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

(11) **EP 4 027 069 A1**

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

(43) Date of publication:
13.07.2022 Bulletin 2022/28

(21) Application number: **20860858.8**

(22) Date of filing: **09.06.2020**

(51) International Patent Classification (IPC):
F24F 11/38 *(2018.01)* ***F24F 11/64*** *(2018.01)*
F24F 11/74 *(2018.01)* ***F24F 11/80*** *(2018.01)*
F24F 11/88 *(2018.01)* ***F24F 110/10*** *(2018.01)*
F24F 110/20 *(2018.01)*

(52) Cooperative Patent Classification (CPC):
F24F 11/38; F24F 11/64; F24F 11/74; F24F 11/80; F24F 11/88

(86) International application number:
PCT/CN2020/095114

(87) International publication number:
WO 2021/042793 (11.03.2021 Gazette 2021/10)

(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: **04.09.2019 CN 201910833040**

(71) Applicants:
- **Qingdao Haier Air-Conditioning Electronic Co., Ltd**
  Qingdao, Shandong 266101 (CN)
- **Haier Smart Home Co., Ltd.**
  Qingdao, Shandong 266101 (CN)

(72) Inventors:
- **ZHANG, Xiaodi**
  Qingdao, Shandong 266101 (CN)
- **ZHANG, Dong**
  Qingdao, Shandong 266101 (CN)
- **XU, Lei**
  Qingdao, Shandong 266101 (CN)
- **GAO, Qiang**
  Qingdao, Shandong 266101 (CN)
- **ZHANG, Ming**
  Qingdao, Shandong 266101 (CN)

(74) Representative: **Brand Murray Fuller LLP**
50 Eastcastle Street
London W1W 8EA (GB)

(54) **REFRIGERATION CAPACITY DETERMINATION METHOD, REFRIGERATION ENERGY EFFICIENCY RATIO DETERMINATION METHOD, AND FAILURE NOTIFICATION METHOD**

(57) The present invention relates to the technical field of air conditioners, and particularly relates to a refrigeration capacity determination method, a refrigeration energy efficiency ratio determination method, and a failure notification method. The present invention aims to solve the problem in which existing refrigeration capacity determination methods for air conditioners are unable to accurately calculate the refrigeration capacity of air-cooled air conditioners. The refrigeration capacity determination method of the present invention comprises: acquiring an indoor air density; acquiring an air output volume of an indoor unit; acquiring an air inlet enthalpy value of the indoor unit; acquiring an air outlet enthalpy value of the indoor unit; and determining a refrigeration capacity of an air conditioner according to the indoor air density, and the air output volume, the air inlet enthalpy value, and the air outlet enthalpy value of the indoor unit. The present invention estimates, by means of the indoor air density and the air output volume, an air mass that the indoor unit is capable of refrigerating per second, and uses the air inlet enthalpy value and the air outlet enthalpy value which are capable of indicating energy contained in the air. In this way, the present invention combines the indoor air density, the air output volume, the air inlet enthalpy value, and the air outlet enthalpy value to achieve accurate calculation of the refrigeration capacity.

EP 4 027 069 A1

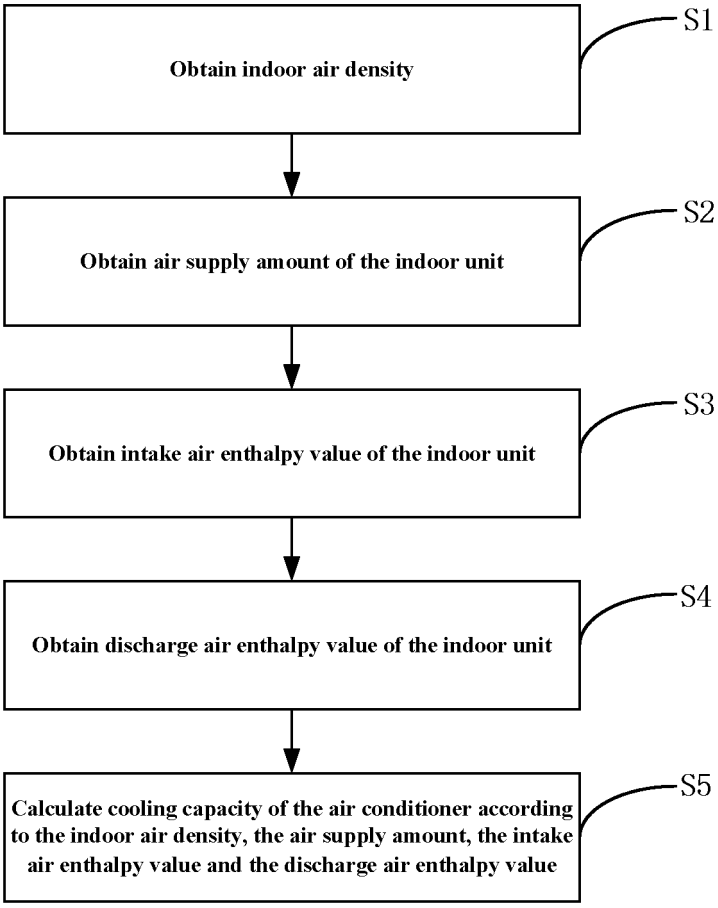
Obtain indoor air density
S1
Obtain air supply amount of the indoor unit
S2
Obtain intake air enthalpy value of the indoor unit
S3
Obtain discharge air enthalpy value of the indoor unit
S4
Calculate cooling capacity of the air conditioner according to the indoor air density, the air supply amount, the intake air enthalpy value and the discharge air enthalpy value
S5

FIG. 1

Description

FIELD OF THE INVENTION

[0001] The present disclosure belongs to the technical field of air conditioners, and specifically relates to a method for determining a cooling capacity for an air conditioner, a method for determining a cooling energy-efficiency ratio for an air conditioner, and a method for reminding a fault for an air conditioner.

BACKGROUND OF THE INVENTION

[0002] With the continuous improvement of people's living standards, people have also raised higher and higher requirements on the living environment. In order to maintain a comfortable ambient temperature, the air conditioner has become an indispensable device in people's lives. In recent years, in order to control the operation of the air conditioner more accurately, a controller of the air conditioner often needs to monitor various operating parameters of the air conditioner in real time. It is relatively easy to collect the operating parameters that can be directly measured by sensors. However, parameters that cannot be directly measured by sensors, such as a cooling capacity and a cooling energy-efficiency ratio, are relatively difficult to collect. Especially for a multi-connection air conditioner composed of one outdoor unit and multiple indoor units, in order to facilitate users to manage operating conditions of the multiple indoor units, it is often required for the multi-connection air conditioner to measure the cooling capacity of each indoor unit separately. Although there are a few methods for calculating the cooling capacity in the prior art, these calculation methods often need to rely on measuring a temperature change of heat exchange water to calculate the cooling capacity, that is, these calculation methods are only suitable for water-cooled multi-connection air-conditioners, and it is impossible for them to well calculate the cooling capacity of each indoor unit in the air-cooled multi-connection air conditioner.

[0003] Accordingly, there is a need in the art for a new method for determining a cooling capacity for an air conditioner, a new method for determining a cooling energy-efficiency ratio for an air conditioner, and a new method for reminding a fault for an air conditioner to solve the above problem.

SUMMARY OF THE INVENTION

[0004] In order to solve the above problem in the prior art, that is, in order to solve the problem that the existing methods for determining a cooling capacity for an air-conditioner cannot calculate the cooling capacity of an air-cooled air-conditioner simply and accurately, the present disclosure provides a method for determining a cooling capacity for an air conditioner, the air conditioner including an indoor unit, and the method for determining the cooling capacity including: obtaining an indoor air density; obtaining an air supply amount of the indoor unit; obtaining an intake air enthalpy value of the indoor unit; obtaining a discharge air enthalpy value of the indoor unit; and determining the cooling capacity of the air conditioner according to the indoor air density, the air supply amount of the indoor unit, the intake air enthalpy value, and the discharge air enthalpy value.

[0005] In a preferred technical solution of the above method for determining the cooling capacity, the step of "determining the cooling capacity of the air conditioner according to the indoor air density, the air supply amount of the indoor unit, the intake air enthalpy value, and the discharge air enthalpy value" specifically includes calculating the cooling capacity of the air conditioner through the following equation: $Q=\rho\times v\times(H_1-H_2)$, where Q is the cooling capacity of the air conditioner, p is the indoor air density, v is the air supply amount of the indoor unit, H_1 is the intake air enthalpy value of the indoor unit, and H_2 is the discharge air enthalpy value of the indoor unit.

[0006] In a preferred technical solution of the above method for determining the cooling capacity, the step of "obtaining the indoor air density" specifically includes: obtaining an intake air density of the indoor unit.

[0007] In a preferred technical solution of the above method for determining the cooling capacity, the step of "obtaining the air supply amount of the indoor unit" specifically includes: determining the air supply amount of the indoor unit according to a model and horsepower of the air conditioner.

[0008] In a preferred technical solution of the above method for determining the cooling capacity, the step of "obtaining the intake air enthalpy value of the indoor unit" specifically includes: obtaining an intake air temperature and an intake air humidity of the indoor unit; and determining the intake air enthalpy value of the indoor unit according to the intake air temperature and the intake air humidity of the indoor unit.

[0009] In a preferred technical solution of the above method for determining the cooling capacity, the step of "obtaining the discharge air enthalpy value of the indoor unit" specifically includes: obtaining a discharge air temperature and a discharge air humidity of the indoor unit; and determining the discharge air enthalpy value of the indoor unit according to the discharge air temperature and the discharge air humidity of the indoor unit.

[0010] The present disclosure also provides a method for determining a cooling energy-efficiency ratio for an air conditioner, which includes: obtaining a cooling capacity of the air conditioner; obtaining a power of the air conditioner; and calculating a ratio of the cooling capacity of the air conditioner to the power of the air conditioner and denoting it as the cooling energy-efficiency ratio; in which the cooling capacity of the air conditioner is determined using the method for determining the cooling capacity according to any one of the above preferred technical solutions.

[0011] In a preferred technical solution of the above

method for determining the cooling energy-efficiency ratio, the step of "obtaining the power of the air conditioner" specifically includes: obtaining a power source current of the air conditioner; obtaining a power source voltage of the air conditioner; and calculating a product of the power source current of the air conditioner and the power source voltage of the air conditioner and denoting it as the power of the air conditioner.

[0012] The present disclosure also provides a method for reminding a fault for an air conditioner, which includes: obtaining a cooling capacity of the air conditioner; comparing the obtained cooling capacity of the air conditioner with a preset cooling capacity; and controlling the air conditioner to issue a fault reminder, if a difference between the preset cooling capacity and the obtained cooling capacity of the air conditioner is larger than a preset difference; in which the cooling capacity of the air conditioner is determined using the method for determining the cooling capacity according to any one of the above preferred technical solutions.

[0013] The present disclosure also provides a method for reminding a fault for an air conditioner, which includes: obtaining a cooling energy-efficiency ratio of the air conditioner; comparing the obtained cooling energy-efficiency ratio of the air conditioner with a preset energy-efficiency ratio; and controlling the air conditioner to issue a fault reminder, if the obtained cooling energy-efficiency ratio of the air conditioner is smaller than the preset energy-efficiency ratio; in which the cooling energy-efficiency ratio of the air conditioner is determined using the method for determining the cooling energy-efficiency ratio according to any one of the above preferred technical solutions.

[0014] It can be understood by those skilled in the art that in the technical solutions of the present disclosure, the air conditioner of the present disclosure includes an indoor unit, and the method for determining the cooling capacity of the present disclosure includes: obtaining an indoor air density; obtaining an air supply amount of the indoor unit; obtaining an intake air enthalpy value of the indoor unit; obtaining a discharge air enthalpy value of the indoor unit; and determining the cooling capacity of the air conditioner according to the indoor air density, the air supply amount of the indoor unit, the intake air enthalpy value, and the discharge air enthalpy value. The determination method of the present disclosure predicts the mass of air that the indoor unit can cool per second through the indoor air density and the air supply amount of the indoor unit, whereas both the intake air enthalpy value and the discharge air enthalpy value can reflect the energy contained in the air, so the present disclosure realizes the accurate calculation of the cooling capacity by combining the indoor air density, the air supply amount of the indoor unit, the intake air enthalpy value and the discharge air enthalpy value. This determination method involves only a few basic parameters, which are obtained in a simple way and which are calculated also very simply; in addition, this calculation method is not only be applicable to air-cooled air conditioners, but also enables the cooling capacity of each indoor unit in the air-cooled multi-connection air conditioner to be calculated separately, so that the controller of the air conditioner can implement accurate and effective management of each indoor unit based on the cooling capacity of each indoor unit, thus further enabling the air conditioner to always maintain an efficient operating efficiency.

[0015] Further, in the preferred technical solutions of the present disclosure, the cooling capacity of the air conditioner is calculated through the following equation in the present disclosure: $Q=\rho\times v\times(H_1-H_2)$, where Q is the cooling capacity of the air conditioner, p is the indoor air density, v is the air supply amount of the indoor unit, H_1 is the intake air enthalpy value of the indoor unit, and H_2 is the discharge air enthalpy value of the indoor unit. The present disclosure predicts the mass of air that the indoor unit can cool per second by calculating a product of the indoor air density and the air supply amount of the indoor unit, predicts an energy change amount of the air after being cooled by the indoor unit through an enthalpy difference between the intake air enthalpy value and the discharge air enthalpy value, and then predicts the cooling capacity of the air conditioner through the product of the two; it should be noted that many existing methods for determining the cooling capacity predicts the heat change amount of the air only by using the amount of temperature change during the calculation, whereas the fact that the cooling capacity is also significantly related to the amount of air humidity change is completely neglected. The present application has discovered this problem. Therefore, the determination method of the present disclosure uses the enthalpy difference to participate in the calculation, so that the amount of humidity change is sufficiently taken into consideration, thereby greatly improving the accuracy of the calculation.

[0016] Further, in the preferred technical solutions of the present disclosure, when the air conditioner is operating in a cooling mode, the method for reminding a fault of the present disclosure can judge whether an abnormal situation occurs in the air conditioner itself according to the cooling capacity of the air conditioner. It can be understood that the cooling capacity represents the cooling ability of the air conditioner, so the cooling capacity can be used to judge whether the cooling ability of the air conditioner is abnormal, and a fault reminder will be issued in time when the cooling ability of the air conditioner is abnormal, so that the user can timely and accurately know about the abnormal situation of the air conditioner, and then realize an effective protection for the air conditioner.

[0017] Further, in the preferred technical solutions of the present disclosure, when the air conditioner is operating in the cooling mode, the method for reminding a fault of the present disclosure can judge whether an abnormal situation occurs in the air conditioner itself according to the cooling energy-efficiency ratio of the air conditioner. It can be understood that the cooling energy-

efficiency ratio represents the cooling efficiency of the air conditioner, so the cooling energy-efficiency ratio can be used to judge whether the cooling efficiency of the air conditioner is abnormal, and a fault reminder will be issued in time when the cooling efficiency of the air conditioner is abnormal, so that the user can timely and accurately know about the abnormal situation of the air conditioner, and then realize an effective protection for the air conditioner.

BRIEF DESCRIPTION OF DRAWINGS

[0018]

FIG. 1 is a flowchart showing main steps of a method for determining a cooling capacity of the present disclosure; and

FIG. 2 is a flowchart showing steps of a method for reminding a fault of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0019] Preferred embodiments of the present disclosure will be described below with reference to the accompanying drawings. It should be understood by those skilled in the art that these embodiments are only used to explain the technical principles of the present disclosure, and are not intended to limit the scope of protection of the present disclosure. For example, although the various steps of the method of the present disclosure are described in a specific order in the present application, these orders are not limitative, and those skilled in the art can execute these described steps in a different order without departing from the basic principles of the present disclosure.

[0020] Based on the problem pointed out in the "BACKGROUND OF THE INVENTION" that the existing methods for determining a cooling capacity for an air-conditioner cannot calculate the cooling capacity of an air-cooled air-conditioner simply and accurately, the present disclosure provides a method for determining a cooling capacity for an air conditioner, which includes: obtaining an indoor air density; obtaining an air supply amount of the indoor unit; obtaining an intake air enthalpy value of the indoor unit; obtaining a discharge air enthalpy value of the indoor unit; and calculating the cooling capacity of the air conditioner according to the indoor air density, the air supply amount of the indoor unit, the intake air enthalpy value, and the discharge air enthalpy value, so that the cooling capacity of the air conditioner can be calculated quickly and accurately.

[0021] Specifically, the air conditioner of the present disclosure includes an indoor unit, and the indoor unit is provided with an air inlet and an air outlet. Air flows into the indoor unit through the air inlet for heat exchange, and then flows out through the air outlet. It should be noted that the present disclosure does not impose any limitations on the specific structure of the air conditioner, and technicians may apply the determination method of the present disclosure to various types of air conditioners. The air conditioner also includes an intake air temperature sensor, a discharge air temperature sensor, an intake air humidity sensor, and a discharge air humidity sensor. The intake air temperature sensor can detect the intake air temperature of the indoor unit, the discharge air temperature sensor can detect the discharge air temperature of the indoor unit, the intake air humidity sensor can detect the intake air humidity of the indoor unit, and the discharge air humidity sensor can detect the discharge air humidity of the indoor unit. The air conditioner further includes a controller that can obtain the intake air temperature of the indoor unit through the intake air temperature sensor, obtain the discharge air temperature of the indoor unit through the discharge air temperature sensor, obtain the intake air humidity of the indoor unit through the intake air humidity sensor, and obtain the discharge air humidity of the indoor unit through the discharge air humidity sensor. In addition, it can be understood by those skilled in the art that the present disclosure does not impose any limitations on the specific structure and model of the controller, and the controller may be the original controller of the air conditioner, or it may be a controller separately provided for implementing the determination method and the method for reminding a fault of the present disclosure. Technicians may set the structure and model of the controller by themselves according to actual requirements on use.

[0022] First, reference is made to FIG. 1, which is a flowchart showing main steps of a method for determining a cooling capacity of the present disclosure. As shown in FIG. 1, based on the air conditioner described in the above embodiment, the method for determining the cooling capacity of the present disclosure mainly includes the following steps:

S1: obtaining an indoor air density;

S2: obtaining an air supply amount of the indoor unit;

S3: obtaining an intake air enthalpy value of the indoor unit;

S4: obtaining a discharge air enthalpy value of the indoor unit; and

S5: calculating the cooling capacity of the air conditioner according to the indoor air density, the air supply amount, the intake air enthalpy value, and the discharge air enthalpy value.

[0023] Further, in step S1, the controller can obtain the indoor air density of a room in which the indoor unit is located; it should be noted that the present disclosure does not impose any limitations on the method through which the controller obtains the indoor air density. Tech-

nicians may either use a dedicated measurement instrument for measuring and then directly transmit measured data to the controller, or they may calculate the indoor air density by themselves by measuring indoor temperature and indoor pressure, as long as the controller can obtain the indoor air density. In addition, it should also be noted that since there may be slight differences in the air density between different places in the room, in order to better ensure the accuracy of the calculation result, the intake air density of the indoor unit is preferably used as the basic parameter in the present disclosure, namely, the density of the air near the air inlet; of course, this is not limiting, and technicians may also set it according to actual requirements.

[0024] Further, in step S2, the controller can obtain the air supply amount of the indoor unit; it should be noted that the present disclosure does not impose any limitations on the way in which the controller obtains the air supply amount. The controller may directly determine the air supply amount of the indoor unit according to the model and horsepower of the air conditioner, that is, determine the air supply amount through original data from the manufacturer, or may also calculate the air supply amount of the indoor unit by measuring the area of the air outlet and the air supply speed; that is, technicians may set the way of obtaining the air supply amount by themselves according to actual requirements on use.

[0025] Further, in step S3, the controller can obtain the intake air enthalpy value of the indoor unit; as a preferred embodiment, the controller obtains the intake air temperature of the indoor unit through the intake air temperature sensor, and obtains the intake air humidity of the indoor unit through the intake air humidity sensor. After the controller obtains the intake air temperature and the intake air humidity of the indoor unit, the controller can determine the intake air enthalpy value of the indoor unit according to an internally stored temperature and humidity map. Of course, it can be understood by those skilled in the art that the present disclosure does not impose any limitations on the way in which the controller obtains the intake air enthalpy value, and technicians may set it by themselves according to actual requirements on use. Such changes to the specific way of obtaining the intake air enthalpy value do not depart from the basic principle of the present disclosure, and belong to the scope of protection of the present disclosure.

[0026] Further, in step S4, the controller can obtain the discharge air enthalpy value of the indoor unit; as a preferred embodiment, the controller obtains the discharge air temperature of the indoor unit through the discharge air temperature sensor, and obtains the discharge air humidity of the indoor unit through the discharge air humidity sensor. After the controller obtains the discharge air temperature and the discharge air humidity of the indoor unit, the controller can determine the discharge air enthalpy value of the indoor unit according to the internally stored temperature and humidity map. Of course, it can be understood by those skilled in the art that the present disclosure does not impose any limitations on the way in which the controller obtains the discharge air enthalpy value, and technicians may set it by themselves according to actual requirements on use. Such changes to the specific way of obtaining the discharge air enthalpy value do not depart from the basic principle of the present disclosure, and belong to the scope of protection of the present disclosure.

[0027] In addition, it should also be noted that the present disclosure does not impose any limitations on the order of obtaining the above four basic parameters, that is, the controller may either obtain these four parameters in a specific order, or obtain these four parameters at the same time. Such changes to the specific order do not deviate from the basic principle of the present disclosure. At the same time, it can be understood by those skilled in the art that for an air conditioner with multiple indoor units, the controller only needs to calculate the cooling capacity of each indoor unit through the determination method, and then perform a summation so that the total cooling capacity of the air conditioner can be obtained.

[0028] Further, in step S5, the controller can calculate the cooling capacity of the air conditioner according to the indoor air density, the air supply amount, the intake air enthalpy value, and the discharge air enthalpy value. It should be noted that the present disclosure does not impose any limitations on the specific way of calculating the cooling capacity of the air conditioner. Technicians may obtain the calculation formula by themselves through fitting based on experiments according to structural characteristics of different air conditioners, which falls within the scope of protection of the present disclosure as long as only the four measurement values of the indoor air density, the air supply amount, the intake air enthalpy value and the discharge air enthalpy value are used for calculation in the method for determining the cooling capacity. As a preferred embodiment, the present disclosure can calculate the cooling capacity Q of the air conditioner through the following equation:

$$Q=\rho\times v\times(H_1-H_2);$$

where p is the indoor air density, with the unit being kg/m^3; v is the air supply amount of the indoor unit, with the unit being m^3/s; H_1 is the intake air enthalpy value of the indoor unit, with the unit being kj/kg; and H_2 is the discharge air enthalpy value of the indoor unit, with the unit being kj/kg. Of course, technicians may also add one or more correction coefficients to the above formula according to actual calculation requirements, so as to further improve the accuracy of the calculation.

[0029] In addition, the present disclosure also provides a method for determining a cooling energy-efficiency ratio. After the cooling capacity of the air conditioner is calculated through the above determination method, the controller can also first calculate the power of the air con-

ditioner according to P=U×I; where U is a power source voltage of the air conditioner, which is typically 220V, and I is a power source current of the air conditioner, which can usually be measured by directly providing a current sensor at a power source terminal of an electrical control box of the air conditioner. Of course, this method of calculating the power of the air conditioner is not limiting, and technicians may set the method by themselves according to actual requirements on use. After the power of the air conditioner has been calculated, the controller can obtain the cooling energy-efficiency ratio of the air conditioner by calculating a ratio of the cooling capacity to the power, so that the controller can calculate the cooling energy-efficiency ratio of the air conditioner in real time.

[0030] Next, reference is made to FIG. 2, which is a flowchart showing steps of a method for reminding a fault of the present disclosure. As shown in FIG. 2, based on the air conditioner described in the previous embodiment, the method for reminding a fault of the present disclosure specifically includes the following steps:

S101: making the air conditioner operate in a cooling mode;

S102: obtaining a cooling capacity of the air conditioner;

S103: judging whether a difference between a preset cooling capacity and the cooling capacity is larger than a preset difference; if yes, executing step S106; and if not, executing step S102 again;

S104: obtaining a cooling energy-efficiency ratio of the air conditioner;

S105: judging whether the cooling energy-efficiency ratio of the air conditioner is smaller than a preset energy-efficiency ratio; if yes, executing step S106; and if not, executing step S104 again; and

S106: controlling the air conditioner to issue a fault reminder.

[0031] Further, in a case where the air conditioner is operating in the cooling mode, in step S102, the controller can obtain the cooling capacity of the air conditioner; it should be noted that the cooling capacity used in this step is the cooling capacity calculated by the above determination method. Next, step S103 is executed, and the controller judges whether the difference between the preset cooling capacity and the obtained cooling capacity is larger than the preset difference, so as to judge whether the cooling ability of the air conditioner meets the standard. It can be understood by those skilled in the art that technicians may set the specific values of the preset cooling capacity and the preset difference according to actual requirements on use, as long as it can indicate that the cooling ability of the air conditioner does not meet the standard if the difference between the preset cooling capacity and the cooling capacity is larger than the preset difference. Based on the judgment result of step S103, if the difference between the preset cooling capacity and the obtained cooling capacity is larger than the preset difference, it means that the cooling ability of the air conditioner is insufficient. At this time, step S106 is executed. If the difference between the preset cooling capacity and the obtained cooling capacity is smaller than or equal to the preset difference, it means that the cooling ability of the air conditioner has met the standard. At this time, step S102 is executed again to continue to monitor the cooling ability of the air conditioner.

[0032] Further, in a case where the air conditioner is operating in the cooling mode, in step S104, the controller obtains the cooling energy-efficiency ratio of the air conditioner; it should be noted that the cooling energy-efficiency ratio used in this step is the cooling energy-efficiency ratio calculated by the above determination method. Next, step S105 is executed, and the controller judges whether the obtained cooling energy-efficiency ratio is smaller than the preset energy-efficiency ratio, so as to judge whether the cooling efficiency of the air conditioner meets the standard. It can be understood by those skilled in the art that technicians may set the specific value of the preset energy-efficiency ratio according to actual requirements on use, as long as the preset energy-efficiency ratio can represent the minimum standard of the cooling efficiency. Based on the judgment result of step S105, if the obtained cooling energy-efficiency ratio is smaller than the preset energy-efficiency ratio, it means that the cooling efficiency of the air conditioner is insufficient. In this situation, step S106 is executed. If the obtained cooling energy-efficiency ratio is larger than or equal to the preset energy-efficiency ratio, it means that the cooling efficiency of the air conditioner has met the standard. At this time, step S104 is executed again to continue to monitor the cooling efficiency of the air conditioner.

[0033] Further, in step S106, if the cooling ability of the air conditioner does not meet the standard or the cooling efficiency does not meet the standard, the controller can control the air conditioner to issue a fault reminder. It should be noted that the present disclosure does not impose any limitations on the way in which the air conditioner issues the fault reminder, and technicians may set it by themselves according to actual requirements on use. For example, the air conditioner may issue a voice reminder to the user through a voice device, or issue a text reminder through a control terminal thereof.

[0034] Finally, it should be noted that the above embodiments are all preferred implementations of the present disclosure, and they are not intended to limit the scope of protection of the present disclosure. When practicing the present disclosure in actual use, those skilled in the art can appropriately add or delete a part of the steps as needed, or exchange the order between different steps. Such changes do not go beyond the basic

principles of the present disclosure, and belong to the scope of protection of the present disclosure.

[0035] Hitherto, the preferred implementations of the present disclosure have been described in conjunction with the accompanying drawings, but it is easily understood by those skilled in the art that the scope of protection of the present disclosure is obviously not limited to these specific embodiments. Without departing from the principles of the present disclosure, those skilled in the art can make equivalent changes or replacements to relevant technical features, and all the technical solutions after these changes or replacements will fall within the scope of protection of the present disclosure.

Claims

1. A method for determining a cooling capacity for an air conditioner, wherein the air conditioner comprises an indoor unit, and the method for determining the cooling capacity comprises:

   obtaining an indoor air density;
   obtaining an air supply amount of the indoor unit;
   obtaining an intake air enthalpy value of the indoor unit;
   obtaining a discharge air enthalpy value of the indoor unit; and
   determining the cooling capacity of the air conditioner according to the indoor air density, the air supply amount of the indoor unit, the intake air enthalpy value, and the discharge air enthalpy value.

2. The method for determining the cooling capacity according to claim 1, wherein the step of "determining the cooling capacity of the air conditioner according to the indoor air density, the air supply amount of the indoor unit, the intake air enthalpy value, and the discharge air enthalpy value" specifically comprises calculating the cooling capacity of the air conditioner through the following equation:

$$Q=\rho\times v\times(H_1-H_2),$$

   where Q is the cooling capacity of the air conditioner, p is the indoor air density, v is the air supply amount of the indoor unit, H_1 is the intake air enthalpy value of the indoor unit, and H_2 is the discharge air enthalpy value of the indoor unit.

3. The method for determining the cooling capacity according to claim 2, wherein the step of "obtaining the indoor air density" specifically comprises:
   obtaining an intake air density of the indoor unit.

4. The method for determining the cooling capacity according to claim 2, wherein the step of "obtaining the air supply amount of the indoor unit" specifically comprises:
   determining the air supply amount of the indoor unit according to a model and horsepower of the air conditioner.

5. The method for determining the cooling capacity according to claim 2, wherein the step of "obtaining the intake air enthalpy value of the indoor unit" specifically comprises:

   obtaining an intake air temperature and an intake air humidity of the indoor unit; and
   determining the intake air enthalpy value of the indoor unit according to the intake air temperature and the intake air humidity of the indoor unit.

6. The method for determining the cooling capacity according to claim 2, wherein the step of "obtaining the discharge air enthalpy value of the indoor unit" specifically comprises:

   obtaining a discharge air temperature and a discharge air humidity of the indoor unit; and
   determining the discharge air enthalpy value of the indoor unit according to the discharge air temperature and the discharge air humidity of the indoor unit.

7. A method for determining a cooling energy-efficiency ratio for an air conditioner, comprising:

   obtaining a cooling capacity of the air conditioner;
   obtaining a power of the air conditioner; and
   calculating a ratio of the cooling capacity of the air conditioner to the power of the air conditioner and denoting it as the cooling energy-efficiency ratio;
   wherein the cooling capacity of the air conditioner is determined using the method for determining the cooling capacity according to any one of claims 1 to 6.

8. The method for determining the cooling energy-efficiency ratio according to claim 7, wherein the step of "obtaining the power of the air conditioner" specifically comprises:

   obtaining a power source current of the air conditioner;
   obtaining a power source voltage of the air conditioner; and
   calculating a product of the power source current of the air conditioner and the power source voltage of the air conditioner and denoting it as the power of the air conditioner.

9. A method for reminding a fault for an air conditioner, comprising:

obtaining a cooling capacity of the air conditioner;
comparing the obtained cooling capacity of the air conditioner with a preset cooling capacity; and
controlling the air conditioner to issue a fault reminder, if a difference between the preset cooling capacity and the obtained cooling capacity of the air conditioner is larger than a preset difference;
wherein the cooling capacity of the air conditioner is determined using the method for determining the cooling capacity according to any one of claims 1 to 6.

10. A method for reminding a fault for an air conditioner, comprising:

obtaining a cooling energy-efficiency ratio of the air conditioner;
comparing the obtained cooling energy-efficiency ratio of the air conditioner with a preset energy-efficiency ratio; and
controlling the air conditioner to issue a fault reminder, if the obtained cooling energy-efficiency ratio of the air conditioner is smaller than the preset energy-efficiency ratio;
wherein the cooling energy-efficiency ratio of the air conditioner is determined using the method for determining the cooling energy-efficiency ratio according to claim 7 or 8.

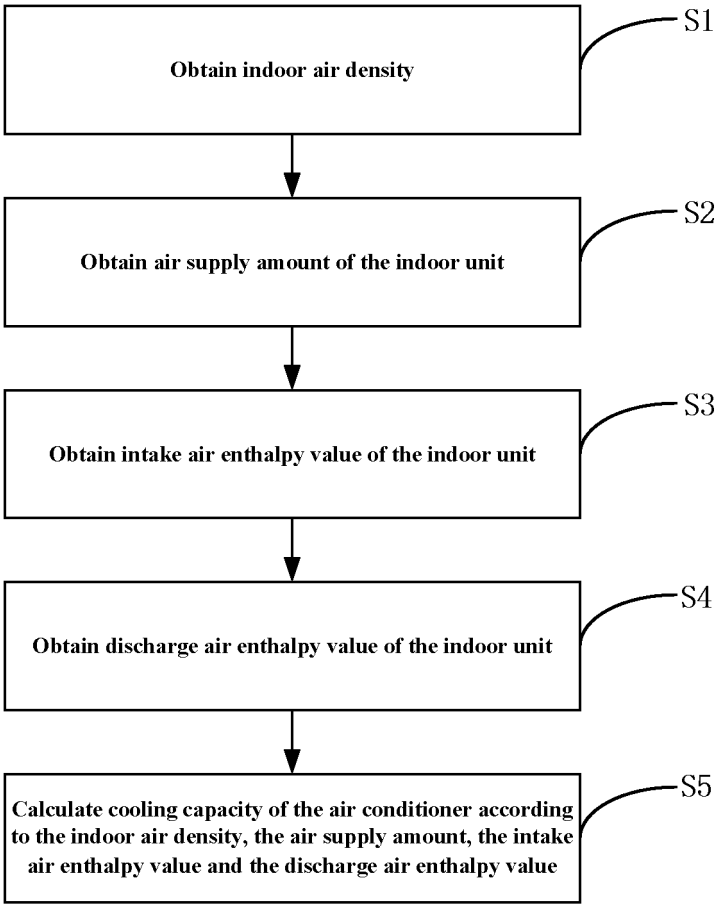
Obtain indoor air density
S1
Obtain air supply amount of the indoor unit
S2
Obtain intake air enthalpy value of the indoor unit
S3
Obtain discharge air enthalpy value of the indoor unit
S4
Calculate cooling capacity of the air conditioner according to the indoor air density, the air supply amount, the intake air enthalpy value and the discharge air enthalpy value
S5

FIG. 1

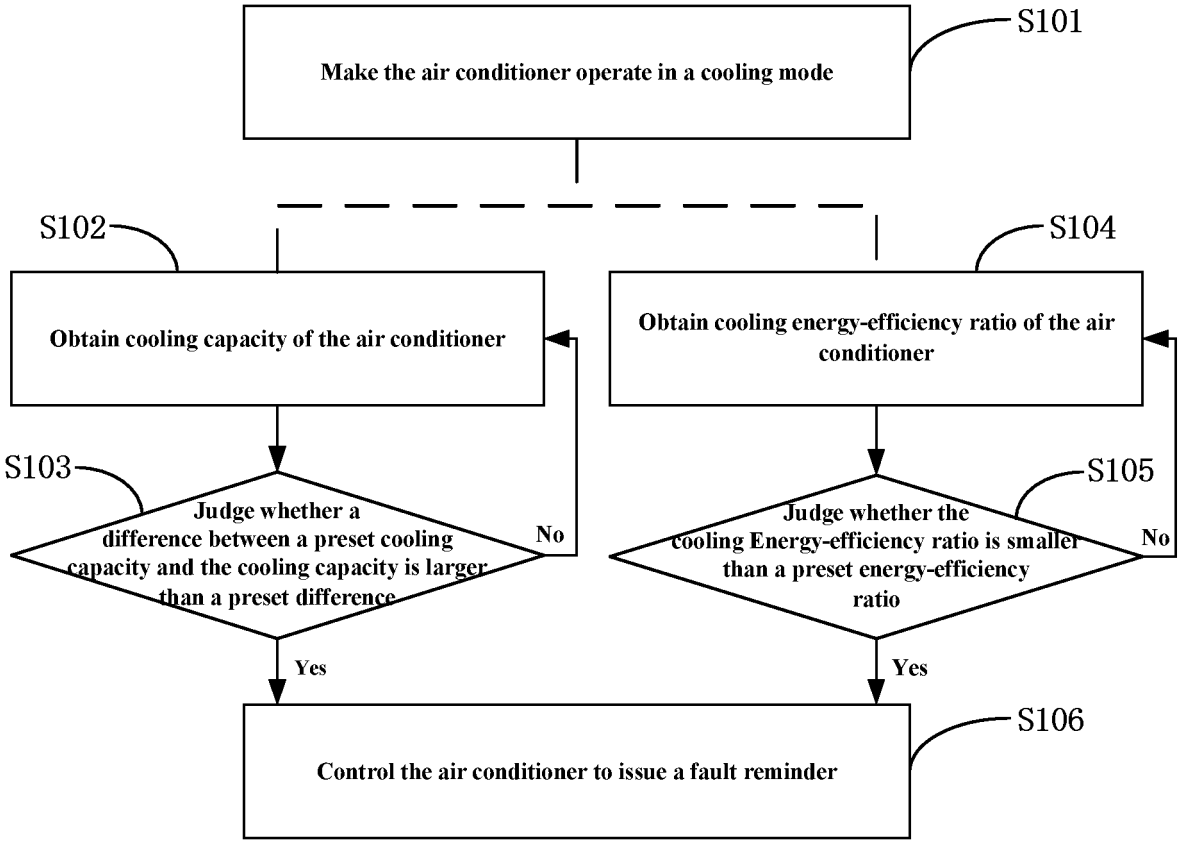
Make the air conditioner operate in a cooling mode
S101
S102
Obtain cooling capacity of the air conditioner
S104
Obtain cooling energy-efficiency ratio of the air conditioner
S103
Judge whether a difference between a preset cooling capacity and the cooling capacity is larger than a preset difference
No
Yes
S105
Judge whether the cooling Energy-efficiency ratio is smaller than a preset energy-efficiency ratio
No
Yes
Control the air conditioner to issue a fault reminder
S106

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/095114

A. CLASSIFICATION OF SUBJECT MATTER

F24F 11/38(2018.01)i; F24F 11/64(2018.01)i; F24F 11/74(2018.01)i; F24F 11/80(2018.01)i; F24F 11/88(2018.01)i; F24F 110/10(2018.01)n; F24F 110/20(2018.01)n

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)

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)

CNABS; CNTXT; DWPI; SIPOABS; CNKI; USTXT; EPTXT; WOTXT: 海尔, 空调, 制冷量, 室内机, 空气密度, 风量, 进风, 出风, 焓值, 温度, 湿度, 功率, 能效比, air condition+, inlet, outlet, enthalpy, power, cool+, refrigerat+, capacity, air density, energy efficiency

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 106839323 A (QINGDAO HAIER AIR CONDITIONER ELECTRIC CO., LTD.) 13 June 2017 (2017-06-13) description, paragraphs [0005]-[0031], and figures 1-4	1-10
A	CN 104776944 A (GUANGDONG MEDIA REFRIGERATION EQUIPMENT CO., LTD. et al.) 15 July 2015 (2015-07-15) entire document	1-10
A	CN 1664524 A (HANGZHOU HOMEWELL INTELLIGENCE CONTROL CO., LTD.) 07 September 2005 (2005-09-07) entire document	1-10

☐ 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
22 July 2020	**02 September 2020**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China**	
Facsimile No. **(86-10)62019451**	Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2020/095114

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 106839323 A	13 June 2017	None	
CN 104776944 A	15 July 2015	None	
CN 1664524 A	07 September 2005	None	

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