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(54) **HEAT EXCHANGE TUBE, HEAT EXCHANGER AND HEAT PUMP UNIT**

(57) The present disclosure relates to a heat exchange tube, a heat exchanger and a heat pump unit. The heat exchange tube includes a tube body and a fin arranged on an outer surface of the tube body, wherein the fin includes: a fin root part, arranged on the outer surface of the tube body; a transverse fin part, arranged on the top of the fin root part and extending laterally from two sides of the fin root part; and a fin top part, arranged on the top of the transverse fin part and constructed as a saw-toothed part, a concave portion of the saw-toothed part extending to the transverse fin part. The present disclosure is beneficial to enlarging a heat exchange area of the fin top part and thinning a liquid film; the saw-toothed fin top part is favorable for refrigerant flowing, thereby enhancing condensation property; and the transverse fin part extends laterally from the two sides of the fin to form a lower layer of channel and an upper layer of channel beneficial to evaporation and condensation, such that the heat exchange tube has both evaporation and condensation properties.

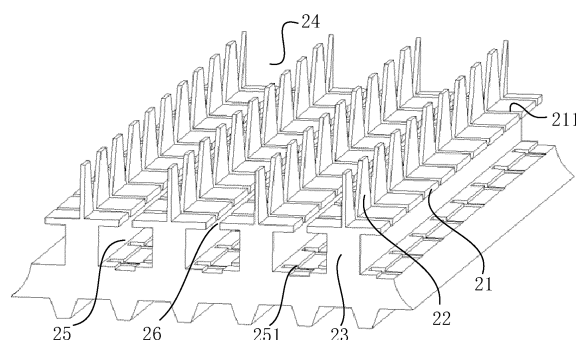


FIG. 4

EP 3 736 521 A1

Description

CROSS REFERENCE OF RELATED APPLICATION

[0001] The application is based upon and claims priority to Chinese Patent Application No. 201810409402.5, filed on May 2, 2018, the entire contents of all of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to the field of air conditioning, and in particular, relates to a heat exchange tube, a heat exchanger and a heat pump unit.

BACKGROUND

[0003] Due to different functions and working principles, the heat exchanger for the flooded heat pump unit is divided into a flooded evaporator and a flooded condenser, which are two heat exchangers with different structural forms. Similarly, the heat exchange tube, as a core component of the flooded heat exchanger, is also divided into a flooded evaporation tube and a flooded condenser tube.

[0004] Based on the evaporation and condensation functional requirements on the heat exchanger by the heat pump unit, it is necessary to redesign and adjust the structure of the heat exchanger so as to obtain a structure type of the heat exchanger which is adapted to meet both evaporation and condensation requirements. However, the development of the evaporative and condensing heat exchange tube of the heat exchanger has become a bottleneck of the development of the unit.

[0005] Therefore, it is necessary to develop a heat exchange tube which can meet both evaporation and condensation functions.

SUMMARY

[0006] According to one aspect of some embodiments of the present disclosure, the heat exchange tube includes a tube body and a fin arranged on an outer surface of the tube body, wherein the fin includes: a fin root part, arranged on the outer surface of the tube body; a transverse fin part, arranged on the top of the fin root part and extending laterally from two sides of the fin root part; and a fin top part, arranged on the top of the transverse fin part and constructed as a saw-toothed part, a concave portion of the saw-toothed part extending to the transverse fin part.

[0007] In some embodiments, the fins are arranged on the outer surface of the tube body spirally or in parallel, a channel is formed between two adjacent fins, and a gap is formed between adjacent transverse fin parts in the channel.

[0008] In some embodiments, the fins are arranged on the outer surface of the tube body spirally or in parallel,

a channel is formed between two adjacent fins (20), and the transverse fin part divides the channel into an outer cavity and an inner cavity, the inner cavity is close to the outer surface of the tube body relative to the outer cavity.

[0009] In some embodiments, a first groove is disposed on a wall surface of the inner cavity.

[0010] In some embodiments, the first groove is formed on the outer surface of the tube body.

[0011] In some embodiments, a cross section of the first groove is I-shaped, cross-shaped, X-shaped, U-shaped, triangular or polygonal with more than three sides.

[0012] In some embodiments, the transverse fin part is constructed as a curved shape, or a surface of the transverse fin part is constructed as a curved shape.

[0013] In some embodiments, the transverse fin part is provided with a plurality of slits, at least one of the slits extends to one concave portion of the saw-toothed part.

[0014] In some embodiments, each of the slits is correspondingly connected to one corresponding concave portion of the saw-toothed part.

[0015] In some embodiments, the transverse fin part at least disposed on one side of the fin root part inclines towards the outer surface of the tube body.

[0016] In some embodiments, the transverse fin parts disposed on two sides of the fin root part symmetrically incline towards the outer surface of the tube body.

[0017] In some embodiments, a cross section of a convex portion of the saw-toothed part is trapezoidal, triangular or rectangular and is roughly vertical to an axis of the tube body.

[0018] In some embodiments, a cross section of a convex portion of the saw-toothed part is rectangular, parallelogram-shaped or trapezoidal and is roughly parallel with an axis of the tube body.

[0019] In some embodiments, a cross section of concave portion of the saw-toothed part is trapezoidal, triangular or rectangular.

[0020] In some embodiments, at least one of a spine and a second groove is arranged on at least one side of the fin top part.

[0021] In some embodiments, the fin is arranged on the outer surface of the tube body spirally, there are 40 to 95 convex portions of the saw-toothed part disposed in a segment of the fin on a circumference of the tube body.

[0022] In some embodiments, an inner surface of the tube body is provided with a thread, an included angle between a tangent line of the thread and an axis line of the tube body is 15° to 65°.

[0023] Some embodiments of the present disclosure provide a heat exchanger, including the above described heat exchange tube.

[0024] Some embodiments of the present disclosure provide a heat pump unit, including the above described heat exchanger.

[0025] In some embodiments, the heat pump unit is a flooded heat pump unit.

[0026] According to some embodiments of the present disclosure, the heat exchange tube includes a tube body and a fin arranged on an outer surface of the tube body; wherein the fin includes a fin root part, a transverse fin part and a fin top part, the fin top part is arranged on the top of the transverse fin part and constructed as a saw-toothed part, and a concave portion of the saw-toothed part extends to the transverse fin part, it is beneficial to enlarging a heat exchange area of the fin top part and thinning a liquid film; the saw-toothed fin top part is favorable for refrigerant flowing, thereby enhancing condensation property; and the transverse fin part extends laterally from the two sides of the fin to form a lower layer of channel and an upper layer of channel beneficial to evaporation and condensation, such that the heat exchange tube has both evaporation and condensation properties.

BRIEF DESCRIPTION OF DRAWINGS

[0027]

FIG. 1 is a schematic overall diagram of a heat exchange tube according to some embodiments of the present disclosure;

FIG. 2 is a schematic partial diagram of a heat exchange tube according to some embodiments of the present disclosure;

FIG. 3 is a schematic section view of a heat exchange tube according to some embodiments of the present disclosure;

FIG. 4 is a schematic partial enlarged diagram of a heat exchange tube according to some embodiments of the present disclosure;

FIG. 5 is a schematic partial enlarged diagram of a fin of a heat exchange tube according to some embodiments of the present disclosure;

FIG. 6 is a schematic partial side view of a heat exchange tube according to some embodiments of the present disclosure; and

FIG. 7 is a schematic partial enlarged diagram of a fin of a heat exchange tube according to some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0028] The following clearly and completely describes the technical solutions in the embodiments with reference to the accompanying drawings in the embodiments of the present disclosure. Apparently, the described embodiments are merely a portion rather than all of the embodiments of the present disclosure. All other embodiments made on the basis of the embodiments of the present disclosure by a person of ordinary skill in the art without paying any creative effort shall be included in the protection scope of the present disclosure.

[0029] In the description of the present disclosure, it should be understood that an azimuth or position relationship indicated by terms "center", "longitudinal", "transverse", "front", "rear", "left", "right", "vertical", "horizontal", "top", "bottom", "inner", "outer" and the like is an azimuth or position relationship based on the accompanying draws, which is only for facilitating description of the present disclosure and simplifying description, but not indicates or implies that the referred device or component must have a specific azimuth and perform construction and operation in the specific azimuth; therefore, it cannot be interpreted as a limitation to the protection scope of the present disclosure.

[0030] One of the objectives of some embodiments of the present disclosure is to provide a heat exchange tube with evaporation and condensation functions, a heat exchanger and a heat pump unit.

[0031] As shown in FIG. 1, in some embodiments, the heat exchange tube includes a tube body 10, wherein the tube body 10 includes an unprocessed smooth section 11, a fin-forming section 13 completely forming a fin along a circumference, and a transition section 12 between the smooth section 11 and the fin-forming section 13.

[0032] In some embodiments, the smooth section 11 is used to perform expanded connection and sealing between a shell tube and the heat exchange tube. The heat exchange tube maintains a vibration state for a long time when operating in a unit, and the transition section 12 is used to enhance the strength of the heat exchange tube. An outer diameter of the transition section 12 is less than that of the smooth section 11.

[0033] As shown in FIG. 2, in some embodiments, the heat exchange tube includes a tube body 10 and a fin 20 arranged on an outer surface of the tube body 10. The fin 20 is arranged on a fin-forming section 13 of the tube body 10.

[0034] In some embodiments, the fin 20 is a spiral fin and is spirally arranged on the tube body 10 along an axial direction of the tube body 10.

[0035] In some embodiments, the fin 20 includes a plurality of annular fins, wherein each of the annular fins is arranged along a circumferential direction of the tube body 10, and all the annular fins are arranged at intervals along an axial direction of the tube body 10. Further, all the annular fins are arranged in parallel.

[0036] In some embodiments, the fin 20 includes a plurality of linear fins, wherein a length direction of each of the linear fins is consistent with an axial direction of the tube body 10, and all the linear fins are arranged at intervals along a circumferential direction of the tube body 10. Further, all the linear fins are arranged in parallel.

[0037] As shown in FIG. 4, in some embodiments, the fin 20 includes a fin root part 23, a transverse fine portion 21 and a fin top part 22.

[0038] In some embodiments, the fin root part 23 is arranged on an outer surface of the tube body 10.

[0039] In some embodiments, the transverse fin part 21 is arranged on the top of the fin root part 23 and extends laterally from two sides of the fin root part 23. Apart

below the transverse fin part 21, the fin root part 23 and the outer surface of the tube body 10 form a space beneficial to improving evaporation property.

[0040] In some embodiments, the fin top part 22 is arranged on the top of the transverse fin part 21 and is constructed as a saw-toothed part; a concave portion of the saw-toothed part of the fin top part 22 extends to the transverse fin part 21 and is adapted to enlarging the heat exchange area of the fin top part 22 and thinning a liquid film; and the saw-toothed fin top part 22 is favorable for refrigerant flowing, thereby improving condensation property.

[0041] In some embodiments, a thickness of the fin top part 22 is less than that of the fin root part 22, which is beneficial to forming a sharp edge on the fin top part 22, thereby piercing a gaseous refrigerant carrying liquid.

[0042] In some embodiments, the fin top part 22 is formed by extruding the top of the fin 20, a thickness of the fin top part 22 is less than that of the fin root part 23, and the transverse fin part 21 extends laterally from the two sides of the fin 20 relative to the fin root part 23 and the fin top part 22.

[0043] As shown in FIG. 2 and FIG. 4, in some embodiments, the fin top part 22 is constructed as a saw-toothed part, a concave portion of the saw-toothed part extends to the transverse fin part 21 and the transverse fin part 21 extends laterally from the two sides of the fin 20. The structure has both evaporation and condensation properties, thereby relieving the problem of property attenuation when the conventional condenser tube serves as an evaporation tube and relieving the problem of property attenuation when the conventional evaporation tube serves as a condenser tube.

[0044] As shown in FIG. 4, in some embodiments, the fins 20 are arranged on an outer surface of the tube body 10 spirally or in parallel, a channel is formed among spiral body of the fin, or a channel is formed between two adjacent fins of the plurality of fins, and a gap 26 is formed between two adjacent transverse fin parts 21 in the channels.

[0045] In some embodiments, a gap 26 is formed between two adjacent transverse fin parts 21 in the channel along an extending direction of the transverse fin part 2.

[0046] In some embodiments, an overlapped section is arranged between two adjacent transverse fin parts 21 in the channel along an extending direction of the transverse fin part 2, and a gap 26 is disposed in a space of the adjacent transverse fin parts 21 in a height direction of the fin. Further, one of the transverse fin parts 21 is higher than the adjacent transverse fin part 21 in the height direction of the fin. Or a tail end (the overlapped section position) of one of the transverse fin parts 21 is higher than a tail end (the overlapped section position) of the adjacent transverse fin part 21 in the height direction of the fin.

[0047] In some embodiments, a gap 26 is formed between the adjacent transverse fin parts 21 in the channel, and an upper layer of the channel is fluid communication

with a lower layer of the channel, among the two adjacent fins 20, such that it is beneficial to circulation of a liquid refrigerant and the condensation effect is enhanced; furthermore, when the refrigerant is evaporated, supplementation of the refrigerant and discharge of a gaseous refrigerant are benefited, and the evaporation function is enhanced; and the evaporation and condensation properties are not attenuated.

[0048] In some embodiments, the fins 20 are arranged on an outer surface of the tube body 10 spirally or in parallel, the transverse fin part 21 divides a channel formed between the two adjacent fins 20 into an outer cavity 24 and an inner cavity 25, and the inner cavity 25 is close to the outer surface of the tube body 10 relative to the outer cavity 24.

[0049] In some embodiments, the transverse fin part 21 divides the channel formed between the two adjacent fins 20 into an outer cavity 24 and an inner cavity 25. A gap 26 is formed between the adjacent transverse fin parts 21 in the channel, which is beneficial to ensuring escape of evaporative bubbles formed by the lower layer of the channel with evaporation function and is favorable for discharging of a liquid refrigerant during condensation of the refrigerant. The inner cavity 25 is surrounded by the transverse fin part 21, the fin root part 23 and the outer surface of the tube body 10 and principally forms a small cavity favorable for evaporation by mainly adopting a nucleate boiling principle. The outer cavity 25 is surrounded by the transverse fin part 21 and the fin top part 22, and mainly enlarges the heat exchange area and thins a liquid film to facilitate condensation. Therefore, the evaporation and condensation properties are not attenuated.

[0050] In some embodiments, a first groove 251 is disposed on a wall surface of the inner cavity 25, which enables an inner surface of the inner cavity 25 to be rough and is beneficial to forming a vaporization core required by evaporation, thereby enhancing evaporative heat exchange.

[0051] In some embodiments, the first groove 251 is disposed on an outer surface of the tube body 10. A secondary refrigerant is introduced into the tube body 10 and is used to exchange heat with a refrigerant outside the tube body 10, and the first groove 251 is disposed on the outer surface of the tube body 10, it is benefit to forming a vaporization core on the outer surface of the tube body 10 and enhancing evaporative heat exchange; and the heat exchange area is increased on the basis of the outer surface of the original smooth tube body 10. Further, a plurality of first grooves 251 are disposed on the outer surface of the tube body 10 along a direction of channel among two adjacent fins 20.

[0052] In some embodiments, the outer surface of the tube body 10 is barreled and flattened by a smooth barreling wheel, such that a multi-pit surface structure is formed on the outer surface of the tube body 10, thereby providing a vaporization core required by evaporation and enhancing evaporative heat exchange.

[0053] In some embodiments, the first groove 251 is disposed on a surface of the fin root part 23, which is beneficial to forming a vaporization core. Further, the first groove 251 is arranged along a height direction of the fin root part 23 so as to facilitate flowing of a refrigerant along the first groove 251.

[0054] In some embodiments, a cross section of the first groove 251 is I-shaped, cross-shaped, X-shaped, U-shaped, round, triangular, quadrangular, polygonal (more than four sides), or of other irregular or regular shapes.

[0055] The inner cavity 25 is provided with a plurality of first grooves 251. The uneven structure is beneficial to increasing the roughness of the inner cavity 25, forming a vaporization core and enhancing the evaporation function.

[0056] In some embodiments, the transverse fin part 21 is constructed as a curved shape, or a surface of the transverse fin part 21 is formed as a curved shape. A body or surface of the transverse fin part 21 is constructed as a curved shape, which is beneficial to enlarging the heat exchange area and thinning a liquid film and facilitates flowing of a refrigerant.

[0057] In some embodiments, the transverse fin part 21 is provided with a slit 211 favorable for fluid to pass through, thereby facilitating supplementation of a refrigerant and escape of evaporative bubbles.

[0058] In some embodiments, the transverse fin part 21 is provided with a plurality of slits 211, each of the slits 211 correspondingly extends to one corresponding concave portion of the saw-toothed part of the fin top part 22. Arranging the slits 211 facilitates flowing of the refrigerant; furthermore, the slits 211 extend to the concave portions of the fin top part 22, thereby facilitating flowing of the refrigerant to the inner cavity 25.

[0059] In some embodiments, the slit 211 is long strip-shaped and extend along an extending direction of the transverse fin part 21.

[0060] In some embodiments, the transverse fin part 21 is provided with a plurality of round, triangular, square, or polygonal (more than four sides), or other regular or irregular through holes, thereby facilitating flowing of a refrigerant to the inner cavity 25 or discharge of a gaseous refrigerant.

[0061] In some embodiments, the transverse fin part 21 at least disposed on one side of the fin root part 23 inclines towards the outer surface of the tube body 10, thereby facilitating flowing of a refrigerant to the inner cavity 25.

[0062] In some embodiments, the transverse fin parts 21 disposed on two sides of the fin root part 23 symmetrically incline towards the outer surface of the tube body 10, and a cross section of the fin root part 23 combined with the transverse fin parts 21 on two sides of the top of the fin root part 23 is similarly shaped like an umbrella (as shown in FIG. 6), thereby facilitating flowing of a refrigerant to the inner cavity 25.

[0063] In some embodiments, the transverse fin parts

21 disposed on two sides of the fin root part 23 are arranged horizontally.

[0064] In some embodiments, a first cross section of a convex portion of the saw-toothed part of the fin top part 22 is trapezoidal, triangular or rectangular and is roughly vertical to an axis of the tube body 10.

[0065] In some embodiments, a second cross section of a convex portion of the saw-toothed part of the fin top part 22 is rectangular, parallelogram-shaped or trapezoidal and is roughly parallel with an axis of the tube body 10. As shown in FIG. 5, β_1 is 90 degrees when the second cross section is rectangular, or β_1 is an acute angle or an obtuse angle when the second cross section is parallelogram-shaped or trapezoidal.

[0066] In some embodiments, a concave portion of the saw-toothed fin top part 22 is trapezoidal, triangular or rectangular.

[0067] In some embodiments, the fin top part 22 is provided with at least one of a spine 221 (as shown in FIG. 6) and a second groove 222 (as shown in FIG. 7).

[0068] Further, the spine 221 is arranged on at least one side of the fin top part 22 and is adapted to enlarge the heat exchange area of the fin top part 22, such that it is beneficial to piercing a liquid film and accelerating discharge of condensed liquid. A second groove 222 is disposed on at least one side of the fin top part 22 and is adapted to enlarge the heat exchange area of the fin top part 22, thereby thinning a liquid film and enhancing condensation property. Further, the second grooves 222 are disposed on two sides of the fin top part 22, or disposed at the top of the fin top part 22.

[0069] In some embodiments, the fin 20 is arranged on the outer surface of the tube body (10) spirally, there are 40 to 95 convex portions of the saw-toothed fin top part 22 in a segment of the fin 20 on a circumference of the tube body 10.

[0070] Further, a plurality of slits is arranged at the transverse fin part 21, and each of the slits 211 extends correspondingly to a corresponding concave portion of the saw-toothed fin top part 22, and the number of slits is 40 to 95, thereby enhancing evaporation effect and facilitating supplementation of a refrigerant and discharge of a gaseous refrigerant.

[0071] In some embodiments, an inner surface of the tube body 10 is provided with a thread 14 while an outer surface of the tube body 10 is enhanced; an included angle β_2 between a tangent line of the thread 14 and an axis line of the tube body 10 is 15° to 65° (as shown in FIG. 3), that is, a spiral angle β_2 is 15° to 65°; and the thread is adapted to increase a disturbance intensity of a secondary refrigerant side, and the heat exchange area is increased by increasing the spiral angle.

[0072] In some embodiments, a plurality of threads 14 are distributed on an inner side of the tube body 10 uniformly along a circumferential direction, wherein the number n of the threads is equal to 30 to 65. Increment of the threads is mainly adapted to enlarge the heat exchange area and improve a disturbance intensity of a

secondary refrigerant on an inner side, thereby enhancing heat exchange of the inner side.

[0073] In some embodiments, an inner side of the tube body 10 is rolled by a grooved lining core to form a spirally protruded internal thread structure.

[0074] In some embodiments, the fins 20 are distributed along a surface of the tube body 10 in a single-head spiral manner; and due to single spiral distribution, the fins are formed more uniformly and have higher consistency.

[0075] In some embodiments, a bottom of the convex portion of the saw-toothed fin top part 22 is crack-shaped, thereby facilitating processing and refrigerant flowing.

[0076] In some embodiments, the fin 20 on the heat exchange tube is processed by a special fin rolling mill and is rolled by cutter combination and a lining core grooving mold and by an extrusion forming scrapless processing process, wherein both sides are strengthened simultaneously. As a refrigerant side of the heat exchange tube has higher requirement on cleanliness, copper scraps are avoided by extrusion forming scrapless processing. Moreover, since integration by extrusion forming, the strength is higher.

[0077] In some embodiments, since a width h_1 of a channel formed between the fins is 0.254 mm to 0.558 mm, the condensation effect of the upper layer is taken into consideration. If the gap is too small, the lower layer of evaporation cavity is liable to block and the condensed liquid of the upper layer is unfavorable for discharging, thereby reducing the condensation effect.

[0078] In some embodiments, as shown in FIG. 3, a thickness h_2 of the fin 20 is 0.15 mm to 0.305 mm. If the fin 20 is too thin, it is unfavorable for rolling two sides of the fin 20 to form a transverse fin part 21; and if the fin 20 is too thick, the fin 20 extends to the two sides to enable a cavity to be small, even to be congested, which is unfavorable for deformation of an evaporation cavity.

[0079] In a specific embodiment, a tube body 10 with an outer diameter of 19.05 mm and a wall thickness of 1.15 mm is processed. On the basis of the tube body 10, a certain spirally protruded structure (fin 20) is extruded by a combined mold, the extruded protruded structured is rolled by cutter combination, and saw-toothed parts are formed on the fin top part 22. First, the surface area of the heat exchange tube is increased, a rough and uneven outer surface is formed by knurling and movement of condensation is promoted; and second, a thickness of a refrigerant liquid film is reduced. Meanwhile, due to deformation caused by processing, a natural crack is formed at the bottom of the saw-toothed fin top part 22. Two sides of the fin are extruded to form a transverse fin part 21 extending into a fin groove while the spiral fin is extruded. Meanwhile, a gasket of 0.1 mm is placed between the adjacent transverse fin parts 21 to form a gap 26, and liquid is discharged by channels among the fins, thereby enhancing the condensation effect. The top of the fin is extruded to form a saw-toothed part, and a slit 211 is naturally formed while the fin is extruded to extend

into a groove (the two sides of the fin).

[0080] In some embodiments, a working principle of the heat exchange tube is as follows.

[0081] The heat exchange tube serves as an evaporation tube under a working condition of refrigeration: a liquid refrigerant on an outer side of the tube body 10 is mainly evaporated in the inner cavity 25; firstly, the liquid refrigerant enters into the inner cavity 25 through at least one of the gap 26 and the slit 211 from the outer cavity 24, the surface temperature of the tube body 10 at the bottom of the inner cavity 25 is high and has superheat degree required for evaporation; meanwhile, the surface of the tube body 10 at the bottom of the inner cavity 25 is provided with a plurality of first grooves 251, thereby increasing the roughness of the fin root part and forming a large number of vaporization cores on the fin root part; the saturated liquid refrigerant is evaporated in the inner cavity 25 with a certain superheat degree and a large number of vaporization cores, a large number of bubbles generated by evaporation is discharged through at least one of the gap 26 and the slit 211; and meanwhile, the liquid refrigerant in the inner cavity 25 is also supplemented by at least one of the gap 26 and the slit 211.

[0082] The heat exchange tube serves as a condenser tube under a working condition of heating: a high-pressure gaseous refrigerant on an outer side of the tube is mainly condensed in the outer cavity 24, and the saw-toothed fin top part 22 on the fin 20 is formed by extrusion, such that two sides of the convex portion of the fin top part 22 are sharp, refrigerant bubbles are pierced and the gaseous refrigerant is rapidly condensed into liquid. The concave portion of the fin top part 22 and the transverse fin part 21 inclining towards an outer surface of the tube body 10 significantly increase the surface area of the outer cavity 24, which is especially favorable for condensation and heat exchange of the gaseous refrigerant.

[0083] As the transverse fin part 21 is inclined or bended, the liquid refrigerant generated on the transverse fin part 21 by condensation flows downwards under the comprehensive action of a surface tension or a gravity force of the liquid refrigerant and is discharged into the inner cavity 25 timely through at least one of the gap 26 and the slit 211 to be further cooled. Due to circumferential communication of the inner cavity 25, a certain amount of liquid refrigerant which is accumulated finally is discharged out of a surface of the heat exchange tube through the bottom of the heat exchange tube.

[0084] Some embodiments provide a heat exchanger, including the above described heat exchange tube.

[0085] Some embodiments provide a heat pump unit, including the above described heat exchanger. By adoption of the above described heat exchanger, energy efficiency of the heat pump unit is improved.

[0086] In some embodiments, the heat pump unit is a flooded heat pump unit.

[0087] In the flooded heat pump unit, evaporation and condensation have different working principles and functions and are two opposite processes during operation.

The condensation process is to convert a gaseous refrigerant into a liquid refrigerant, thin a liquid film as much as possible and discharge the liquid refrigerant timely, such that the condensation process operates continuously and efficiently, otherwise, the condensation property will be attenuated. The evaporation process is to convert a liquid refrigerant into a gaseous refrigerant and requires that more vaporization cores is provided and the refrigerant wet the surface of the heat exchange tube, thereby improving heat exchange property.

[0088] The heat exchange tube and the heat exchanger according to some embodiments of the present disclosure meet the requirements of the heat pump unit on refrigeration and heating when the working condition is adjusted.

[0089] In the description of the present disclosure, it should be understood that the words "first", "second", "third" and the like for limiting parts are merely for convenience of distinguishing the parts. Unless otherwise stated, the above words do not have special meanings and cannot be construed as limitations to the protection scope of the present disclosure.

[0090] Finally, it should be noted that the above embodiments are merely intended to illustrate the technical solutions of the present disclosure and are not to limit them. Although the present disclosure has been illustrated in detail with reference to the preferred embodiments, those of ordinary skill in the art should understand that modification can be made on the specific embodiments of the present disclosure and equivalent replacement can be made on part of the technical features; and the modification and the equivalent replacement should be covered within the protection scope of the technical solutions claimed by the present disclosure without departing from the spirit of the technical solutions of the present disclosure.

Claims

1. A heat exchange tube, comprising:

- a tube body (10), and
- a fin (20), arranged on an outer surface of the tube body (10), and comprising:
 - a fin root part (23), arranged on the outer surface of the tube body (10);
 - a transverse fin part (21), arranged on the top of the fin root part (23) and extending laterally from two sides of the fin root part (23); and
 - a fin top part (22), arranged on the top of the transverse fin part (21) and configured as a saw-toothed part, a concave portion of the saw-toothed part extending to the transverse fin part (21).

2. The heat exchange tube according to claim 1, wherein the fins (20) are arranged on the outer surface of the tube body (1) spirally or in parallel, a channel is formed between two adjacent fins (20), and a gap (26) is formed between two adjacent transverse fin parts (21) in the channel.
3. The heat exchange tube according to claim 1, wherein the fins (20) are arranged on the outer surface of the tube body (10) spirally or in parallel; a channel is formed between two adjacent fins (20), and the transverse fin part (21) divides the channel into an outer cavity (24) and an inner cavity (25), the inner cavity (25) is close to the outer surface of the tube body (10) relative to the outer cavity (24).
4. The heat exchange tube according to claim 3, wherein a first groove (251) is disposed on a wall surface of the inner cavity (25).
5. The heat exchange tube according to claim 4, wherein the first groove (251) is formed on the outer surface of the tube body (10).
6. The heat exchange tube according to claim 4, wherein a cross section of the first groove (251) is I-shaped, cross-shaped, X-shaped, U-shaped, triangular or polygonal with more than three sides.
7. The heat exchange tube according to claim 1, wherein the transverse fin part (21) is constructed as a curved shape, or a surface of the transverse fin part (21) is constructed as a curved shape.
8. The heat exchange tube according to claim 1, wherein the transverse fin part (21) is provided with a plurality of slits (211), at least one of the slits (211) extends to one concave portion of the saw-toothed part.
9. The heat exchange tube according to claim 8, wherein each of the slits (211) is correspondingly connected to one corresponding concave portion of the saw-toothed part.
10. The heat exchange tube according to claim 1, wherein the transverse fin part (21) at least disposed on one side of the fin root part (23) inclines towards the outer surface of the tube body (10).
11. The heat exchange tube according to claim 10, wherein the transverse fin parts (21) disposed on two sides of the fin root part (23) symmetrically incline towards the outer surface of the tube body (10).
12. The heat exchange tube according to claim 1, wherein a cross section of a convex portion of the saw-toothed part is trapezoidal, triangular or rectangular and is vertical to an axis of the tube body (10).

13. The heat exchange tube according to claim 1, wherein a cross section of a convex portion of the saw-toothed part is rectangular, parallelogram-shaped or trapezoidal and is parallel with an axis of the tube body (10). 5
14. The heat exchange tube according to claim 1, wherein a cross section of the concave portion of the saw-toothed part is trapezoidal, triangular or rectangular. 10
15. The heat exchange tube according to claim 1, wherein at least one of a spine (221) and a second groove (222) is arranged on at least one side of the fin top part (22). 15
16. The heat exchange tube according to claim 1, wherein there are 40 to 95 convex portions of the saw-toothed part in a segment of the fin (20) on a circumference of the tube body (10). 20
17. The heat exchange tube according to claim 1, wherein an inner surface of the tube body (10) is provided with a thread (14), an included angle between a tangent line of the thread (14) and an axis line of the tube body (10) is 15° to 65°. 25
18. A heat exchanger, comprising the heat exchange tube according to any one of claims 1 to 17.
19. A heat pump unit, comprising the heat exchanger according to claim 18. 30
20. The heat pump unit according to claim 19, wherein the heat pump unit is a flooded heat pump unit. 35

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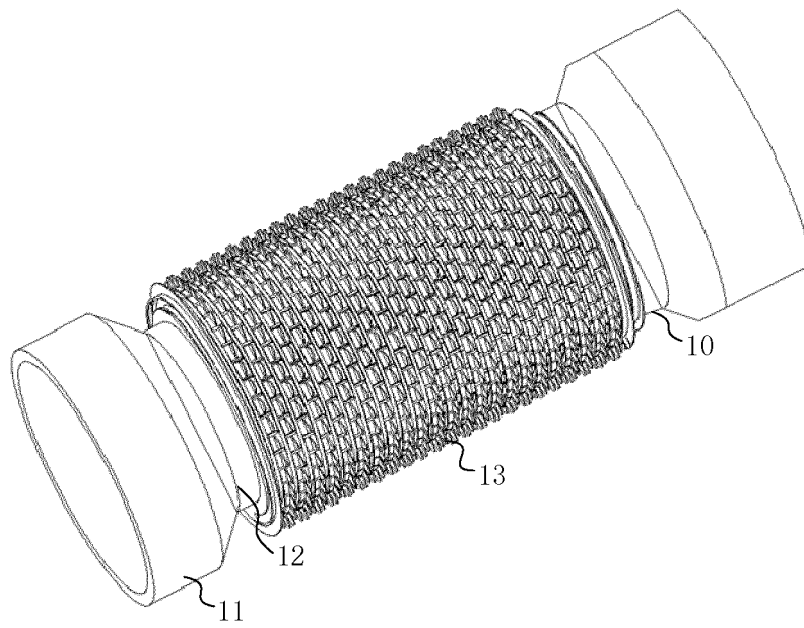


FIG. 1

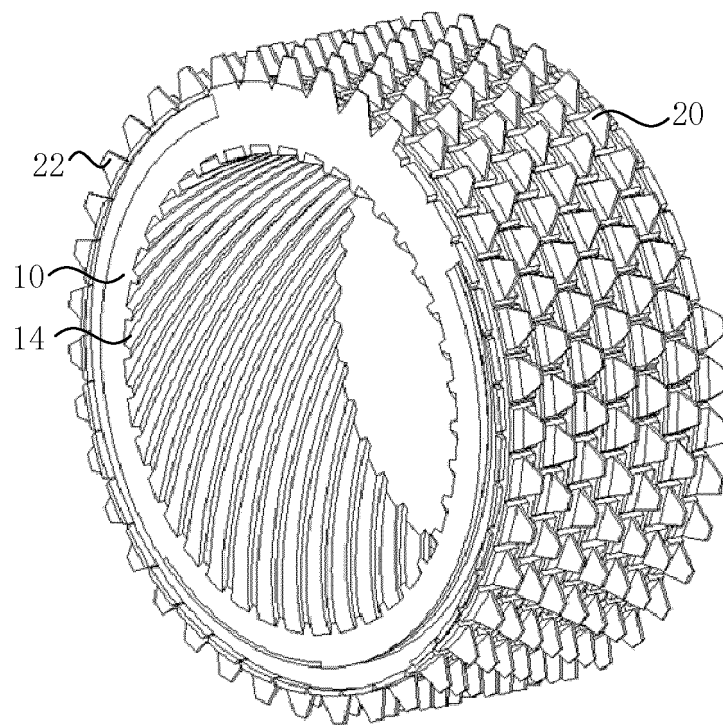


FIG. 2

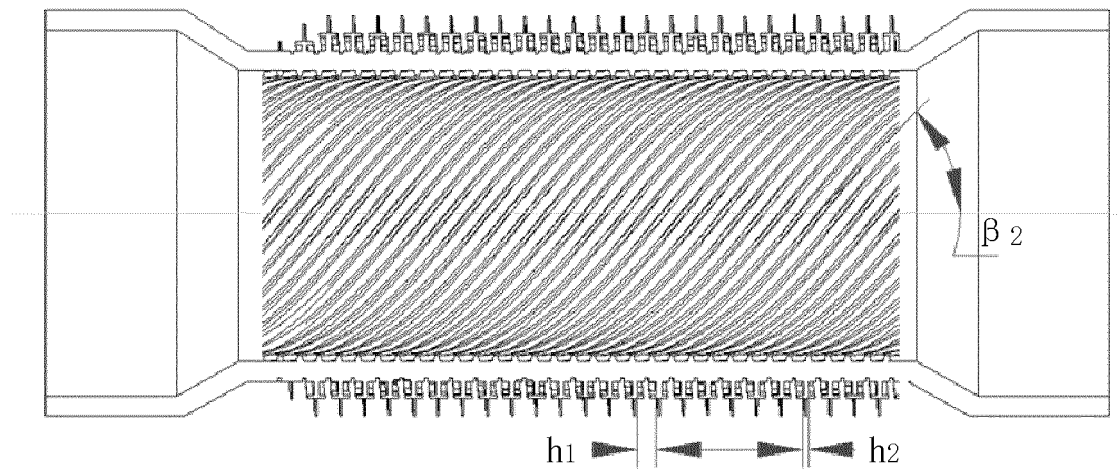


FIG. 3

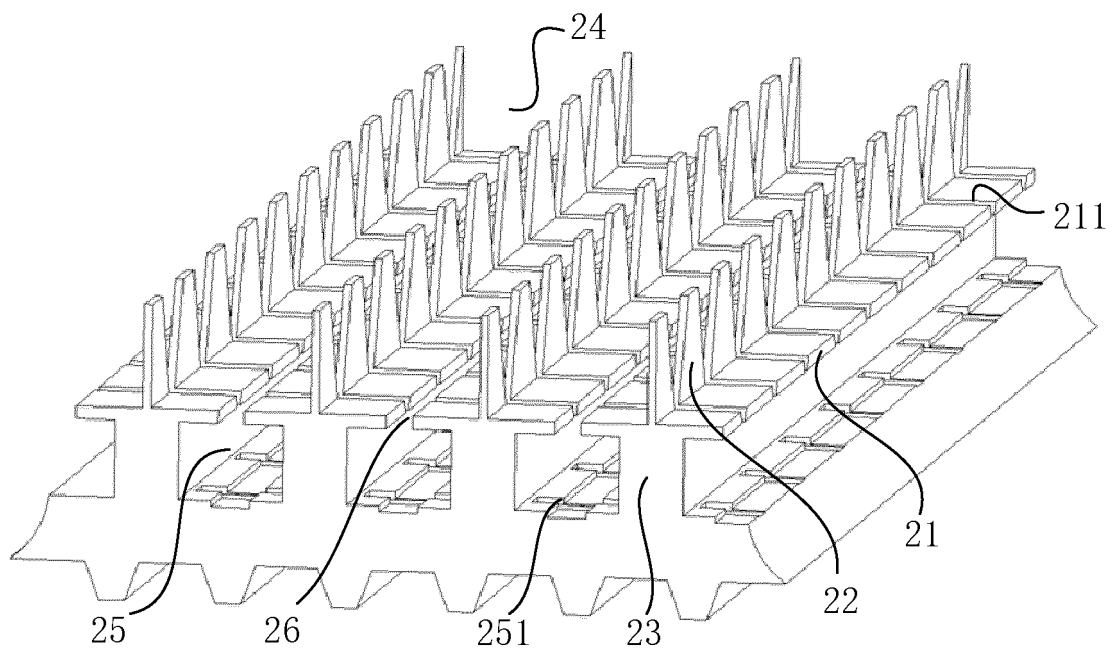


FIG. 4

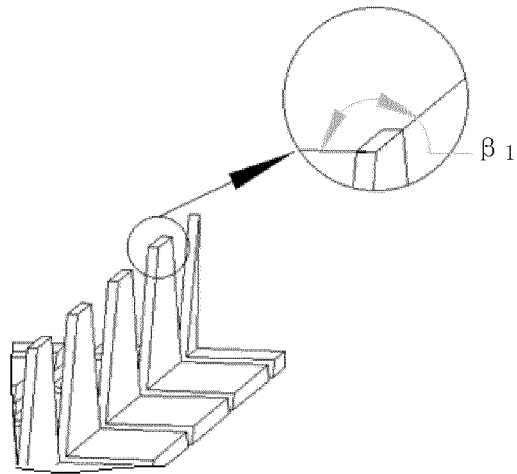


FIG. 5

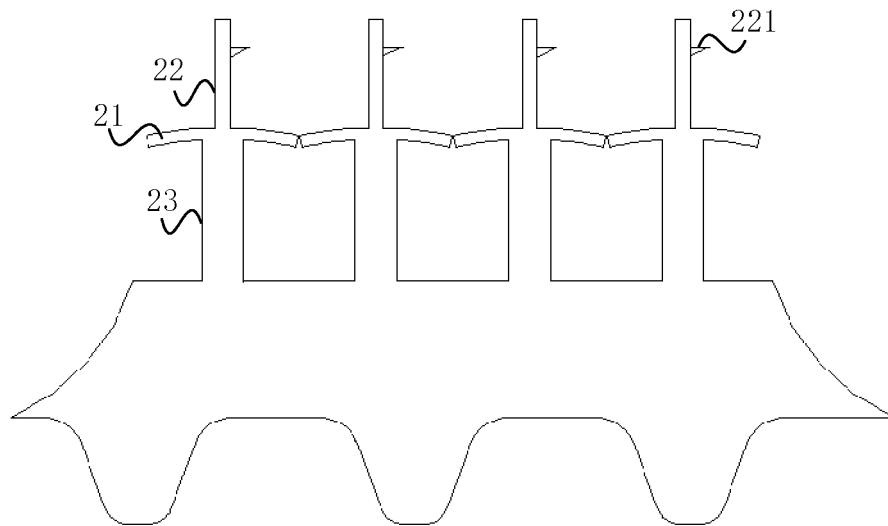


FIG. 6

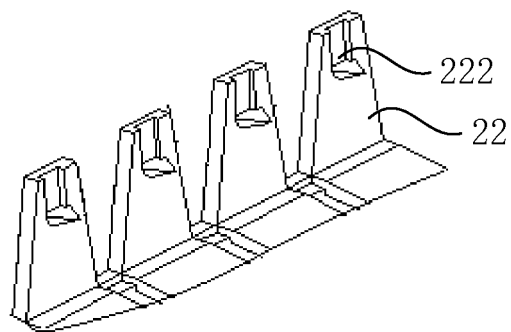


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/121202

5	A. CLASSIFICATION OF SUBJECT MATTER		
	F28F 1/42(2006.01)i		
	According to International Patent Classification (IPC) or to both national classification and IPC		
	B. FIELDS SEARCHED		
10	Minimum documentation searched (classification system followed by classification symbols)		
	F28F 1.; F25B 30		
	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
	CNKI, CNTXT, VEN, CNABS: 换热, 翅根, 横翅, 凹槽, 缝隙, 狭缝, heat exchang+, fin?, groove?, gap		
	C. DOCUMENTS CONSIDERED TO BE RELEVANT		
20	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	PX	CN 108387131 A (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI) 10 August 2018 (2018-08-10) claims 1-20	1-20
25	Y	CN 101004337 A (GAOKELING TUBING (SHANGHAI) CO., LTD.) 25 July 2007 (2007-07-25) description, page 4, paragraph 2 to page 7, paragraph 2, and figures 1 and 2	1-20
	Y	CN 107782192 A (SOUTH CHINA UNIVERSITY OF TECHNOLOGY) 09 March 2018 (2018-03-09) description, paragraphs [0028]-[0053], and figures 1-5	1-20
30	A	CN 1731066 A (JIANGSU CUILONG COPPER CO., LTD.) 08 February 2006 (2006-02-08) entire document	1-20
	A	CN 103486894 A (GOLDEN DRAGON PRECISE COPPER TUBE GROUP INC.) 01 January 2014 (2014-01-01) entire document	1-20
35	A	CN 201803635 U (YANTAI HENGHUI COPPER MATERIAL CO., LTD.) 20 April 2011 (2011-04-20) entire document	1-20
	☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
40	* 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
45	Date of the actual completion of the international search		Date of mailing of the international search report
	29 January 2019		26 February 2019
50	Name and mailing address of the ISA/CN		Authorized officer
	National Intellectual Property Administration, PRC (ISA/CN) No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088 China		
55	Facsimile No. (86-10)62019451		Telephone No.

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International application No.
PCT/CN2018/121202

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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014034277 A1 (LIN, SHENGHUANG ET AL.) 06 February 2014 (2014-02-06) entire document	1-20

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2018/121202

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CN	1731066	A	08 February 2006	US	2007034361	A1	15 February 2007
				US	7789127	B2	07 September 2010
				CN	100365369	C	30 January 2008
CN	103486894	A	01 January 2014	None			
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				TW	201407124	A	16 February 2014
				US	9604328	B2	28 March 2017
				US	2015052731	A1	26 February 2015

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REFERENCES CITED IN THE DESCRIPTION

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