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(71) Applicant: **Gree Electric Appliances, Inc. of Zhuhai**
Zhuhai, Guangdong 519070 (CN)

(72) Inventors:
- **MIAO, Zhiqiang**
  Zhuhai, Guangdong 519070 (CN)
- **SUN, Qingyiming**
  Zhuhai, Guangdong 519070 (CN)
- **LI, Fuliang**
  Zhuhai, Guangdong 519070 (CN)
- **WU, Mingguo**
  Zhuhai, Guangdong 519070 (CN)
- **GUAN, Huanhao**
  Zhuhai, Guangdong 519070 (CN)
- **ZHANG, Chen**
  Zhuhai, Guangdong 519070 (CN)

(74) Representative: **Noble, Nicholas et al**
Kilburn & Strode LLP
Lacon London
84 Theobalds Road
London WC1X 8NL (GB)

(54) EVAPORATION DEVICE AND CONTROL METHOD THEREFOR, AND REFRIGERATED DISPLAY CABINET

(57) The present disclosure relates to an evaporator, a control method thereof, and a refrigeration display cabinet. The evaporator includes a heat exchange body (1). The heat exchange body (1) includes a dehumidification area (A) and an anti-frost cooling area (B) sequentially arranged along a first direction. The dehumidification area (A) is located at an air inflow side in the first direction. The heat exchange body (1) includes a heat exchange channel for refrigerant to flow. The heat exchange channel includes a plurality of first channel sections and a plurality of second channel sections. The plurality of first channel sections are arranged at intervals along the first direction, and extend along a second direction perpendicular to the first direction. The same side ends of adjacent first channel sections in the heat exchange channel are in communication with each other through the second channel sections. The number density of the first channel sections in the anti-frost cooling area (B) is less than the number density of the first channel sections in the dehumidification area (A).

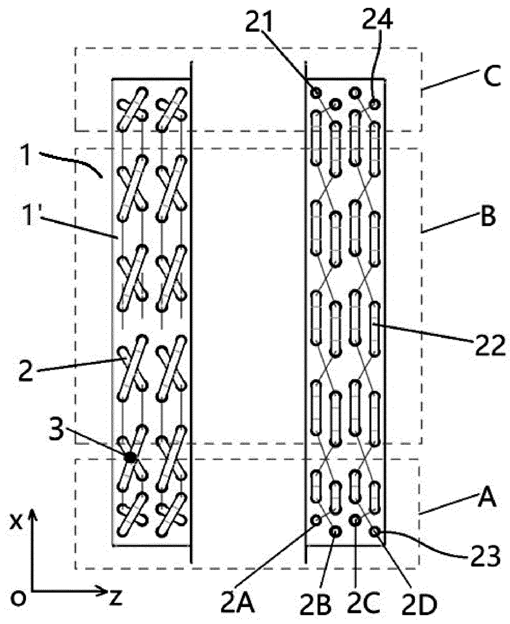

FIG. 1

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present disclosure is based on and claims priority to Chinese application No. 202011084822.4, filed on October 12, 2020, the disclosure of which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to the technical field of refrigeration equipment, and particularly relates to an evaporator, a control method thereof, and a refrigeration display cabinet.

BACKGROUND

[0003] A refrigeration display cabinet is a cabinet with refrigeration for display of food, medicine, or the like, and is widely used in large stores, supermarkets, etc.

[0004] The air-curtain type refrigeration display cabinet has an open structure, due to which hot air in environment can easily enter the cabinet and form frost on the evaporator, so that the heat and flow resistances of the outer surface of the evaporator become larger, and finally the power consumption caused by frequent defrosting is increased. Various methods are being sought in the industry to reduce the frost, but none of them can well alleviate the frost formation for the evaporator.

SUMMARY

[0005] Embodiments of the present disclosure provide an evaporator, a control method thereof, and a refrigeration display cabinet in order to well alleviate the frost formation for the evaporator.

[0006] According to a first aspect of the present disclosure, an evaporator is provided, which includes:

a heat exchange body; the heat exchange body includes a dehumidification area and an anti-frost cooling area sequentially arranged along a first direction; the dehumidification area is located at an air inflow side in the first direction;

the heat exchange body includes a heat exchange channel for refrigerant to flow, the heat exchange channel includes a plurality of first channel sections and a plurality of second channel sections, the plurality of first channel sections are arranged at intervals along the first direction, and extend along a second direction perpendicular to the first direction, same side ends of adjacent first channel sections in the heat exchange channel are in communication with each other through the second channel sections; and

a number density of the first channel sections in the anti-frost cooling area is less than a number density of the first channel sections in the dehumidification area.

[0007] In some embodiments, the heat exchange body further includes an enhanced cooling area located downstream of the anti-frost cooling area in the first direction; and
a number density of the first channel sections in the anti-frost cooling area is less than a number density of the first channel sections in the enhanced cooling area.

[0008] The heat exchange body further includes an enhanced cooling area located downstream of the anti-frost cooling area in the first direction; and
a number density of the first channel sections in the anti-frost cooling area is less than a number density of the first channel sections in the enhanced cooling area.

[0009] In some embodiments, a distance in the first direction between adjacent first channel sections in the anti-frost cooling area is greater than a distance in the first direction between adjacent first channel sections in the dehumidification area.

[0010] In some embodiments, the heat exchange body further includes an enhanced cooling area located downstream of the anti-frost cooling area in the first direction; and
a distance in the first direction between adjacent first channel sections in the anti-frost cooling area is greater than a distance in the first direction between adjacent first channel sections in the enhanced cooling area.

[0011] In some embodiments, the evaporator includes:

a heat exchange body; the heat exchange body includes a dehumidification area and an anti-frost cooling area sequentially arranged along an airflow direction; the dehumidification area is located at an air inflow side;

the heat exchange body includes a heat exchange channel for refrigerant to flow, the heat exchange channel includes a plurality of first channel sections and a plurality of second channel sections, the plurality of first channel sections are arranged at intervals along a first direction parallel to the airflow direction, and extend along a second direction perpendicular to the first direction, same side ends of adjacent first channel sections in the heat exchange channel are in communication with each other through the second channel sections; and

a distance in the first direction between adjacent first channel sections in the anti-frost cooling area is greater than a distance in the first direction between adjacent first channel sections in the dehumidification area.

[0012] In some embodiments, the heat exchange body further includes an enhanced cooling area located downstream of the anti-frost cooling area in the airflow direction; and

a distance in the first direction between adjacent first channel sections in the anti-frost cooling area is greater than a distance in the first direction between adjacent first channel sections in the enhanced cooling area.

[0013] In some embodiments, for the same heat exchange channel, the number of the first channel sections in the anti-frost cooling area is greater than the number of the first channel sections in the dehumidification area; and/or the number of the first channel sections in the dehumidification area is greater than the number of the first channel sections in the enhanced cooling area.

[0014] In some embodiments, for the same heat exchange channel,

the number of the first channel sections in the dehumidification area is the number of the first channel sections without frost;

the number of the first channel sections in the anti-frost cooling area is configured such that the dehumidification area and the anti-frost cooling area together remove a predetermined percentage of moisture in an airflow and to achieve a predetermined heat exchange amount; and/or

the number of the first channel sections in the enhanced cooling area is configured such that an overall heat exchange amount of the heat exchange body meets a requirement.

[0015] In some embodiments, the heat exchange body includes:

a base; and

a heat exchange tube mounted on the base,

wherein the heat exchange channel is defined inside the heat exchange tube, the heat exchange tube includes a plurality of first tube sections and a plurality of second tube sections, the first channel sections are defined inside the first tube sections, and the second channel sections are defined inside the second tube sections.

[0016] In some embodiments, the heat exchange channel includes a plurality of the heat exchange channels arranged along a third direction, the plurality of the heat exchange channels each include a first end and a second end arranged along the first direction, the first end is configured for inflow of the refrigerant, the second end is configured for outflow of the refrigerant, and the third direction is perpendicular to the first direction and the second direction; and

the plurality of the heat exchange channels at least include a pair of adjacent and crossed heat exchange channels, at the same side ends of the first channel sections, the second channel sections of the two crossed heat exchange channels are crossed with each other.

[0017] In some embodiments, at least one side of the heat exchange body along the third direction is provided with the two crossed heat exchange channels.

[0018] In some embodiments, an upwind surface of the heat exchange body includes a surface of the dehumidification area perpendicular to a third direction and facing inflow of air, and a surface of the dehumidification area perpendicular to the first direction, wherein the third direction is perpendicular to the first direction and the second direction.

[0019] In some embodiments, a surface of the heat exchange body is coated with a hydrophobic coating.

[0020] In some embodiments, the evaporator further includes:

a liquid supply tube and an gas outlet tube respectively in communication with an inlet and an outlet at two ends of the heat exchange channel, the liquid supply tube being provided with a throttling element; and

a first temperature detecting member configured to detect a temperature at the dehumidification area of the heat exchange body,

wherein an opening degree of the throttling element is configured to increase on a condition that a detected value of the first temperature detecting member exceeds a predetermined temperature value, and to decrease on a condition that the detected value of the first temperature detecting member does not exceed the predetermined temperature value.

[0021] In some embodiments, the evaporator further includes:

a second temperature detecting member configured to detect a temperature of the liquid supply tube; and
a third temperature detecting member configured to detect a temperature of the gas outlet tube,
wherein the opening degree of the throttling element is configured to be determined according to a difference between detected values of the third temperature detecting member and the second temperature detecting member, and the opening degree of the throttling element is positively correlated with the difference between the detected values.

[0022] In some embodiments, the heat exchange tube has a diameter in a range of 6 mm to 13 mm.
[0023] According to a second aspect of the present disclosure, a refrigeration display cabinet is provided, which includes the evaporator in the above embodiments.
[0024] In some embodiments, the refrigeration display cabinet further includes:

a cabinet body in which a first air pathway and a second air pathway are defined, the first air pathway extending along a front-and-rear direction of the cabinet body and being provided at a lower portion of the cabinet body, and the second air pathway extending along an up-and-down direction of the cabinet body and being provided at a rear portion of the cabinet body, and a lower portion of the second air pathway is in communication with a rear portion of the first air pathway; and
a fan disposed in the first air pathway and configured to deliver cold air to the first air pathway, the cold air sequentially passing through the first air pathway and the second air pathway and forming a cold air curtain in a front surface of the cabinet body,
wherein the evaporator is disposed in a lower region of the second air pathway, and the first direction coincides with the up-and-down direction.

[0025] In some embodiments, the refrigeration display cabinet further includes:

a baffle plate disposed between the first air pathway and the second air pathway,
wherein the dehumidification area is located below the baffle plate, the anti-frost cooling area and the enhanced cooling area are located above the baffle plate, and an upwind surface of the heat exchange body includes a surface of the dehumidification area directly facing inflow of air and a bottom surface of the dehumidification area.

[0026] According to a third aspect of the present disclosure, a control method of the evaporator is provided, which includes:

detecting, by a first temperature detecting member, a temperature at the dehumidification area of the heat exchange body; and
determining whether a detected value of the first temperature detecting member exceeds a predetermined temperature value, increasing an opening degree of a throttling element if the detected value exceeds the predetermined temperature value, and decreasing the opening degree of the throttling element if the detected value does not exceed the predetermined temperature value, wherein the throttling element is provided on a liquid supply tube of the evaporator, and the liquid supply tube is in communication with an inlet of the heat exchange channel.

[0027] In some embodiments, when there is a need to adjust the opening degree of the throttling element, the control method further includes:

detecting, by a second temperature detecting member, a temperature of the liquid supply tube;
detecting, by a third temperature detecting member, a temperature of an gas outlet tube, the as outlet tube is in communication with an outlet of the heat exchange channel; and
determining the opening degree of the throttling element according to a difference between detected values of the third temperature detecting member and the second temperature detecting member, and the opening degree of the throttling element is positively correlated with the difference between the detected values.

[0028] According to the evaporator of the embodiments of the present disclosure, the airflow flows along the evaporator and in the first direction perpendicular to the first channel section, and thus different cooling effects will occur sequentially in different areas when the airflow passing through the evaporator. In the area of the heat exchange body adjacent to the air inflow side, since the temperature of the air entering from the environment is relatively high, this area is not easy to frost, but the humidity of the air is high. Through the dehumidification area the dehumidification effect can be optimized. After the airflow passes through the dehumidification area for heat exchange, some water vapor is still present in the airflow, and frost is easily formed during further cooling. By increasing the distance between adjacent first channel sections in the anti-frost cooling area, the amount of frost can be reduced to alleviate the frost formation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The drawings described herein are used to provide a further understanding of the present disclosure, and constitute a part of the present application. The exemplary embodiments of the present disclosure and the description thereof are used to explain the present disclosure, but are not intended to be construed as improper limitations to the present disclosure. In the drawings:

FIG. 1 is a schematic structural view of two end surfaces in X-Z planes of an evaporator in some embodiments of the present disclosure.
FIG. 2 is a schematic structural view of a refrigeration display cabinet in some embodiments of the present disclosure.
FIG. 3 is a schematic view showing airflows in the evaporator in some embodiments of the present disclosure.
FIG. 4 is a schematic view showing a principle of the evaporator in some embodiments of the present disclosure.

Description of reference signs:

[0030] 1, heat exchange body; 1’, base; 2, heat exchange tube; 21, first tube section; 22, second tube section; 23, inlet; 24, outlet; 2A, first heat exchange tube; 2B, second heat exchange tube; 2C, third heat exchange tube; 2D, fourth heat exchange tube; 3, first temperature detecting member; 4, liquid supply tube; 5, gas outlet tube; 6, second temperature detecting member; 7, third temperature detecting member; 8, throttling element; A, dehumidification area; B, anti-frost cooling area; C, enhanced cooling area; S, upwind surface; X, first direction; Y, second direction; Z, third direction;
10, evaporator ; 20, cabinet body; 30, first air pathway; 40, second air pathway; 50, third air pathway; 60, flow guide channel; 70, fan; and 80, baffle plate.

DETAILED DESCRIPTION

[0031] The present disclosure is described hereinafter in detail. In the following paragraphs, different aspects of embodiments are defined in detail. The aspects defined may be combined with one or more of any other aspects unless specifically stated otherwise. In particular, any features considered to be preferred or advantageous may be combined with one or more of other features considered to be preferred or advantageous.

[0032] The terms "first", "second" and the like appearing in the present disclosure are only used to facilitate description so as to distinguish different components with the same name, but not to represent a sequence or a primary and secondary relationship.

[0033] In addition, when an element is referred to as being "on" another element, the element can be directly arranged on the other element, or can be indirectly arranged on the other element via one or more intermediate elements inserted therebetween. In addition, when an element is referred to as being "connected" to another element, the element can be directly connected to the other element, or can be indirectly connected to the other element via one or more intermediate elements inserted therebetween. In the following description, the same reference sign represents the same element.

[0034] The present disclosure includes terms indicating directions or position relationships, such as "upper", "lower", "top", "bottom", "front", "rear", "inner", "outer" and the like. These terms are only for facilitating the description of the present disclosure, rather than indicating or implying that the referred devices must have specific orientations or be constructed and operated in the specific orientations, and therefore, cannot be interpreted as limitations to the protection scope of the present disclosure.

[0035] As shown in FIGS. 1 to 4, the present disclosure provides an evaporator 10 for refrigeration. The evaporator 10 includes a heat exchange body 1. The heat exchange body 1 includes a dehumidification area A and an anti-frost cooling area B sequentially arranged along a first direction. The dehumidification area A is located at an air inflow side in the first direction. The heat exchange body 1 includes a heat exchange channel for refrigerant to flow. The heat exchange channel includes a plurality of first channel sections and a plurality of second channel sections. The plurality of first channel sections are arranged at intervals along the first direction, and extend along a second direction perpendicular to the first direction. The same side ends of adjacent first channel sections in the heat exchange channel are in communication with each other through the second channel sections. The number density of the first channel sections in the anti-frost cooling area B is less than the number density of the first channel sections in the dehumidification area A.

[0036] In some embodiments, the heat exchange body 1 further includes an enhanced cooling area C located downstream of the anti-frost cooling area B in the first direction. The number density of the first channel sections in the anti-frost cooling area B is less than the number density of the first channel sections in the enhanced cooling area C.

[0037] In some embodiments, the evaporator 10 includes the heat exchange body 1. The heat exchange body 1 includes the dehumidification area A and the anti-frost cooling area B sequentially arranged along an airflow direction. The dehumidification area A is located at the air inflow side, and the anti-frost cooling area B is located downstream of the dehumidification area A.

[0038] The heat exchange body 1 includes the heat exchange channel for refrigerant to flow. The heat exchange channel includes an inlet 23 and an outlet 24. The inlet 23 is provided for inflow of liquid refrigerant, and the outlet 24 is provided for outflow of gaseous refrigerant. The heat exchange body 1 includes the heat exchange channel for refrigerant to flow. The heat exchange channel includes the plurality of first channel sections and the plurality of second channel sections. The plurality of first channel sections are arranged at intervals along the first direction X, and extend along the second direction Y perpendicular to the first direction X. The first direction X is parallel to the airflow direction. The same side ends of adjacent first channel sections in the heat exchange channel are in communication with each other through a second channel section. For example, the first channel sections may be straight sections, and the second channel sections may be in U-shape, arc-shape or other curved shape.

[0039] In some embodiments, as shown in FIG. 1, the heat exchange body 1 includes a base 1' and a heat exchange tube 2 mounted on the base 1'. The heat exchange channel is defined inside the heat exchange tube 2. The heat exchange tube 2 includes a plurality of first tube sections 21 and a plurality of second tube sections 22. The first channel sections are defined inside the first tube sections 21, and the second channel sections are defined inside the second tube sections 22. The heat exchange tube 2 includes the plurality of first tube sections 21 and the plurality of second tube sections 22. The plurality of first tube sections 21 are arranged at intervals along the first direction X parallel to the airflow direction, and extend along the second direction Y perpendicular to the first direction X. The same side ends of adjacent first tube sections 21 corresponding to the same heat exchange channel are in communication with each other through a second tube section 22. Alternatively, the heat exchange channel can be directly defined by the heat exchange body 1.

[0040] The distance in the first direction X between adjacent first channel sections in the anti-frost cooling area B is greater than the distance in the first direction X between adjacent first channel sections in the dehumidification area A.

[0041] In the present embodiment, since air flows along the evaporator 10 and in the first direction X perpendicular to the first channel sections, rather than perpendicular to the largest side surface of the evaporator 10, different cooling effects occur in different areas when the airflow passing through the evaporator 10.

[0042] In the area of the heat exchange body 1 adjacent to the air inflow side, since the temperature of the air entering from the environment is relatively high, this area is not easy to frost. However, the humidity of the air is high. Due to the evaporation effect of the dehumidification area A, water vapor in the air can be condensed. The relatively small distance between adjacent first channel sections in the dehumidification area A can improve the dehumidification effect.

[0043] After the airflow passes through the dehumidification area A for evaporation heat exchange, some water vapor is still present in the airflow, and the temperature of the airflow is reduced. When the airflow passes through the anti-frost cooling area B for further cooling, the water vapor in the airflow tends to condense on the surface of the heat exchange body 1 to form frost. By increasing the distance between adjacent first channel sections in the anti-frost cooling area B, the frost amount can be reduced to alleviate the frost formation. In addition, the airflow is further dehumidified by passing through the anti-frost cooling area B. As a result, the present embodiment can ensure heat exchange and dehumidification effects while alleviate the frost formation for the evaporator 10, thereby improving the overall performance of the evaporator 10.

[0044] In some embodiments, as shown in FIG. 1, the heat exchange body 1 further includes the enhanced cooling area C located downstream of the anti-frost cooling area B in the airflow direction. The enhanced cooling area C is located at an air outflow side. The distance in the first direction X between adjacent first channel sections in the anti-frost cooling area B is greater than the distance in the first direction X between adjacent first channel sections in the enhanced cooling area C.

[0045] In this embodiment, after the airflow sequentially passes through the dehumidification area A and the anti-frost cooling area B, the content of the water vapor in the airflow is greatly reduced. In the process that the airflow is further cooled by the enhanced cooling area C, frost is not easy to be formed on the heat exchange body 1. Therefore, by reducing the distance between adjacent first channel sections in the enhanced cooling area C, the overall heat exchange amount of the evaporator 10 can be ensured to achieve. In FIG. 1, the arrangement of the first channel sections in the anti-frost cooling area B is relatively sparse in the airflow direction, while the arrangement of the first channel sections in the dehumidification area A and the enhanced cooling area C is relatively dense in the airflow direction. Therefore, the effects of heat exchange and dehumidification are ensured while the frost formation of the evaporator 10 is alleviated, and thus the overall performance of the evaporator 10 is improved.

[0046] In some embodiments, as shown in FIG. 1, for the same heat exchange channel, the number of the first channel sections in the anti-frost cooling area B is greater than the number of the first channel sections in the dehumidification area A. For example, the number of the first channel sections in the dehumidification area A is 3 to 5, and the number of the first channel sections in the anti-frost cooling area B is 6 to 8.

[0047] In some embodiments, for the same heat exchange channel, the number of the first channel sections in the dehumidification area A is greater than the number of the first channel sections in the enhanced cooling area C. For example, the number of the first channel sections in the enhanced cooling area C is about 2.

[0048] In some embodiments, for the same heat exchange channel, the number of the first channel sections in the dehumidification area A is the number of the first channel sections without frost. Since the ambient temperature is relatively high, at the beginning of the airflow passing through the heat exchange body 1, due to the high temperature of the airflow, frost is not easy to be formed even though the humidity of the airflow is at the maximum. However, as the airflow is gradually cooled, frost is easy to be formed because the temperature of the airflow decreases. Therefore, the number of the first channel sections in the dehumidification area A can be determined according to a critical position between the frost area and the no-frost area in the heat exchange body 1. As such, the first channel sections can be densely arranged to ensure the dehumidification effect and to prevent the dehumidification area A from frosting as well.

[0049] In some embodiments, the number of the first channel sections in the anti-frost cooling area B is configured such that the dehumidification area A and the anti-frost cooling area B together remove a predetermined percentage of moisture in an airflow and to achieve a predetermined heat exchange amount. The anti-frost cooling area B is a heat exchange main area, which can realize the main evaporation heat exchange while remove most of the water vapor in the airflow, thereby ensuring the dehumidification effect and preventing frost formation when the airflow passing through the enhanced cooling area C.

[0050] In some embodiments, the number of the first channel sections in the enhanced cooling area C is configured such that the overall heat exchange amount of the heat exchange body 1 meets a requirement. Since the distancebetween the first channel sections is relatively large in the anti-frost cooling area B, the heat exchange performance will be compromised though the frost formation can be reduced. The heat exchange performance can be further enhanced by the densely arranged first channel sections in the enhanced cooling area C, thereby satisfying the overall heat exchange requirement of the heat exchange body 1.

[0051] In some embodiments, a plurality of the heat exchange channels are arranged along a third direction Z (i.e., the thickness direction of the heat exchange body 1). The plurality of the heat exchange channels each include a first end and a second end arranged along the first direction X. The first end is configured for inflow of refrigerant, and the second end is configured for outflow of the refrigerant. The third direction Z is perpendicular to the first direction X and the second direction Y The plurality of the heat exchange channels at least include a pair of adjacent and crossed heat exchange channels. At the same side ends of the first channel sections, the second channel sections of the two crossed heat exchange channels are crossed with each other. As shown on the left of FIG. 1, the second channel sections of the two crossed heat exchange channels, located at one end of the first channel sections, are crossed with each other. As shown on the right of FIG. 1, the second channel sections of the crossed heat exchange channels, located at the other end of the first channel sections, are parallel with each other.

[0052] The evaporator 10 is disposed in an air pathway. As the wind speed in the width direction of the air pathway (i.e., the third direction Z) may be not uniform, the temperature of a local position of the heat exchange body 1 may be over low, resulting in serious frost formation. By using the crossed heat exchange channels, it is possible to improve the uniformity of heat exchange and prevent local frosting due to a local low temperature.

[0053] In some embodiments, as shown in FIG. 1, at least one side of the heat exchange body 1 along the third direction Z is provided with the two crossed heat exchange channels. For example, edge areas on both sides of the heat exchange body 1 along the third direction are each provided with a pair of crossed heat exchange channels. Optionally, between the two pairs of crossed heat exchange channels, additional crossed heat exchange channels can be added as desired.

[0054] The evaporator 10 is disposed in the air pathway, e.g., in the air pathway of a refrigeration display cabinet. Due to the Coanda effect of the airflow in the air pathway, the airflow would flow on the wall of the air pathway at a high speed. Moreover, since the evaporator 10 is sandwiched and fixed between two plates and a gap is formed between the plates and the heat exchange body 1, the flow resistance is small and the speed of the airflow is high. As shown in FIG. 3, the airflow speeds Q1 and Q3 located on both sides along the third direction Z are greater than the airflow speed Q2 in the middle, which would cause the local temperature of the heat exchange body 1 to be too low, resulting in serious frost formation. By using the crossed heat exchange channels, it is possible to improve the uniformity of heat exchange and prevent local frosting due to a local low temperature.

[0055] As shown on the right of FIG. 1, the heat exchange body 1 includes four heat exchange tubes 2, including, from left to right, a first heat exchange tube 2A, a second heat exchange tube 2B, a third heat exchange tube 2C, and a fourth heat exchange tube 2D. The first heat exchange tube 2A and the second heat exchange tube 2B cross each other, and the third heat exchange tube 2C and the fourth heat exchange tube 2D cross each other.

[0056] In some embodiments, as shown in FIG. 2, an upwind surface S of the heat exchange body 1 includes a surface of the dehumidification area A perpendicular to the third direction Z and facing the inflow of air and a surface of the dehumidification area A perpendicular to the first direction X, wherein the third direction Z is perpendicular to the first direction X and the second direction Y

[0057] In this embodiment, both the bottom surface and the side surface of the dehumidification area A of the heat exchange body 1 are exposed in the inflow of air, so that the area of the upwind surface of the heat exchange body 1 can be increased. As the ambient temperature is relatively high, the upwind surface is not easy to frost. For example, when the evaporator 10 is disposed in the display cabinet, the temperature of the inflow of air is equal to or above 10° C, and thus the upwind surface is not easy to frost. As such, the first channel sections in the dehumidification area A can be densely arranged to optimize the dehumidification effect while no-frost can be ensured.

[0058] In some embodiments, a surface of the heat exchange body 1 is coated with a hydrophobic coating. In the structure that the heat exchange channel is defined in the heat exchange tube 2, fins can be disposed on the heat exchange tube 2, and the hydrophobic coating can be applied to the surface of the heat exchange tube 2 and the surface of the fins.

[0059] In the present embodiment, frost formation can be more effectively suppressed by applying the hydrophobic coating in combination with the varied distances. The reason is that the hydrophobic coating can increase the contact angle between the condensed water and the surface of the heat exchange body 1, allowing the water vapor in the airflow to condense into a sphere on the surface of the fin in the evaporation and refrigeration. The water sphere has a small contact area with the heat exchange body 1, and thus is not easy to freeze. As a result, a degree of supercooling can be achieved such that the fin is at a predetermined temperature (e.g., -2°C) when the condensed water freezes, thereby the supercooling degree of frosting is increased and the frosting temperature is reduced.

[0060] In some embodiments, the diameter of the heat exchange tube 2 ranges from 6 mm to 13 mm, for example, is 6 mm, 6.5 mm, 7 mm, 7.5mm, 8 mm, 8.5 mm, 9 mm, 9.5 mm, 10 mm, 10.5 mm, 11 mm, 11.5 mm, 12 mm, 12.5 mm, or 13 mm. In a specific embodiment, the diameter of the heat exchange tube 2 is 9.52 mm. In a conventional evaporator, the heat exchange tubesmay be equal distanced, and the heat exchange tube 2 is easy to frost when the diameter of the tube is small. In the embodiments of the present disclosure, frost formation can be effectively suppressed by using the heat exchange tube with the varied distances, exposing the dehumidification area A to the inflow of air, and applying a hydrophobic coating. Thus, the diameter of the heat exchange tube 2 can be reduced, the thickness of the evaporator 10 can be reduced, and the occupation of space of the air pathway can be reduced. When the evaporator 10 is used in a refrigeration display cabinet, a double-layer double-temperature air curtain can be provided to effectively block the entry of ambient heat and water vapor.

[0061] As shown in FIG. 4, the evaporator 10 of the present disclosure further includes a liquid supply tube 4, an gas outlet tube 5, and a first temperature detecting member 3. The liquid supply tube 4 and the gas outlet tube 5 are respectively in communication with an inlet 23 and an outlet 24 at two ends of the heat exchange channel. The liquid supply tube 4 is provided with a throttling element 8, such as an electronic expansion valve or a capillary tube. The first temperature detecting member 3 which can be a temperature sensor, is disposed in the dehumidification area A of the heat exchange body 1 and configured to detect the temperature of the dehumidification area A of the heat exchange body 1.

[0062] The opening degree of the throttling element 8 increases on a condition that a detected value of the first temperature detecting member 3 exceeds a predetermined temperature value (of the dehumidification area A), and decreases on a condition that the detected value of the first temperature detecting member 3 does not exceed the predetermined temperature value. The opening degree of the throttling element 8 can be automatically adjusted by a controller.

[0063] In the present embodiment, the temperature of the dehumidification area A can be detected, and the opening degree of the throttling element 8 can be adjusted in time according to the temperature of the dehumidification area A to change a superheat degree, thereby ensuring that the dehumidification area A does not frost and controlling the dehumidification area and the dehumidification temperature.

[0064] In some embodiments, the evaporator 10 further includes a second temperature detecting member 6 and a third temperature detecting member 7. The second temperature detecting member 6 is disposed on the liquid supply tube 4 and configured to detect a temperature of the liquid supply tube 4. The third temperature detecting member 7 is disposed on the gas outlet tube 5 and configured to detect a temperature of the gas outlet tube 5. The opening degree of the throttling element 8 is determined according to a difference between detected values of the third temperature detecting member 7 and the second temperature detecting member 6, and the opening degree of the throttling element 8 is positively correlated with the difference between the detected values.

[0065] In this embodiment, after an adjustment tendency of the throttling element 8 is determined according to the first temperature detecting member 3, an adjustment amount of the throttling element 8 can be further determined quantitatively based on the temperature difference between the third temperature detecting member 7 and the second temperature detecting member 6, so that a heat exchange effect can be ensured while a superior frost suppressing effect is achieved.

[0066] In a specific embodiment, the evaporator 10 is used in a refrigeration display cabinet. By respectively arranging the temperature sensor on the liquid supply tube 4 to detect the liquid temperature and arranging the temperature sensor on the gas outlet tube 5 to detect the gas temperature, the temperature of the tube is detected in real time. The number of steps that the electronic expansion valve takes can be adjusted based on the temperature difference between the gas outlet tube 5 and the liquid supply tube 4 in order to control the superheat degree of the evaporator 10. Meanwhile, the temperature of the dehumidification area A is detected, and on a condition that this temperature is greater than -2°C, the controller controls the opening degree of the electronic expansion valve to be increased, so as to reduce the superheat degree; and on a condition that this temperature is less than -2°C, the controller controls the opening degree of the electronic expansion valve to be reduced, so as to increase the superheat degree. Accordingly, it is possible to maintain a certain superheat degree of the evaporator such that the tube temperature of the dehumidification area A at the bottom of the evaporator is higher than or equal to -2°C, and thus this area can fulfil the dehumidifying function without frost formation.

[0067] Secondly, the present disclosure also provides a refrigeration display cabinet, which includes the evaporator 10 in the above-described embodiments. For example, the refrigeration display cabinet can be a vertical display cabinet.

[0068] Due to the open structure of the refrigeration display cabinet, hot air in the environment can easily enter the cabinet to frost the evaporator 10. By using the evaporator 10 of the present disclosure, a superior frost suppressing effect can be achieved, and the frost formation on the surface of the heat exchange body 1 can be greatly reduced, thereby preventing increase of the heat and flow resistances of the surface of the heat exchange body 1, so as to improve the heat exchange effect, reduce the power consumption of the display cabinet, and stabilize the cabinet temperature.

[0069] In some embodiments, as shown in FIG. 2, the refrigeration display cabinet further includes a cabinet body 20 and a fan 70. A first air pathway 30 and a second air pathway 40 are defined in the cabinet body 20. The first air pathway 30 extends along a front-and-rear direction of the cabinet body 20 and is provided at a lower portion of the cabinet body 20. The second air pathway 40 extends along an up-and-down direction of the cabinet body 20 and is provided at a rear portion of the cabinet body 20. A lower portion of the second air pathway 40 is in communication with a rear portion of the first air pathway 30. The fan 70 is disposed in the first air pathway 30 and configured to deliver cold air to the first air pathway 30. The cold air sequentially passes through the first air pathway 30 and the second air pathway 40 and forms a cold air curtain in the front surface of the cabinet body 20.

[0070] The evaporator 10 is disposed in a lower region of the second air pathway 40, and the first direction X coincides with the up-and-down direction. Accordingly, the air driven by the fan 70 will flow along the second air pathway 40 and pass through the evaporator 10 from the smallest side surface of the evaporator 10 so as to undergo different cooling effects during the airflow flowing through the evaporator 10.

[0071] Further, a third air pathway 50 is also defined in the cabinet body 20, extends along the front-and-rear direction of the cabinet body 20, and is provided at a top portion of the cabinet body 20. A rear portion of the third air pathway 50 is in communication with a top portion of the second air pathway 40. Accordingly, the airflow driven by the fan 70 can sequentially flow along the first air pathway 30, the second air pathway 40, and the third air pathway 50, and finally a first air curtain from top to bottom is formed in the front of the display cabinet.

[0072] Further, a flow guide mechanism is located at an upper portion of the cabinet body 20. A flow guide channel 60 is defined in the flow guide mechanism. A flow guide outlet of the flow guide channel 60 is located in front of the outlet of the cold air. External ambient air is supplied to the flow guide mechanism by another fan, and is blown out from the flow guide outlet, so that a second air curtain can be formed in front of the first air curtain. The temperature of the second air curtain is higher than that of the first air curtain. Thus, heat exchange between the external environment and the storage area of the cabinet body 20 can be reduced, and the cooling effect of the display cabinet can be improved.

[0073] As shown in FIG. 2, the evaporator 10 is disposed in the lower region of the second air pathway 40, the first direction X coincides with the up-and-down direction, and the third direction Z coincides with the front-and-rear direction. The dehumidification area A is located at a lower side, the enhanced cooling area C is located at an upper side, and the anti-frost cooling area B is located between the dehumidification area A and the enhanced cooling area C. In the present embodiment, the evaporator 10 is vertically arranged, so that different cooling effects can be sequentially obtained when the airflow flows from the bottom to the top in the second air pathway 40.

[0074] In some embodiments, as shown in FIG. 1, since the heat exchange tubes 2 in the dehumidification area A are not easily frosted, the first tube sections 21 can be densely arranged, e.g., at a distance of 25.4 mm $\times$ 22 mm, to optimize the dehumidification effect. After the airflow passes through the dehumidification area A, the temperature and humidity of the airflow in the anti-frost cooling area B are lower than those of the airflow in the dehumidification area A, and higher than those of the airflow in the enhanced cooling area C. As the heat exchange tubes 2 in the anti-frost cooling area B are easily frosted, the first tube sections 21 are sparsely arranged, e.g., at a distance of 50.8 mm $\times$ 22 mm to reduce the frost formation. As such, the surface temperature of the fins is increased, surface area with frost is reduced, and thus the anti-frost ability of the evaporator in this area is enhanced, thereby avoiding frost blocking induced by the frost formation. Since the temperature and humidity of the airflow in the enhanced cooling area C are relatively low, and there is no water vapor source required for frosting, the first tube sections 21 can be densely arranged so as to enhance heat exchange and ensure the overall heat exchange requirements of the evaporator 10.

[0075] In some embodiments, as shown in FIG. 2, the refrigeration display cabinet of the present disclosure further includes a baffle plate 80 disposed between the first air pathway 30 and the second air pathway 40. The baffle plate 80 can be horizontally disposed in front of the evaporator 10. The dehumidification area A is located below the baffle plate

80. The anti-frost cooling area B and the enhanced cooling area C are located above the baffle plate 80. The upwind surface S of the heat exchange body 1 includes a surface of the dehumidification area A directly facing the inflow of air and a bottom surface of the dehumidification area A.

[0076] In this embodiment, the dehumidification area A of the heat exchange body 1 is exposed from the baffle plate 80. Compared with the prior art in which the entire heat exchange body 1 is disposed above the baffle plate, the dehumidification area A can be exposed in the inflow of air, that is, both the bottom surface and the front side surface of the dehumidification area A are exposed in the inflow of air, so that the upwind surface area of the heat exchange body 1 can be increased. As the temperature of the inflow of air of the display cabinet is relatively high, the upwind surface is not easy to frost. For example, when the evaporator 10 is disposed in the display cabinet, since the temperature of the inflow of air is equal to or above 10° C, the upwind surface is not easy to frost. As such, the first channel sections in the dehumidification area A can be densely arranged to optimize the dehumidification effect while no-frost can be ensured.

[0077] In a specific embodiment, the evaporator adopting equal-distanced heat exchange tube is compared with the evaporator adopting varied distancedheat exchange tube of the present disclosure, and comparison of the refrigeration display cabinets is as follows:

Table 1: Comparison of an evaporator adopting equal-distanced heat exchange tube with an evaporator adopting varied distanced heat exchange tube

Evaporator type	Conventional evaporator	Evaporator of the present disclosure
Average cabinet temperature before cabinet temperature imbalance occurs	7.1°C	3.6°C
Refrigeration time until the cabinet temperature is imbalanced and rises 0.4°C	45 min	88 min

[0078] Finally, the present disclosure also provides a control method based on the evaporator 10 of the above embodiments. In some embodiments the method includes:

detecting, by a first temperature detecting member 3, a temperature at the dehumidification area A of the heat exchange body 1; and

determining whether a detected value of the first temperature detecting member 3 exceeds a predetermined temperature value, increasing an opening degree of a throttling element 8 if the detected value exceeds the predetermined temperature value, and decreasing the opening degree of the throttling element 8 if the detected value does not exceed the predetermined temperature value, wherein the throttling element 8 is disposed on a liquid supply tube 4 of the evaporator 10, and the liquid supply tube 4 is in communication with an inlet 23 of the heat exchange channel.

[0079] In this embodiment, by detecting the temperature of the dehumidification area A, the opening degree of the throttling element 8 can be adjusted in time according to the temperature of the dehumidification area A to change a superheat degree, thereby ensuring that the dehumidification area A does not frost and controlling the dehumidification area and the dehumidification temperature.

[0080] In some embodiments, when there is a need to adjust the opening degree of the throttling element 8, the control method further includes:

detecting, by a second temperature detecting member 6, a temperature of the liquid supply tube 4;

detecting, by a third temperature detecting member 7, a temperature of the gas outlet tube 5; and

determining the opening degree of the throttling element 8 according to a difference between detected values of the third temperature detecting member 7 and the second temperature detecting member 6, and the opening degree of the throttling element 8 is positively correlated with the difference between the detected values.

[0081] In this embodiment, after an adjustment tendency of the throttling element 8 is determined according to the first temperature detecting member 3, an adjustment amount of the throttling element 8 can be further determined quantitatively based on the temperature difference between the third temperature detecting member 7 and the second temperature detecting member 6, so that a heat exchange effect can be ensured while an advantageous frost suppressing effect is achieved.

[0082] The evaporator, the control method thereof, and the refrigeration display cabinet provided by the present disclosure are described in detail above. The principles and implementations of the present disclosure have been described with reference to specific embodiments herein. The description of the embodiments is provided merely to assist in understanding the method of the present disclosure and its core idea. It should be noted that various improvements and modifications of the present disclosure may be made by those skilled in the art without departing from the principles of the disclosure, which also fall within the protection scope of the claims of the disclosure.

Claims

1. An evaporator (10), comprising a heat exchange body (1), wherein the heat exchange body (1) comprises a dehumidification area (A) and an anti-frost cooling area (B) sequentially arranged along a first direction, the dehumidification area (A) is located at an air inflow side in the first direction;

   the heat exchange body (1) comprises a heat exchange channel for refrigerant to flow, the heat exchange channel comprises a plurality of first channel sections and a plurality of second channel sections, the plurality of first channel sections are arranged at intervals along the first direction, and extend along a second direction perpendicular to the first direction, same side ends of adjacent first channel sections in the heat exchange channel are in communication with each other through the second channel sections; and
   a number density of the first channel sections in the anti-frost cooling area (B) is less than a number density of the first channel sections in the dehumidification area (A).

2. The evaporator (10) of claim 1, wherein the heat exchange body (1) further comprises an enhanced cooling area (C) located downstream of the anti-frost cooling area (B) in the first direction; and
   a number density of the first channel sections in the anti-frost cooling area (B) is less than a number density of the first channel sections in the enhanced cooling area (C).

3. The evaporator (10) of claim 1 or 2, wherein a distance in the first direction between adjacent first channel sections in the anti-frost cooling area (B) is greater than a distance in the first direction between adjacent first channel sections in the dehumidification area (A).

4. The evaporator (10) of any one of claims 1 to 3, wherein the heat exchange body (1) further comprises an enhanced cooling area (C) located downstream of the anti-frost cooling area (B) in the first direction; and
   a distance in the first direction between adjacent first channel sections in the anti-frost cooling area (B) is greater than a distance in the first direction between adjacent first channel sections in the enhanced cooling area (C).

5. The evaporator (10) of claim 2 or 4, wherein for the same heat exchange channel, the number of the first channel sections in the anti-frost cooling area (B) is greater than the number of the first channel sections in the dehumidification area (A); and/or the number of the first channel sections in the dehumidification area (A) is greater than the number of the first channel sections in the enhanced cooling area (C).

6. The evaporator (10) of claim 2 or 4, wherein for the same heat exchange channel,

   the number of the first channel sections in the dehumidification area (A) is the number of the first channel sections without frost;
   the number of the first channel sections in the anti-frost cooling area (B) is configured such that the dehumidification area (A) and the anti-frost cooling area (B) together remove a predetermined percentage of moisture in an airflow and to achieve a predetermined heat exchange amount; and/or
   the number of the first channel sections in the enhanced cooling area (C) is configured such that an overall heat exchange amount of the heat exchange body (1) meets a requirement.

7. The evaporator (10) of any one of claims 1 to 6, wherein the heat exchange body (1) comprises:

   a base (1'); and
   a heat exchange tube (2) mounted on the base (1'),
   wherein the heat exchange channel is defined inside the heat exchange tube (2), the heat exchange tube (2) comprises a plurality of first tube sections (21) and a plurality of second tube sections (22), the first channel sections are defined inside the first tube sections (21), and the second channel sections are defined inside the second tube sections (22).

8. The evaporator (10) of any one of claims 1 to 7, wherein the heat exchange channel comprises a plurality of the heat exchange channels arranged along a third direction, the plurality of the heat exchange channels each comprise a first end and a second end arranged along the first direction, the first end is configured for inflow of the refrigerant, the second end is configured for outflow of the refrigerant, and the third direction is perpendicular to the first direction and the second direction; and
the plurality of the heat exchange channels at least comprise a pair of adjacent and crossed heat exchange channels, at the same side ends of the first channel sections, the second channel sections of the two crossed heat exchange channels are crossed with each other.

9. The evaporator (10) of claim 8, wherein at least one side of the heat exchange body (1) along the third direction is provided with the two crossed heat exchange channels.

10. The evaporator (10) of any one of claims 1 to 9, wherein an upwind surface (S) of the heat exchange body (1) comprises a surface of the dehumidification area (A) perpendicular to a third direction and facing inflow of air, and a surface of the dehumidification area (A) perpendicular to the first direction, wherein the third direction is perpendicular to the first direction and the second direction.

11. The evaporator (10) of any one of claims 1 to 10, wherein a surface of the heat exchange body (1) is coated with a hydrophobic coating.

12. The evaporator (10) of any one of claims 1 to 11, further comprising:

a liquid supply tube (4) and an gas outlet tube (5) respectively in communication with an inlet (23) and an outlet (24) at two ends of the heat exchange channel, the liquid supply tube (4) being provided with a throttling element (8); and
a first temperature detecting member (3) configured to detect a temperature at the dehumidification area (A) of the heat exchange body (1),
wherein an opening degree of the throttling element (8) is configured to increase on a condition that a detected value of the first temperature detecting member (3) exceeds a predetermined temperature value, and to decrease on a condition that the detected value of the first temperature detecting member (3) does not exceed the predetermined temperature value.

13. The evaporator (10) of claim 12, further comprising:

a second temperature detecting member (6) configured to detect a temperature of the liquid supply tube (4); and
a third temperature detecting member (7) configured to detect a temperature of the gas outlet tube (5),
wherein the opening degree of the throttling element (8) is configured to be determined according to a difference between detected values of the third temperature detecting member (7) and the second temperature detecting member (6), and the opening degree of the throttling element (8) is positively correlated with the difference between the detected values.

14. The evaporator (10) of claim 7, wherein the heat exchange tube (2) has a diameter in a range of 6 mm to 13 mm.

15. A refrigeration display cabinet comprising the evaporator (10) of any one of claims 1 to 14.

16. The refrigeration display cabinet of claim 15, further comprising:

a cabinet body (20) in which a first air pathway (30) and a second air pathway (40) are defined, the first air pathway (30) extending along a front-and-rear direction of the cabinet body (20) and being provided at a lower portion of the cabinet body (20), and the second air pathway (40) extending along an up-and-down direction of the cabinet body (20) and being provided at a rear portion of the cabinet body (20), and a lower portion of the second air pathway (40) is in communication with a rear portion of the first air pathway (30); and
a fan (70) disposed in the first air pathway (30) and configured to deliver cold air to the first air pathway (30), the cold air sequentially passing through the first air pathway (30) and the second air pathway (40) and forming a cold air curtain in a front surface of the cabinet body (20),
wherein the evaporator (10) is disposed in a lower region of the second air pathway (40), and the first direction coincides with the up-and-down direction.

17. The refrigeration display cabinet of claim 16, further comprising:

a baffle plate (80) disposed between the first air pathway (30) and the second air pathway (40),
wherein the dehumidification area (A) is located below the baffle plate (80), the anti-frost cooling area (B) and the enhanced cooling area (C) are located above the baffle plate (80), and an upwind surface (S) of the heat exchange body (1) comprises a surface of the dehumidification area (A) directly facing inflow of air and a bottom surface of the dehumidification area (A).

18. A control method based on the evaporator (10) of any one of claims 1 to 14, comprising:

detecting, by a first temperature detecting member (3), a temperature at the dehumidification area (A) of the heat exchange body (1); and
determining whether a detected value of the first temperature detecting member (3) exceeds a predetermined temperature value, increasing an opening degree of a throttling element (8) if the detected value exceeds the predetermined temperature value, and decreasing the opening degree of the throttling element (8) if the detected value does not exceed the predetermined temperature value, wherein the throttling element (8) is provided on a liquid supply tube (4) of the evaporator (10), and the liquid supply tube (4) is in communication with an inlet (23) of the heat exchange channel.

19. The control method of claim 18, wherein when there is a need to adjust the opening degree of the throttling element (8), the control method further comprises:

detecting, by a second temperature detecting member (6), a temperature of the liquid supply tube (4);
detecting, by a third temperature detecting member (7), a temperature of an gas outlet tube (5), the as outlet tube (5) is in communication with an outlet (24) of the heat exchange channel; and
determining the opening degree of the throttling element (8) according to a difference between detected values of the third temperature detecting member (7) and the second temperature detecting member (6), and the opening degree of the throttling element (8) is positively correlated with the difference between the detected values.

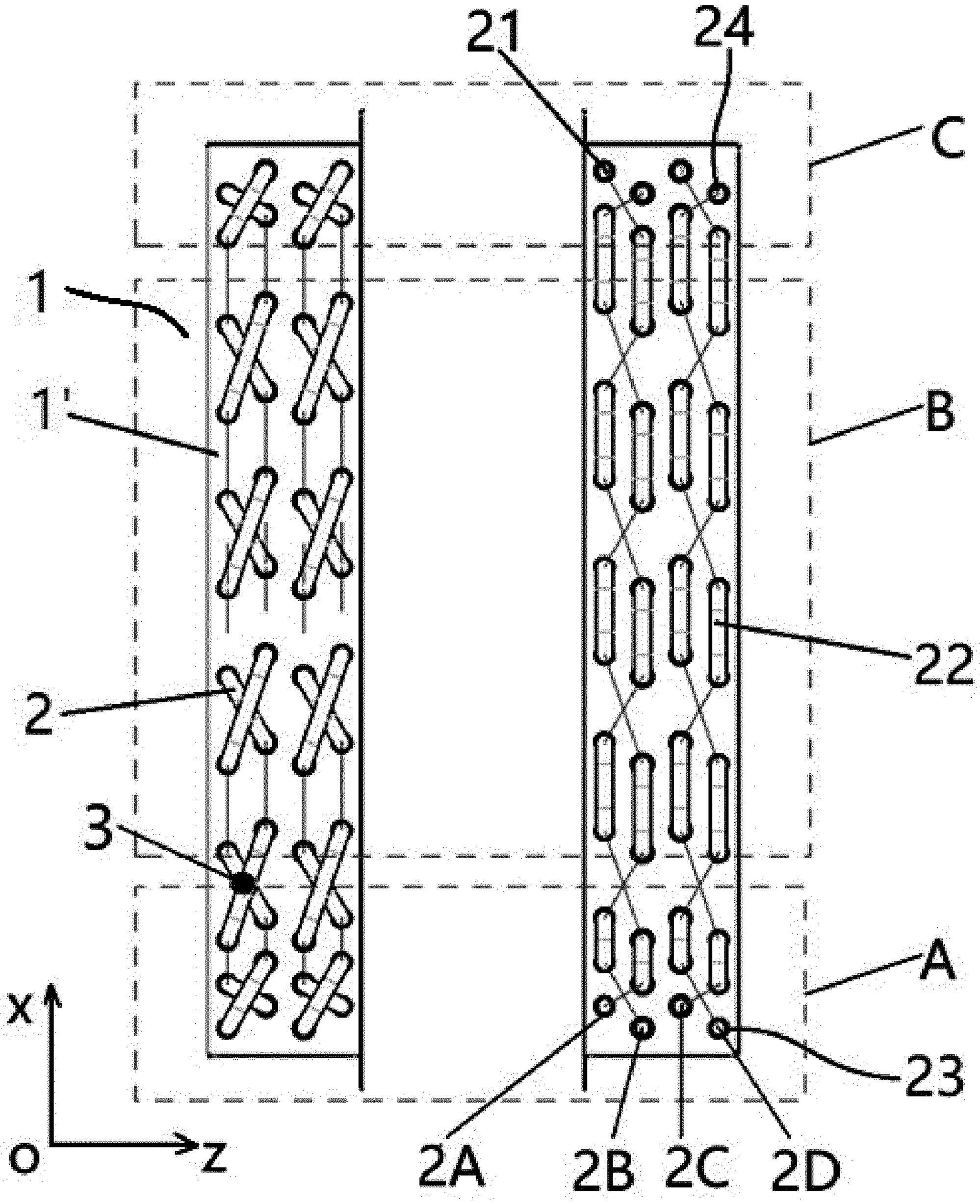

FIG. 1

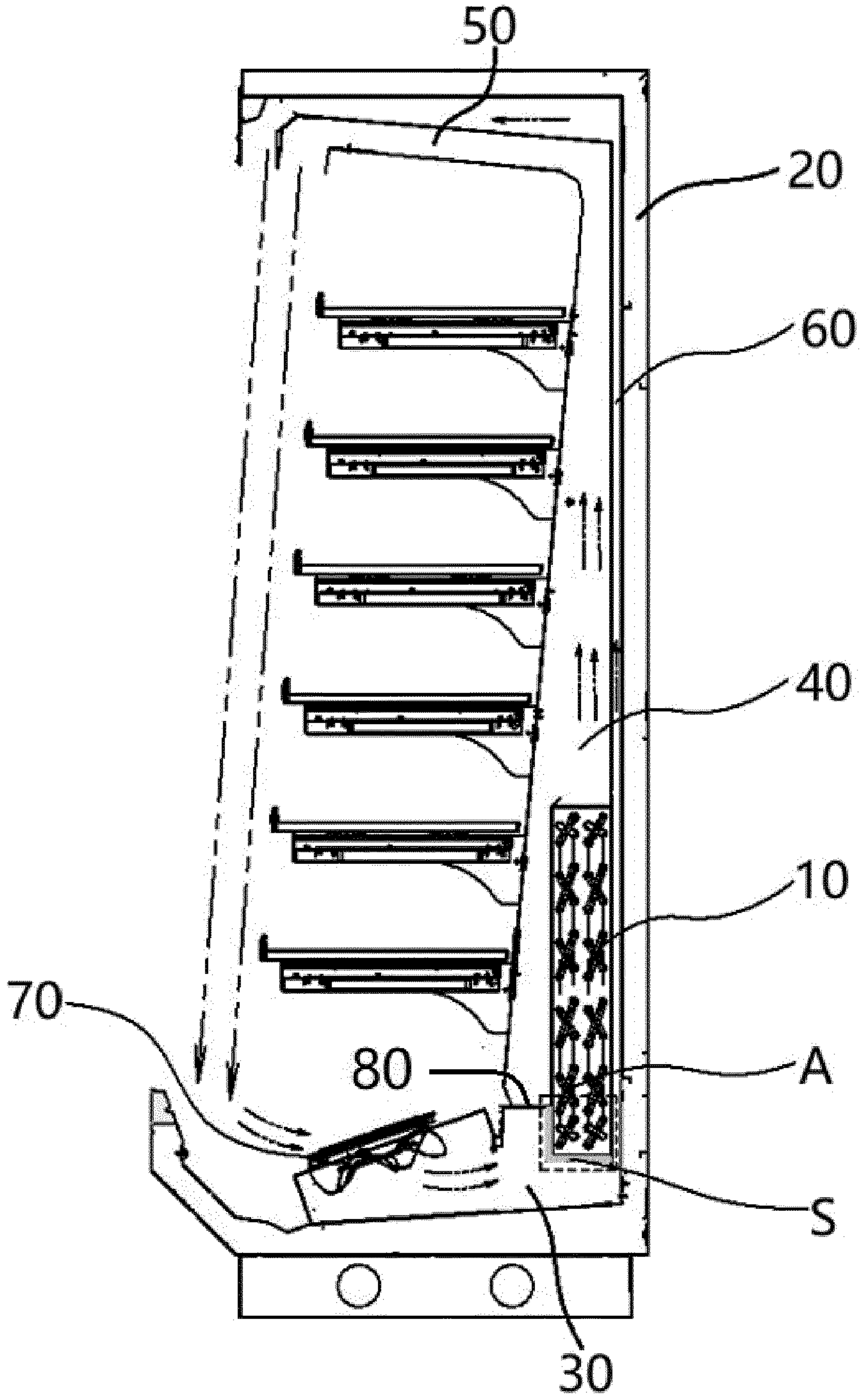

FIG. 2

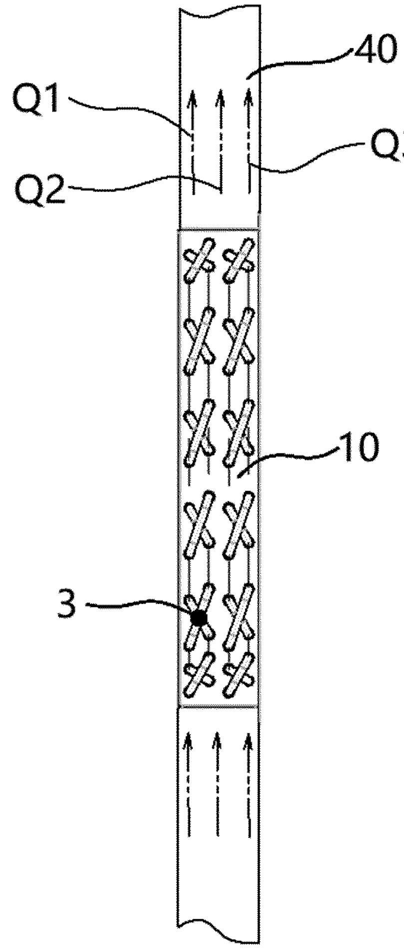

FIG. 3

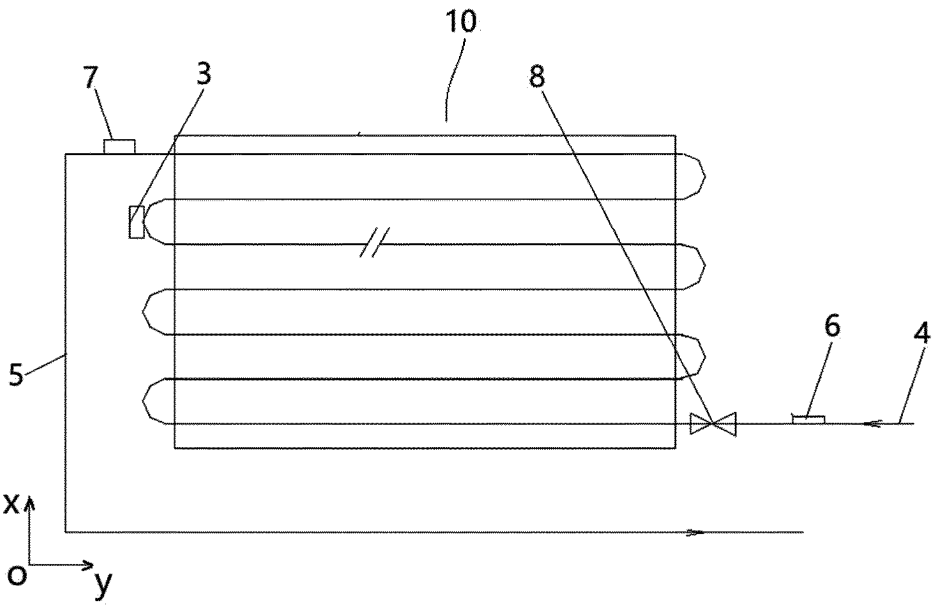

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/121517

A. CLASSIFICATION OF SUBJECT MATTER

F25B 39/02(2006.01)i; A47F 3/04(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)

F25B39 F25D11 F25D17 F25D21 A47F3

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, DWPI: 蒸发器 霜 管 间距 密度 数量 evaporator frost defrost+ tube pipe conduit interval density number amount quantity

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 112113379 A (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI) 22 December 2020 (2020-12-22) description, paragraphs [0060]-[0111] and figures 1-4	1-19
PX	CN 213119670 U (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI) 04 May 2021 (2021-05-04) description, paragraphs [0054]-[0105] and figures 1-4	1-19
X	CN 109737676 A (XI'AN JIAOTONG UNIVERSITY) 10 May 2019 (2019-05-10) description, paragraphs [0025]-[0027] and figure 2	1, 3, 5, 7-15, 18-19
Y	CN 109737676 A (XI'AN JIAOTONG UNIVERSITY) 10 May 2019 (2019-05-10) description, paragraphs [0025]-[0027] and figure 2	16, 17
Y	CN 111449457 A (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI) 28 July 2020 (2020-07-28) description, paragraph [0021], and figure 1	16, 17
A	CN 1912504 A (SHOWA DENKO K. K.) 14 February 2007 (2007-02-14) entire document	1-19

☑ 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
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- "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
29 October 2021	**30 December 2021**

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

International application No.
PCT/CN2021/121517

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 2013327070 A1 (REES BRIAN J et al.) 12 December 2013 (2013-12-12) entire document	1-19
A	JP 2001153532 A (FUJI ELECTRIC CO., LTD.) 08 June 2001 (2001-06-08) entire document	1-19

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/121517

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CN	213119670	U	04 May 2021	None			
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Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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