

DESCRIPTION

Title of Invention

EVAPORATOR

[Technical Field]

[0001]

The present disclosure relates to an evaporator.

[Background Art]

[0002]

A liquid film-type evaporator in which a liquid-phase refrigerant is supplied from above to a heat transfer pipe group through which a medium to be cooled circulates is known as an evaporator used in a chiller (for example, Patent Document 1).

Patent Document 1 describes an evaporator in which a refrigerant evaporated in a heat transfer pipe group is guided to a suction pipe provided in a shell via a suction slot formed in a baffle wall.

[Citation List]

[Patent Document]

[0003]

[Patent Document 1] U.S. Patent No. 8944152

[Summary of Invention]

[Technical Subject]

[0004]

In the liquid film-type evaporator, the heat transfer pipe group is disposed up to the upper portion of a pressure vessel, and thus the heat transfer pipe group and a refrigerant outlet tend to be close to each other. Accordingly, a phenomenon in which a gas-phase refrigerant discharged to the outside of a housing accompanies a liquid-phase refrigerant (so-called carryover) is likely to occur. In addition, the space above the heat transfer pipe group becomes narrow by the heat transfer pipe group being disposed up to the upper portion of the pressure vessel. Accordingly, there is a problem that it is difficult to dispose, for example, a gas-liquid separation structure in the space above the heat transfer pipe group.

[0005]

In addition, in Patent Document 1, the refrigerant guided to the suction pipe turns back in the horizontal direction, and thus gas-liquid separation of the refrigerant may be performed insufficiently and the phenomenon in which a gas-phase refrigerant discharged to the outside of a housing accompanies a liquid-phase refrigerant (so-called carryover) may occur. In the event of carryover, the liquid-phase refrigerant is suctioned into a turbo compressor disposed on the downstream side of the evaporator. When the liquid-phase refrigerant is

suctioned into the turbo compressor, the compression ratio of the turbo compressor decreases to lead to a decline in efficiency and, for example, the blade of the turbo compressor may be damaged.

[0006]

In addition, it is conceivable to provide, for example, a demister between the refrigerant outlet leading to the outside of the housing and the heat transfer pipe group in order to perform gas-liquid separation on the refrigerant. However, the demister is a relatively expensive member. In addition, in order to ensure the separation performance of the demister, the front surface flow speed of the demister needs to be suppressed, which leads to an increase in evaporator size. Accordingly, the initial cost of the evaporator may increase in a case where the demister is provided.

[0007]

The present disclosure has been made in view of such circumstances, and an object of the present disclosure is to provide an evaporator capable of making carryover unlikely to occur.

Another object of the present invention is to provide an evaporator capable of initial cost reduction.

[Subject to be solved]

[0008]

In order to solve the above subjects, the evaporator of the present disclosure employs the following means.

An evaporator according to one embodiment of the present disclosure includes: a housing having a refrigerant outlet discharging an evaporated refrigerant and forming an outer shell; a first heat transfer pipe group accommodated in the housing, immersed in a liquid-phase refrigerant stored in a storage portion provided in a lower portion of the housing, and having a plurality of first heat transfer pipes in which a medium to be cooled circulates; a second heat transfer pipe group accommodated in the housing, provided above a liquid surface of the liquid-phase refrigerant stored in the lower portion of the housing, and having a plurality of second heat transfer pipes in which a medium to be cooled circulates; a refrigerant supply unit accommodated in the housing and supplying a liquid-phase refrigerant from above to the second heat transfer pipe group; and a flow path guiding a refrigerant evaporated in the second heat transfer pipe group to the refrigerant outlet, in which the flow path has a first flow path in which a refrigerant circulates upward from below, a second flow path in which a refrigerant circulates downward from above, and a connecting flow path connecting the first flow path and the second flow path and turning back a refrigerant.

[Advantageous Effects of Invention]

[0009]

According to the present disclosure, carryover can be made unlikely to occur. In addition, the initial cost can be reduced.

[Brief Description of Drawings]

[0010]

Fig. 1 is a schematic vertical cross-sectional view of an evaporator according to a first embodiment of the present disclosure.

Fig. 2 is a vertical cross-sectional view illustrating a modification example of Fig. 1.

Fig. 3 is a vertical cross-sectional view illustrating a modification example of Fig. 1.

Fig. 4 is an enlarged perspective view of a main part (IV part) of Fig. 3.

Fig. 5 is a cross-sectional view taken along the V-V arrow of Fig. 4.

Fig. 6 is a schematic vertical cross-sectional view of an evaporator according to a second embodiment of the present disclosure.

Fig. 7 is a vertical cross-sectional view illustrating a modification example of Fig. 6.

[Description of Embodiments]

[0011]

Hereinafter, an embodiment of the evaporator according to the present disclosure will be described with reference to the drawings.

[First Embodiment]

Hereinafter, a first embodiment of the present disclosure will be described with reference to Fig. 1. It should be noted that in the following description and drawings, the vertical up-down direction is the Z-axis direction, the extension direction of a heat transfer pipe is the X-axis direction, and the Y-axis direction is orthogonal to the Z-axis direction and the X-axis direction.

[0012]

An evaporator 10 according to the present embodiment is applied to a centrifugal chiller. The centrifugal chiller includes, for example, a turbo compressor (not illustrated) compressing a refrigerant, a condenser (not illustrated) condensing the refrigerant boosted by the turbo compressor, an expansion valve (not illustrated) expanding the refrigerant condensed by the condenser, and an evaporator evaporating the refrigerant reduced in pressure by the expansion valve and is configured in a unit shape. Each device is connected by a refrigerant circulation pipe. Used as the refrigerant is, for example, a low-pressure refrigerant such as R1233zd used at a

maximum pressure of less than 0.2 MPaG. It should be noted that the applicable refrigerant is not limited to the low-pressure refrigerant. For example, a high-pressure refrigerant may be used as the refrigerant.

[0013]

As illustrated in Fig. 1, the evaporator 10 has a pressure vessel (housing) 11 forming an outer shell, a refrigerant inlet pipe 12 introducing a refrigerant into the pressure vessel 11, a refrigerant tray (refrigerant supply unit) 13 provided below the refrigerant inlet pipe 12, a flooded-type heat transfer pipe group (first heat transfer pipe group) 14 immersed in the liquid-phase refrigerant stored in the lower portion of the pressure vessel 11, a liquid film-type heat transfer pipe group (second heat transfer pipe group) 15 provided above a liquid surface S (see Figs. 2 and 3) of the liquid-phase refrigerant stored in the lower portion of the pressure vessel 11, a refrigerant outlet pipe (refrigerant outlet) 16 discharging the evaporated refrigerant from the pressure vessel 11, a baffle plate 17 covering the liquid film-type heat transfer pipe group 15 from the side, and a gas-liquid separation flow path (flow path) 20 guiding the refrigerant evaporated in the flooded-type heat transfer pipe group 14 and the liquid film-type heat transfer pipe group 15 to the refrigerant outlet pipe 16.

[0014]

The pressure vessel 11 integrally has a cylindrical portion 11a with a central axis extending along the X-axis direction and two pipe plates (not illustrated) closing both end portions of the cylindrical portion 11a in the direction along the central axis (X-axis direction). The cylindrical portion 11a is disposed so as to have a substantially horizontal central axis. Each pipe plate is a disk-shaped plate member. In addition, the liquid-phase refrigerant is stored in the lower portion of the pressure vessel 11. Hereinafter, the region where the liquid-phase refrigerant is stored will be referred to as a storage portion 11c.

It should be noted that in the following description, the terms of "inside" and "outside" simply referred to mean "inside" and "outside" with reference to the central axis of the cylindrical portion 11a. In other words, "inside" means the central axis side of the cylindrical portion 11a, and "outside" means the inner peripheral surface side of the cylindrical portion 11a.

[0015]

The refrigerant inlet pipe 12 is a cylindrical member extending in the up-down direction and is formed in a substantially linear shape. The refrigerant inlet pipe 12 is provided so as to penetrate the upper portion of the

cylindrical portion 11a in the up-down direction. The refrigerant inlet pipe 12 is provided substantially at the center of the cylindrical portion 11a in the X-axis direction. The refrigerant inlet pipe 12 is connected to the pipe (not illustrated) by which the evaporator 10 and the expansion valve are connected. In other words, the refrigerant expanded by the expansion valve is guided into the pressure vessel 11 via the refrigerant inlet pipe 12.

[0016]

The refrigerant tray 13 is a substantially rectangular plate-shaped member. The refrigerant tray 13 is disposed in the upper portion of the inner portion of the pressure vessel 11 so as to have a substantially horizontal plate surface. In addition, the refrigerant tray 13 is provided such that the lower end of the refrigerant inlet pipe 12 and the plate surface face each other. Both end portions of the refrigerant tray 13 in the Y-axis direction are disposed apart by a predetermined distance from the inner peripheral surface of the cylindrical portion 11a of the pressure vessel 11. In addition, the refrigerant tray 13 is provided over substantially the entire area of the pressure vessel 11 in the X-axis direction. Both end portions of the refrigerant tray 13 in the X-axis direction are fixed to the pipe plates, respectively. Multiple holes penetrating

the refrigerant tray 13 in the up-down direction are formed in the refrigerant tray 13. The multiple holes are formed in substantially the entire area of the refrigerant tray 13. The liquid refrigerant ejected from the refrigerant inlet pipe 12 is discharged onto the refrigerant tray 13. The refrigerant discharged to the refrigerant tray 13 flows on the upper surface of the refrigerant tray 13 and then falls downward through the multiple holes. In this manner, the refrigerant tray 13 distributes the refrigerant supplied from the refrigerant inlet pipe 12 in the X-axis direction and the Y-axis direction.

[0017]

The flooded-type heat transfer pipe group 14 is accommodated in the pressure vessel 11. In addition, the flooded-type heat transfer pipe group 14 is immersed in the refrigerant stored in the storage portion 11c. In other words, the flooded-type heat transfer pipe group 14 is disposed below the liquid surface S of the stored refrigerant. The flooded-type heat transfer pipe group 14 has a plurality of first heat transfer pipes 14a extending along the X-axis direction. The plurality of first heat transfer pipes 14a are disposed substantially in parallel. The plurality of first heat transfer pipes 14a are disposed side by side at predetermined intervals in the

up-down direction (Z-axis direction) and the Y-axis direction. Specifically, the plurality of first heat transfer pipes 14a are arranged in a plurality of stages in the up-down direction and in a plurality of rows in the Y-axis direction. Water as a medium to be cooled (hereinafter, referred to as "water to be cooled") circulates in each first heat transfer pipe 14a. In addition, each first heat transfer pipe 14a is formed in a linear shape. In addition, each first heat transfer pipe 14a extends from one end to the other end of the pressure vessel 11 in the X-axis direction and penetrates each pipe plate.

[0018]

The liquid film-type heat transfer pipe group 15 is accommodated in the pressure vessel 11. The liquid film-type heat transfer pipe group 15 is disposed above the liquid surface S of the stored refrigerant. The liquid film-type heat transfer pipe group 15 has a plurality of second heat transfer pipes 15a extending along the X-axis direction. The plurality of second heat transfer pipes 15a are disposed substantially in parallel. The plurality of second heat transfer pipes 15a are disposed side by side at predetermined intervals in the up-down direction (Z-axis direction) and the Y-axis direction. Specifically, the plurality of second heat transfer pipes 15a are

arranged in a plurality of stages in the up-down direction and in a plurality of rows in the Y-axis direction. Water as a medium to be cooled circulates in each second heat transfer pipe 15a. In addition, each second heat transfer pipe 15a is formed in a linear shape. In addition, each second heat transfer pipe 15a extends from one end to the other end of the pressure vessel 11 in the X-axis direction and penetrates each pipe plate.

[0019]

The refrigerant outlet pipe 16 is a cylindrical member extending so as to be inclined with respect to the Z-axis direction. The refrigerant outlet pipe 16 is provided so as to communicate with the opening that is formed in the upper portion of the cylindrical portion 11a. The refrigerant outlet pipe 16 is provided on the end portion side of the cylindrical portion 11a in the X-axis direction. In other words, the refrigerant outlet pipe 16 is provided in the vicinity of the pipe plate of the pressure vessel 11. The refrigerant evaporated by the evaporator 10 is discharged to the outside of the pressure vessel 11 via the refrigerant outlet pipe 16.

[0020]

The baffle plate 17 is a flat plate-shaped member disposed so as to have a vertical plate surface. The baffle plate 17 is disposed on both sides of the liquid

film-type heat transfer pipe group 15. In other words, the baffle plate 17 is disposed outside the liquid film-type heat transfer pipe group 15 in the Y-axis direction. Each baffle plate 17 is disposed so as to have a plate surface facing the liquid film-type heat transfer pipe group 15. The baffle plates 17 extend downward and by a predetermined distance from both end portions of the refrigerant tray 13 in the Y-axis direction. The lower end of the baffle plate 17 is positioned above the lower end of the liquid film-type heat transfer pipe group 15. In addition, the baffle plate 17 extends over substantially the entire area of the pressure vessel 11 in the X-axis direction along the liquid film-type heat transfer pipe group 15. It should be noted that the baffle plate 17 may be provided only at a part in the X-axis direction.

[0021]

The gas-liquid separation flow path 20 is a flow path guiding the refrigerant evaporated in the flooded-type heat transfer pipe group 14 and the refrigerant evaporated in the liquid film-type heat transfer pipe group 15 to the refrigerant outlet pipe 16. It should be noted that the refrigerant that has flowed into the pressure vessel 11 from the refrigerant inlet pipe 12 includes a gas-phase refrigerant. The gas-liquid

separation flow path 20 may guide the gas-phase refrigerant that has flowed into the space where the liquid film-type heat transfer pipe group 15 is disposed via the refrigerant inlet pipe 12 and the refrigerant tray 13 to the refrigerant outlet pipe 16.

The gas-liquid separation flow path 20 is provided on both sides of the liquid film-type heat transfer pipe group 15. The two gas-liquid separation flow paths 20 are symmetrically provided with reference to the XZ plane passing through the central axis of the pressure vessel 11, and thus only one of the gas-liquid separation flow paths 20 will be described and the other gas-liquid separation flow path 20 will not be described in the following description.

The gas-liquid separation flow path 20 has a flat plate-shaped first flow path defining portion 21 disposed outside the baffle plate 17 in the Y-axis direction and a plate-shaped second flow path defining portion 22 disposed outside the first flow path defining portion 21 in the Y-axis direction. The gas-liquid separation flow path 20 is provided over substantially the entire area of the pressure vessel 11 in the X-axis direction.

[0022]

The first flow path defining portion 21 is disposed so as to face the baffle plate 17. The first flow path

defining portion 21 is disposed so as to have a vertical plate surface. The first flow path defining portion 21 and the baffle plate 17 are separated from each other. An ascending flow path 23 through which the refrigerant evaporated mainly in the liquid film-type heat transfer pipe group 15 circulates is formed between the first flow path defining portion 21 and the baffle plate 17. In other words, the ascending flow path 23 is defined by the plate surface of the first flow path defining portion 21 and the plate surface of the baffle plate 17.

The lower end of the first flow path defining portion 21 is positioned below the liquid surface S of the refrigerant stored in the storage portion 11c. In addition, the lower end of the first flow path defining portion 21 is separated from the inner peripheral surface of the pressure vessel 11. In other words, a gap G is formed between the lower end of the first flow path defining portion 21 and the inner peripheral surface of the pressure vessel 11. The upper end of the first flow path defining portion 21 is positioned below the upper end of the baffle plate 17 and above the lower end of the baffle plate 17. Specifically, the upper end of the first flow path defining portion 21 is positioned at substantially the same height as the vicinity of the

central portion of the baffle plate 17 in the Z-axis direction.

In addition, a first delamination prevention portion 27 is provided in the upper end portion of the first flow path defining portion 21 in order to prevent the circulating refrigerant from delaminating. The first delamination prevention portion 27 protrudes from the outside plate surface of the first flow path defining portion 21.

[0023]

The second flow path defining portion 22 integrally has a curved portion 22a curving and extending outward and downward from the end portion of the refrigerant tray 13 in the Y-axis direction and a vertical portion 22b extending downward from the lower end of the curved portion 22a.

[0024]

The curved portion 22a is disposed above the first flow path defining portion 21. A connecting flow path 25 connecting the ascending flow path 23 and a descending flow path 24, which will be described later, is formed below the curved portion 22a.

[0025]

The vertical portion 22b is disposed outside the first flow path defining portion 21 in the Y-axis

direction. The vertical portion 22b is disposed so as to face the first flow path defining portion 21. The vertical portion 22b is disposed so as to have a vertical plate surface. The vertical portion 22b and the first flow path defining portion 21 are separated from each other. The separation distance between the vertical portion 22b and the first flow path defining portion 21 is longer than the separation distance between the first flow path defining portion 21 and the baffle plate 17. The descending flow path 24 through which the refrigerant evaporated mainly in the liquid film-type heat transfer pipe group 15 circulates is formed between the vertical portion 22b and the first flow path defining portion 21. In other words, the descending flow path 24 is defined by the plate surface of the vertical portion 22b and the plate surface of the first flow path defining portion 21. As described above, the separation distance between the vertical portion 22b and the first flow path defining portion 21 is longer than the separation distance between the first flow path defining portion 21 and the baffle plate 17. Accordingly, the flow path area of the ascending flow path 23 is smaller than the flow path area of the descending flow path 24.

[0026]

In addition, the outside plate surface of the vertical portion 22b faces the inner peripheral surface of the cylindrical portion 11a. A pressure vessel flow path (housing flow path) 26 through which the refrigerant evaporated mainly in the liquid film-type heat transfer pipe group 15 circulates is formed between the vertical portion 22b and the cylindrical portion 11a. In other words, the pressure vessel flow path 26 is defined by the plate surface of the vertical portion 22b and the inner peripheral surface of the cylindrical portion 11a. The pressure vessel flow path 26 is formed such that the inner peripheral surface of the pressure vessel 11 (see P in Fig. 1) is positioned at the position where the refrigerant flowing in collides. In addition, the separation distance between the vertical portion 22b and the inner peripheral surface of the cylindrical portion 11a is longer than the separation distance between the vertical portion 22b and the first flow path defining portion 21. Accordingly, the flow path area of the pressure vessel flow path 26 is larger than the flow path area of the descending flow path 24.

[0027]

The lower end of the vertical portion 22b is positioned above the lower end of the first flow path defining portion 21. The lower end of the vertical

portion 22b is positioned below the upper end of the first flow path defining portion 21.

In addition, a second delamination prevention portion 28 is provided in the lower end portion of the vertical portion 22b in order to prevent the circulating refrigerant from delaminating. The second delamination prevention portion 28 protrudes from the outside plate surface of the vertical portion 22b.

[0028]

The refrigerant circulates as follows in the evaporator 10 configured as described above.

As illustrated in Fig. 1, in the evaporator 10, the refrigerant flows into the pressure vessel 11 from the refrigerant inlet pipe 12. The refrigerant that has flowed into the pressure vessel 11 is distributed in the X-axis direction and the Y-axis direction of the pressure vessel 11 by the refrigerant tray 13 and then passes through the multiple holes formed in the refrigerant tray 13 to fall downward.

The liquid-phase refrigerant that has fallen from the refrigerant tray 13 comes into contact with the second heat transfer pipe 15a disposed in the uppermost stage of the liquid film-type heat transfer pipe group 15 and covers the outer peripheral surface of the second heat transfer pipe 15a in a film shape. The refrigerant that

covers the outer peripheral surface of the second heat transfer pipe 15a in the film shape exchanges heat with the water to be cooled in the second heat transfer pipe 15a. The refrigerant that exceeds the boiling point as a result of the heat exchange evaporates, and the refrigerant that does not exceed the boiling point falls to the second heat transfer pipe 15a disposed further below. Such heat exchange is repeated continuously. The refrigerant that does not evaporate even by heat exchange with the water in the second heat transfer pipe 15a disposed in the lowermost portion is stored in the storage portion 11c provided in the lower portion of the pressure vessel 11. In this manner, a pool of the liquid-phase refrigerant is formed in the storage portion 11c in the pressure vessel 11. The level of the liquid surface S of this refrigerant pool is automatically adjusted to a predetermined height.

[0029]

Meanwhile, the refrigerant evaporated in the liquid film-type heat transfer pipe group 15 bypasses the lower end of the baffle plate 17 and flows into the ascending flow path 23 as indicated by the arrow A1. The refrigerant that has flowed into the ascending flow path 23 circulates upward from below in the ascending flow path 23. The refrigerant that has circulated through the

ascending flow path 23 flows into the connecting flow path 25 from the upper end of the ascending flow path 23. The refrigerant that has flowed into the connecting flow path 25 turns back in the circulation direction as indicated by the arrow A2. The refrigerant that has turned back in the connecting flow path 25 flows into the descending flow path 24. The refrigerant that has flowed into the descending flow path 24 circulates downward from above in the descending flow path 24 as indicated by the arrow A3. The refrigerant discharged from the second flow path bypasses the lower end of the vertical portion 22b of the second flow path defining portion 22 and heads upward. At this time, the refrigerant discharged from the second flow path collides, as indicated by the arrow A4, with a collision position P on the inner peripheral surface of the cylindrical portion 11a of the pressure vessel 11. As indicated by the arrow A5, the refrigerant that has collided with the collision position P moves upward along the inner peripheral surface of the cylindrical portion 11a in the pressure vessel flow path 26 and flows into the space above the refrigerant tray 13. The refrigerant that has flowed into the space above the refrigerant tray 13 is guided to the refrigerant outlet pipe 16 and discharged to the outside of the pressure vessel 11. The refrigerant

discharged from the refrigerant outlet pipe 16 is suctioned and compressed by the turbo compressor.

[0030]

The first heat transfer pipe 14a of the flooded-type heat transfer pipe group 14 is in a state of being immersed in the liquid-phase refrigerant stored in the storage portion 11c. The water to be cooled circulating in the second heat transfer pipe 15a exchanges heat with the refrigerant stored in the storage portion 11c. The refrigerant that has exchanged heat with the second heat transfer pipe 15a evaporates and is guided upward from the liquid surface S. The refrigerant evaporated in the liquid film-type heat transfer pipe group 15 and the flooded-type heat transfer pipe group 14 is guided to the refrigerant outlet pipe 16. The refrigerant guided to the refrigerant outlet pipe 16 is discharged to the outside of the pressure vessel 11. The refrigerant discharged from the refrigerant outlet pipe 16 is suctioned and compressed by the turbo compressor.

[0031]

The action and effect of the present embodiment are as follows.

In the present embodiment, the refrigerant evaporated in the liquid film-type heat transfer pipe group 15 circulates through the gas-liquid separation flow

path 20. The refrigerant circulating through the gas-liquid separation flow path 20 turns back in the circulation direction downward from above in the connecting flow path 25. At this time, a centrifugal force acts on the refrigerant circulating through the connecting flow path 25. As a result, it is possible to centrifuge the refrigerant into a gas-phase refrigerant and a liquid-phase refrigerant. As a result, a phenomenon in which the refrigerant discharged from the refrigerant outlet pipe 16 to the outside of the pressure vessel 11 accompanies a liquid-phase refrigerant (so-called carryover) can be made unlikely to occur.

In addition, in the present embodiment, gas-liquid separation is performed on the refrigerant by the gas-liquid separation flow path 20. As a result, the gas-liquid separation of the refrigerant can be performed without using an expensive member such as a demister. Accordingly, the initial cost of the evaporator 10 can be reduced.

[0032]

In addition, in the present embodiment, the flow path area of the ascending flow path 23 connected to the upstream side of the connecting flow path 25 is smaller than the flow path area of the descending flow path 24 connected to the downstream side of the connecting flow

path 25. As a result, it is possible to increase the flow speed of the refrigerant circulating through the ascending flow path 23 connected to the upstream side of the connecting flow path 25. Accordingly, it is possible to increase the centrifugal force that acts on the refrigerant during the circulation through the connecting flow path 25. Accordingly, the refrigerant can be more effectively centrifuged into the gas-phase refrigerant and the liquid-phase refrigerant.

[0033]

In addition, in the present embodiment, the refrigerant flowing into the pressure vessel flow path 26 collides with the inner peripheral surface of the pressure vessel 11. The refrigerant undergoes gas-liquid separation due to the impact of the collision with the inner peripheral surface of the pressure vessel 11 (so-called collision separation). Accordingly, the refrigerant can be separated into a gas-phase refrigerant and a liquid-phase refrigerant by the pressure vessel flow path 26. Accordingly, carryover can be made less likely to occur.

[0034]

In addition, in the present embodiment, the flow path area of the pressure vessel flow path 26 is larger than the flow path areas of the ascending flow path 23 and

the descending flow path 24. As a result, it is possible to decrease the flow speed of the refrigerant flowing through the pressure vessel flow path 26. In the pressure vessel flow path 26, the refrigerant circulates upward from below. Accordingly, by the flow speed being decreased, the gas-liquid separation of the refrigerant can be more suitably performed by gravity. Accordingly, carryover can be made less likely to occur.

[0035]

In addition, the lower end of the first flow path defining portion 21 is provided below the liquid surface S. In other words, the lower end of the first flow path defining portion 21 is immersed in the refrigerant stored in the storage portion 11c. As a result, the liquid-phase refrigerant that has adhered to the first flow path defining portion 21 is guided to the storage portion 11c along the first flow path defining portion 21. Accordingly, the liquid-phase refrigerant can be suitably returned to the storage portion 11c.

In addition, the gap G is formed between the lower end of the first flow path defining portion 21 and the inner peripheral surface of the cylindrical portion 11a of the pressure vessel 11. As a result, the space inside the first flow path defining portion 21 and the space outside the first flow path defining portion 21 can be connected

by the gap G. Accordingly, even in a case where the gas-liquid-separated liquid-phase refrigerant is returned to the outside of the first flow path defining portion 21, the liquid-phase refrigerant returned to the storage portion 11c can be guided through the gap G to the space where the flooded-type heat transfer pipe group 14 is provided.

[0036]

[Modification Example 1]

A modification example of the present embodiment will be described. In the above description, a case where the baffle plate 17 is provided has been described, but the present disclosure is not limited thereto. For example, the baffle plate 17 may be omitted as illustrated in Fig. 2. In a case where the baffle plate 17 is omitted, the ascending flow path 23 and the connecting flow path 25 do not exist.

Even in such a configuration, when the refrigerant evaporated in the liquid film-type heat transfer pipe group 15 flows into the pressure vessel flow path 26 from the descending flow path 24, the refrigerant is centrifuged by the circulation direction turning back in the up-down direction. In addition, as in a case where the baffle plate 17 exists, the refrigerant is collision-separated in flowing into the pressure vessel flow path 26

and the refrigerant is gravitationally separated in circulating through the pressure vessel flow path 26. Accordingly, carryover can be made unlikely to occur even in a case where the baffle plate 17 is omitted.

[0037]

[Modification Example 2]

In addition, as illustrated in Fig. 3, a first drain pipe (first drain portion) 30 may be provided at the lower end of the vertical portion 22b of the second flow path defining portion 22. The first drain pipe 30 extends along the Z-axis direction. As illustrated in Figs. 4 and 5, the first drain pipe 30 has a shape in which a cylindrical member is divided into two along the longitudinal direction. In addition, the upper end of the first drain pipe 30 is connected to the lower end of the vertical portion 22b as illustrated in Figs. 3 and 4. In addition, as illustrated in Fig. 3, the lower end of the first drain pipe 30 is positioned below the liquid surface S of the refrigerant stored in the storage portion 11c. In addition, the lower end of the first drain pipe 30 is separated from the inner peripheral surface of the pressure vessel 11. As illustrated in Fig. 4, the first drain pipe 30 is provided in a partial region of the vertical portion 22b in the X-axis direction. In addition, a plurality of the first drain pipes 30 may be provided.

In a case where the plurality of first drain pipes 30 are provided, the first drain pipes 30 may be disposed side by side at predetermined intervals in the X-axis direction. In addition, as illustrated in Fig. 5, the first drain pipe 30 is disposed such that a cylindrical outer peripheral surface faces the upstream side of the refrigerant flow circulating through the gas-liquid separation flow path 20.

[0038]

The action and effect of this modification example are as follows.

During the circulation through the gas-liquid separation flow path 20, a part of the gas-liquid-separated liquid-phase refrigerant adheres to the second flow path defining portion 22. In this modification example, the refrigerant that has adhered can be guided to the storage portion 11c via the first drain pipe 30. The refrigerant guided to the storage portion 11c evaporates by heat exchange with the flooded-type heat transfer pipe group 14. In this manner, the gas-liquid-separated liquid-phase refrigerant can be guided to the flooded-type heat transfer pipe group 14, and thus it is possible to reduce the refrigerant that is not supplied to each heat transfer pipe group. Accordingly, the performance of the evaporator 10 can be improved.

[0039]

In addition, in this modification example, the first drain pipe 30 is disposed such that a cylindrical outer peripheral surface faces the upstream side of the refrigerant flow circulating through the gas-liquid separation flow path 20. As a result, the first drain pipe 30 is capable of covering a refrigerant W (see Fig. 5) moving through the first drain pipe 30 from the upstream side. Accordingly, as indicated by the broken-line arrow in Fig. 4, the refrigerant circulating through the gas-liquid separation flow path 20 bypasses the first drain pipe 30 and circulates. Accordingly, the refrigerant W guided by the first drain pipe 30 can be made unlikely to be scattered by the refrigerant circulating through the gas-liquid separation flow path 20. Accordingly, the liquid-phase refrigerant can be suitably guided to the storage portion 11c.

[0040]

In addition, the lower end of the first drain pipe 30 is provided below the liquid surface S. In other words, the lower end of the first drain pipe 30 is immersed in the refrigerant stored in the storage portion 11c. As a result, the liquid-phase refrigerant that has adhered to the first drain pipe 30 is guided to the storage portion 11c along the first drain pipe 30. Accordingly, the

liquid-phase refrigerant can be suitably returned to the storage portion 11c.

[0041]

[Second Embodiment]

Next, a second embodiment according to the present disclosure will be described with reference to Fig. 6.

The present embodiment is different from the first embodiment mainly in gas-liquid separation flow path structure. The embodiments are similar to each other as to the other points, and thus the same structures will be denoted by the same reference numerals with detailed description thereof omitted.

[0042]

A gas-liquid separation flow path 40 according to the present embodiment is disposed outside the baffle plate 17 in the Y-axis direction and has a third flow path defining portion 41 provided above the lower end of the baffle plate 17 and a fourth flow path defining portion 42 provided above the third flow path defining portion 41. The gas-liquid separation flow path 40 is provided over substantially the entire area of the pressure vessel 11 in the X-axis direction.

[0043]

The third flow path defining portion 41 integrally has a plate-shaped first horizontal portion 41a extending

outward in the Y-axis direction from the outside plate surface of the baffle plate 17 and a plate-shaped first vertical portion 41b bent at a substantially right angle and extending upward from the outside end portion of the first horizontal portion 41a in the Y-axis direction.

[0044]

The first horizontal portion 41a is disposed so as to have a horizontal plate surface. The inside end portion of the first horizontal portion 41a in the Y-axis direction abuts against or is in close proximity to the lower portion of the baffle plate 17. In addition, the outside end portion of the first horizontal portion 41a in the Y-axis direction extends to the vicinity of the inner peripheral surface of the cylindrical portion 11a.

[0045]

The first vertical portion 41b is disposed so as to have a vertical plate surface. The outside plate surface of the first vertical portion 41b faces the inner peripheral surface of the cylindrical portion 11a. A pressure vessel flow path (housing flow path) 43 through which the refrigerant evaporated mainly in the liquid film-type heat transfer pipe group 15 circulates is formed between the first vertical portion 41b and the cylindrical portion 11a. In other words, the pressure vessel flow path 43 is defined by the plate surface of the first

vertical portion 41b and the inner peripheral surface of the cylindrical portion 11a.

[0046]

The fourth flow path defining portion 42 integrally has a plate-shaped second horizontal portion 42a extending inward in the Y-axis direction from the inner peripheral surface of the cylindrical portion 11a, a plate-shaped second vertical portion 42b bent downward at a substantially right angle and extending downward from the inside end portion of the second horizontal portion 42a, a plate-shaped collecting portion 42c bent at a substantially right angle and extending outward in the Y-axis direction from the lower end of the second vertical portion 42b, and a plate-shaped third vertical portion 42d bent at a substantially right angle and extending upward from the outside end portion of the collecting portion 42c in the Y-axis direction.

[0047]

The second horizontal portion 42a is disposed so as to have a horizontal plate surface. The second horizontal portion 42a is provided above the upper end of the first vertical portion 41b. The outside end portion of the second horizontal portion 42a in the Y-axis direction abuts against or is in close proximity to the inner peripheral surface of the cylindrical portion 11a. In

addition, the inside end portion of the second horizontal portion 42a in the Y-axis direction extends to the vicinity of the baffle plate 17. The inside end portion of the second horizontal portion 42a in the Y-axis direction is separated from the baffle plate 17. In addition, a connecting flow path 47 connecting the pressure vessel flow path 43 and a descending flow path 46, which will be described later, is formed below the second horizontal portion 42a.

[0048]

The second vertical portion 42b is disposed so as to have a vertical plate surface. The inside plate surface of the second vertical portion 42b faces the baffle plate 17. An ascending flow path 44 through which the refrigerant evaporated mainly in the liquid film-type heat transfer pipe group 15 circulates is formed between the second vertical portion 42b and the baffle plate 17. In other words, the ascending flow path 44 is defined by the second vertical portion 42b and the baffle plate 17. The lower end of the second vertical portion 42b is disposed above the first horizontal portion 41a. The lower end of the second vertical portion 42b is separated from the first horizontal portion 41a.

[0049]

The collecting portion 42c is disposed so as to have a horizontal plate surface. The collecting portion 42c is disposed above the first horizontal portion 41a. In addition, the collecting portion 42c is disposed below the upper end of the first vertical portion 41b. The lower surface of the collecting portion 42c faces the upper surface of the first horizontal portion 41a. A horizontal flow path 45 is formed between the lower surface of the collecting portion 42c and the upper surface of the first horizontal portion 41a. In other words, the horizontal flow path 45 is defined by the collecting portion 42c and the first horizontal portion 41a. A space where the centrifuged liquid-phase refrigerant is collected is formed between the upper surface of the collecting portion 42c and the lower surface of the second horizontal portion 42a. The inside of this space in the Y-axis direction is defined by the second vertical portion 42b.

[0050]

The collecting portion 42c is provided with a second drain pipe (second drain portion) 50 guiding the collected liquid-phase refrigerant to the storage portion 11c. The second drain pipe 50 is different from the first drain pipe 30 described in Modification Example 2 of the first embodiment in that the upper end of the second drain pipe 50 is connected to the upper surface of the collecting

portion 42c. The first drain pipe 30 and the second drain pipe 50 are substantially identical to each other as to the other points, and thus detailed description of the second drain pipe 50 will be omitted.

[0051]

In addition, the horizontal flow path 45 is provided with a third drain pipe 51 guiding the liquid-phase refrigerant to the storage portion 11c. The third drain pipe 51 is different from the first drain pipe 30 described in Modification Example 2 of the first embodiment in that the upper end of the third drain pipe 51 is connected to the upper surface of the first horizontal portion 41a. The first drain pipe 30 and the third drain pipe 51 are substantially identical to each other as to the other points, and thus detailed description of the third drain pipe 51 will be omitted. The third drain pipe 51 is provided in the vicinity of the vertically lower part of the ascending flow path 44.

[0052]

The third vertical portion 42d is disposed so as to have a vertical plate surface. The outside plate surface of the third vertical portion 42d faces the inside plate surface of the second vertical portion 42b. The descending flow path 46 through which the refrigerant evaporated mainly in the liquid film-type heat transfer

pipe group 15 circulates is formed between the third vertical portion 42d and the second vertical portion 42b. In other words, the descending flow path 46 is defined by the third vertical portion 42d and the first vertical portion 41b. The flow path area of the descending flow path 46 is smaller than the flow path area of the ascending flow path 44.

The upper end of the third vertical portion 42d is disposed below the second horizontal portion 42a. The upper end of the third vertical portion 42d is separated from the second horizontal portion 42a. In addition, the upper end of the third vertical portion 42d is disposed below the upper end of the first vertical portion 41b.

[0053]

Next, how the refrigerant in the present embodiment circulates will be described. It should be noted that the second embodiment is similar to the first embodiment except for the flow of the refrigerant evaporated in each heat transfer pipe group and thus description thereof will be omitted.

In the present embodiment, as indicated by the arrow A6, the refrigerant evaporated in the liquid film-type heat transfer pipe group 15 bypasses the lower end of the baffle plate 17 and collides with the collision position P on the inner peripheral surface of the cylindrical portion

11a of the pressure vessel 11. As indicated by the arrow A7, the refrigerant that has collided with the collision position P moves upward along the inner peripheral surface of the cylindrical portion 11a in the pressure vessel flow path 43. The refrigerant that has circulated through the pressure vessel flow path 43 flows into the connecting flow path 47 from the upper end of the pressure vessel flow path 43. The refrigerant that has flowed into the connecting flow path 47 turns back in the circulation direction. The liquid-phase refrigerant is higher in density than the gas-phase refrigerant, and thus the refrigerant makes a large turn, as indicated by the arrow A8, in turning back. The liquid-phase refrigerant that has made the large turn is collected in the collecting portion 42c. Meanwhile, the low-density gas-phase refrigerant makes a small turn and flows into the descending flow path 46 as indicated by the arrow A9. The refrigerant that has flowed into the descending flow path 46 circulates downward from above in the descending flow path 46. The refrigerant that has circulated through the descending flow path 46 circulates through the horizontal flow path 45. The refrigerant that has circulated through the horizontal flow path 45 flows into the ascending flow path 44. The refrigerant that has flowed into the ascending flow path 44 circulates upward from below in the

ascending flow path 44 as indicated by the arrow A10. The refrigerant that has circulated through the ascending flow path 44 flows into the space above the refrigerant tray 13. The refrigerant that has flowed into the space above the refrigerant tray 13 is guided to the refrigerant outlet pipe 16 and discharged to the outside of the pressure vessel 11.

[0054]

The action and effect of the present embodiment are as follows.

In the present embodiment, the refrigerant evaporated in the liquid film-type heat transfer pipe group 15 is first guided to the pressure vessel flow path 43. As a result, it is possible to cause the refrigerant to collide with the inner peripheral surface of the pressure vessel 11 and perform collision separation before performing centrifugation on the refrigerant in the connecting flow path 47. Accordingly, it is possible to increase the speed of the refrigerant colliding with the inner peripheral surface of the pressure vessel 11. Accordingly, the gas-liquid separation of the refrigerant can be more effectively performed by the collision separation.

[0055]

In addition, in the present embodiment, the collecting portion 42c where the separated liquid-phase refrigerant is collected is provided on the downstream-side flow path (descending flow path 46) side of the connected flow path. As a result, the centrifuged liquid phase can be suitably collected.

[0056]

In addition, in the present embodiment, the collected refrigerant is guided to the storage portion 11c via the second drain pipe 50. The refrigerant guided to the storage portion 11c evaporates by heat exchange with the flooded-type heat transfer pipe group 14. In this manner, the gas-liquid-separated liquid-phase refrigerant can be guided to the flooded-type heat transfer pipe group 14, and thus it is possible to reduce the refrigerant that is not supplied to each heat transfer pipe group. Accordingly, the performance of the evaporator 10 can be improved.

[0057]

[Modification Example 3]

It should be noted that the collecting portion 42c may be inclined along the X-axis direction with respect to a horizontal plane. In this case, the liquid-phase refrigerant collects in the second drain pipe 50 on condition that the collecting portion 42c is inclined such

that the part where the second drain pipe 50 is provided becomes low, and thus the liquid-phase refrigerant can be more suitably returned to the storage portion 11c. In addition, in a case where a plurality of the second drain pipes 50 are disposed side by side along the X-axis direction, the collecting portion 42c may have a plurality of inclined surfaces such that the part where each second drain pipe 50 is provided becomes low.

[0058]

[Modification Example 4]

In addition, as illustrated in Fig. 7, the third flow path defining portion may be formed by a curved surface. A third flow path defining portion (curved portion) 60 according to this modification example integrally has a first part 61 extending while curving outward and upward in the Y-axis direction from the lower end of the baffle plate 17 and a second part 62 extending while curving inward and upward in the Y-axis direction from the upper end of the first part 61. The upper end of the second part 62 extends to the vicinity of the second horizontal portion 42a. The upper end of the second part 62 and the second horizontal portion 42a are separated from each other. In addition, the upper end of the second part 62 and the second vertical portion 42b are separated from each other.

In addition, the third drain pipe 51 is provided at the first part 61. Specifically, the third drain pipe 51 is provided at the lower end of the first part 61.

[0059]

In this modification example, the refrigerant evaporated in the liquid film-type heat transfer pipe group 15 circulates between the third flow path defining portion 60 and the inner peripheral surface of the pressure vessel 11 as indicated by the arrow A11. Next, as indicated by the arrow A12, the refrigerant circulates between the upper end of the second part 62 and the second horizontal portion 42a and between the upper end of the second part 62 and the second vertical portion 42b. Next, as indicated by the arrow A13, the refrigerant flows in between the first part 61 and the third vertical portion 42d and circulates along the first part 61. Then, as indicated by the arrow A14, the refrigerant flows into the ascending flow path 44 and flows into the space above the refrigerant tray 13. The refrigerant that has flowed into the space above the refrigerant tray 13 is guided to the refrigerant outlet pipe 16 and discharged to the outside of the pressure vessel 11.

[0060]

In this modification example, the third flow path defining portion 60 is curved. As a result, pressure loss

is reduced with respect to the refrigerant circulating through the gas-liquid separation flow path. Accordingly, the refrigerant can be suitably guided to the refrigerant outlet pipe 16.

In addition, since the third flow path defining portion 60 is curved, the liquid-phase refrigerant can be guided to the third drain pipe 51 even if the gas-liquid-separated liquid-phase refrigerant falls at any position on the upper surface of the first part 61. As a result, the region where the refrigerant is guided to the third drain pipe 51 can be widened as compared with, for example, a case where the third flow path defining portion is configured only by a flat plate member as in the second embodiment. Accordingly, the liquid-phase refrigerant can be suitably returned to the storage portion 11c.

[0061]

It should be noted that the present disclosure is not limited to the above embodiments and can be appropriately modified without departing from the gist thereof.

For example, the present disclosure is not limited to the embodiments described as examples in which a flow path through which a refrigerant circulates upward is connected to the upstream side of the connecting flow path and a flow path through which a refrigerant circulates

downward is connected to the downstream side of the connecting flow path. For example, a flow path through which a refrigerant circulates downward may be connected to the upstream side of the connecting flow path.

In addition, for example, the present disclosure is not limited to the embodiments described as examples in which the refrigerant tray is used as a device supplying a refrigerant to the liquid film-type heat transfer pipe group or the like. The refrigerant supply device may be any structure capable of supplying a refrigerant to the liquid film-type heat transfer pipe group and may be, for example, a pipe-shaped member extending along the X-axis direction.

[0062]

The evaporator described in the present embodiment described above is, for example, grasped as follows.

An evaporator according to one aspect of the present disclosure includes: a housing (11) having a refrigerant outlet (16) discharging an evaporated refrigerant and forming an outer shell; a first heat transfer pipe group (14) accommodated in the housing, immersed in a liquid-phase refrigerant stored in a storage portion (11c) provided in a lower portion of the housing, and having a plurality of first heat transfer pipes (14a) in which a medium to be cooled circulates; a second heat transfer

pipe group (15) accommodated in the housing, provided above a liquid surface (S) of the liquid-phase refrigerant stored in the lower portion of the housing, and having a plurality of second heat transfer pipes (15a) in which a medium to be cooled circulates; a refrigerant supply unit (13) accommodated in the housing and supplying a liquid-phase refrigerant from above to the second heat transfer pipe group; and a flow path (20) guiding a refrigerant evaporated in the second heat transfer pipe group to the refrigerant outlet, in which the flow path has a first flow path (23) in which a refrigerant circulates upward from below, a second flow path (24) in which a refrigerant circulates downward from above, and a connecting flow path (25) connecting the first flow path and the second flow path and turning back a refrigerant.

[0063]

In the above configuration, the refrigerant evaporated in the second heat transfer pipe group circulates through the flow path. The refrigerant circulating through the flow path turns back downward from above or upward from below in the connecting flow path. At this time, a centrifugal force acts on the refrigerant circulating through the connecting flow path. As a result, it is possible to centrifuge the refrigerant into a gas-phase refrigerant and a liquid-phase refrigerant. As a

result, a phenomenon in which the refrigerant discharged from the refrigerant outlet to the outside of the housing accompanies a liquid-phase refrigerant (so-called carryover) can be made unlikely to occur.

In addition, in the above configuration, gas-liquid separation is performed on the refrigerant by the flow path. As a result, the gas-liquid separation of the refrigerant can be performed without using an expensive member such as a demister. Accordingly, the initial cost can be reduced.

It should be noted that the first flow path and the second flow path are names for convenience and "first" and "second" do not mean the order of refrigerant circulation.

[0064]

In addition, in the evaporator according to one aspect of the present disclosure, the first flow path or the second flow path connected to an upstream side of the connecting flow path is smaller in flow path area than the first flow path or the second flow path connected to a downstream side of the connecting flow path.

[0065]

In the above configuration, the flow path cross-sectional area of the flow path provided on the upstream side of the connecting flow path is small. As a result, it is possible to increase the flow speed of the

refrigerant circulating through the flow path provided on the upstream side of the connecting flow path. Accordingly, it is possible to increase the centrifugal force that acts on the refrigerant during the circulation through the connecting flow path. Accordingly, the refrigerant can be more effectively centrifuged into the gas-phase refrigerant and the liquid-phase refrigerant.

[0066]

In addition, in the evaporator according to one aspect of the present disclosure, the flow path has a housing flow path (26) partially defined by an inner peripheral surface of the housing and, in the housing flow path, the inner peripheral surface of the housing is disposed at a position where a refrigerant flowing in collides.

[0067]

In the above configuration, the refrigerant flowing into the housing flow path collides with the inner peripheral surface of the housing. The refrigerant undergoes gas-liquid separation due to the impact of the collision with the inner peripheral surface of the housing (so-called collision separation). Accordingly, the refrigerant can be separated into a gas-phase refrigerant and a liquid-phase refrigerant by the housing flow path. Accordingly, the phenomenon in which the refrigerant

discharged from the refrigerant outlet to the outside of the housing accompanies a liquid-phase refrigerant (so-called carryover) can be made less likely to occur.

[0068]

In addition, in the evaporator according to one aspect of the present disclosure, the housing flow path is provided upstream of the connecting flow path.

[0069]

In the above configuration, it is possible to cause the refrigerant to collide with the inner peripheral surface of the housing and perform collision separation before performing centrifugation on the refrigerant in the connecting portion. As a result, it is possible to increase the speed of the refrigerant colliding with the inner peripheral surface of the housing. Accordingly, the gas-liquid separation of the refrigerant can be more effectively performed by the collision separation.

[0070]

In addition, in the evaporator according to one aspect of the present disclosure, the flow path is provided with a first drain portion (30) guiding a liquid-phase refrigerant to the storage portion.

[0071]

In the above configuration, the gas-liquid-separated liquid-phase refrigerant adheres to the flow path during

the circulation through the flow path. The refrigerant that has adhered is guided to the storage portion via the first drain portion. The refrigerant guided to the storage portion evaporates by heat exchange with the first heat transfer pipe group. In this manner, the gas-liquid-separated liquid-phase refrigerant can be guided to the first heat transfer pipe group, and thus it is possible to reduce the refrigerant that is not supplied to each heat transfer pipe group. Accordingly, the performance of the evaporator can be improved.

It should be noted that the first drain portion may have a shape in which, for example, a cylindrical member is divided into two along the longitudinal direction and be disposed such that a cylindrical surface is positioned on the upstream side of the refrigerant flow circulating through the flow path. By doing so, the first drain portion is capable of covering the refrigerant guided by the first drain portion from the upstream side of the refrigerant flow circulating through the flow path. Accordingly, the refrigerant guided by the first drain portion can be made unlikely to be scattered by the refrigerant circulating through the flow path. Accordingly, the liquid-phase refrigerant can be suitably guided to the storage portion.

In addition, the first drain portion may be disposed such that the upper end thereof is connected to the flow path and the lower end thereof is positioned in the refrigerant stored in the storage portion and separated from the inner peripheral surface of the housing.

[0072]

In addition, in the evaporator according to one aspect of the present disclosure, the connecting flow path is provided with a collecting portion (42c) collecting a separated liquid-phase refrigerant on a connected downstream-side flow path side.

[0073]

The liquid-phase refrigerant centrifuged in the connecting portion is higher in density than the separated gas-phase refrigerant. As a result, the separated liquid-phase refrigerant turns more than the gas-phase refrigerant in turning back. In other words, the liquid-phase refrigerant circulates near the flow path on the downstream side in turning back. In the above configuration, the collecting portion collecting the separated liquid-phase refrigerant is provided on the downstream-side flow path side of the connected flow path. As a result, the centrifuged liquid phase can be suitably collected.

[0074]

In addition, in the evaporator according to one aspect of the present disclosure, the collecting portion is provided with a second drain portion (50) guiding the collected liquid-phase refrigerant to the storage portion.

[0075]

In the above configuration, the collected refrigerant is guided to the storage portion via the second drain portion. The refrigerant guided to the storage portion evaporates by heat exchange with the first heat transfer pipe group. In this manner, the gas-liquid-separated liquid-phase refrigerant can be guided to the first heat transfer pipe group, and thus it is possible to reduce the refrigerant that is not supplied to each heat transfer pipe group. Accordingly, the performance of the evaporator can be improved.

[0076]

In addition, in the evaporator according to one aspect of the present disclosure, the collecting portion is inclined such that a position where the second drain portion is provided becomes low.

[0077]

In the above configuration, the collecting portion is inclined such that the position where the second drain portion is provided becomes low. As a result, the liquid-phase refrigerant collected in the collecting portion

flows toward the second drain portion. Accordingly, the collected refrigerant can be more suitably guided to the storage portion via the second drain portion.

[0078]

In addition, in the evaporator according to one aspect of the present disclosure, the flow path has a curved portion (60) where a surface defining the flow path is curved.

[0079]

In the above configuration, the flow path has the curved portion. As a result, in the curved portion, pressure loss is reduced with respect to the refrigerant circulating through the flow path. Accordingly, the refrigerant can be suitably guided to the refrigerant outlet.

[Reference Signs List]

[0080]

10: evaporator

11: pressure vessel (housing)

11a: cylindrical portion

11c: storage portion

12: refrigerant inlet pipe

13: refrigerant tray (refrigerant supply unit)

14: flooded-type heat transfer pipe group (first heat transfer pipe group)

14a: first heat transfer pipe

15: liquid film-type heat transfer pipe group
(second heat transfer pipe group)

15a: second heat transfer pipe

16: refrigerant outlet pipe (refrigerant outlet)

17: baffle plate

20: gas-liquid separation flow path (flow path)

21: first flow path defining portion

22: second flow path defining portion

22a: curved portion

22b: vertical portion

23: ascending flow path (first flow path)

24: descending flow path (second flow path)

25: connecting flow path

26: pressure vessel flow path (housing flow path)

27: first delamination prevention portion

28: second delamination prevention portion

30: first drain pipe (first drain portion)

40: gas-liquid separation flow path

41: third flow path defining portion

41a: first horizontal portion

41b: first vertical portion

42: fourth flow path defining portion

42a: second horizontal portion

42b: second vertical portion

42c: collecting portion
42d: third vertical portion
43: pressure vessel flow path (housing flow path)
44: ascending flow path
45: horizontal flow path
46: descending flow path
47: connecting flow path
50: second drain pipe (second drain portion)
51: third drain pipe
60: third flow path defining portion
61: first part
62: second part
G: gap
P: collision position
S: liquid surface

Claims

[Claim 1]

An evaporator comprising:

a housing having a refrigerant outlet discharging an evaporated refrigerant and forming an outer shell;

a first heat transfer pipe group accommodated in the housing, immersed in a liquid-phase refrigerant stored in a storage portion provided in a lower portion of the housing, and having a plurality of first heat transfer pipes in which a medium to be cooled circulates;

a second heat transfer pipe group accommodated in the housing, provided above a liquid surface of the liquid-phase refrigerant stored in the lower portion of the housing, and having a plurality of second heat transfer pipes in which a medium to be cooled circulates;

a refrigerant supply unit accommodated in the housing and supplying a liquid-phase refrigerant from above to the second heat transfer pipe group; and

a flow path guiding a refrigerant evaporated in the second heat transfer pipe group to the refrigerant outlet,

wherein the flow path has a first flow path in which a refrigerant circulates upward from below, a second flow path in which a refrigerant circulates downward from above,

and a connecting flow path connecting the first flow path and the second flow path and turning back a refrigerant.

[Claim 2]

The evaporator according to Claim 1, wherein the first flow path or the second flow path connected to an upstream side of the connecting flow path is smaller in flow path area than the first flow path or the second flow path connected to a downstream side of the connecting flow path.

[Claim 3]

The evaporator according to Claim 1 or 2, wherein the flow path has a housing flow path partially defined by an inner peripheral surface of the housing, and

in the housing flow path, the inner peripheral surface of the housing is disposed at a position where a refrigerant flowing in collides.

[Claim 4]

The evaporator according to Claim 3, wherein the housing flow path is provided upstream of the connecting flow path.

[Claim 5]

The evaporator according to any one of Claims 1 to 4, wherein the flow path is provided with a first drain portion guiding a liquid-phase refrigerant to the storage portion.

[Claim 6]

The evaporator according to any one of Claims 1 to 5, wherein the connecting flow path is provided with a collecting portion collecting a separated liquid-phase refrigerant on a connected downstream-side flow path side.

[Claim 7]

The evaporator according to Claim 6, wherein the collecting portion is provided with a second drain portion guiding the collected liquid-phase refrigerant to the storage portion.

[Claim 8]

The evaporator according to Claim 7, wherein the collecting portion is inclined such that a position where the second drain portion is provided becomes low.

[Claim 9]

The evaporator according to any one of Claims 1 to 8,
wherein the flow path has a curved portion where a surface
defining the flow path is curved.