The control method for an air source heat pump comprises the following steps: acquiring (S310) a set temperature and the current temperature at a water outlet (221); determining (S320) a target equivalent heat exchange temperature according to the set temperature and the current temperature at the water outlet (221); acquiring (S330) the current heat exchange temperature of a heat exchanger (210); and determining (S340) an operation frequency of a compressor (130) according to the target equivalent heat exchange temperature and the current heat exchange temperature.

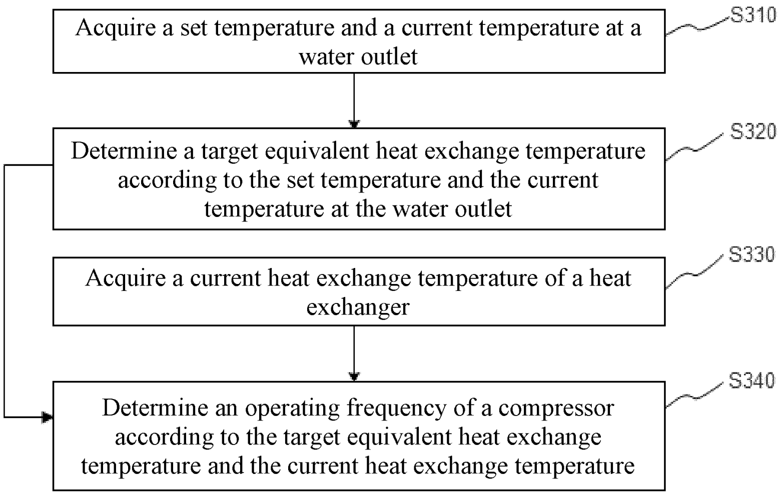

FIG. 3

EP 4 379 289 A1

Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority of Chinese patent application No. 202111135796.8, filed on September 27, 2021, and entitled "CONTROL METHOD, SYSTEM AND DEVICE OF AIR SOURCE HEAT PUMP, AND STORAGE MEDIUM", the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to the technical field of household appliances, in particular to a control method, system and device of an air source heat pump, and a storage medium.

BACKGROUND

[0003] Currently, an increasing number of users are utilizing air source heat pumps for indoor heating or cooling purposes. Specifically, a hydraulic device is incorporated into the air source heat pump. The hydraulic device comprises a heat exchanger which enables heat exchange with water, thereby raising or lowering a temperature of water in a capillary tube floor for indoor heating or cooling. In addition, the air source heat pump can also provide heat to domestic water tanks, or be used for refrigeration purposes.

[0004] In the existing technology, the air source heat pump adopts the following water temperature control method: a temperature sensor is installed at a water outlet of the hydraulic device, and by controlling an operating frequency of a compressor based on a temperature at the water outlet and a set water temperature by users, a desired water temperature is finally obtained at the water outlet. For example, if the set water temperature by users is 55°C and a current temperature at the water outlet is detected as 30°C, the compressor will start at a certain frequency for heating water. Once the temperature at the water outlet reaches the set water temperature by users, the compressor will shut down. However, due to the low heat transfer coefficient of the floor and the low heat exchange efficiency between water in capillary tubes and the indoor environment, the temperature at the water outlet can quickly reach the set temperature by users, causing the compressor to stop running. After the compressor stops running, the water in the capillary tubes continues to exchange heat with the indoor environment, resulting in the temperature at the water outlet dropping below the set temperature. Consequently, the compressor starts again to heat the water until the set temperature is reached. This control method results in frequent starting and stopping of the compressor, which in turn reduces the overall lifespan of the compressor.

SUMMARY

[0005] The present disclosure aims at solving at least one of the technical problems existing in the related art. To this end, the present disclosure provides a control method, system and device of an air source heat pump, and a storage medium, so as to improve the operation reliability of the air source heat pump.

[0006] In accordance with one aspect, an embodiment of the present disclosure provides a control method of an air source heat pump comprising a water outlet, a compressor and a heat exchanger. The control method comprises the following steps:

acquiring a set temperature and a current temperature at the water outlet;
determining a target equivalent heat exchange temperature according to the set temperature and the current temperature at the water outlet;
acquiring a current heat exchange temperature of the heat exchanger; and
determining an operating frequency of the compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature.

[0007] The control method of an air source heat pump provided by the embodiment of the present disclosure has at least the following beneficial effects. The method is realized by acquiring the set temperature and the current temperature at the water outlet, determining the target equivalent heat exchange temperature of the heat exchanger according to the set temperature and the current temperature at the water outlet, acquiring the current heat exchange temperature of the heat exchanger, and determining the operating frequency of the compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature of the heat exchanger. Compared to directly determining the operating frequency of the compressor based on a temperature difference between a set temperature at a user side and a current temperature at the water outlet, the present disclosure detects a temperature difference between the target equivalent heat exchange temperature and the current heat exchange temperature at a heat exchanger side, instead of detecting the temperature difference between the set temperature and the current temperature at the water outlet, so as to determine the operating frequency of the compressor. This avoids the frequent starting and stopping of the compressor and prevents it from operating beyond its limits due to factors such as the heat exchange efficiency of user-side water pipes, thereby improving the operation reliability of the compressor.

[0008] According to some embodiments of the present disclosure, the step of determining a target equivalent heat exchange temperature according to the set temperature and the current temperature at the water outlet comprises:

determining a temperature difference between the set temperature and the current temperature at the water outlet as a first temperature difference;
determining a first correction coefficient according to the first temperature difference; and
determining the target equivalent heat exchange temperature according to the first correction coefficient and the set temperature.

[0009] In this embodiment, by determining the first correction coefficient of the set temperature according to the first temperature difference between the set temperature and the current temperature at the water outlet, the set temperature can be converted into the target equivalent heat exchange temperature of the heat exchanger based on the set temperature according to the first correction coefficient.

[0010] According to some embodiments of the present disclosure, the step of determining an operating frequency of the compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature comprises:

determining a temperature difference between the target equivalent heat exchange temperature and the current heat exchange temperature as a second temperature difference;
determining a temperature difference range to which the second temperature difference belongs; and
determining the operating frequency of the compressor according to the temperature difference range.

[0011] In this embodiment, by determining the second temperature difference between the target equivalent heat exchange temperature and the current heat exchange temperature, then determining the temperature difference range to which the second temperature difference belongs, and correspondingly adjusting the operating frequency of the compressor according to the temperature difference range, frequent adjustment of the operating frequency of the compressor is avoided, and the reliability of the air source heat pump is improved.

[0012] According to some embodiments of the present disclosure, the heat exchanger comprises a refrigerant pipeline, and the step of acquiring a current heat exchange temperature of the heat exchanger comprises:

acquiring a current pressure value of the refrigerant pipeline; and
determining the current heat exchange temperature according to the current pressure value.

[0013] In this embodiment, the current pressure value of the refrigerant outlet pipeline is acquired first, and a saturation temperature corresponding to the pressure, that is, the current heat exchange temperature, is obtained according to the current pressure value. Compared to directly using a temperature sensor to detect the current heat exchange temperature, the adoption of pressure value detection as a means to measure the current heat exchange temperature improves temperature detection accuracy.

[0014] According to some embodiments of the present disclosure, the control method further comprises the following steps:

acquiring an upper limit value and a lower limit value of the target equivalent heat exchange temperature;
in response to the target equivalent heat exchange temperature being less than the lower limit value, taking the lower limit value as the target equivalent heat exchange temperature; or
in response to the target equivalent heat exchange temperature being greater than the upper limit value, taking the upper limit value as the target equivalent heat exchange temperature.

[0015] In this embodiment, the control of the target equivalent heat exchange temperature within a reasonable range, through the implementation of the upper limit value and the lower limit value, allows for reasonable control of the operating frequency of the compressor and ultimately enhances the control reliability of the air source heat pump.

[0016] According to some embodiments of the present disclosure, the upper limit value is obtained by the following steps:

acquiring an outdoor temperature;

acquiring a current operating frequency of the compressor; and
determining the upper limit value according to the outdoor temperature and the current operating frequency of the compressor.

[0017] In this embodiment, the outdoor temperature can affect the operation of the whole unit to a certain extent. By determining the upper limit value according to the outdoor temperature and the current operating frequency of the compressor, the safety of the air source heat pump unit can be improved.

[0018] According to some embodiments of the present disclosure, the heat exchanger comprises a refrigerant outlet pipeline and a refrigerant inlet pipeline, and the step of acquiring a current heat exchange temperature of the heat exchanger comprises:

acquiring a temperature of the refrigerant inlet pipeline as a first refrigerant temperature;
acquiring a temperature of the refrigerant outlet pipeline as a second refrigerant temperature; and
determining the current heat exchange temperature according to the first refrigerant temperature and the second refrigerant temperature.

[0019] In this embodiment, when there is no pressure sensor in the refrigerant pipeline, the current heat exchange temperature can be determined according to the first refrigerant temperature of the refrigerant inlet pipeline and the second refrigerant temperature of the refrigerant outlet pipeline, the first refrigerant temperature and second refrigerant temperature can be directly detected, thus improving the applicability of the control method of an air source heat pump provided by the embodiment of the present disclosure.

[0020] According to some embodiments of the present disclosure, the step of determining a target equivalent heat exchange temperature according to the set temperature and the current temperature at the water outlet comprises:

determining a temperature difference between the set temperature and the current temperature at the water outlet as a first temperature difference;
determining a second correction coefficient according to the first temperature difference and the set temperature by referring to a table;
acquiring an outdoor temperature; and
determining the target equivalent heat exchange temperature according to the second correction coefficient and the outdoor temperature.

[0021] In this embodiment, based on the second correction coefficient determined according to the set temperature and the current temperature at the water outlet by referring to the table, as well as the outdoor temperature, the target equivalent heat exchange temperature can be obtained.

[0022] According to some embodiments of the present disclosure, the control method further comprises the following steps:

acquiring a working mode; and
acquiring an exhaust temperature in response to the working mode being a cold water supply mode;
determining an adjustment opening degree of an electronic expansion valve according to the exhaust temperature.

[0023] In this embodiment, in the cold water supply mode, to reduce the impact of the liquid backflow of an evaporator on the compressor, the opening degree of the electronic expansion valve is controlled to decrease. However, the smaller the opening degree of the electronic expansion valve, the higher the exhaust temperature of the compressor. An excessive exhaust temperature can adversely impact the performance of the air source heat pump unit. Therefore, by determining the adjustment opening degree of the electronic expansion valve based on the exhaust temperature, the control reliability of air source heat pump can be improved.

[0024] According to some embodiments of the present disclosure, the step of determining an adjustment opening degree of an electronic expansion valve according to the exhaust temperature comprises:

in response to the exhaust temperature being greater than a preset temperature value, taking a preset adjustment opening degree as the adjustment opening degree; or
in response to the exhaust temperature being less than the preset temperature value, acquiring a first refrigerant temperature, a second refrigerant temperature and an exhaust superheat degree, and determining the adjustment opening degree according to the first refrigerant temperature, the second refrigerant temperature and the exhaust superheat degree, where the first refrigerant temperature is used to represent a temperature of a refrigerant inlet pipeline of a heat exchanger in a hydraulic device, the second refrigerant temperature is used to represent a tem-

perature of a refrigerant outlet pipeline of the heat exchanger in the hydraulic device, and the exhaust superheat degree is obtained according to the exhaust temperature by referring to a table.

[0025] In this embodiment, when the exhaust temperature is greater than the preset temperature value, the preset adjustment opening degree is taken as the adjustment opening degree, and when the exhaust temperature is less than the preset temperature value, adjustment is based on the temperatures of the inlet and outlet of the refrigerant pipeline, thus realizing reasonable adjustment of the electronic expansion valve.

[0026] In accordance with another aspect, an embodiment of the present disclosure provides a control device of an air source heat pump, comprising:

a first module, configured to acquire a set temperature and a current temperature at a water outlet;
a second module, configured to determine a target equivalent heat exchange temperature according to the set temperature and the current temperature at the water outlet;
a third module, configured to acquire a current heat exchange temperature of a heat exchanger; and
a fourth module, configured to determine an operating frequency of a compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature.

[0027] The control device of an air source heat pump provided by the embodiment of the present disclosure has at least the following beneficial effects. The first module acquires the set temperature by users and the current temperature at the water outlet, the second module determines the target equivalent heat exchange temperature of the heat exchanger according to the set temperature and the current temperature at the water outlet, the third module acquires the current heat exchange temperature of the heat exchanger, and the fourth module determines the operating frequency of the compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature of the heat exchanger. Compared to directly determining the operating frequency of the compressor based on a temperature difference between the set temperature at a user side and the current temperature at the water outlet, the present disclosure detects a temperature difference between the target equivalent heat exchange temperature and the current heat exchange temperature at a heat exchanger side, instead of detecting the temperature difference between the set temperature and the current temperature at the water outlet, so as to determine the operating frequency of the compressor. This avoids the frequent starting and stopping of the compressor and prevents it from operating beyond its limits due to factors such as the heat exchange efficiency of user-side water pipes, thereby improving the operation reliability of the compressor.

[0028] In accordance with another aspect, an embodiment of the present disclosure provides a control device, comprising:

at least one processor; and
at least one memory for storing at least one program, where
the at least one program, when executed by the at least one processor, enables the at least one processor to implement the control method of an air source heat pump as described above.

[0029] The control device provided by the embodiment of the present disclosure has at least the following beneficial effects.

[0030] The control device acquires the set temperature and the current temperature at the water outlet, determines the target equivalent heat exchange temperature of the heat exchanger according to the set temperature and the current temperature at the water outlet, acquires the current heat exchange temperature of the heat exchanger, and determines the operating frequency of the compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature of the heat exchanger. Compared to directly determining the operating frequency of the compressor based on a temperature difference between the set temperature at a user side and the current temperature at the water outlet, the present disclosure detects a temperature difference between the target equivalent heat exchange temperature and the current heat exchange temperature at a heat exchanger side, instead of detecting the temperature difference between the set temperature and the current temperature at the water outlet, so as to determine the operating frequency of the compressor. This avoids the frequent starting and stopping of the compressor and prevents it from operating beyond its limits due to factors such as the heat exchange efficiency of user-side water pipes, thereby improving the operation reliability of the compressor.

[0031] In accordance with another aspect, an embodiment of the present disclosure provides an air source heat pump, comprising the control device of an air source heat pump or the control device as described above.

[0032] The air source heat pump provided by the embodiment of the present disclosure has at least the following beneficial effects.

[0033] The air source heat pump controls the operation of the compressor by acquiring the set temperature and the current temperature at the water outlet, determining the target equivalent heat exchange temperature of the heat exchanger according to the set temperature and the current temperature at the water outlet, acquiring the current heat exchange temperature of the heat exchanger, and determining the operating frequency of the compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature of the heat exchanger. Compared to directly determining the operating frequency of the compressor based on a temperature difference between the set temperature at a user side and the current temperature at the water outlet, the present disclosure detects a temperature difference between the target equivalent heat exchange temperature and the current heat exchange temperature at a heat exchanger side, instead of detecting the temperature difference between the set temperature and the current temperature at the water outlet, so as to determine the operating frequency of the compressor. This avoids the frequent starting and stopping of the compressor and prevents it from operating beyond its limits due to factors such as the heat exchange efficiency of user-side water pipes, thereby improving the operation reliability of the air source heat pump.

[0034] In accordance with another aspect, an embodiment of the present disclosure provides a computer-readable storage medium with computer-executable instructions stored thereon, and the computer-executable instructions are used to enable a computer to execute the control method of an air source heat pump as described above.

BRIEF DESCRIPTION OF DRAWINGS

[0035]

FIG. 1 is a schematic diagram of an air source heat pump unit in a hot water supply mode according to an embodiment of the present disclosure;

FIG. 2 is a schematic diagram of an air source heat pump unit in a cold water supply mode according to an embodiment of the present disclosure;

FIG. 3 is a schematic diagram of a control method of an air source heat pump according to an embodiment of the present disclosure;

FIG. 4 is a schematic diagram of an embodiment of a detailed process of S320 in FIG. 3;

FIG. 5 is a schematic diagram of an embodiment of a detailed process of S340 in FIG. 3;

FIG. 6 is a schematic diagram of an embodiment of a detailed process of S330 in FIG. 3;

FIG. 7 is a schematic diagram of an embodiment of a process subsequent to S320 in FIG. 3;

FIG. 8 is a schematic diagram of an embodiment of a process for acquiring an upper limit value of a target equivalent heat exchange temperature;

FIG. 9 is a schematic diagram of another embodiment of the detailed process of S330 in FIG. 3;

FIG. 10 is a schematic diagram of another embodiment of the detailed process of S320 in FIG. 3;

FIG. 11 is a schematic diagram of an air source heat pump unit in a hot water supply mode according to another embodiment of the present disclosure;

FIG. 12 is a schematic diagram of an embodiment of a detailed process of S1130 in FIG. 11;

FIG. 13 is a schematic diagram illustrating the values taken by parameter ΔT_{rs} according to an embodiment of the present disclosure;

FIG. 14 is a schematic diagram of a control device of an air source heat pump according to an embodiment of the present disclosure; and

FIG. 15 is a schematic diagram of a control device according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0036] Embodiments of the present disclosure will be described in detail below, examples of which are illustrated in the accompanying drawings, where the same or similar reference numerals indicate the same or similar elements or elements having the same or similar functions throughout. The embodiments described below by referring to the drawings are exemplary, only for explaining the present disclosure, and cannot be understood as limiting the present disclosure.

[0037] In the description of the present disclosure, it should be understood that, descriptions relating to orientation, for example, orientation or positional relationships indicated by up, down, left, right, etc. are based on the orientation or positional relationships shown in the accompanying drawings, and are to facilitate the description of the present disclosure and simplify the description only, rather than indicating or implying that the device or element referred to must have a specific orientation or be constructed and operated in a specific orientation, and therefore cannot be construed as limiting the present disclosure.

[0038] In the description of the present disclosure, the usage of terms such as "first", "second" etc. is solely used for the purpose of distinguishing technical features and should not be construed as indicating or implying relative importance or implicitly indicating the number of indicated technical features or implicitly indicating the sequence of indicated technical features.

[0039] In order to explain the embodiments of the present disclosure in detail, the structure of an air source heat pump is described with reference to FIGS. 1 and 2. The air source heat pump mainly comprises an outdoor unit 100 and a hydraulic device 200. The outdoor unit 100 comprises an outdoor heat exchanger 110, a gas-liquid separator 120 and a compressor 130. The hydraulic device 200 comprises a hydraulic heat exchanger 210 and a water tank 220. The water tank 220 is provided with a water outlet 221 and a water inlet 222. For an air source heat pump capable of supplying both cold water and hot water, a four-way valve 140 is further provided. The four-way valve 140 is used to change the flow direction of a refrigerant, thereby realizing the functions of supplying cold water and hot water.

[0040] Specifically, referring to FIG. 1 which is a schematic diagram of an air source heat pump unit in a hot water supply mode, in which the outdoor heat exchanger 110 serves as an evaporator, the hydraulic heat exchanger 210 in the hydraulic device 200 serves as a condenser, a refrigerant in the condenser liquefies and releases heat, and the released heat is transferred to water in the water tank 220, realizing heat supply to users. The flow direction of the refrigerant is as follows: first refrigerant end 211→ hydraulic heat exchanger 210→ second refrigerant end 212→ outdoor heat exchanger 110→ four-way valve 140→ gas-liquid heat exchanger 120→ compressor 130→ first refrigerant end 211, thus forming a circulating passage of the refrigerant.

[0041] Referring to FIG. 2 which is a schematic diagram of an air source heat pump unit in a hot water supply mode, in which the outdoor heat exchanger 110 serves as a condenser, the hydraulic heat exchanger 210 in the hydraulic device 200 serves as an evaporator, a refrigerant in the evaporator vaporizes and absorbs heat, and the heat of water in the water tank 220 is transferred to the refrigerant to cause water to cool down, thus supplying cold water to users. The flow direction of the refrigerant is as follows: second refrigerant end 212→ hydraulic heat exchanger 210→ first refrigerant end 211→ four-way valve 140→ gas-liquid heat exchanger 120→ compressor 130→ outdoor heat exchanger 110→ second refrigerant end 212, thus forming a circulating passage of the refrigerant.

[0042] An embodiment of the present disclosure provides a control method of an air source heat pump. Referring to FIG. 3, the control method of an air source heat pump provided by this embodiment comprises but is not limited to step S310, step S320, step S330 and step S340.

[0043] At S310, a set temperature and a current temperature at a water outlet are acquired.

[0044] In some embodiments, the set temperature can be defined by users as needed. For example, users can input a set temperature into a main control module of the air source heat pump through devices such as a remote control or a smart phone. Referring to FIGS. 1 and 2, a temperature sensor is arranged at the water outlet 221 to detect a water temperature at the water outlet, and the temperature sensor sends the detected temperature at the water outlet to the main control module periodically, such that the main control module of the air source heat pump can obtain a current temperature at the water outlet.

[0045] At S320, a target equivalent heat exchange temperature is determined according to the set temperature and the current temperature at the water outlet.

[0046] In some embodiments, by means of the energy transfer relationship conversion principle among different air source heat pump units, the set temperature defined by users and the current temperature at the water outlet are converted into a heat exchange temperature required by a hydraulic heat exchanger in a hydraulic device, which is referred to as the target equivalent heat exchange temperature. When the air source heat pump is in a hot water supply mode and the hydraulic heat exchanger serves as a condenser, the target equivalent heat exchange temperature is a target equivalent condensation temperature. When the air source heat pump is in a cold water supply mode and the hydraulic heat exchanger serves as an evaporator, the target equivalent heat exchange temperature is a target equivalent evaporation temperature.

[0047] At S330, a current heat exchange temperature of the heat exchanger is acquired.

[0048] In some embodiments, a current heat exchange temperature of the hydraulic heat exchanger is acquired, which can be directly detected by a temperature sensor arranged in the hydraulic heat exchanger. Alternatively, a pressure sensor can be arranged to detect a pressure of a refrigerant pipeline of the hydraulic heat exchanger, and the current heat exchange temperature can be determined based on a saturation temperature corresponding to this pressure value. When the air source heat pump is in a hot water supply mode and the hydraulic heat exchanger serves as a condenser, the current heat exchange temperature is a current condensation temperature. When the air source heat pump is in a cold water supply mode and the hydraulic heat exchanger serves as an evaporator, the current heat exchange temperature is a current evaporation temperature.

[0049] At S340, an operating frequency of the compressor is determined according to the target equivalent heat exchange temperature and the current heat exchange temperature.

[0050] In some embodiments, based on a difference between the target equivalent heat exchange temperature required by the hydraulic heat exchanger and the current heat exchange temperature of the hydraulic heat exchanger, the operating frequency of the compressor can be determined. Due to the higher heat exchange efficiency of the heat exchanger compared to other devices such as capillary tubes at the user side, determining the operating frequency of the compressor directly based on the target equivalent heat exchange temperature and the current heat exchange temperature of the hydraulic heat exchanger can avoid the frequent starting and stopping of the compressor, thereby enhancing the control reliability of the air source heat pump.

[0051] Another embodiment of the present disclosure provides a control method of an air source heat pump. As shown in FIG. 4 which is a schematic diagram of an embodiment of a detailed process of S320 in FIG. 3, S320 comprises but is not limited to step S410, step S420 and step S430.

[0052] At S410, a temperature difference between the set temperature and the current temperature at the water outlet is determined as a first temperature difference.

[0053] At S420, a first correction coefficient is determined according to the first temperature difference.

[0054] In some embodiments, the first correction coefficient is obtained by Formula (1):

$$k = \Delta T_{rs} - e; \quad (1)$$

where ΔT_{rs} represents the values based on different first temperature differences, a first temperature difference is the set temperature minus the current temperature at the water outlet, and *e* represents differential correction and is an engineering value, which is used to correct the first correction coefficient according to the performance of different units. Typically, the value of *e* can be in a range of -5 to 5, for example, the value of *e* is 1.

[0055] For example, the value of ΔT_{rs} can be determined according to the range to which the first temperature difference belongs. As shown in FIG. 13, it can be seen that when the first temperature difference is less than -1, the value of ΔT_{rs} is -2; when the first temperature difference falls within the range [-0.5, 0], the value of ΔT_{rs} is -1.5; when the first temperature difference falls within the range [0.5, 1], the value of ΔT_{rs} is -1; and when the first temperature difference falls within the range [11, 15], the value of ΔT_{rs} is 7. It should be noted that the values shown in FIG. 13 are only one example, and in practice, the corresponding relationship between the first temperature difference and ΔT_{rs} can be determined according to the energy conversion conditions of different air source heat pumps. As can be seen from FIG. 13, when the first temperature difference is less than -1, ΔT_{rs} takes a value of -2, and when the first temperature difference is greater than 11, ΔT_{rs} takes a value of 7. The value of ΔT_{rs} is constrained within a range of -2 to 7, thereby limiting the first correction coefficient within a certain range. For example, in a hot water supply mode, the value of *k* is in a range of -5 to 15. When *k* is less than -5, the hydraulic heat exchanger may not be able to transfer heat to water; and when k is greater than 15, a pressure at the target equivalent condensation temperature may exceed a maximum condensation pressure set for the air source heat pump unit, which may affect the operation safety of the unit.

[0056] At S430, the target equivalent heat exchange temperature is determined according to the first correction coefficient and the set temperature.

[0057] In some embodiments, the target equivalent heat exchange temperature can be determined by Formula (2):

$$T_{C1} = T_{C0} + (T_S - C) + k; \quad (2)$$

where T_{C1} represents the target equivalent heat exchange temperature; and T_{C0} represents a heat exchange coefficient, the value of T_{C0} is determined according to the heat exchange performance of the unit, C represents a preset engineering value, which is related to the air source heat pump unit and the usage habits of users, T_S represents the set temperature, and k is the first correction coefficient. Typically, in a hot water supply mode, T_{C0} can take a value within a recommended range of 40-52°C, for example, 45°C, and C can take the value of 45°C. In a cold water supply mode, T_{C0} can take a value within a recommended range of 5-25°C, for example, 10°C, and C can take the value of 10°C.

[0058] Another embodiment of the present disclosure provides a control method of an air source heat pump. As shown in FIG. 5 which is a schematic diagram of an embodiment of a detailed process of S340 in FIG. 3, S340 comprises but is not limited to step S510, step S520 and step S530.

[0059] At S510, a temperature difference between the target equivalent heat exchange temperature and the current heat exchange temperature is determined as a second temperature difference.

[0060] At S520, a temperature difference range to which the second temperature difference belongs is determined.

[0061] At S530, the operating frequency of the compressor is determined according to the temperature difference range.

[0062] In some embodiments, the target equivalent heat exchange temperature is subtracted from the current heat exchange temperature to obtain the second temperature difference X, and a frequency adjustment range is determined according to the temperature difference range to which the second temperature difference belongs, thus obtaining the operating frequency of the compressor. Refer to Table 1 for the frequency adjustment range of the compressor.

Table 1 Reference table for frequency adjustment range of compressor

Condition (°C)	X<-3	-3≤X<-2	-2≤X<-1	-1≤X<1	1≤X<2	2≤X<3	X>_3
Frequency adjustmen t (Hz)	-5	-2	-1	0	+1	+2	+3

[0063] For example, when a current frequency of the compressor is 50 Hz and the second temperature difference is detected as 1°C, the compressor is controlled to increase the frequency by 1 Hz every other adjustment period.

[0064] Another embodiment of the present disclosure provides a control method of an air source heat pump. As shown in FIG. 6 which is a schematic diagram of an embodiment of a detailed process of S330 in FIG. 3, S330 comprises but is not limited to step S610 and step S620.

[0065] At S610, a current pressure value of the refrigerant pipeline is acquired.

[0066] In some embodiments, referring to FIGS. 1 and 2, the refrigerant pipeline refers to a pipeline on a side of the hydraulic heat exchanger 210. The refrigerant pipeline comprises a first refrigerant end 211 and a second refrigerant end 212, and a pressure sensor 230 is arranged at the first refrigerant end 211. It can be understood that the pressure sensor 230 can also be arranged at the second refrigerant end 212.

[0067] At S620, the current heat exchange temperature is determined according to the current pressure value.

[0068] In some embodiments, according to the detected current pressure value of the refrigerant pipeline, a saturation temperature corresponding to the current pressure value is obtained by reverse lookup in a pressure and saturation temperature correspondence table of a corresponding refrigerant based on the physical properties of the refrigerant. The saturation temperature is the current heat exchange temperature. In the case of refrigerant R22, the corresponding saturation temperature is 46°C under the pressure of 1.67M MPa and 50°C under the pressure of 1.84M MPa.

[0069] Another embodiment of the present disclosure provides a control method of an air source heat pump. As shown in FIG. 7 which is a schematic diagram of an embodiment of a process subsequent to S320 in FIG. 3, the subsequent process comprises but is not limited to step S710, step S720 and step S730.

[0070] At S710, an upper limit value and a lower limit value of the target equivalent heat exchange temperature are acquired.

[0071] At S720, in response to the target equivalent heat exchange temperature being less than the lower limit value, the lower limit value is taken as the target equivalent heat exchange temperature.

[0072] At S730, in response to the target equivalent heat exchange temperature being greater than the upper limit value, the upper limit value is taken as the target equivalent heat exchange temperature.

[0073] In some embodiments, by setting the upper limit and lower limit of the target equivalent heat exchange temperature, the value of the target equivalent heat exchange temperature is constrained based on the upper and lower limits, so as to improve the operation reliability of the air source heat pump. In a hot water supply mode, the lower limit value can be chosen from 25°C to 35°C, for example, 30°C. In a cold water supply mode, the lower limit value can be chosen from 3°C to 12°C, for example, 5°C. The setting of the lower limit value can avoid a situation where excessively low target equivalent heat exchange temperatures hinder oil pumping of the compressor.

[0074] In some embodiments, since excessively high target equivalent heat exchange temperatures will result in a high exhaust temperature of the compressor, and the exhaust temperature has a certain relationship with the outdoor environment, it is necessary to determine the upper limit value based on the outdoor temperature. Specifically, referring to FIG. 8 which is a schematic diagram of an embodiment of a process for acquiring an upper limit value of a target equivalent heat exchange temperature, the process comprises but not limited to step S810, step S820 and step S830.

[0075] At S810, an outdoor temperature is acquired.

[0076] In some embodiments, an outdoor unit of the air source heat pump is equipped with a temperature sensor which can acquire the outdoor temperature.

[0077] At S820, a current operating frequency of the compressor is acquired.

[0078] At S830, the upper limit value is determined according to the outdoor temperature and a current operating frequency of the compressor.

[0079] In some embodiments, after acquiring the outdoor temperature and the operating frequency of the compressor, a working mode of the air source heat pump is determined, a corresponding table is called based on the working mode, and the upper limit value is obtained by referring to the table.

[0080] For example, when the working mode is a hot water supply mode, the upper limit value is determined by referring to Table 3.

Table 3 Mapping table of upper limit value of target equivalent condensation temperature

Current operating frequency / Upper limit value / Outdoor temperature	≤45Hz	≤60Hz	≤70Hz	≤90Hz	>90Hz
≤-25°C	40	40	40	40	40
≤-11°C	56	56	56	56	40
≤10°C	62	62	62	58	40
≤15°C	56	62	62	58	40
≤23°C	56	58	54	50	40
>23°C	40	40	40	40	40

[0081] For example, when the working mode is a cold water supply mode, the upper limit value is determined by referring to Table 4.

Table 4 Mapping table of upper limit value of target equivalent evaporation temperature

Current operating frequency / Upper limit value / Outdoor temperature	≤30Hz	≤60Hz	≤70Hz	≤90Hz	>90Hz
≤55°C	20	15	15	15	5
≤45°C	23	15	15	15	5
≤35°C	23	15	15	15	5
≤25°C	23	15	15	15	5
≤15°C	23	15	15	15	5
>5°C	23	15	15	15	5

[0082] For example, in the case of a hot water supply mode, after determining the target equivalent heat exchange temperature as 60°C based on the set temperature and the current temperature at the water outlet, the outdoor temperature as 9°C and the current operating frequency of the compressor as 90 Hz, referring to Table 3, it is determined that the upper limit value is 58°C. Then, it is concluded that the target equivalent heat exchange temperature exceeds the upper limit value. Therefore, the upper limit value of 58°C will be adopted as the target equivalent heat exchange temperature.

[0083] Another embodiment of the present disclosure provides a control method of an air source heat pump. As shown in FIG. 9 which is a schematic diagram of an embodiment of a detailed process of S330 in FIG. 3, S330 comprises but is not limited to step S910, step S920 and step S930.

[0084] At S910, a temperature of the refrigerant inlet pipeline is acquired as a first refrigerant temperature.

[0085] At S920, a temperature of the refrigerant outlet pipeline is acquired as a second refrigerant temperature.

[0086] At S930, the current heat exchange temperature is determined according to the first refrigerant temperature and the second refrigerant temperature.

[0087] In some embodiments, referring to FIG. 1, to reduce the hardware structure cost, some air source heat pumps may not be provided with pressure sensors. For the air source heat pump without the pressure sensor 230, the current heat exchange temperature can also be obtained by directly detecting the temperatures of the refrigerant pipeline. A first condensing end 211 and a second condensing end 212 are respectively provided with temperature sensors. For the air source heat pump in a hot water supply mode, the first condensing end 211 is the refrigerant inlet pipeline, a temperature detected by the temperature sensor arranged at the first condensing end 211 is the first refrigerant temperature; and the second condensing end 212 is the refrigerant outlet pipeline, and a temperature detected by the temperature sensor arranged at the second condensing end 212 is the second refrigerant temperature. The current heat exchange temperature can be determined by Formula (3):

$$T_d = w \times (T_{in} + T_{out}); \quad (3)$$

where T_d represents the current heat exchange temperature, T_{in} represents the first refrigerant temperature, T_{out} represents the second refrigerant temperature, and W represents a weighting coefficient. Generally, w=0.5 .

[0088] Another embodiment of the present disclosure provides a control method of an air source heat pump. As shown in FIG. 10 which is a schematic diagram of an embodiment of a detailed process of S320 in FIG. 3, S320 comprises but is not limited to step S1010, step S1020, step S1030 and step S1040.

[0089] At S1010, a temperature difference between the set temperature and the current temperature at the water outlet is determined as a first temperature difference.

[0090] At S1020, a second correction coefficient is determined according to the first temperature difference and the set temperature by referring to a table.

[0091] At S1030, an outdoor temperature is acquired.

[0092] At S1040, the target equivalent heat exchange temperature is determined according to the second correction coefficient and the outdoor temperature.

[0093] In some embodiments, when there is no pressure sensor in the air source heat pump, the target equivalent heat exchange temperature can be determined by referring to a table. In the case of a hot water supply mode, the second correction coefficient is obtained by referring to a second correction coefficient mapping table according to the set temperature and the first temperature difference. The second correction coefficient mapping table is shown in Table 5.

Table 5 Second correction coefficient mapping table

Set temperature Second correction coefficient First temperature difference	< 30°C	< 35°C	< 40°C	< 45°C	< 50°C	< 55°C	< 60°C	≥60°C
>6°C	8	8	8	7	7	6	2	1
>4°C	7	7	7	6	5	5	2	1
>2°C	6	6	6	5	4	3	1	0
>1°C	5	5	4	4	3	2	1	0
>0°C	4	3	3	3	2	2	1	0
>-1°C	3	3	2	2	1	1	0	-1
≤-1°C	2	2	1	1	0	0	-1	-1

[0094] The outdoor temperature is obtained first, and then a limit value is obtained by referring to a limit value mapping table based on the outdoor temperature. The limit value mapping table is shown in Table 6.

Table 6 Limit value mapping table

Outdoor temperature/ °C	≤-25	≥-24	≤-23	≥-22	≥-21	≥-20	≥-19	≥-18	≥-17	≥-16
Limit value	28	30	32	35	38	40	40	41	41	43
Outdoor temperature/ °C	≥-15	≥-14	≥-13	≥-12	≥-11	≥-10	≥-9	≥-8	7~29	≥30
Limit value	45	47	50	52	54	56	58	60	62	60
Outdoor temperature/ °C	≥31	≥32	≥33	≥-34	≥35	≥36	≥37	≥38		
Limit value	59	58	57	56	55	55	55	53		

[0095] After the second correction coefficient and the limit value are obtained by referring to Table 5 and Table 6, the sum of the set temperature and the second correction value is compared with the limit value, and the smaller one is taken as the target equivalent condensation temperature. For example, the obtained set temperature is 42°C, the current temperature at the water outlet is 39°C, and the outdoor temperature is 0°C. Firstly, the current temperature at the water outlet is subtracted from the set temperature to obtain a first temperature difference of 3°C. Then, a second correction coefficient of 5 is obtained by referring to Table 5 based on the first temperature difference and the set temperature. Next, based on the outdoor temperature, a limit value of 62°C is obtained by referring to Table 6. The sum of the set temperature and the second correction coefficient is calculated as 47°C. Finally, the limit value of 62°C is compared with the sum of the set temperature and the second correction coefficient of 47°C, and the smaller one is taken as the equivalent target condensation temperature. Therefore, the equivalent target condensation temperature is 47°C.

[0096] Another embodiment of the present disclosure provides a control method of an air source heat pump. As shown in FIG. 11, the control method comprises but is not limited to step S1110, step S1120 and step S1130.

[0097] At S1110, a working mode is acquired.

[0098] At S1120, an exhaust temperature is acquired in response to the working mode being a cold water supply mode.

[0099] At S1130, an adjustment opening degree of an electronic expansion valve is determined according to the exhaust temperature.

[0100] In some embodiments, when the air source heat pump works in a cold water supply mode, to reduce the occurrence of liquid refrigerant entering the compressor due to incomplete evaporation in the evaporator, which can cause damage to the compressor, it is generally advisable to decrease the opening degree of the electronic expansion valve. However, the smaller the opening degree of the electronic expansion valve, the higher the exhaust temperature of the compressor. An excessively high exhaust temperature can adversely affect the operation of other components. Therefore, considering the possibility of excessively high exhaust temperature caused by excessively small opening of the electronic expansion valve due to liquid return detection, it is necessary to adjust the opening degree of the electronic expansion valve based on the exhaust temperature of the compressor, so as to ensure the control reliability of the air source heat pump.

[0101] Another embodiment of the present disclosure provides a control method of an air source heat pump. As shown in FIG. 12 which is a schematic diagram of an embodiment of a detailed process of S1130 in FIG. 11, S1130 comprises but is not limited to step S1210 and step S1220.

[0102] At S1210, in response to the exhaust temperature being greater than a preset temperature value, a preset adjustment opening degree is taken as the adjustment opening degree.

[0103] In some embodiments, the preset temperature value can be 102°C, and the preset adjustment opening degree can be 50 steps. When the exhaust temperature of the compressor is detected to be greater than 102°C, the electronic expansion valve is controlled to increase by 50 steps every cycle to increase the flow through the evaporator and reduce the exhaust temperature.

[0104] At S1220, in response to the exhaust temperature being less than the preset temperature value, a first refrigerant temperature, a second refrigerant temperature and an exhaust superheat degree are acquired, and the adjustment opening degree is determined according to the first refrigerant temperature, the second refrigerant temperature and the exhaust superheat degree.

[0105] In some embodiments, referring to FIG. 2, a first condensing end 211 and a second condensing end 212 are respectively provided with temperature sensors. For the air source heat pump in a cold water supply mode, the first condensing end 211 is the refrigerant outlet pipeline, a temperature detected by the temperature sensor arranged at the first condensing end 211 is the second refrigerant temperature; and the second condensing end 212 is the refrigerant inlet pipeline, and a temperature detected by the temperature sensor arranged at the second condensing end 212 is the first refrigerant temperature.

[0106] When the exhaust temperature is less than 102°C, the adjustment opening degree is determined by Formula (4):

$$E_{cp} = a \times (T_{out} - T_{in} - T_t)\,; \quad (4)$$

where E_{cp} represents the adjustment opening degree, a is an adjustment coefficient which is a constant, T_{out} is the second refrigerant temperature, T_{in} is the first refrigerant temperature, and T_t is the exhaust superheat degree.

[0107] The exhaust superheat degree T_t can be obtained by:
acquiring an oil return time of the air source heat pump unit and the exhaust temperature, and in response to the oil return time being less than a first preset time value and the exhaust temperature being less than a first preset superheat temperature value, taking a first preset exhaust superheat degree as the exhaust superheat degree. For example, when the oil return time of the air source heat pump unit is within 10 minutes and the exhaust temperature is less than 80°C, the exhaust superheat degree is the first preset exhaust superheat degree, which is 8°C.

[0108] A starting time of the air source heat pump and the exhaust temperature are acquired, and in response to the starting time being less than a second preset time value and the exhaust temperature being less than a second preset superheat temperature value, a second preset exhaust superheat degree is taken as the exhaust superheat degree. For example, when the starting time of the air source heat pump is within 10 minutes and the exhaust temperature is less than 75°C, the exhaust superheat degree is the second preset exhaust superheat degree, which is 5°C.

[0109] In other cases, that is, the oil return time of the air source heat pump unit is greater than the first preset time value, or the starting time of the air source heat pump is greater than the second preset time value, or the oil return time is less than the first preset time value but the exhaust temperature is greater than the first preset superheat temperature value, or the starting time is less than the first preset time value but the exhaust temperature is greater than the second preset superheat temperature value, then the exhaust superheat degree can be determined by referring to an exhaust superheat degree mapping table according to the exhaust temperature and the current heat exchange temperature. The current heat exchange degree here is the saturation temperature corresponding to the pressure value detected by the pressure sensor 230 in FIG. 2.

[0110] For example, the current heat exchange temperature is subtracted from the exhaust temperature to obtain a third temperature difference, and according to the third temperature, the exhaust superheat degree is obtained by referring to an exhaust superheat degree mapping table shown in Table 7.

Table 7 Exhaust superheat degree mapping table

Third temperature difference Te/°C	Exhaust superheat degree T_f/°C
$Te \geq 10$	1
$5 < Te < 10$	2
$Te \leq 5$	3

[0111] According to some specific embodiments of the present disclosure, taking an air source heat pump with a pressure sensor and operating in a heating mode as an example, the specific process of controlling and adjusting an operating frequency of a compressor by the air source heat pump is as follows:

acquiring a set temperature defined by users;

monitoring and acquiring a current temperature at a water outlet, a current operating frequency of the compressor, a current pressure value of a refrigerant pipeline and an outdoor temperature;

determining a current condensation temperature according to the current pressure value by referring to a pressure and saturation temperature correspondence table of a refrigerant;

subtracting the current temperature at the water outlet from the set temperature to obtain a first temperature, determining the value of ΔT_{rs} based on a range to which the first temperature difference belongs, and substituting ΔT_{rs} into Formula (1) to obtain a first correction coefficient;

substituting the set temperature and the first correction coefficient into Formula (2) to obtain a target equivalent condensation temperature;

acquiring a lower limit value of the target equivalent condensation temperature which can be directly set and stored in a processor,

the lower limit value of the target equivalent condensation temperature being obtained by referring to Table 3 according to the outdoor temperature and the current operating frequency of the compressor;

comparing the target equivalent condensation temperature with upper and lower limit values, taking the lower limit value as a target equivalent heat exchange temperature in response to the target equivalent condensation temperature being less than the lower limit value, or taking the upper limit value as the target equivalent heat exchange temperature in response to the target equivalent condensation temperature being greater than the upper limit value, or keeping the target equivalent condensation temperature unchanged in response to the target equivalent condensation temperature being between the lower and upper limit values;

subtracting the target equivalent condensation temperature from the current condensation temperature to obtain a second temperature difference; and

obtaining a frequency adjustment range of the compressor by referring to Table 1 according to a range to which the second temperature difference belongs, so as to determine the operating frequency of the compressor.

[0112] According to some specific embodiments of the present disclosure, taking an air source heat pump without a pressure sensor and operating in a heating mode as an example, the specific process of controlling and adjusting an operating frequency of a compressor by the air source heat pump is as follows:

acquiring a set temperature defined by users;

monitoring and acquiring a current temperature at a water outlet, a first refrigerant temperature, a second refrigerant temperature and an outdoor temperature;

substituting the first refrigerant temperature and the second refrigerant temperature into Formula (3) to obtain a current condensation temperature;

subtracting the current at the water outlet from the set temperature to obtain a first temperature difference;

referring to Table 5 according to the first temperature difference and the set temperature to obtain a second correction coefficient;

referring to Table 6 according to the outdoor temperature to obtain a limit value;

comparing the sum of the set temperature and the second correction value with the limit value, and taking the smaller one as a target equivalent condensation temperature;

subtracting the target equivalent condensation temperature from the current condensation temperature to obtain a second temperature difference; and

obtaining a frequency adjustment range of the compressor by referring to Table 1 according to a range to which the second temperature difference belongs, so as to determine the operating frequency of the compressor.

[0113] Referring to FIG. 14, an embodiment of the present disclosure provides a control device of an air source heat pump, comprising:

a first module, configured to acquire a set temperature and a current temperature at a water outlet;

a second module, configured to determine a target equivalent heat exchange temperature according to the set temperature and the current temperature at the water outlet;

a third module, configured to acquire a current heat exchange temperature of a heat exchanger; and

a fourth module, configured to determine an operating frequency of a compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature.

[0114] FIG. 15 is a schematic diagram of a control device according to an embodiment of the present disclosure. The control device provided by the embodiment of the present disclosure is built in the air source heat pump and comprises one or more control processors and memories. As an example, FIG. 15 shows one control processor and one memory.

[0115] The control processor and the memory can be connected by bus or other means. As an example, FIG. 15 shows bus connection.

[0116] As a non-transitory computer-readable storage medium, the memory can be configured to store a non-transitory software program and a non-transitory computer-executable program. In addition, the memory may comprise a high-speed random access memory and a non-transitory memory, for example, at least one magnetic disk storage device, a flash memory device, or another non-transitory solid-state storage device. In some implementations, the memory optionally comprises memories that are located at a distance from the control processor and can be connected to the control device through a network. Examples of the above-mentioned network comprise, but are not limited to, the Internet, an intranet, a local area network, a mobile communication network, and a combination thereof.

[0117] It can be understood by those skilled in the art that the device structure shown in FIG. 15 does not constitute a limitation to the control device, and more or fewer components, or a combination of certain components, or a different component arrangement is possible.

[0118] Non-transitory software programs and instructions required to implement the control method applied to the control device in the above embodiment are stored in a memory, which, when executed by the control processor, the control method applied to the control device in the above embodiment is performed.

[0119] Further, an embodiment of the present disclosure provides a computer-readable storage medium which stores computer-executable instructions, which are executed by one or more control processors, causing the one or more control processors to execute the control method in the above method embodiment.

[0120] It can be understood by those of ordinary skill in the art that all or some of the steps of the methods and systems disclosed above may be implemented as software, firmware, hardware, and appropriate combinations thereof. Some or all of the physical components may be implemented as software executed by a processor, such as a central processing unit, a digital signal processor or a microprocessor, or as hardware, or as an integrated circuit, such as an application-specific integrated circuit. Such software may be distributed on computer-readable media, which may comprise computer-readable storage media (or non-transitory media) and communication media (or transitory media). As well known to those of ordinary skill in the art, the term computer-readable storage medium comprises volatile and nonvolatile, removable and non-removable media implemented in any method or technique for storing information, such as computer-readable instructions, data structures, program modules or other data. A computer-readable storage medium comprises but is not limited to RAM, ROM, EEPROM, flash memory or other memory technologies, CD-ROM, digital versatile disk (DVD) or other optical disk storage, cassettes, magnetic tapes, magnetic disk storage or other magnetic storage apparatuses, or any other medium that can be configured to store desired information and can be accessed by a computer. Furthermore, it is well known to those of ordinary skill in the art that communication media typically contain computer-readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transmission mechanism, and may comprise any information transmission media.

[0121] Although the embodiments of the present disclosure have been described in detail above with reference to the accompanying drawings, the present disclosure is not limited to the above embodiments, and various changes may be made within the knowledge of those of ordinary skill in the art without departing from the purpose of the present disclosure.

Claims

1. A control method of an air source heat pump comprising a water outlet, a compressor and a heat exchanger, the control method comprising the following steps:

acquiring a set temperature and a current temperature at the water outlet;
determining a target equivalent heat exchange temperature according to the set temperature and the current temperature at the water outlet;
acquiring a current heat exchange temperature of the heat exchanger; and
determining an operating frequency of the compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature.

2. The control method of the air source heat pump of claim 1, wherein the step of determining a target equivalent heat exchange temperature according to the set temperature and the current temperature at the water outlet comprises:

determining a temperature difference between the set temperature and the current temperature at the water outlet as a first temperature difference;
determining a first correction coefficient according to the first temperature difference; and
determining the target equivalent heat exchange temperature according to the first correction coefficient and the set temperature.

3. The control method of the air source heat pump of claim 1, wherein the step of determining an operating frequency of the compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature comprises:

determining a temperature difference between the target equivalent heat exchange temperature and the current heat exchange temperature as a second temperature difference;
determining a temperature difference range to which the second temperature difference belongs; and
determining the operating frequency of the compressor according to the temperature difference range.

4. The control method of the air source heat pump of claim 1, wherein the heat exchanger is arranged in a hydraulic device and comprises a refrigerant pipeline, and the step of acquiring a current heat exchange temperature of the heat exchanger comprises:

acquiring a current pressure value of the refrigerant pipeline; and
determining the current heat exchange temperature according to the current pressure value.

5. The control method of the air source heat pump of claim 1, further comprising the following steps:

acquiring an upper limit value and a lower limit value of the target equivalent heat exchange temperature;
in response to the target equivalent heat exchange temperature being less than the lower limit value, taking the lower limit value as the target equivalent heat exchange temperature; or
in response to the target equivalent heat exchange temperature being greater than the upper limit value, taking the upper limit value as the target equivalent heat exchange temperature.

6. The control method of the air source heat pump of claim 5, wherein the upper limit value is obtained by the following steps:

acquiring an outdoor temperature;
acquiring a current operating frequency of the compressor; and
determining the upper limit value according to the outdoor temperature and the current operating frequency of the compressor.

7. The control method of the air source heat pump of claim 1, wherein the heat exchanger comprises a refrigerant outlet pipeline and a refrigerant inlet pipeline, and the step of acquiring a current heat exchange temperature of the heat exchanger comprises:

acquiring a temperature of the refrigerant inlet pipeline as a first refrigerant temperature;
acquiring a temperature of the refrigerant outlet pipeline as a second refrigerant temperature; and
determining the current heat exchange temperature according to the first refrigerant temperature and the second refrigerant temperature.

8. The control method of the air source heat pump of claim 7, wherein the step of determining a target equivalent heat exchange temperature according to the set temperature and the current temperature at the water outlet comprises:

determining a temperature difference between the set temperature and the current temperature at the water outlet as a first temperature difference;
determining a second correction coefficient according to the first temperature difference and the set temperature by referring to a table;
acquiring an outdoor temperature; and
determining the target equivalent heat exchange temperature according to the second correction coefficient and the outdoor temperature.

9. The control method of the air source heat pump of claim 1, further comprising the following steps:

acquiring a working mode;
acquiring an exhaust temperature in response to the working mode being a cold water supply mode; and
determining an adjustment opening degree of an electronic expansion valve according to the exhaust temperature.
The control method of the air source heat pump of claim 9, wherein the step of determining an adjustment opening degree of an electronic expansion valve according to the exhaust temperature comprises:

in response to the exhaust temperature being greater than a preset temperature value, taking a preset adjustment opening degree as the adjustment opening degree; or
in response to the exhaust temperature being less than the preset temperature value, acquiring a first refrigerant temperature, a second refrigerant temperature and an exhaust superheat degree, and determining the adjustment opening degree according to the first refrigerant temperature, the second refrigerant temperature and the exhaust superheat degree, wherein the first refrigerant temperature is used to represent a temperature of a refrigerant inlet pipeline of a heat exchanger in a hydraulic device, the second refrigerant temperature is used to represent a temperature of a refrigerant outlet pipeline of the heat exchanger in the hydraulic device, the exhaust superheat degree is obtained according to the exhaust temperature and a current pressure value by referring to a table, and the current pressure value is obtained by a pressure sensor arranged on a refrigerant pipeline of the heat exchanger in the hydraulic device.

10. A control device of an air source heat pump, comprising:

a first module, configured to acquire a set temperature and a current temperature at a water outlet;
a second module, configured to determine a target equivalent heat exchange temperature according to the set temperature and the current temperature at the water outlet;
a third module, configured to acquire a current heat exchange temperature of a heat exchanger; and
a fourth module, configured to determine an operating frequency of a compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature.

11. A control device, comprising:

at least a processor; and
at least a memory for storing at least a program; wherein
the at least one program, when executed by the at least one processor, causes the at least one processor to implement a control method of an air source heat pump of any one of claims 1 to 10.

12. An air source heat pump, comprising a control device of an air source heat pump of claim 11 or a control device of claim 12.

13. A computer-readable storage medium in which a processor-executable program is stored, wherein the processor-executable program, when executed by a processor, implements a control method of an air source heat pump of any one of claims 1 to 10.

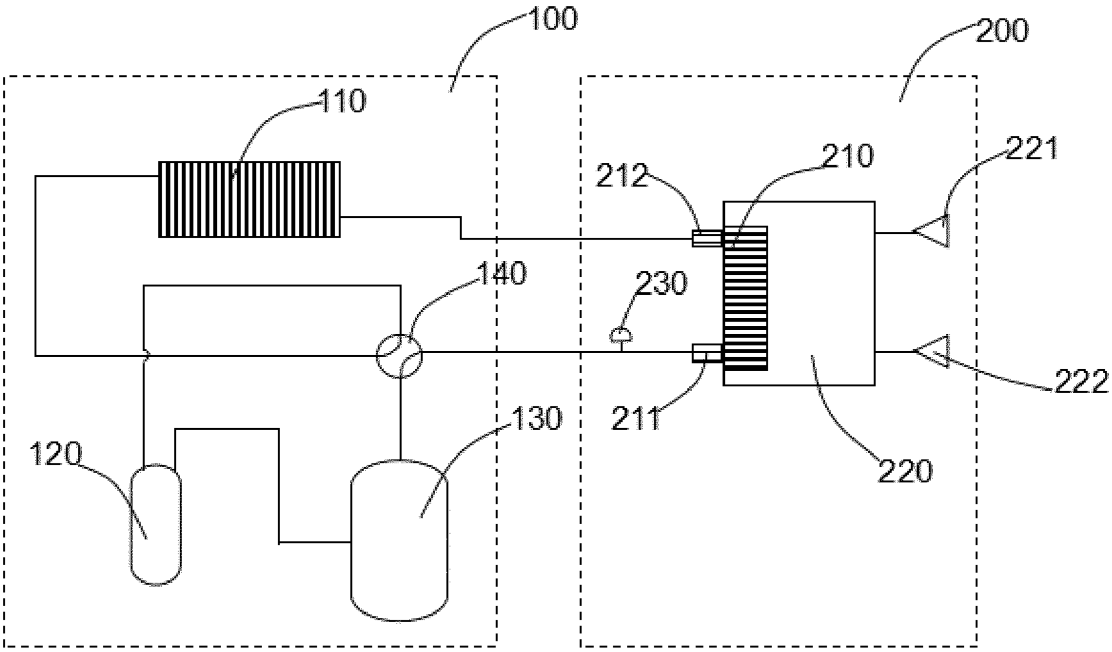
100
200
110
212
210
221
140
230
120
211
130
222
220

FIG. 1

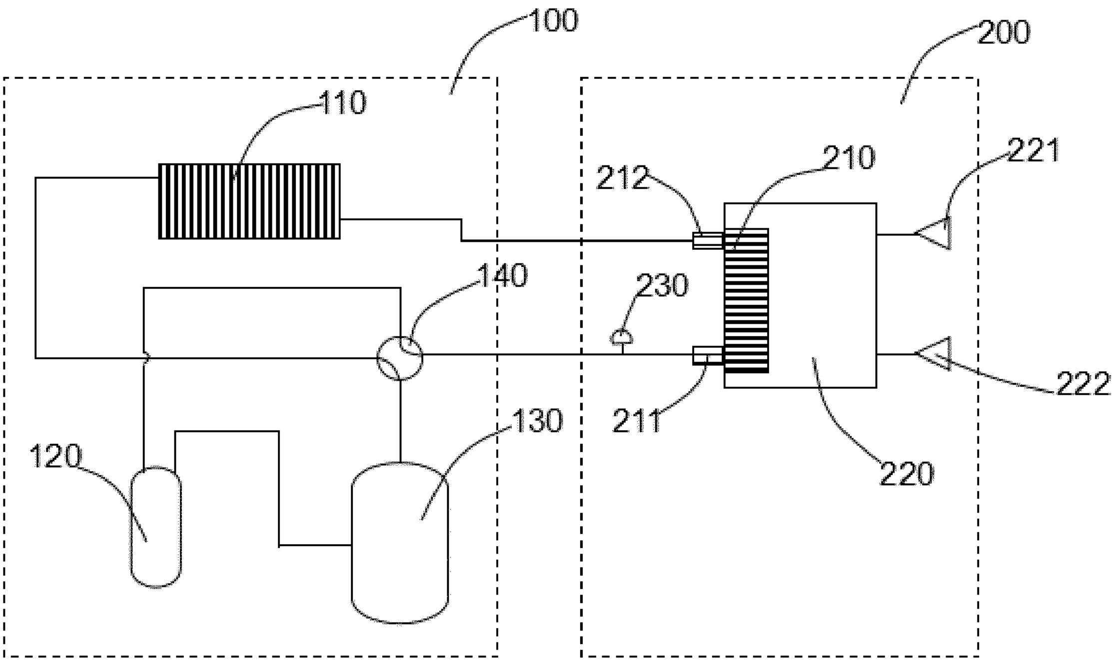
100
200
110
212
210
221
140
230
120
211
130
222
220

FIG. 2

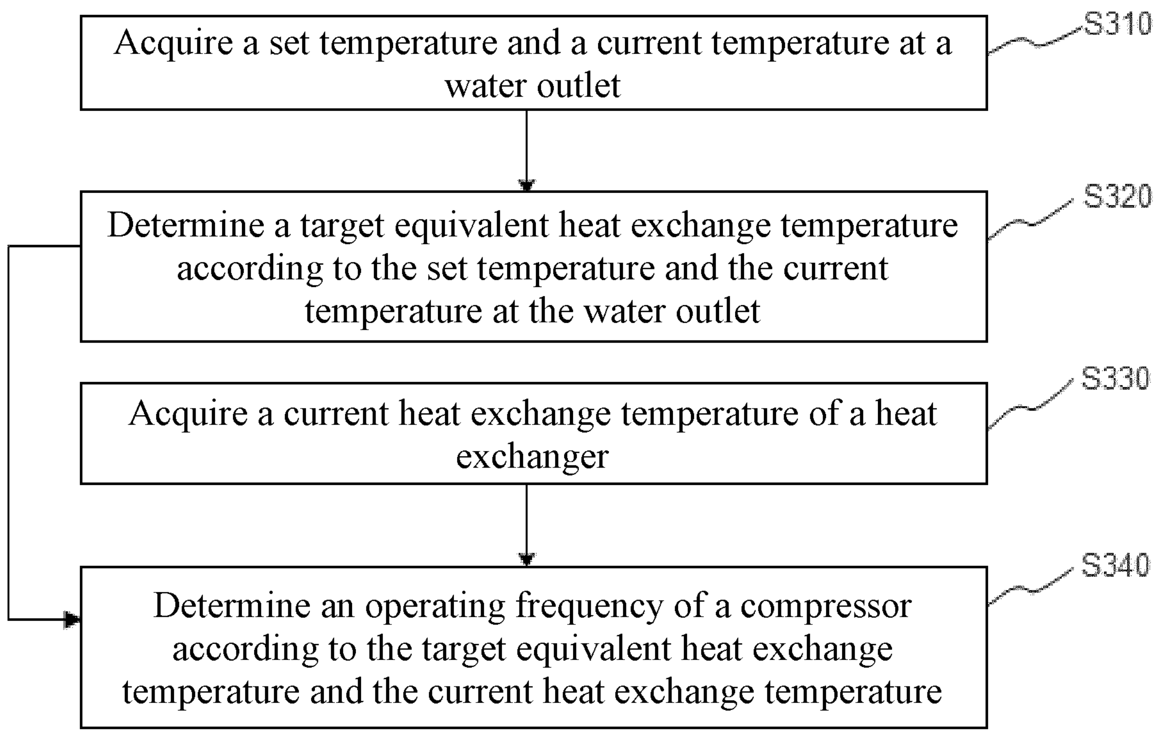
Acquire a set temperature and a current temperature at a water outlet
S310
Determine a target equivalent heat exchange temperature according to the set temperature and the current temperature at the water outlet
S320
Acquire a current heat exchange temperature of a heat exchanger
S330
Determine an operating frequency of a compressor according to the target equivalent heat exchange temperature and the current heat exchange temperature
S340

FIG. 3

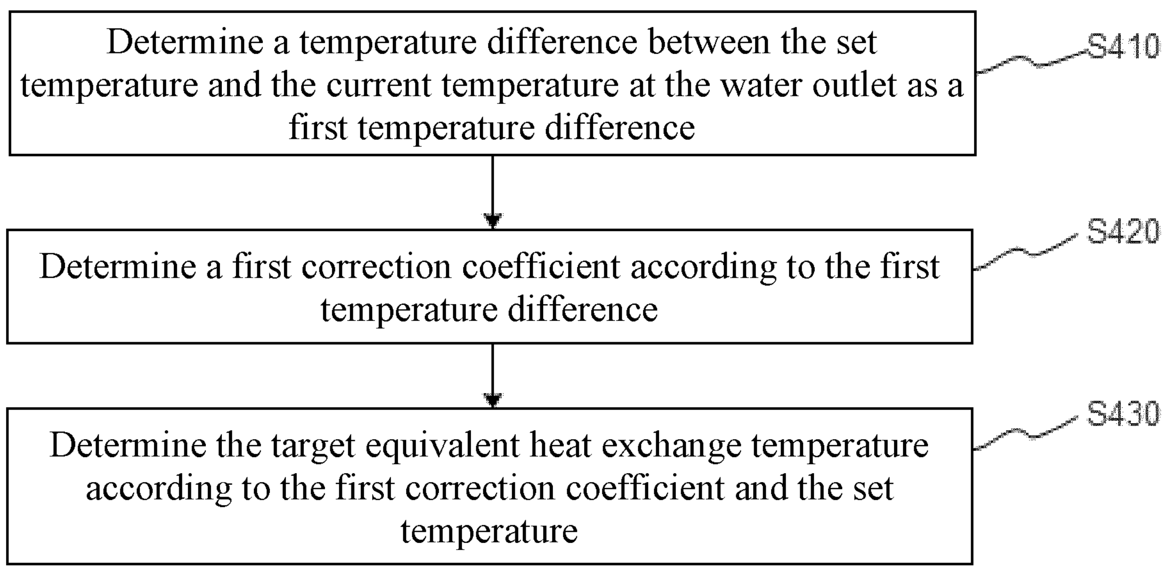
Determine a temperature difference between the set temperature and the current temperature at the water outlet as a first temperature difference
S410
Determine a first correction coefficient according to the first temperature difference
S420
Determine the target equivalent heat exchange temperature according to the first correction coefficient and the set temperature
S430

FIG. 4

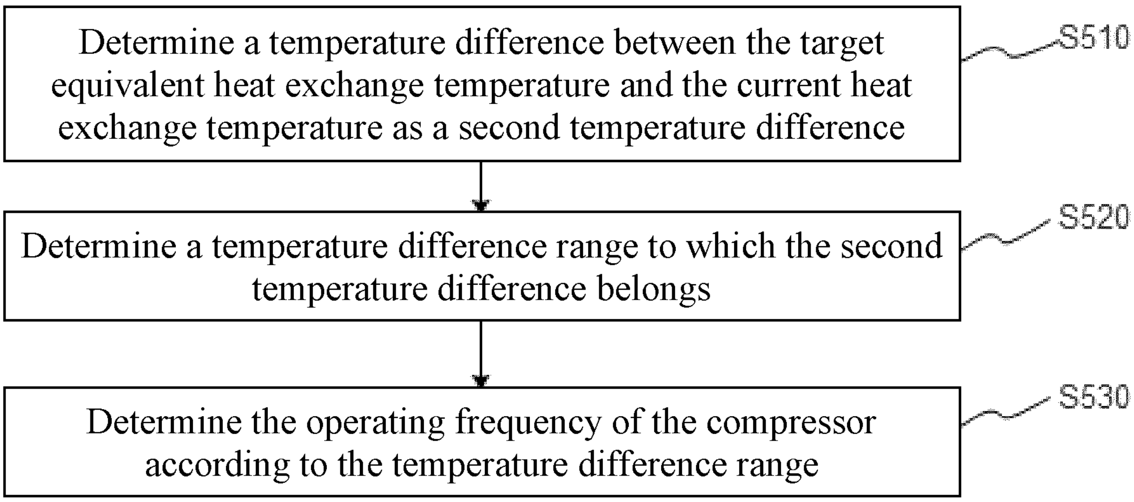

FIG. 5

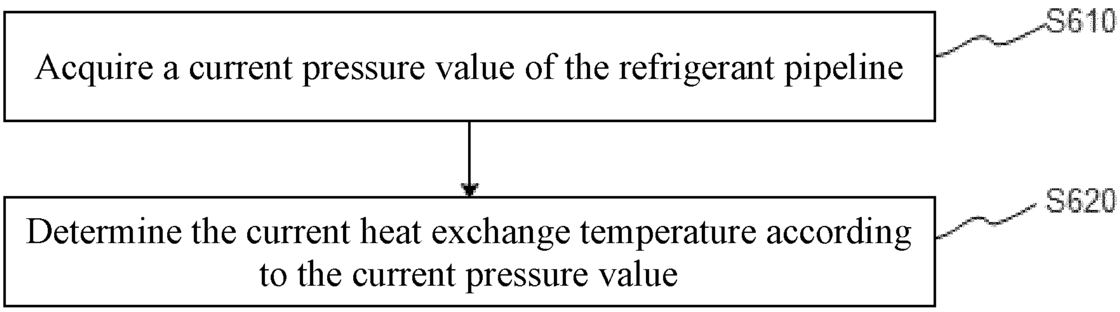

FIG. 6

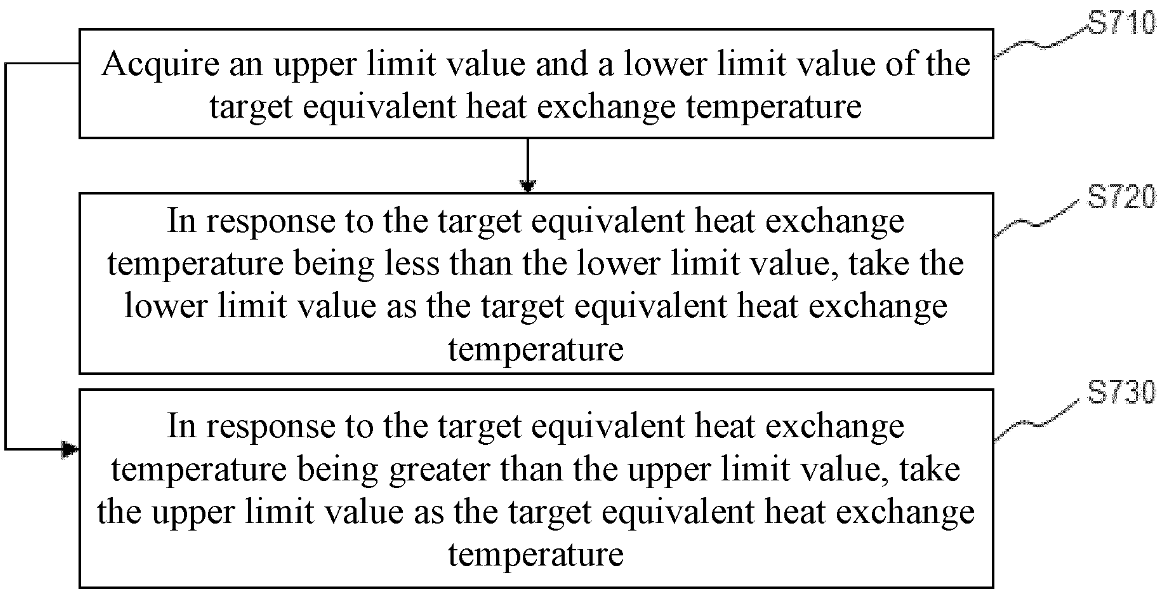

FIG. 7

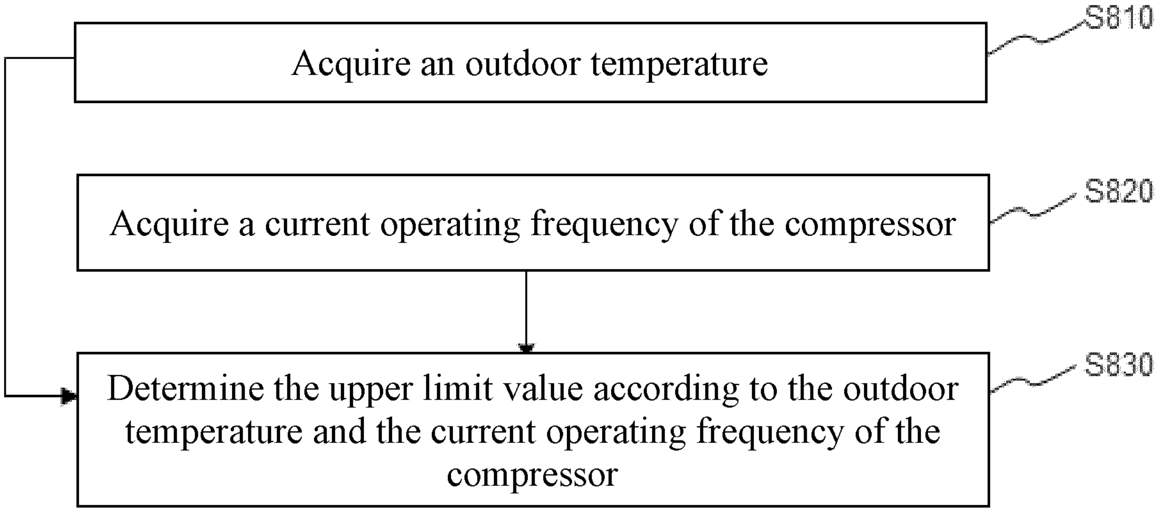
S810
Acquire an outdoor temperature
S820
Acquire a current operating frequency of the compressor
S830
Determine the upper limit value according to the outdoor temperature and the current operating frequency of the compressor

FIG. 8

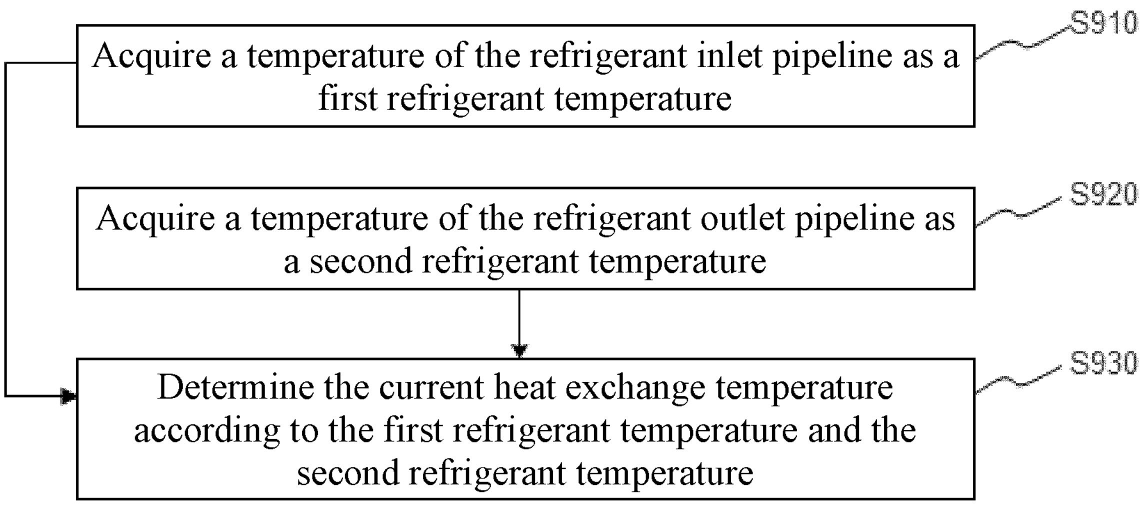
S910
Acquire a temperature of the refrigerant inlet pipeline as a first refrigerant temperature
S920
Acquire a temperature of the refrigerant outlet pipeline as a second refrigerant temperature
S930
Determine the current heat exchange temperature according to the first refrigerant temperature and the second refrigerant temperature

FIG. 9

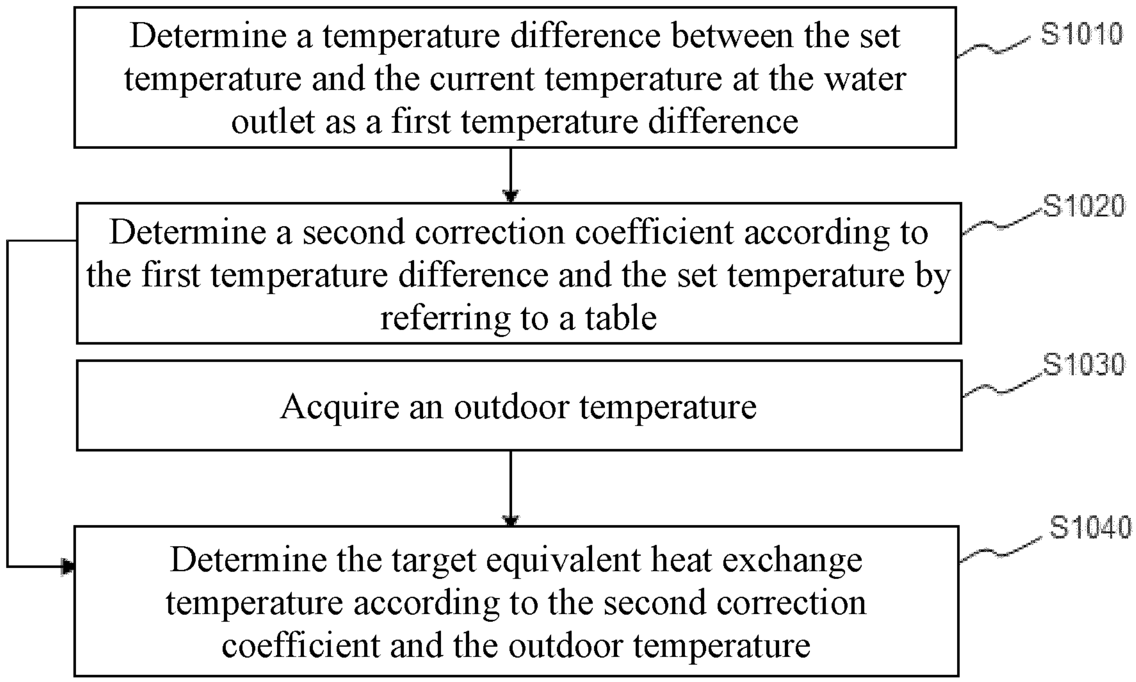
Determine a temperature difference between the set temperature and the current temperature at the water outlet as a first temperature difference
S1010
Determine a second correction coefficient according to the first temperature difference and the set temperature by referring to a table
S1020
Acquire an outdoor temperature
S1030
Determine the target equivalent heat exchange temperature according to the second correction coefficient and the outdoor temperature
S1040

FIG. 10

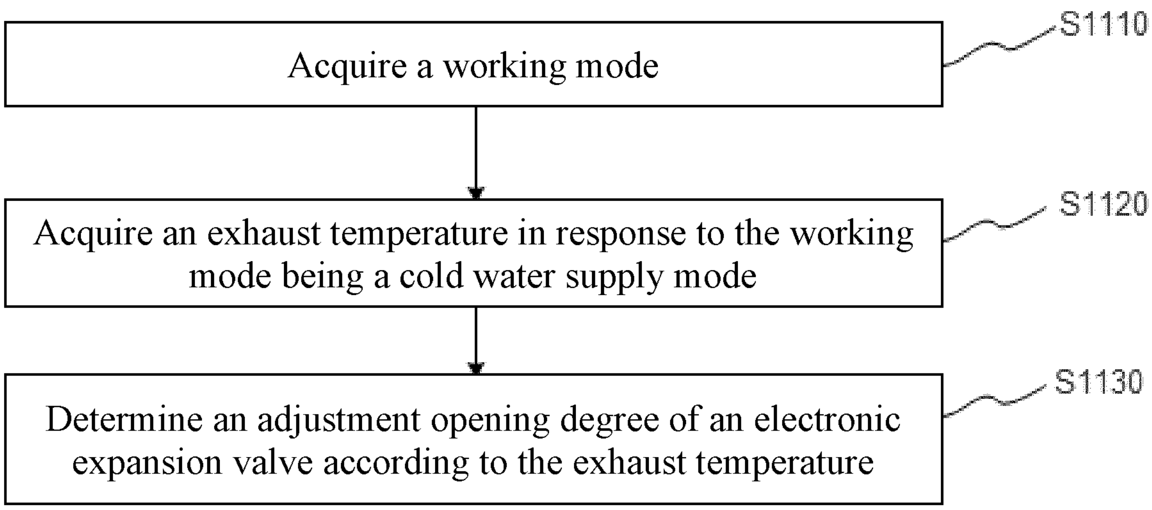
Acquire a working mode
S1110
Acquire an exhaust temperature in response to the working mode being a cold water supply mode
S1120
Determine an adjustment opening degree of an electronic expansion valve according to the exhaust temperature
S1130

FIG. 11

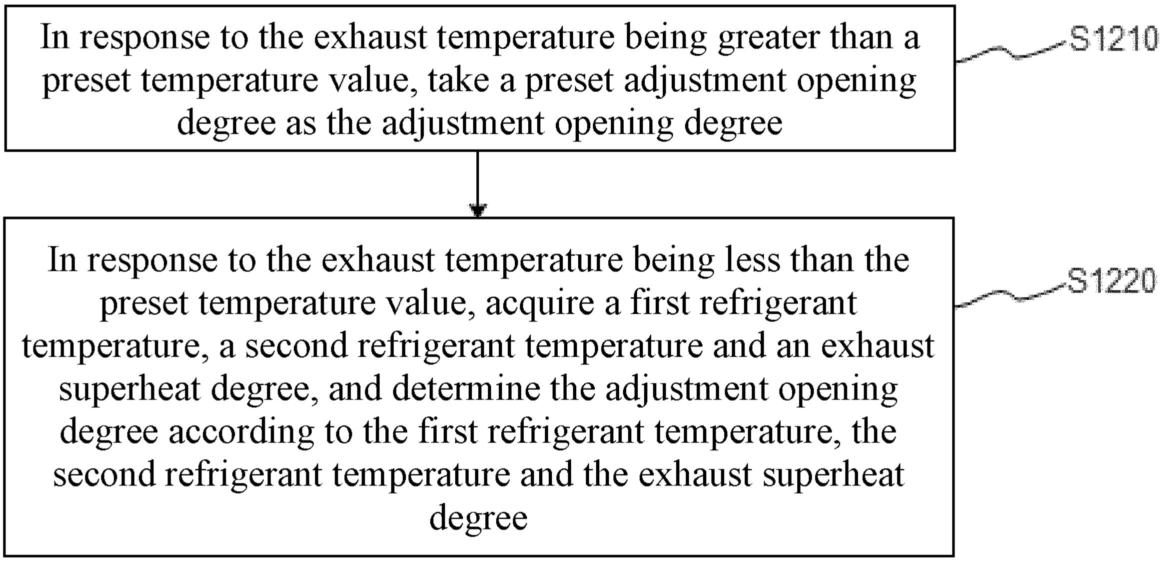
In response to the exhaust temperature being greater than a preset temperature value, take a preset adjustment opening degree as the adjustment opening degree
S1210
In response to the exhaust temperature being less than the preset temperature value, acquire a first refrigerant temperature, a second refrigerant temperature and an exhaust superheat degree, and determine the adjustment opening degree according to the first refrigerant temperature, the second refrigerant temperature and the exhaust superheat degree
S1220

FIG. 12

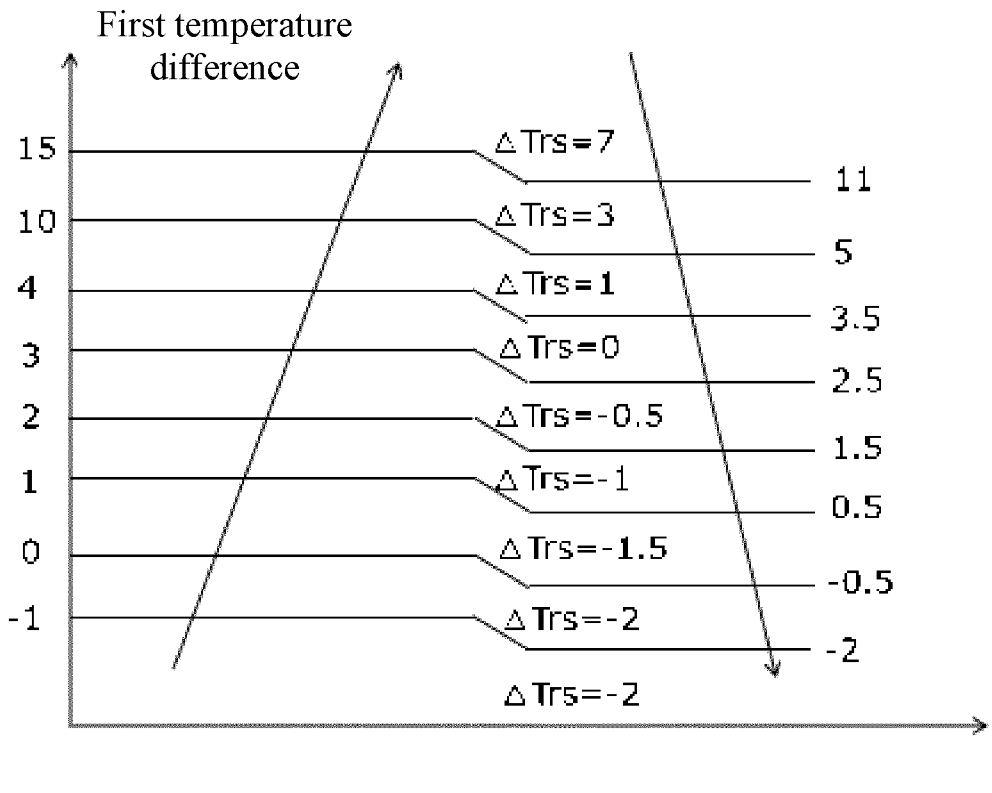
First temperature difference
15
10
4
3
2
1
0
-1
ΔTrs=7
ΔTrs=3
ΔTrs=1
ΔTrs=0
ΔTrs=-0.5
ΔTrs=-1
ΔTrs=-1.5
ΔTrs=-2
ΔTrs=-2
11
5
3.5
2.5
1.5
0.5
-0.5
-2

FIG. 13

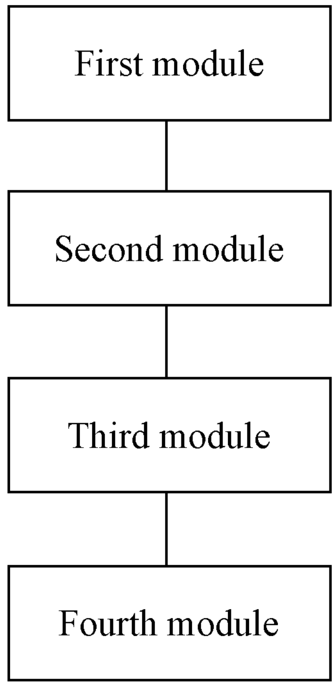
First module
Second module
Third module
Fourth module

FIG. 14

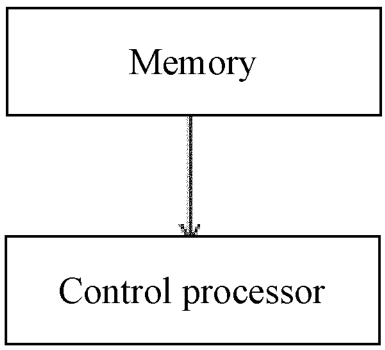
Memory
Control processor

FIG. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/082270

A. CLASSIFICATION OF SUBJECT MATTER

F25B 30/06(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)

F25B30/06; F25B30/00; F25B49/02; F25B49/00

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)

CNABS, CNTXT, CNKI, VEN: 空气源, 热泵, 压缩机, 频率, 出水温度, 预设温度, 等效换热温度, 冷凝, 蒸发, 温差; AIR, SOURCE, HEAT, PUMP, WATER, OUTLET, COMPRESSOR, FREQUENCY, TEMP, SET, DIFFERENCE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 113803909 A (GUANGDONG MIDEA REFRIGERATION EQUIPMENT CO., LTD.) 17 December 2021 (2021-12-17) claims	1-13
A	CN 107461960 A (GUANGDONG MIDEA REFRIGERATION EQUIPMENT CO., LTD.) 12 December 2017 (2017-12-12) description, pages 5-9, and figures 1-3	1-13
A	CN 108895738 A (ZHUHAI GREE ELECTRIC APPLIANCES INC.) 27 November 2018 (2018-11-27) entire document	1-13
A	CN 113339946 A (GUANGDONG TCL INTELLIGENT HEATING VENTILATION EQUIPMENT CO., LTD.) 03 September 2021 (2021-09-03) entire document	1-13
A	KR 20190016261 A (LG ELECTRONICS INC.) 18 February 2019 (2019-02-18) entire document	1-13

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"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
16 June 2022	**28 June 2022**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/ CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/082270

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 113803909 A	17 December 2021	None	
CN 107461960 A	12 December 2017	None	
CN 108895738 A	27 November 2018	None	
CN 113339946 A	03 September 2021	None	
KR 20190016261 A	18 February 2019	None	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- CN 202111135796 **[0001]**