

DESCRIPTION

TITLE OF THE INVENTION

VENTILATION APPARATUS AND VENTILATION METHOD

5 TECHNICAL FIELD

[0001]

The present disclosure relates to a ventilation apparatus and a ventilation method.

10 BACKGROUND ART

[0002]

Patent Document 1 discloses an air conditioning facility that adjusts air guided from the outside to perform air conditioning of an indoor space. Patent Document 1
15 discloses a refrigeration circuit provided in the air conditioning facility, in which a compression unit, a first heat exchanger, a liquid receiver, an expansion valve, and a second heat exchanger are connected by pipes, and a refrigerant circulates inside the refrigeration circuit to
20 perform a refrigeration cycle. In the disclosed Patent Document 1, the air conditioning facility includes a spray unit configured to spray condensed water (drain water), which is generated on the outer surface of the second heat exchanger, onto the outer surface of the first heat exchanger
25 during the dehumidification operation.

RELATED ART DOCUMENT

PATENT DOCUMENT

[0003]

30 Patent Document 1: Japanese Unexamined Patent Application Publication No. 2009-168434

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0004]

For example, in a ventilation apparatus using a vapor compression type refrigerant circuit, the amount of
5 air to be discharged is equal to the amount of air to be supplied, and thus it is necessary to adjust the temperature by the refrigerant circuit.

[0005]

The present disclosure provides a ventilation
10 apparatus and a ventilation method that efficiently perform heat discharge in a heat exchanger.

MEANS FOR SOLVING THE PROBLEMS

[0006]

15 According to the present disclosure, a ventilation apparatus includes:

a compressor;

a first heat exchanger provided in a first path and through which first air passes, the first path being a
20 path through which outdoor air is supplied indoors;

a second heat exchanger provided in a second path and through which second air passes, the second path being a path through which indoor air is discharged outdoors;

a refrigerant circuit through which a refrigerant
25 flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by refrigerant pipes; and

a spray unit to which a liquid is supplied from outside and configured to spray a cooling liquid onto the
30 second heat exchanger.

[0007]

In the ventilation apparatus according to the present disclosure, the exhaust heat in the exhaust heat

exchanger can be efficiently discharged.

[0008]

The ventilation apparatus according to the present disclosure may further include a control unit configured to
5 control the spray unit to spray the cooling liquid onto the second heat exchanger, based on a physical quantity correlated with a condensation temperature in the second heat exchanger.

[0009]

10 In the ventilation apparatus according to the present disclosure, the physical quantity may be at least one of

a first temperature of the refrigerant flowing into the second heat exchanger,

15 a second temperature of the refrigerant flowing out of the second heat exchanger,

a first pressure of the refrigerant flowing into the second heat exchanger,

20 a second pressure of the refrigerant flowing out of the second heat exchanger,

a third temperature of the second air flowing into the second heat exchanger,

a fourth temperature of the second air flowing out of the second heat exchanger,

25 an air volume passing through the second heat exchanger,

a first rotational speed of a blower that causes air passing through the second heat exchanger to flow,

a second rotational speed of the compressor,

30 a fifth temperature of the refrigerant discharged from the compressor, or

a third pressure of the refrigerant discharged from the compressor.

[0010]

In the ventilation apparatus according to the present disclosure, the control unit may calculate the condensation temperature in the second heat exchanger from
5 the physical quantity, and control the spray unit to spray the cooling liquid onto the second heat exchanger when the condensation temperature is equal to or higher than a target temperature set in advance.

[0011]

10 In the ventilation apparatus according to the present disclosure, the control unit may control an amount of the cooling liquid sprayed from the spray unit, based on a difference between the condensation temperature and the target temperature.

15 [0012]

According to the present disclosure, a ventilation apparatus includes:

a compressor;

20 a first heat exchanger provided in a first path and through which first air passes, the first path being a path through which outdoor air is supplied indoors;

a second heat exchanger provided in a second path and through which second air passes, the second path being a path through which indoor air is discharged outdoors;

25 a refrigerant circuit through which a refrigerant flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by refrigerant pipes;

30 a cooling unit provided on an upstream side of the second heat exchanger in the second path and through which the second air passes, the cooling unit being made of an absorbing material capable of absorbing and internally holding a liquid, and capable of externally discharging the

internally held liquid, and the cooling unit being configured to cool the second air by heat of evaporation when the liquid is discharged to outside; and

5 a spray unit configured to spray a cooling liquid onto the cooling unit.

[0013]

In the ventilation apparatus according to the present disclosure, the exhaust heat in the exhaust heat exchanger can be efficiently discharged.

10 [0014]

The ventilation apparatus according to the present disclosure may further include a control unit configured to control the spray unit to spray the cooling liquid onto the second heat exchanger, based on a physical quantity correlated with a condensation temperature in the second heat exchanger.

[0015]

In the ventilation apparatus according to the present disclosure, the physical quantity may be at least one of

a first temperature of the refrigerant flowing into the second heat exchanger,

a second temperature of the refrigerant flowing out of the second heat exchanger,

25 a first pressure of the refrigerant flowing into the second heat exchanger,

a second pressure of the refrigerant flowing out of the second heat exchanger,

30 a third temperature of the second air flowing into the second heat exchanger,

a fourth temperature of the second air flowing out of the second heat exchanger,

an air volume passing through the second heat

exchanger,

a first rotational speed of a blower that causes air passing through the second heat exchanger to flow,

a second rotational speed of the compressor,

5 a fifth temperature of the refrigerant discharged from the compressor, or

a third pressure of the refrigerant discharged from the compressor.

[0016]

10 In the ventilation apparatus according to the present disclosure, the control unit may calculate a condensation temperature in the second heat exchanger from the physical quantity, and control the spray unit to spray the cooling liquid onto the cooling unit when the
15 condensation temperature is equal to or higher than a target temperature set in advance.

[0017]

In the ventilation apparatus according to the present disclosure, the control unit may control an amount
20 of the cooling liquid sprayed from the spray unit, based on a difference between the condensation temperature and the target temperature.

[0018]

The ventilation apparatus according to the present
25 disclosure may further include a first temperature detector configured to measure any one of a sixth temperature of the refrigerant supplied to the second heat exchanger or a seventh temperature of the refrigerant discharged from the second heat exchanger, wherein the control unit may calculate
30 the condensation temperature, based on a measurement result of the first temperature detector.

[0019]

The ventilation apparatus according to the present

disclosure may further include a second temperature detector configured to measure an eighth temperature of the refrigerant discharged from the compressor to the second heat exchanger, wherein the control unit may calculate the
5 condensation temperature, based on a measurement result of the second temperature detector.

[0020]

In the ventilation apparatus according to the present disclosure, the control unit may
10 acquire first learned data on any one of a sixth temperature of the refrigerant supplied to the second heat exchanger, a seventh temperature of the refrigerant discharged from the second heat exchanger, or an eighth temperature of the refrigerant discharged from the
15 compressor to the second heat exchanger;

acquire second learned data on a flow rate of the cooling liquid sprayed by the spray unit;

learn a first prediction model that predicts a decrease in an amount of the condensation temperature from
20 a corresponding one of the sixth temperature, the seventh temperature or the eighth temperature, and the flow rate, based on the first learned data and the second learned data; and

calculate the flow rate of the cooling liquid
25 sprayed from the spray unit from the condensation temperature and the corresponding one of the sixth temperature, the seventh temperature or the eighth temperature used for learning, based on the first prediction model.

[0021]

30 In the ventilation apparatus according to the present disclosure, the second heat exchanger may include
internal pipes through which the refrigerant flows;

fins connected to the internal pipes; and

a liquid holding portion formed on surfaces of the fins, the liquid holding portion being made of a water absorbing material capable of absorbing and internally holding the cooling liquid sprayed from the spray unit, and capable of externally discharging the internally held cooling liquid, and the second heat exchanger may cool the refrigerant by the cooling liquid evaporating from the water absorbing material.

10 [0022]

The ventilation apparatus according to the present disclosure may further include a third heat exchanger provided on an upstream side of the second heat exchanger in the second path and connected to the refrigerant circuit.

15 [0023]

The ventilation apparatus according to the present disclosure may further include

a fourth heat exchanger provided on a downstream side of the second heat exchanger in the second path and connected to the refrigerant circuit; and

a second spray unit provided between the second heat exchanger and the fourth heat exchanger, the second spray unit being configured to spray a second cooling liquid onto the fourth heat exchanger.

25 [0024]

The ventilation apparatus according to the present disclosure may further include:

a fourth heat exchanger provided on a downstream side of the second heat exchanger in the second path and connected to the refrigerant circuit;

a second cooling unit provided between the second heat exchanger and the fourth heat exchanger and through which second air passes, the second cooling unit being made

of a water absorbing material capable of absorbing and internally holding water, and capable of externally discharging the internally held water, and the cooling unit being configured to cool the second air by heat of
5 evaporation when the water is discharged to outside; and

a second spray unit configured to spray the second cooling liquid onto the second cooling unit.

[0025]

According to the present disclosure, in a
10 ventilation method using a ventilation apparatus, the ventilation apparatus including a compressor; a first heat exchanger provided in a first path and through which first air passes, the first path being a path through which outdoor air is supplied indoors; a second heat exchanger provided in
15 a second path and through which second air passes, the second path being a path through which indoor air is discharged outdoors; and a refrigerant circuit through which a refrigerant flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by
20 refrigerant pipes, the ventilation method includes

spraying a cooling liquid onto the second heat exchanger, the cooling liquid containing water supplied from outside.

[0026]

25 In the ventilation apparatus according to the present disclosure, the exhaust heat in the exhaust heat exchanger can be efficiently discharged.

[0027]

According to the present disclosure, in a
30 ventilation method using a ventilation apparatus, the ventilation apparatus including a compressor; a first heat exchanger provided in a first path and through which first air passes, the first path being a path through which outdoor

air is supplied indoors; a second heat exchanger provided in a second path and through which second air passes, the second path being a path through which indoor air is discharged outdoors; a refrigerant circuit through which a refrigerant
5 flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by refrigerant pipes; and a cooling unit provided on an upstream side of the second heat exchanger in the second path and through which the second air passes, the cooling unit being made of
10 a water absorbing material capable of absorbing and internally holding water, and capable of externally discharging the internally held water, and the cooling unit being configured to cool the second air by heat of evaporation when the water is discharged to outside, the
15 ventilation method includes

spraying a cooling liquid onto the cooling unit.

[0028]

In the ventilation apparatus according to the present disclosure, the exhaust heat in the exhaust heat
20 exchanger can be efficiently discharged.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

[FIG. 1] FIG. 1 is a plan view illustrating a usage state of a ventilation apparatus according to a first embodiment.
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[FIG. 2] FIG. 2 is a side view illustrating the usage state of the ventilation apparatus according to the first embodiment.

[FIG. 3] FIG. 3 is a view illustrating a schematic configuration of the ventilation apparatus according to the first embodiment.
30

[FIG. 4] FIG. 4 is a functional block diagram of the ventilation apparatus according to the first embodiment.

[FIG. 5] FIG. 5 is a flowchart illustrating a process of the ventilation apparatus according to the first embodiment.

[FIG. 6] FIG. 6 is a flowchart illustrating a process of the ventilation apparatus according to the first embodiment.

5 [FIG. 7] FIG. 7 is a view illustrating a schematic configuration of a ventilation apparatus according to a second embodiment.

[FIG. 8] FIG. 8 is a flowchart illustrating a process of the ventilation apparatus according to the second embodiment.

10 [FIG. 9] FIG. 9 is a flowchart illustrating a process of the ventilation apparatus according to the second embodiment.

[FIG. 10] FIG. 10 is a view illustrating an outline of a heat exchanger of a ventilation apparatus according to a present embodiment.

15 [FIG. 11] FIG. 11 is a view illustrating a schematic configuration of a ventilation apparatus according to a third embodiment.

[FIG. 12] FIG. 12 is a view illustrating a schematic configuration of a ventilation apparatus according to a
20 fourth embodiment.

[FIG. 13] FIG. 13 is a view illustrating a schematic configuration of a ventilation apparatus according to a fifth embodiment.

[FIG. 14] FIG. 14 is a view illustrating a schematic
25 configuration of a ventilation apparatus according to a sixth embodiment.

[FIG. 15] FIG. 15 is a flowchart illustrating a process of the ventilation apparatus according to a seventh embodiment.

[FIG. 16] FIG. 16 is a flowchart illustrating a process of
30 the ventilation apparatus according to the seventh embodiment.

[FIG. 17] FIG. 17 is a view illustrating a schematic configuration of a ventilation apparatus according to an

eighth embodiment.

[FIG. 18] FIG. 18 is a view illustrating an outline of an exhaust unit of the ventilation apparatus according to the eighth embodiment.

5 [FIG. 19] FIG. 19 is a diagram illustrating an operation of the ventilation apparatus according to the eighth embodiment.

[FIG. 20] FIG. 20 is a view illustrating an outline of a modification of the exhaust unit of the ventilation apparatus according to the eighth embodiment.

10 [FIG. 21] FIG. 21 is a view illustrating an outline of a water spray unit provided in the ventilation apparatus according to the present embodiment.

[FIG. 22] FIG. 22 is a view illustrating an outline of a modification of the water spray unit provided in the
15 ventilation apparatus according to the present embodiment.

[FIG. 23] FIG. 23 is a view illustrating an outline of a modification of the exhaust unit provided in the ventilation apparatus according to the present embodiment.

[FIG. 24] FIG. 24 is a diagram illustrating a functional
20 configuration of the ventilation apparatus according to the present embodiment.

EMBODIMENT OF THE INVENTION

[0030]

25 Hereinafter, embodiments will be described with reference to the accompanying drawings. In the description of the specification and the drawings according to each embodiment, components having substantially the same or corresponding functional configurations are denoted by the
30 same reference numerals, and redundant descriptions thereof may be omitted. In addition, for facilitating understanding of the description, the scale of each part in the drawings may be different from the actual scale.

[0031]

<<First Embodiment>>

A ventilation apparatus 1 supplies outdoor air of a building BLD to the inside of the building BLD, for example, a room RM. The ventilation apparatus 1 discharges indoor air of the building BLD to the outside of the building BLD. FIG. 1 is a plan view illustrating a usage state of a ventilation apparatus 1 according to the present embodiment. FIG. 2 is a side view illustrating a usage state of the ventilation apparatus 1 according to the present embodiment. FIG. 3 is a diagram illustrating a schematic configuration of the ventilation apparatus 1 according to the present embodiment.

[0032]

The ventilation apparatus 1 according to the present embodiment includes a compressor 10, a supply air unit 20, and an exhaust unit 30. The ventilation apparatus 1 also includes a refrigerant pipe 41, a refrigerant pipe 42, a refrigerant pipe 43, a refrigerant pipe 44, and an expansion valve 51. The ventilation apparatus 1 further includes a control unit 60 that controls the entire ventilation apparatus 1. The compressor 10, a supply air heat exchanger 21 of the supply air unit 20 described later, an exhaust heat exchanger 31 of the exhaust unit 30 described later, the refrigerant pipe 41, the refrigerant pipe 42, the refrigerant pipe 43, the refrigerant pipe 44, and the expansion valve 51 may be collectively referred to as a refrigerant circuit 50.

[0033]

The air taken in by the supply air unit 20 from the outside of the building BLD is referred to as outdoor air OA. The air sent into the inside of the building BLD by the supply air unit 20 is referred to as supply air SA. The air taken in from the inside of the building BLD by the

exhaust unit 30 is referred to as return air RA. The air exhausted to the outside of the building BLD by the exhaust unit 30 is referred to as exhaust air (EA).

[0034]

5 In FIG. 3, the refrigerant flowing through the refrigerant circuit 50 is indicated as refrigerant R1 and refrigerant R2. The refrigerant R1 and the refrigerant R2 are the same refrigerant. In FIG. 3, the same refrigerant is illustrated as the refrigerant R1 and the refrigerant R2 by
10 being distinguished from each other by the difference in pressures before and after the expansion valve 51.

[0035]

FIG. 3 illustrates a usage state of the ventilation apparatus 1 in summer. That is, the exhaust heat exchanger
15 31 is operated as a condenser to cool the refrigerant R1 by the return air RA. The refrigerant R1 obtained by reducing the pressure of the cooled refrigerant R2 is used to operate the supply air heat exchanger 21 as an evaporator to cool the outdoor air OA. The directions of the arrow-lines of the
20 refrigerant R1 and the refrigerant R2 in FIG. 3 indicate the directions of the flows of the refrigerant R1 and the refrigerant R2 when the compressor 10 supplies the compressed refrigerants to the exhaust unit 30.

[0036]

25 The supply air unit 20 of the ventilation apparatus 1 is provided on the ceiling of the room RM. The supply air unit 20 takes in outdoor air OA from the outside of the building BLD and supplies supply air SA to the room RM.

[0037]

30 The exhaust unit 30 of the ventilation apparatus 1 is provided on the ceiling of the room RM. The exhaust unit 30 takes in return air RA from the inside of the building BLD, specifically, from the room RM, and discharges exhaust

air EA to the outside of the building BLD. The exhaust unit 30 exhausts the indoor air of the building BLD to the outside of the building BLD, and therefore, it is desirable that the exhaust unit 30 is provided in a place where the indoor air is easily contaminated, for example, a toilet room, a kitchen, or the like. For example, in a place where odor is likely to be generated, such as a toilet room, the odor may be prevented from leaking by setting the pressure to be negative pressure with respect to the surrounding rooms.

10 [0038]

In the ventilation apparatus 1 illustrated in FIGS. 1 and 2, the supply air unit 20 and the exhaust unit 30 are provided in the room RM partitioned by the wall WL through which air can flow, but the supply air unit 20 and the exhaust unit 30 may be provided in the same room RM.

[0039]

The compressor 10, the refrigerant pipe 41, the refrigerant pipe 42, the refrigerant pipe 43, the refrigerant pipe 44, and the expansion valve 51 are provided in the attic AT of the building BLD.

[0040]

In the above description, the installation locations of the supply air unit 20 and the exhaust unit 30 are merely examples, and the supply air unit 20 and the exhaust unit 30 may be installed in a kitchen, a bedroom, a closet, a dressing room, a locker room, or the like, for example. Further, for example, each of the supply air unit 20 and the exhaust unit 30 may be installed not only in a residential building but also in a business building, a warehouse, or the like.

[0041]

Each component constituting the ventilation apparatus 1 will be described.

[0042]

[Compressor 10]

The compressor 10 compresses the refrigerant flowing through the refrigerant circuit 50. For example, in
5 summer, when the indoor temperature of the building BLD is lower than the outdoor temperature due to a cooling device or the like, the compressor 10 supplies the compressed refrigerant to the exhaust unit 30. For example, in winter,
10 when the indoor temperature of the building BLD is higher than the outdoor temperature due to a heating device or the like, the compressor 10 supplies the compressed refrigerant to the supply air unit 20.

[0043]

The compressor 10 is connected to the control unit
15 60. The control unit 60 controls the compressor 10.

[0044]

The ventilation apparatus 1 includes a manometer 10p1 and a manometer 10p2 configured to measure pressure of the refrigerant in the vicinity of the compressor 10. The
20 manometer 10p1 measures the pressure of the refrigerant flowing through the refrigerant pipe 41 connecting the compressor 10 and the supply air unit 20. The manometer 10p2 measures the pressure of the refrigerant flowing through the refrigerant pipe 42 connecting the compressor 10 and the
25 exhaust unit 30.

[0045]

Each of the manometer 10p1 and the manometer 10p2 is connected to the control unit 60. The control unit 60 acquires the results of measuring the pressure of the
30 refrigerant from the manometer 10p1 and the manometer 10p2.

[0046]

The ventilation apparatus 1 includes a thermometer 10r1 and a thermometer 10r2 that measure the temperature of

the refrigerant. The thermometer 10r1 measures the temperature of the refrigerant flowing through the refrigerant pipe 41 connecting the compressor 10 and the supply air unit 20. The thermometer 10r2 measures the
5 temperature of the refrigerant flowing through the refrigerant pipe 42 connecting the compressor 10 and the exhaust unit 30.

[0047]

Each of the thermometer 10r1 and the thermometer
10 10r2 is connected to the control unit 60. The control unit 60 acquires the result of measuring the temperature of the refrigerant from each of the thermometer 10r1 and the thermometer 10r2.

[0048]

15 [Supply air unit 20]

The supply air unit 20 takes in outdoor air OA from the outside of the building BLD, exchanges heat between the taken-in outdoor air OA and the refrigerant, and supplies the heat-exchanged outdoor air OA to the inside of the
20 building BLD as supply air SA. The supply air unit 20 includes the supply air heat exchanger 21 and a blower 22. A path through which the outdoor air OA acting as the air outside the building BLD is supplied as the supply air SA to the inside of the building BLD via the supply air unit 20 is
25 referred to as an air supply path P1. In FIG. 3, the outside of the building BLD is illustrated as an area Rout, and the inside of the building BLD is illustrated as an area Rin.

[0049]

The supply air heat exchanger 21 exchanges heat
30 between the outdoor air OA and the refrigerant R2. The supply air heat exchanger 21 includes a plurality of plate-type fins, and pipes which penetrate the fins and through which the refrigerant R2 flows.

[0050]

The supply air heat exchanger 21 is connected to the compressor 10 via the refrigerant pipe 41, and is connected to the exhaust heat exchanger 31 provided in the exhaust unit 30 via the refrigerant pipe 43, the expansion valve 51, and the refrigerant pipe 44, whereby the refrigerant R2 flows through the pipes of the supply air heat exchanger 21. The outdoor air OA flows between the fins of the supply air heat exchanger 21, whereby heat exchange is performed between the outdoor air OA and the refrigerant R2 flowing through the pipe of the supply air heat exchanger 21.

[0051]

The blower 22 blows the outdoor air OA to the supply air heat exchanger 21. The outdoor air OA blown by the blower 22 to the supply air heat exchanger 21 is subjected to heat exchange with the refrigerant R2 flowing through the supply air heat exchanger 21. The heat-exchanged outdoor air OA is blown into the building BLD as supply air SA. The blower 22 is, for example, a centrifugal blower or an axial blower. The blower 22 is connected to the control unit 60. The control unit 60 controls the blower 22.

[0052]

The outdoor air OA heat exchanged with the refrigerant R2 by the supply air heat exchanger 21 is blown into the building BLD as the supply air SA by the blower 22. The air passing through the supply air heat exchanger 21 in the supply air unit 20 is referred to as air A1 (first air).

[0053]

The arrangement of the supply air heat exchanger 21 and the blower 22 may be reversed such that the outdoor air OA subjected to heat exchange by the supply air heat exchanger 21 may be blown indoors by the blower 22.

[0054]

The ventilation apparatus 1 includes a thermometer 21r1 and a thermometer 21r2 configured to measure the temperature of the refrigerant R2 in the vicinity of the supply air unit 20. The thermometer 21r1 measures the temperature of the refrigerant R2 flowing through the refrigerant pipe 43 connecting the supply air unit 20 and the exhaust unit 30. That is, the thermometer 21r1 measures the temperature of the refrigerant R2 at one refrigerant port of the supply air heat exchanger 21. The thermometer 21r2 measures the temperature of the refrigerant R2 flowing through the refrigerant pipe 41 connecting the compressor 10 and the supply air unit 20. The thermometer 21r2 measures the temperature of the refrigerant R2 at the other refrigerant port of the supply air heat exchanger 21.

[0055]

Each of the thermometer 21r1 and the thermometer 21r2 is connected to the control unit 60. The control unit 60 acquires the measurement results of the temperature of the refrigerant R2 from the thermometer 21r1 and the thermometer 21r2.

[0056]

The ventilation apparatus 1 includes a thermometer 21a1 configured to measure the temperature of the air A1 flowing into the supply air heat exchanger 21 and a thermometer 21a2 configured to measure the temperature of the air A1 flowing out of the supply air heat exchanger 21, in the vicinity of the supply air unit 20. The thermometer 21a1 is provided in the vicinity of the inflow side of the supply air heat exchanger 21. The thermometer 21a2 is provided in the vicinity of the outflow side of the supply air heat exchanger 21.

[0057]

Each of the thermometer 21a1 and the thermometer 21a2 is connected to the control unit 60. The control unit 60 acquires the measurement results of the temperature of the air A1 from the thermometer 21a1 and the thermometer 21a2.

5 [0058]

The ventilation apparatus 1 further includes a hygrometer 21h that measures the humidity of the air A1 flowing into the supply air heat exchanger 21, in the vicinity of the supply air unit 20. The hygrometer 21h is provided in the vicinity of the inflow side of the supply air heat exchanger 21. The hygrometer 21h may measure the humidity of the air A1 flowing out from the supply air heat exchanger 21.

10 [0059]

The hygrometer 21h is connected to the control unit 60. The control unit 60 acquires the measurement result of the humidity of the air A1 from the hygrometer 21h.

[0060]

20 [Exhaust unit 30]

The exhaust unit 30 takes in return air RA from the inside of the building BLD, exchanges heat between the taken-in return air RA and the refrigerant R1, and exhausts the heat-exchanged return air RA to the outside of the building BLD as exhaust air EA. The exhaust unit 30 includes the exhaust heat exchanger 31, a blower 32, and a nozzle 33. A path through which the return air RA, which is the indoor air of the building BLD, is discharged as the exhaust air EA to the outside of the building BLD via the exhaust unit 30 is referred to as an exhaust path P2.

25 [0061]

30

The exhaust heat exchanger 31 exchanges heat between the return air RA and the refrigerant R1. The exhaust

heat exchanger 31 includes a plurality of plate-type fins and pipes that penetrate the fins and through which the refrigerant flows.

[0062]

5 The exhaust heat exchanger 31 is connected to the compressor 10 via the refrigerant pipe 42 and is connected to the supply air heat exchanger 21 of the supply air unit 20 via the refrigerant pipe 44, the expansion valve 51, and the refrigerant pipe 43, so that the refrigerant R1 flows
10 through the pipe of the exhaust heat exchanger 31. The return air RA flows between the fins of the exhaust heat exchanger 31, whereby heat exchange is performed between the return air RA and the refrigerant R1 flowing through the pipes of the exhaust heat exchanger 31.

15 [0063]

 The blower 32 blows the return air RA to the exhaust heat exchanger 31. The blower 32 is, for example, a centrifugal blower or an axial blower. The return air RA heat-exchanged by the exhaust heat exchanger 31 is discharged
20 outdoors as exhaust air EA. The blower 32 is connected to the control unit 60. The control unit 60 controls the blower 32.

[0064]

 The nozzle 33 sprays cooling water supplied from
25 a water supply unit 34 toward the exhaust heat exchanger 31. The cooling water sprayed from the nozzle 33 is applied to the exhaust heat exchanger 31 to cool the exhaust heat exchanger 31.

[0065]

30 The water supply unit 34 supplies cooling water to the nozzle 33. The cooling water is, for example, tap water. For example, the condensed water condensed in the supply air heat exchanger 21 may be used as the cooling water. The

cooling water may contain, for example, a rust inhibitor, a fungicide, a cleaning agent, and the like. Further, an antifreeze solution may be used as the cooling water. The direction of spraying the cooling water from the nozzle may
5 be a direction of a counter flow to the flow of the air.
[0066]

The water supply unit 34 includes, for example, a tank that stores cooling water and a pump that sends the cooling water from the tank to the nozzle 33 while
10 pressurizing the cooling water. The water supply unit 34 is connected to the control unit 60. The control unit 60 controls the water supply unit 34. Water is supplied to the tank for storing the cooling water from the outside of the ventilation apparatus 1, for example, from a water supply.
15 [0067]

The nozzles 33 and the water supply unit 34 are collectively referred to as a water spray unit 39.
[0068]

In the above example, the cooling water is sprayed
20 from the water spray unit 39, but the liquid to be sprayed is not limited to water. A liquid other than water may be sprayed from the water spray unit 39. That is, the ventilation apparatus 1 may include, instead of the water spray unit 39, a spray unit that sprays a cooling liquid,
25 which is a liquid for cooling the exhaust heat exchanger 31.
[0069]

The return air RA heat exchanged with the refrigerant R2 by the exhaust heat exchanger 31 is blown to the outside of the building BLD as exhaust air EA by the
30 blower 32. The air passing through the exhaust heat exchanger 31 in the exhaust unit 30 is referred to as air A2 (second air).
[0070]

The arrangement of the exhaust heat exchanger 31 and the blower 32 may be reversed, and the return air RA that has been heat-exchanged in the exhaust heat exchanger 31 may be blown as the exhaust air EA to the outside of the building BLD by the blower 32.

[0071]

The ventilation apparatus 1 includes a thermometer 31r1 and a thermometer 31r2 configured to measure the temperature of the refrigerant R1 in the vicinity of the exhaust unit 30. The thermometer 31r1 measures the temperature of the refrigerant R1 flowing through the refrigerant pipe 42 connecting the exhaust unit 30 and the compressor 10. The thermometer 31r2 measures the temperature of the refrigerant R1 flowing through the refrigerant pipe 44 connecting the supply air unit 20 and the exhaust unit 30. That is, the thermometer 31r1 measures the temperature of the refrigerant R1 at one refrigerant port of the exhaust heat exchanger 31. The thermometer 31r2 measures the temperature of the refrigerant R1 at the other refrigerant port of the exhaust heat exchanger 31.

[0072]

Each of the thermometer 31r1 and the thermometer 31r2 is connected to the control unit 60. The control unit 60 acquires the result of measuring the temperature of the refrigerant from each of the thermometer 31r1 and the thermometer 31r2.

[0073]

The ventilation apparatus 1 includes a manometer 31p1 and a manometer 31p2 that measure pressures of the refrigerants R1 in the vicinity of the exhaust unit 30. The manometer 31p1 measures the pressure of the refrigerant R1 flowing through the refrigerant pipe 42 connecting the exhaust unit 30 and the compressor 10. The manometer 31p2

measures the pressure of the refrigerant R1 flowing through the refrigerant pipe 44 connecting the supply air unit 20 and the exhaust unit 30. That is, the manometer 31p1 measures the pressure of the refrigerant R1 at the one refrigerant
5 port of the exhaust heat exchanger 31. The manometer 31p2 measures the pressure of the refrigerant R1 at the other refrigerant port of the exhaust heat exchanger 31.

[0074]

Each of the manometers 31p1 and 31p2 is connected
10 to the control unit 60. The control unit 60 acquires the results of measuring the pressures of the refrigerant from the manometer 31p1 and the manometer 31p2.

[0075]

The ventilation apparatus 1 includes a thermometer
15 31a1 that measures the temperature of the air A2 flowing into the exhaust heat exchanger 31 and a thermometer 31a2 that measures the temperature of the air A2 flowing out of the exhaust heat exchanger 31, in the vicinity of the exhaust unit 30. The thermometer 31a1 is provided in the vicinity of
20 the inflow side of the exhaust heat exchanger 31. The thermometer 31a2 is provided in the vicinity of the outflow side of the exhaust heat exchanger 31.

[0076]

Each of the thermometer 31a1 and the thermometer
25 31a2 is connected to the control unit 60. The control unit 60 acquires the measurement results of the temperature of the air A2 from the thermometer 31a1 and the thermometer 31a2.

[0077]

30 The ventilation apparatus 1 further includes a hygrometer 31h that measures the humidity of the air A2 flowing into the exhaust heat exchanger 31, in the vicinity of the exhaust unit 30. The hygrometer 31h is provided in

the vicinity of the inflow side of the exhaust heat exchanger 31. The hygrometer 31h may measure the humidity of the air A2 flowing out from the exhaust heat exchanger 31.

[0078]

5 The hygrometer 31h is connected to the control unit 60. The control unit 60 acquires the measurement result of the humidity of the air A1 from the hygrometer 31h.

[0079]

 Furthermore, the ventilation apparatus 1 includes
10 a flow meter 33f between the water supply unit 34 and the nozzle 33. The flow meter 33f measures the flow rate of the cooling water supplied from the water supply unit 34 to the nozzle 33. The flow meter 33f is, for example, an electromagnetic flow meter, a vortex flow meter, an
15 ultrasonic flow meter, a Coriolis flow meter, a differential pressure flow meter, or the like. The flow meter 33f is connected to the control unit 60. The control unit 60 acquires, from the flow meter 33f, a result of measurement of the amount of the cooling water sprayed from the nozzle
20 33 to the exhaust heat exchanger 31.

[0080]

[Refrigerant pipe 41, refrigerant pipe 42, refrigerant pipe 43, and refrigerant pipe 44]

 The refrigerant pipe 41 connects between the
25 compressor 10 and the supply air unit 20, more specifically, connects between the compressor 10 and the supply air heat exchanger 21 provided in the supply air unit 20. The refrigerant pipe 42 connects between the compressor 10 and the exhaust unit 30, more specifically, connects between the
30 compressor 10 and the exhaust heat exchanger 31 provided in the exhaust unit 30. The refrigerant pipe 43 connects between the supply air unit 20 and the expansion valve 51, more specifically, connects between the supply air heat exchanger

21 provided in the supply air unit 20 and the expansion valve 51. The refrigerant pipe 44 connects between the exhaust unit 30 and the expansion valve 51, more specifically, connects between the exhaust heat exchanger 31 provided in the exhaust unit 30 and the expansion valve 51.

[0081]

[Expansion valve 51]

The expansion valve 51 decompresses and discharges the refrigerant flowing from the high-pressure side. In FIG. 3, the expansion valve 51 decompresses the flowed in refrigerant R1 on the high-pressure side, and discharges the refrigerant R2. Instead of the expansion valve 51, for example, a capillary tube may be used.

[0082]

[Refrigerant circuit 50]

The refrigerant circuit 50 is a so-called vapor compression type refrigerant circuit. The refrigerant circuit 50 includes the compressor 10, the supply air heat exchanger 21, the exhaust heat exchanger 31, the refrigerant pipe 41, the refrigerant pipe 42, the refrigerant pipe 43, the refrigerant pipe 44, and an expansion valve 51. In the refrigerant circuit 50, the compressor 10, the supply air heat exchanger 21, the exhaust heat exchanger 31, and the expansion valve 51 are connected by the refrigerant pipe 41, the refrigerant pipe 42, the refrigerant pipe 43, and the refrigerant pipe 44, and the refrigerant flows inside.

[0083]

The operation of the refrigerant circuit 50 will be described. For example, in summer, when the indoor temperature of the building BLD is lower than the outdoor temperature due to a cooling device or the like, the compressor 10 supplies the compressed refrigerant to the exhaust unit 30. The exhaust heat exchanger 31 provided in

the exhaust unit 30 functions as a condenser when compressed refrigerant is supplied thereto. On the other hand, the supply air heat exchanger 21 provided in the supply air unit 20 functions as an evaporator.

5 [0084]

By having the exhaust heat exchanger 31 function as a condenser, and the supply air heat exchanger 21 function as an evaporator, the heat of the return air RA can be collected to cool the outdoor air OA.

10 [0085]

For example, in winter, when the indoor temperature of the building BLD is higher than the outdoor temperature due to a heating device or the like, the compressor 10 supplies the compressed refrigerant to the supply air unit 20. The supply air heat exchanger 21 provided in the supply air unit 20 functions as a condenser when compressed refrigerant is supplied thereto. On the other hand, the exhaust heat exchanger 31 provided in the exhaust unit 30 functions as an evaporator.

20 [0086]

By having the supply air heat exchanger 21 function as a condenser and the exhaust heat exchanger 31 function as an evaporator, the heat of the return air RA can be collected to heat the outdoor air OA.

25 [0087]

[Control unit 60]

The control unit 60 controls the entire ventilation apparatus 1. FIG. 4 is a functional block diagram of the control unit 60 included in the ventilation apparatus 1 according to the first embodiment. Note that FIG. 4 also illustrates components related to the control unit 60.

30 [0088]

The control unit 60 is, for example, a control

circuit including a processor such as a central processing unit (CPU) and a memory. The functions of the control unit 60 are implemented by the processor operating according to a program readably stored in the memory. A specific example
5 of the control unit 60 is a microcomputer. The control unit 60 may be a field programmable gate array (FPGA) or an application specific integrated circuit (ASIC).

[0089]

The control unit 60 includes a calculation unit
10 61, a device driving unit 62, and a connection unit 63.

[0090]

The calculation unit 61 controls the entire control unit 60. The calculation unit 61 also controls the compressor 10, the blower 22, the blower 32, and the water
15 supply unit 34.

[0091]

The device driving unit 62 outputs signals for controlling the compressor 10, the blower 22, the blower 32, and the water supply unit 34.

20 [0092]

The connection unit 63 communicates with a device or the like connected to the control unit 60. The connection unit 63 is connected to the thermometers 10r1, 10r2, 21a1, 21a2, 21r1, 21r2, 31a1, 31a2, 31r1, and 31r2, the manometers
25 10p1, 10p2, 31p1, and 32p2, and the hygrometers 21h and 31h.

[0093]

The devices connected to the control unit 60 are not limited to the above-described devices. Necessary devices may be connected as appropriate in accordance with
30 a process performed by the control unit 60.

[0094]

<Process in control unit 60>

The ventilation apparatus 1 according to the first

embodiment includes a vapor compression type refrigerant circuit 50. The ventilation apparatus 1 collects heat from return air RA and adds the collected heat to outdoor air OA to obtain supply air SA. Here, a process in summer will be described.

[0095]

In summer, the temperature of the outdoor air OA is higher than the temperature of the return air RA. In summer, the ventilation apparatus 1 collects heat from the return air RA by the vapor compression type refrigerant circuit 50, cools the outdoor air OA, and supplies the air as the supply air SA. The control unit 60 provided in the ventilation apparatus 1 controls the refrigerant circuit 50 so that the temperature of the supply air SA becomes a predetermined set temperature. Specifically, the control unit 60 performs control so that the temperature of the air A1 measured by the thermometer 21a2 becomes a setting temperature.

[0096]

The ventilation apparatus 1 takes in outdoor air OA and supplies the outdoor air OA to the inside of a room as supply air SA, and discharges return air RA which is air in the room as exhaust air EA. Therefore, an air volume of the supply air SA (supply air volume) and the air volume of a return air RA (exhaust air volume) processed by the ventilation apparatus 1 are equal. The ventilation apparatus 1 needs to disposed of the heat generated by the circuit in addition to the heat applied to the supply air SA to the exhaust air EA. However, in the ventilation apparatus 1, the air supply amount and the air discharge amount are controlled to be equal to each other. Therefore, when the outdoor air OA is at a high temperature, the temperature difference between the temperature of the outdoor air OA and the room

temperature is large, and the temperature of the exhaust air EA may become too high if the amount of heat applied to the outdoor air OA is applied to the exhaust air EA.

[0097]

5 Therefore, when the temperature of the exhaust air EA is high, the ventilation apparatus 1 according to the first embodiment performs control to lower the temperature of the exhaust air EA discharged from the ventilation apparatus 1 using latent heat by spraying the cooling water
10 onto the exhaust heat exchanger 31.

[0098]

 The ventilation apparatus 1 according to the first embodiment controls the water spray unit 39 to spray the cooling water onto the exhaust heat exchanger 31, based on
15 at least one of the condensation temperature of the exhaust heat exchanger 31 or the discharge pressure of the compressor 10 discharging the cooling water toward the exhaust heat exchanger 31.

[0099]

20 Hereinafter, a ventilation method by the ventilation apparatus 1 according to the first embodiment will be described by illustrating a process in the control unit 60.

[0100]

25 [Control based on condensation temperature of exhaust heat exchanger 31]

 First, control based on the condensation temperature of the exhaust heat exchanger 31 executed by the control unit 60 included in the ventilation apparatus 1 will
30 be described. FIG. 5 is a flowchart illustrating a process based on the condensation temperature of the exhaust heat exchanger 31 in the ventilation apparatus 1 according to the first embodiment.

[0101]

(Step S10)

When the control unit 60 starts the process, the control unit 60 measures the outlet temperature of the refrigerant R1 in the compressor 10 (a step of measuring the outlet temperature of the refrigerant in the compressor 10). The control unit 60 measures the temperature of the refrigerant R1 by the thermometer 10r2. The temperature measured by the thermometer 10r2 is the outlet temperature of the refrigerant in the compressor 10.

[0102]

(Step S20)

Next, the control unit 60 measures the inlet temperature and the outlet temperature of the refrigerant R1 in the exhaust heat exchanger 31 (a step of measuring the inlet temperature and the outlet temperature of the refrigerant in the exhaust heat exchanger 31). The control unit 60 measures the temperature of the refrigerant R1 by the thermometer 31r1 and the thermometer 31r2. The temperature measured by the thermometer 31r1 is the inlet temperature of the refrigerant in the exhaust heat exchanger 31. The temperature measured by the thermometer 31r2 is the outlet temperature of the refrigerant in the exhaust heat exchanger 31.

[0103]

(Step S30)

Next, the control unit 60 calculates the condensation temperature of the refrigerant R1 in the exhaust heat exchanger 31 (a step of calculating the condensation temperature of the refrigerant in the exhaust heat exchanger 31). The control unit 60 acquires the inlet temperature (first temperature) of the refrigerant in the exhaust heat exchanger 31, the outlet temperature (second temperature) of

the refrigerant in the exhaust heat exchanger 31, and the outlet temperature (third temperature) of the refrigerant in the compressor 10 measured in step S10 and step S20. The control unit 60 calculates the condensation temperature of the refrigerant in the exhaust heat exchanger 31, based on the first temperature, the second temperature, and the third temperature. In other words, the control unit 60 calculates the condensation temperature of the refrigerant in the exhaust heat exchanger 31, based on the measurement results of the thermometer 31r1, the thermometer 31r2, and the thermometer 10r2 measured in step S10 and step S20.

[0104]

For example, the control unit 60 calculates the condensation temperature of the refrigerant in the exhaust heat exchanger 31 using the first temperature, the second temperature, and the third temperature. For example, the control unit 60 may include a table indicating a relationship between the first temperature, the second temperature, and the third temperature, and the condensation temperature, and may calculate the condensation temperature from the measured first temperature, second temperature, and third temperature using the table.

[0105]

Note that the case where the condensation temperature of the refrigerant in the exhaust heat exchanger 31 is calculated is not limited to the case where all of the first temperature, the second temperature, and the third temperature are used. For example, the control unit 60 may calculate the condensation temperature from any one of the first temperature, the second temperature, or the third temperature, or may select any two temperatures from the first temperature, the second temperature, and the third temperature and calculate the condensation temperature from

the selected temperatures. That is, the control unit 60 calculates the condensation temperature of the refrigerant in the exhaust heat exchanger 31 using at least one of the first temperature, the second temperature, or the third
5 temperature.

[0106]

Further, the control unit 60 may measure, in step S10 and step S20, only the temperature used for calculating the condensation temperature of the refrigerant in the
10 exhaust heat exchanger 31 in step S30.

[0107]

(Step S40)

Next, the control unit 60 determines whether the condensation temperature of the refrigerant in the exhaust
15 heat exchanger 31 calculated in step S30 is equal to or higher than the target temperature (a step of determining whether the condensation temperature is equal to or higher than the target temperature).

[0108]

20 The target temperature is a predetermined temperature or a preset temperature. The target temperature is determined from, for example, an allowable temperature in the refrigerant circuit 50, an allowable temperature of the exhaust air EA, and the like.

25 [0109]

When the condensation temperature calculated in step S30 is equal to or higher than the target temperature (YES in step S40), the control unit 60 advances the process to step S50. When the condensation temperature calculated in
30 step S30 is lower than the target temperature (NO in step S40), the control unit 60 advances the process to step S60.

[0110]

In the above description, when the condensation

temperature is equal to the target temperature in step S40, the control unit 60 advances the process to step S50, but the control unit 60 may advance the process to step S60. In other words, in step S40, the control unit 60 determines
5 whether the condensation temperature of the refrigerant in the exhaust heat exchanger 31 calculated in step S30 is equal to or higher than the target temperature.

[0111]

When the control unit 60 executes step S40, the
10 control unit 60 controls the water spray unit 39 to spray the cooling water onto the exhaust heat exchanger 31 based on the condensation temperature.

[0112]

(Step S50)

15 When the condensation temperature calculated in step S30 is equal to or higher than the target temperature (YES in step S40), the control unit 60 controls the water spray unit 39 to spray the cooling water from the nozzle 33 onto the exhaust heat exchanger 31 (a step of spraying the
20 cooling water from the nozzle 33 onto the exhaust heat exchanger 31).

[0113]

For example, when the difference between the condensation temperature and the target temperature
25 calculated in step S30 is large, the control unit 60 controls the water spray unit 39 to spray a large amount of cooling water from the nozzle 33.

[0114]

After the end of step S50, the control unit 60
30 advances the process to step S70.

[0115]

(Step S60)

When the condensation temperature calculated in

step S30 is lower than the target temperature (NO in step S40), the control unit 60 stops spraying of the cooling water from the nozzle 33 (a step of stopping of spraying the cooling water from the nozzle 33). Note that, when the
5 cooling water is not sprayed from the nozzle 33, the stopped state of the spraying of the cooling water is maintained.

[0116]

After the end of step S60, the control unit 60 advances the process to step S70.

10 [0117]

(Step S70)

Next, the control unit 60 determines whether to end the process (a step of determining whether to end the process).

15 [0118]

When the process is to be ended (YES in step S70), the control unit 60 advances the process to step S80. When the process is not to be ended (NO in step S70), the control unit 60 returns to step S10 to repeats the process.

20 [0119]

(Step S80)

The control unit 60 stops the process (a step of stopping the process). When the process is stopped, the control unit 60 performs a post-process such as stopping of
25 spraying water when cooling water is sprayed from the nozzle 33, for example.

[0120]

[Control based on discharge pressure at which compressor 10 discharges refrigerant toward exhaust heat exchanger 31]

30 Next, control based on the discharge pressure of the air discharged from the compressor 10 to the exhaust heat exchanger 31, which is executed by the control unit 60 included in the ventilation apparatus 1, will be described.

FIG. 6 is a flowchart illustrating a process based on the discharge pressure at which the compressor 10 discharges air toward the exhaust heat exchanger 31 in the ventilation apparatus 1 according to the first embodiment.

5 [0121]

(Step S15)

When the control unit 60 starts the process, the control unit 60 measures the outlet pressure of the refrigerant R1 in the compressor 10 (a step of measuring the
10 outlet pressure of the refrigerant in the compressor 10). The control unit 60 measures the pressure of the refrigerant R1 by the manometer 10p2. The pressure measured by the manometer 10p2 is the outlet pressure of the refrigerant in the compressor 10.

15 [0122]

(Step S25)

Next, the control unit 60 measures the inlet and outlet pressures of the refrigerant R1 in the exhaust heat exchanger 31 (a step of measuring the inlet and outlet
20 pressures of the refrigerant in the exhaust heat exchanger 31). The control unit 60 measures the pressures of the refrigerant R1 by the manometers 31p1 and 31p2. The pressure measured by the manometer 31p1 is an inlet pressure of the refrigerant in the exhaust heat exchanger 31. The pressure
25 measured by the manometer 31p2 is an outlet pressure of the refrigerant in the exhaust heat exchanger 31.

[0123]

(Step S35)

Next, the control unit 60 calculates the discharge
30 pressure of the refrigerant R1 discharged from the compressor 10 to the exhaust heat exchanger 31 (a step of calculating the discharge pressure of the refrigerant discharged from the compressor 10 to the exhaust heat exchanger 31). The

control unit 60 acquires the inlet pressure (first pressure) of the refrigerant in the exhaust heat exchanger 31, the outlet pressure (second pressure) of the refrigerant in the exhaust heat exchanger 31, and the outlet pressure (third pressure) of the refrigerant in the compressor 10, which are measured in step S15 and step S25. The control unit 60 calculates the discharge pressure of the refrigerant R1 discharged from the compressor 10 to the exhaust heat exchanger 31 based on the first, second, and third pressures. In other words, the control unit 60 calculates the discharge pressure of the refrigerant R1 discharged from the compressor 10 to the exhaust heat exchanger 31 based on the respective measurement results of the manometers 31p1, 31p2, and 10p2 measured in steps S15 and S25.

[0124]

For example, the control unit 60 calculates the discharge pressure of the refrigerant R1 discharged from the compressor 10 to the exhaust heat exchanger 31 using the first, second, and third pressures. For example, the control unit 60 may include a table indicating a relationship between the first pressure, the second pressure, and the third pressure, and the discharge pressure, and may calculate the discharge pressure from the measured first pressure, second pressure, and third pressure using the table.

[0125]

The discharge pressure of the refrigerant R1 discharged from the compressor 10 to the exhaust heat exchanger 31 may not be calculated using all of the first, second, and third pressures. For example, the control unit 60 may calculate the discharge pressure by any one of the first pressure, the second pressure, or the third pressure, or may select any two pressures from the first pressure, the second pressure, and the third pressure to calculate the

discharge pressure, based on the selected pressures. That is,
the control unit 60 calculates the discharge pressures of
the refrigerant R1 discharged from the compressor 10 to the
exhaust heat exchanger 31, using at least one of the first,
5 second, or third pressure.

[0126]

Further, the control unit 60 may measure in step
S15 and step S25 only the pressure, which is used to
calculate the discharge pressure of the refrigerant R1
10 discharged from the compressor 10 to the exhaust heat
exchanger 31 in step S35.

[0127]

(Step S45)

Next, the control unit 60 determines whether the
15 discharge pressure of the refrigerant R1 discharged from the
compressor 10 to the exhaust heat exchanger 31 calculated in
step S35 is equal to or higher than target pressure (a step
of determining whether the discharge pressure is equal to or
higher than the target pressure).

20 [0128]

The target pressure is a predetermined pressure or
a preset pressure. The target pressure is determined from,
for example, an allowable pressure in the refrigerant circuit
50, an allowable temperature of the exhaust air EA, and the
25 like.

[0129]

When the discharge pressure calculated in step S35
is equal to or higher than the target pressure (YES in step
S45), the control unit 60 advances the process to step S50.
30 When the discharge pressure calculated in step S30 is less
than the target pressure (NO in step S45), the control unit
60 advances the process to step S60.

[0130]

In the above description, when the discharge pressure is equal to the target pressure, the control unit 60 advances the process to step S50, but the control unit 60 may advance to step S60. In other words, in step S45, it is
5 determined whether the discharge pressure of the refrigerant in the exhaust heat exchanger 31 calculated in step S35 is equal to or higher than the target pressure.
[0131]

The control unit 60 executes step S45, and thereby
10 the control unit 60 controls the water spray unit 39 to spray cooling water onto the exhaust heat exchanger 31.
[0132]

The process contents of step S50, step S60, step S70, and step S80 are the same as those of the above-
15 described process, and thus the description thereof will be omitted. In step S50, the control unit 60 controls the water spray unit 39 to spray a large amount of cooling water from the nozzle 33 when the difference between the discharge and target pressures is large, for example, based on the
20 difference between the discharge and target pressures calculated in step S35.
[0133]

<Conclusion>

The ventilation apparatus 1 according to the first
25 embodiment can lower the condensation temperature by spraying water onto the exhaust heat exchanger 31 serving as a condenser and using latent heat of the cooling water, and can prevent the refrigerant from becoming high temperature or high pressure. By preventing the refrigerant from becoming
30 high temperature or high pressure, the ventilation apparatus 1 can exhibit high cooling capacity. The ventilation apparatus 1 can efficiently discharge heat in the exhaust heat exchanger 31 as the heat exchanger for exhaust air by

spraying water onto the exhaust heat exchanger 31 as the condenser.

[0134]

When the condensation temperature in the exhaust
5 heat exchanger 31 increases or the discharge pressure of the
refrigerant discharged from the compressor 10 to the exhaust
heat exchanger 31 increases, there is a possibility that a
failure of a component such as the compressor 10, for example,
a failure of the refrigeration oil or the like may occur.
10 The ventilation apparatus 1 according to the first embodiment
can be operated for a long period of time by performing
control so that the condensation temperature and the
discharge pressure do not become high.

[0135]

15 The air supply path P1 is an example of a first
path, the exhaust path P2 is an example of a second path,
the supply air heat exchanger 21 is an example of a first
heat exchanger, and the exhaust heat exchanger 31 is an
example of a second heat exchanger. One of the thermometer
20 31r1 or the thermometer 31r2 is an example of a first
temperature detector, the thermometer 10r2 is an example of
a second temperature detector, one of the manometer 31p1 or
the manometer 31p2 is an example of a first pressure detector,
and the manometer 10p2 is an example of a second pressure
25 detector.

[0136]

<<Second Embodiment>>

A ventilation apparatus 2 according to a second
embodiment will be described. The ventilation apparatus 1
30 sprays the cooling water from the nozzle 33 to the exhaust
heat exchanger 31, whereas the ventilation apparatus 2 sprays
the cooling water from the nozzle 33 to the cooling unit 35
provided on an upstream side of the exhaust heat exchanger

31 in the exhaust path P2.

[0137]

FIG. 7 is a diagram illustrating a schematic configuration of the ventilation apparatus 2 according to the second embodiment. The ventilation apparatus 2 according to the second embodiment includes an exhaust unit 130 instead of the exhaust unit 30 of the ventilation apparatus 1 according to the first embodiment.

[0138]

The configuration of the ventilation apparatus 2 common to the ventilation apparatus 1 will not be described, and the description thereof will be omitted by referring to the above description. The exhaust unit 130 included in the ventilation apparatus 2 will be described, particularly, in terms of differences from the exhaust unit 30.

[0139]

[Exhaust unit 130]

The exhaust unit 130 takes in return air RA from the inside of the building BLD, exchanges heat between the taken-in return air RA and the refrigerant R1, and exhausts the heat-exchanged return air RA to the outside of the building BLD as exhaust air EA. The exhaust unit 130 further includes a cooling unit 35 in addition to the configuration of the exhaust unit 30.

[0140]

The cooling unit 35 holds the cooling water to cool the air A2 passing through the cooling unit 35 by the heat of evaporation of the cooling water. The cooling unit 35 has a configuration in which the air A2 can pass through the inside of the cooling unit 35. The cooling unit 35 is made of a water absorbing material that absorbs and holds water inside the cooling unit 35 and discharges the held water from the inside to outside of the cooling unit 35. The

cooling unit 35 cools the passing air A2 by the heat of evaporation when water is discharged from the water absorbing material to the outside.

[0141]

5 The water absorbing material is, for example, silica, a polymer adsorbent, or the like. The water absorbing material is desirably a material which swells when absorbing water and shrinks when discharging water.

[0142]

10 In the above example, the water absorbing material that absorbs water has been described. However, the cooling unit 35 may be made of an absorbing material that absorbs and holds liquid inside the cooling unit 35 and discharges the held liquid from the inside to the outside, instead of
15 the water absorbing material.

[0143]

 The nozzle 33 sprays the cooling water supplied from the water supply unit 34 toward the cooling unit 35. The cooling water sprayed from the nozzle 33 is applied to
20 the cooling unit 35, thereby cooling the air A2 passing through the cooling unit 35.

[0144]

<Process in control unit 60>

 In the ventilation apparatus 2 according to the
25 second embodiment, the nozzle 33 sprays the cooling water, based on at least one of the condensation temperature of the exhaust heat exchanger 31 or the discharge pressure of the compressor 10 discharging the cooling water toward the exhaust heat exchanger 31, as in the ventilation apparatus
30 1 according to the first embodiment. However, the target to which the nozzle 33 sprays the cooling water is different. That is, the nozzle 33 of the ventilation apparatus 2 sprays the cooling water onto the cooling unit 35, not to the

exhaust heat exchanger 31 as in the ventilation apparatus 1.
[0145]

For a process in the control unit 60 of the
ventilation apparatus 2, the description of the process that
5 is the same as that of the ventilation apparatus 1 will be
omitted, and the different points will be described.

[0146]

[Control based on condensation temperature of exhaust heat
exchanger 31]

10 FIG. 8 is a flowchart illustrating a process based
on the condensation temperature of the exhaust heat exchanger
31 in the ventilation apparatus 2 according to the second
embodiment.

[0147]

15 The control unit 60 of the ventilation apparatus
2 according to the second embodiment executes step S50
instead of step S50 (see FIG. 5) executed by the control
unit 60 of the ventilation apparatus 1.

[0148]

20 (Step S150)

When the condensation temperature calculated in
step S30 is equal to or higher than the target temperature
(YES in step S40), the control unit 60 controls the water
spray unit 39 to spray the cooling water from the nozzle 33
25 to the cooling unit 35 (a step of spraying the cooling water
from the nozzle 33 to the cooling unit 35).

[0149]

For example, when the difference between the
condensation temperature and the target temperature
30 calculated in step S30 is large, the control unit 60 controls
the water spray unit 39 to spray a large amount of cooling
water from the nozzle 33.

[0150]

[Control based on discharge pressure at which compressor 10 discharges refrigerant toward exhaust heat exchanger 31]

FIG. 9 is a flowchart illustrating a process based on the discharge pressure at which the compressor 10 discharges air toward the exhaust heat exchanger 31 in the ventilation apparatus 2 according to the second embodiment.
[0151]

The control unit 60 of the ventilation apparatus 2 according to the second embodiment executes step S50 instead of step S50 (see FIG. 6) executed by the control unit 60 of the ventilation apparatus 1.

[0152]

(Step S150)

When the discharge pressure calculated in step S35 is equal to or higher than the target pressure (YES in step S45), the control unit 60 controls the water spray unit 39 to spray the cooling water from the nozzles 33 to the cooling unit 35 (a step of spraying the cooling water from the nozzles 33 to the cooling unit 35).

[0153]

For example, when the difference between the discharge amount and the target amount calculated in step S35 is large, the control unit 60 controls the water spray unit 39 to spray a large amount of cooling water from the nozzle 33. The ventilation apparatus 2 can efficiently discharge heat in the exhaust heat exchanger 31, which is a heat exchanger for exhaust, by spraying water onto the cooling unit 35.

[0154]

The ventilation apparatus 1 according to the first embodiment and the ventilation apparatus 2 according to the second embodiment may be combined to spray the cooling water onto both the exhaust heat exchanger 31 and the cooling unit

35. In the ventilation apparatus 2 according to the second embodiment, a part of the cooling water sprayed to the cooling unit 35 may be sprayed to the exhaust heat exchanger 31 via the cooling unit 35 by spraying a larger amount of cooling water from the nozzle 33.
[0155]

The cooling unit 35 is not limited to use in a ventilation apparatus, and may be used to cool air supplied to an outdoor heat exchanger or the like in an air conditioner, for example.
[0156]

<<Example of Exhaust Heat Exchanger>>

Here, an exhaust heat exchanger 131 will be described as an example of the exhaust heat exchanger used in the ventilation apparatus according to the present embodiment. FIG. 10 is a view illustrating an outline of the exhaust heat exchanger 131 used in the heat exchanger according to the present embodiment. FIG. 10 is a partially cutaway perspective view of the exhaust heat exchanger 131.
[0157]

The exhaust heat exchanger 131 includes a plurality of plate-type fins 131f and a plurality of pipes 131p which penetrate the fins 131f and through which the refrigerant flows. The plurality of fins 131f are provided at intervals. The plurality of fins 131f are connected to the pipe 131p. Air flows between the plurality of fins 131f. The refrigerant flows through the plurality of pipes 131p.
[0158]

A liquid holding portion 131w is made of a water absorbing material capable of absorbing and internally holding water, and capable of externally discharging the internally held water. The liquid holding portion 131w is formed on the surfaces of the fins 131f and the pipes 131p.

The water absorbing material used is made of the same material as the water absorbing material of the cooling unit 35. Similarly to the cooling unit 35, the liquid holding portion 131w may be made of an absorbing material that
5 internally holds a liquid.
[0159]

When the cooling water is sprayed from the nozzle 33, the sprayed cooling water is held by the absorbing material of the liquid holding portion 131w. When the held
10 cooling water is discharged, the fins 131f and the pipes 131p on which the liquid holding portion 131w is formed are cooled by the heat of evaporation. By cooling the fins 131f and the pipes 131p, the refrigerant flowing through the pipes 131p can be further cooled by cooling with the evaporation heat
15 (latent heat) in addition to cooling with air. In addition, since the cooling water sprayed from the nozzle 33 can be held on the fins 131f and the pipes 131p, the refrigerant can be cooled more stably.
[0160]

20 The use of the exhaust heat exchanger 131 is not limited to the exhaust heat exchanger in the ventilation apparatus, and the exhaust heat exchanger 110 may be used as, for example, a supply air heat exchanger, an outdoor heat exchanger in an air conditioner, or the like.

25 [0161]

The pipes 131p are each an example of an internal pipe. The exhaust heat exchanger 131 can be used as the exhaust heat exchanger in each of the embodiments of the present disclosure.

30 [0162]

<<Third Embodiment>>

A ventilation apparatus 3 according to a third embodiment will be described. The ventilation apparatus 3

further includes a second exhaust heat exchanger 36 on the upstream side of the exhaust heat exchanger 31 in the ventilation apparatus 1.

[0163]

5 FIG. 11 is a diagram illustrating a schematic configuration of the ventilation apparatus 3 according to the third embodiment. The ventilation apparatus 3 according to the third embodiment includes an exhaust unit 230 instead of the exhaust unit 30 of the ventilation apparatus 1
10 according to the first embodiment. The ventilation apparatus 3 according to the third embodiment includes a refrigerant circuit 55 instead of the refrigerant circuit 50 of the ventilation apparatus 1 according to the first embodiment.

[0164]

15 The configuration of the ventilation apparatus 3 common to the ventilation apparatus 1 will not be described, and the description thereof will be omitted by referring to the above description. The exhaust unit 230 and the refrigerant circuit 55 included in the ventilation apparatus
20 3 will be described, particularly, with respect to differences from the exhaust unit 30 and the refrigerant circuit 50, respectively.

[0165]

[Exhaust unit 230]

25 The exhaust unit 230 takes in return air RA from the inside of the building BLD, exchanges heat between the taken-in return air RA and the refrigerant R1, and exhausts the heat-exchanged return air RA to the outside of the building BLD as exhaust air EA. The exhaust unit 230 includes
30 the second exhaust heat exchanger 36 on the upstream side of the exhaust heat exchanger 31 in the exhaust path P2. The second exhaust heat exchanger 36 is provided on the upstream side of the nozzle 33 in the exhaust path P2.

[0166]

The second exhaust heat exchanger 36 exchanges heat between the air A2 blown from the blower 32 and the refrigerant R1. The air A2 that has passed through the second exhaust heat exchanger 36 is further heat exchanged with the refrigerant R1 in the exhaust heat exchanger 31 on the downstream side.

[0167]

The second exhaust heat exchanger 36 is connected to the expansion valve 51 via the refrigerant pipe 44. The second exhaust heat exchanger 36 is connected to the exhaust heat exchanger 31 via the refrigerant pipe 45.

[0168]

[Refrigerant circuit 55]

The refrigerant circuit 55 is a so-called vapor compression type refrigerant circuit. The refrigerant circuit 55 includes the compressor 10, the supply air heat exchanger 21, the exhaust heat exchanger 31, the second exhaust heat exchanger 36, the refrigerant pipe 41, the refrigerant pipe 42, the refrigerant pipe 43, the refrigerant pipe 44, the refrigerant pipe 45, and the expansion valve 51. In the refrigerant circuit 55, the compressor 10, the supply air heat exchanger 21, the exhaust heat exchanger 31, the second exhaust heat exchanger 36, and the expansion valve 51 are connected by the refrigerant pipe 41, the refrigerant pipe 42, the refrigerant pipe 43, the refrigerant pipe 44, and the refrigerant pipe 45, and the refrigerant flows through the inside.

[0169]

The ventilation apparatus 3 can more efficiently perform heat exchange between the air A2 and the refrigerant R1 by including the second exhaust heat exchanger 36. The ventilation apparatus 3 can efficiently discharge heat in

the exhaust heat exchanger 31 and the second exhaust heat exchanger 36 which are heat exchangers for exhaust air.

[0170]

5 The ventilation apparatus 3 includes one second exhaust heat exchanger 36, but may include two or more second exhaust heat exchangers 36.

[0171]

The second exhaust heat exchanger 36 is an example of a third heat exchanger.

10 [0172]

<<Fourth Embodiment>>

A ventilation apparatus 4 according to a fourth embodiment will be described. The ventilation apparatus 4 further includes the second exhaust heat exchanger 36 on the upstream side of the exhaust heat exchanger 31 in the ventilation apparatus 2. From another viewpoint, in the ventilation apparatus 4, the nozzle 33 sprays the cooling water onto the cooling unit 35 instead of the nozzle 33 spraying the cooling water onto the exhaust heat exchanger 31 in the ventilation apparatus 3.

20 [0173]

FIG. 12 is a diagram illustrating a schematic configuration of the ventilation apparatus 4 according to the fourth embodiment. The ventilation apparatus 4 according to the fourth embodiment includes an exhaust unit 330 instead of the exhaust unit 230 of the ventilation apparatus 3 according to the third embodiment.

[0174]

30 The configuration of the ventilation apparatus 4 common to the ventilation apparatus 3 is omitted from the description, and the description thereof is omitted by referring to the above description. The exhaust unit 330 included in the ventilation apparatus 4 will be described,

particularly, with respect to differences from the exhaust unit 230 of the ventilation apparatus 3.

[0175]

[Exhaust unit 330]

5 The exhaust unit 330 takes in return air RA from the inside of the building BLD, exchanges heat between the taken-in return air RA and the refrigerant R1, and exhausts the heat-exchanged return air RA to the outside of the building BLD as exhaust air EA. The exhaust unit 330 includes
10 the cooling unit 35 between the exhaust heat exchanger 31 and the second exhaust heat exchanger 36 in the exhaust path P2, more specifically, between the nozzle 33 and the exhaust heat exchanger 31.

[0176]

15 The nozzle 33 of the ventilation apparatus 4 sprays the cooling water not to the exhaust heat exchanger 31 but to the cooling unit 35.

[0177]

 The ventilation apparatus 4 can more efficiently
20 perform heat exchange between the air A2 and the refrigerant R1 by including the second exhaust heat exchanger 36. The ventilation apparatus 4 can efficiently discharge heat in the exhaust heat exchanger 31 and the second exhaust heat exchanger 36 which are heat exchangers for exhaust air.

25 [0178]

 The ventilation apparatus 4 includes one second exhaust heat exchanger 36, but may include two or more second exhaust heat exchangers 36.

[0179]

30 <<Fifth Embodiment>>

 A ventilation apparatus 5 according to a fifth embodiment will be described. The ventilation apparatus 5 further includes a second nozzle 33a and a third exhaust heat

exchanger 37 on the downstream side of the exhaust heat exchanger 31 in the ventilation apparatus 1.

[0180]

FIG. 13 is a diagram illustrating a schematic
5 configuration of the ventilation apparatus 5 according to the fifth embodiment. The ventilation apparatus 5 according to the fifth embodiment includes an exhaust unit 430 instead of the exhaust unit 30 of the ventilation apparatus 1 according to the first embodiment. The ventilation apparatus
10 5 according to the fifth embodiment includes a refrigerant circuit 56 instead of the refrigerant circuit 50 of the ventilation apparatus 1 according to the first embodiment.

[0181]

The configuration of the ventilation apparatus 5
15 common to the ventilation apparatus 1 will not be described, and the description thereof will be omitted by referring to the above description. The exhaust unit 430 and the refrigerant circuit 56 included in the ventilation apparatus 5 will be described, particularly, with respect to
20 differences from the exhaust unit 30 and the refrigerant circuit 50, respectively.

[0182]

[Exhaust unit 430]

The exhaust unit 430 takes in return air RA from
25 the inside of the building BLD, exchanges heat between the taken-in return air RA and the refrigerant R1, and exhausts the heat-exchanged return air RA to the outside of the building BLD as exhaust air EA. The exhaust unit 230 includes the third exhaust heat exchanger 37 on a downstream side of
30 the exhaust heat exchanger 31 in the exhaust path P2. The second nozzle 33a is provided between the exhaust heat exchanger 31 and the third exhaust heat exchanger 37.

[0183]

The third exhaust heat exchanger 37 exchanges heat between the air A2 that has passed through the exhaust heat exchanger 31 and the refrigerant R1. In addition, the cooling water is sprayed from the second nozzle 33a to the third exhaust heat exchanger 37.

[0184]

The third exhaust heat exchanger 37 is connected to the exhaust heat exchanger 31 via the refrigerant pipe 46. The third exhaust heat exchanger 37 is connected to the compressor 10 via the refrigerant pipe 42.

[0185]

The second nozzle 33a sprays the cooling water supplied from a water supply unit 34a toward the third exhaust heat exchanger 37. The cooling water sprayed from the second nozzle 33a is applied to the third exhaust heat exchanger 37 to cool the third exhaust heat exchanger 37.

[0186]

The water supply unit 34a supplies the cooling water to the second nozzle 33a. The water supply unit 34a includes, for example, a tank that stores the cooling water and a pump that feeds the cooling water from the tank to the second nozzle 33a while pressurizing the cooling water. The water supply unit 34a is connected to the control unit 60. The control unit 60 controls the water supply unit 34a. The ventilation apparatus 5 includes a flow meter 33af between the water supply unit 34a and the second nozzle 33a. The flow meter 33af measures the flow rate of the cooling water supplied from the water supply unit 34a to the second nozzle 33a. The flow meter 33af is, for example, an electromagnetic flow meter, a vortex flow meter, an ultrasonic flow meter, a Coriolis flow meter, a differential pressure flow meter, or the like. The flow meter 33af is connected to the control unit 60. The control unit 60 acquires, from the flow meter

33af, a result of measurement of the amount of the cooling water sprayed from the second nozzle 33a to the third exhaust heat exchanger 37.

[0187]

5 The second nozzle 33a and the water supply unit 34a are collectively referred to as a water spray unit 39a. The control unit 60 performs the same control as the water spray unit 39 on the water spray unit 39a.

[0188]

10 [Refrigerant circuit 56]

 The refrigerant circuit 56 is a so-called vapor compression type refrigerant circuit. The refrigerant circuit 56 includes the compressor 10, the supply air heat exchanger 21, the exhaust heat exchanger 31, the third
15 exhaust heat exchanger 37, the refrigerant pipe 41, the refrigerant pipe 42, the refrigerant pipe 43, the refrigerant pipe 44, the refrigerant pipe 46, and the expansion valve 51. In the refrigerant circuit 56, the compressor 10, the supply air heat exchanger 21, the exhaust heat exchanger 31,
20 the third exhaust heat exchanger 37, and the expansion valve 51 are connected by the refrigerant pipe 41, the refrigerant pipe 42, the refrigerant pipe 43, the refrigerant pipe 44, and the refrigerant pipe 46, and the refrigerant flows through the inside.

25 [0189]

 The ventilation apparatus 5 includes the water spray unit 39a and the third exhaust heat exchanger 37, and the ventilation apparatus 5 thus can more efficiently perform heat exchange with the refrigerant R1. The ventilation
30 apparatus 5 can more efficiently cool the refrigerant R1. The ventilation apparatus 5 can efficiently discharge heat in the exhaust heat exchanger 31 and the third exhaust heat exchanger 37 which are heat exchangers for exhaust air.

[0190]

The ventilation apparatus 5 includes one set of the water spray unit 39a and the third exhaust heat exchanger 37; however, the ventilation apparatus 5 may include two or more sets of the water spray unit 39a and the third exhaust heat exchanger 37.

[0191]

<<Sixth Embodiment>>

A ventilation apparatus 6 according to a sixth embodiment will be described. The ventilation apparatus 4 further includes the third exhaust heat exchanger 37 on the downstream side of the exhaust heat exchanger 31 in the ventilation apparatus 2. From another viewpoint, in the ventilation apparatus 6, the nozzle 33 sprays the cooling water onto the cooling unit 38 instead of the nozzle 33 spraying the cooling water onto the exhaust heat exchanger 31 in the ventilation apparatus 5. In addition, in the ventilation apparatus 6, the second nozzle 33a sprays the cooling water onto the cooling unit 38 instead of the second nozzle 33a spraying the cooling water onto the third exhaust heat exchanger 37 in the ventilation apparatus 5.

[0192]

FIG. 14 is a diagram illustrating a schematic configuration of the ventilation apparatus 6 according to the sixth embodiment. The ventilation apparatus 6 according to the sixth embodiment includes an exhaust unit 530 instead of the exhaust unit 430 of the ventilation apparatus 5 according to the fifth embodiment.

[0193]

The configuration of the ventilation apparatus 6 common to the ventilation apparatus 5 is omitted from the description, and the description thereof is omitted by referring to the above description. The exhaust unit 530

included in the ventilation apparatus 6 will be described, particularly, with respect to the difference from the exhaust unit 430 included in the ventilation apparatus 5.

[0194]

5 [Exhaust unit 530]

The exhaust unit 530 takes in return air RA from the inside of the building BLD, exchanges heat between the taken-in return air RA and the refrigerant R1, and exhausts the heat-exchanged return air RA to the outside of the building BLD as exhaust air EA. The exhaust unit 530 includes the cooling unit 35 on the upstream side of the exhaust heat exchanger 31 in the exhaust path P2 and a cooling unit 38 on the upstream side of the third exhaust heat exchanger 37, with respect to the exhaust unit 430. The cooling unit 38 has the same configuration as the cooling unit 35.

[0195]

The nozzle 33 of the ventilation apparatus 6 sprays the cooling water not onto the exhaust heat exchanger 31 but onto the cooling unit 35. The second nozzle 33a of the ventilation apparatus 6 sprays the cooling water not onto the third exhaust heat exchanger 37 but onto the cooling unit 38.

[0196]

The ventilation apparatus 6 includes the water spray unit 39a, the cooling unit 38, and the third exhaust heat exchanger 37, and the ventilation apparatus 6 thus can more efficiently perform heat exchange with the refrigerant R1. The ventilation apparatus 6 can more efficiently cool the refrigerant R1. The ventilation apparatus 6 can efficiently discharge heat in the exhaust heat exchanger 31 and the third exhaust heat exchanger 37 which are heat exchangers for exhaust air.

[0197]

The ventilation apparatus 6 includes one set of the water spray unit 39a, the cooling unit 38, and the third exhaust heat exchanger 37; however, the ventilation apparatus 6 may include two or more sets of the water spray unit 39a, the cooling unit 38, and the third exhaust heat exchanger 37.

[0198]

The cooling unit 38 is an example of a second cooling unit, the third exhaust heat exchanger 37 is an example of a fourth heat exchanger, the water spray unit 39a is an example of a second water spray unit, and the cooling water sprayed from the second nozzle 33a is an example of a second cooling water.

[0199]

15 <<Seventh Embodiment>>

A ventilation apparatus according to a seventh embodiment will be described. The ventilation apparatus according to the seventh embodiment executes a process of calculating the amount of the cooling water to be sprayed in step S50 or step S150 described above.

[0200]

The ventilation apparatus according to the seventh embodiment learns a relationship between the temperature of the refrigerant flowing through the refrigerant circuit, the flow rate of the cooling water, and the condensation temperature, creates a prediction model, and calculates the flow rate of the cooling water, based on the prediction model. The ventilation apparatus according to the seventh embodiment learns a relationship between the pressure of the refrigerant flowing through the refrigerant circuit, the flow rate of the cooling water, and the discharge pressure, creates a prediction model, and calculates the flow rate of the cooling water, based on the prediction model.

[0201]

FIG. 15 is a flowchart illustrating a process based on the condensation temperature of the exhaust heat exchanger 31 in the ventilation apparatus according to the seventh
5 embodiment.

[0202]

(Step S210)

When the process is started, the control unit 60 acquires at least one of the first temperature of the
10 refrigerant R1 supplied to the exhaust heat exchanger 31, the second temperature of the refrigerant R1 discharged from the exhaust heat exchanger 31, or the third temperature of the refrigerant R1 discharged from the compressor 10 to the second heat exchanger, under a plurality of operating
15 conditions. The control unit 60 sets at least one of the acquired first temperature, second temperature, or third temperature as first learned data (a step of acquiring learned data for the refrigerant temperature).

[0203]

20 (Step S220)

Next, the control unit 60 acquires the flow rate of the cooling water sprayed by the water spray unit 39 under a plurality of operating conditions. The control unit 60 sets the acquired flow rate of the cooling water as the second
25 learned data (a step of acquiring learned data for the flow rate of the cooling water).

[0204]

(Step S230)

Next, the control unit 60 learns a prediction model
30 (first prediction model) for predicting a decrease in the amount of the condensation temperature in the exhaust heat exchanger 31, based on the first learned data and the second learned data. Specifically, the control unit 60 creates a

prediction model for predicting a decrease in the amount of the condensation temperature in the exhaust heat exchanger 31 from at least one of the first temperature, the second temperature, or the third temperature and the flow rate of the cooling water (a step of learning the prediction model for the condensation temperature).

[0205]

(Step S240)

Next, the control unit 60 calculates the flow rate of the cooling water to be sprayed from the cooling water spray unit, based on the prediction model learned in step S240. Specifically, the control unit 60 calculates the flow rate of the cooling water to be sprayed from the water spray unit from at least one of the first temperature, the second temperature, or the third temperature used for learning and the condensation temperature (a step of calculating the flow rate of the cooling water using the prediction model).

[0206]

FIG. 16 is a flowchart illustrating a process based on the discharge pressure at which the compressor 10 discharges air toward the exhaust heat exchanger 31 in the ventilation apparatus according to the seventh embodiment.

[0207]

(Step S310)

When the process is started, the control unit 60 acquires at least one of the first pressure of the refrigerant R1 supplied to the exhaust heat exchanger 31, the second pressure of the refrigerant R1 discharged from the exhaust heat exchanger 31, or the third pressure of the refrigerant R1 discharged from the compressor 10 to the second heat exchanger, under a plurality of operating conditions. The control unit 60 sets at least one of the acquired first pressure, second pressure, or third pressure

as third learned data (a step of acquiring learned data for the refrigerant pressure).

[0208]

(Step S320)

5 Next, the control unit 60 acquires the flow rate of the cooling water sprayed by the water spray unit 39 under the plurality of operating conditions. The control unit 60 sets the acquired flow rate of the cooling water as fourth learned data (a step of acquiring learned data for the flow
10 rate of the cooling water).

[0209]

(Step S330)

 Next, the control unit 60 learns a prediction model (second prediction model) for predicting a decrease in the
15 amount of the discharge pressure of the refrigerant discharged from the compressor 10 toward the exhaust heat exchanger 31, based on the third learned data and the fourth learned data (a step of learning a prediction model for the discharge pressures). Specifically, the control unit 60
20 creates a prediction model for predicting a decrease in the amount of the discharge pressure of the refrigerant discharged from the compressor 10 toward the exhaust heat exchanger 31, based on at least one of the first pressure, the second pressure, or the third pressure, and the flow rate
25 of the cooling water.

[0210]

(Step S340)

 Next, the control unit 60 calculates the flow rate of the cooling water to be sprayed from the cooling water
30 spray unit, based on the prediction model learned in step S340. Specifically, the control unit 60 calculates the flow rate of the cooling water to be sprayed from the water spray unit from at least one of the first pressure, the second

pressure, or the third pressure used for learning and the discharge pressure (a step of calculating the flow rate of the cooling water using the prediction model).

[0211]

5 In the ventilation apparatus according to the seventh embodiment, the amount of water to be sprayed can be optimized by calculating the amount of cooling water to be sprayed using the prediction model.

[0212]

10 <<Eighth Embodiment>>

 A ventilation apparatus 8 according to an eighth embodiment will be described. FIG. 17 is a side view illustrating a usage state of the ventilation apparatus 8 according to the present embodiment. The ventilation
15 apparatus 8 supplies outdoor air OA, which is the air outside the building BLD, to the inside of the building BLD. The ventilation apparatus 8 discharges the indoor air of the building BLD to the outside of the building BLD as the exhaust air EA. The ventilation apparatus 8 ventilates the
20 indoor air of the building BLD by supplying air and exhausting air.

[0213]

 The ventilation apparatus 8 according to the eighth embodiment includes a compressor 510, a supply air
25 unit 520, and the exhaust unit 530. The ventilation apparatus 8 includes a refrigerant circuit 550 including the compressor 510, a supply air heat exchanger 521 of a supply air unit 520 described later, an exhaust heat exchanger 531 of the exhaust unit 530 described later, an expansion valve (not
30 illustrated), and a refrigerant pipe 540.

[0214]

 The ventilation apparatus 8 includes a measurement device such as a thermometer configured to measure the

temperature of the refrigerant and a manometer configured to measure the pressure of the refrigerant, and a control unit configured to perform control, as in the ventilation apparatus 1 or the like, and description thereof will be omitted by referring to the ventilation apparatus 1 or the like here.

[0215]

[Compressor 510]

The compressor 510 compresses the refrigerant flowing through the refrigerant circuit 550. For example, in summer, when the indoor temperature of the building BLD is lower than the outdoor temperature due to a cooling device or the like, the compressor 510 supplies the compressed refrigerant to the exhaust unit 530. For example, in winter, when the indoor temperature of the building BLD is higher than the outdoor temperature due to a heating device or the like, the compressor 510 supplies the compressed refrigerant to the supply air unit 520.

[0216]

[Supply air unit 520]

The supply air unit 520 takes in outdoor air OA from the outside of the building BLD, exchanges heat between the taken-in outdoor air OA and the refrigerant, and supplies the heat-exchanged outdoor air OA to the inside of the building BLD as supply air SA. The supply air unit 520 includes the supply air heat exchanger 521.

[0217]

The supply air heat exchanger 521 exchanges heat between the outdoor air OA and the refrigerant. The supply air heat exchanger 521 includes a plurality of plate-type fins and pipes that penetrate the fins and through which the refrigerant flows.

[0218]

The supply air heat exchanger 521 is connected to the compressor 510 via the refrigerant pipe 540 and is connected to the exhaust heat exchanger 531 included in the exhaust unit 530 via the refrigerant pipe 540, so that the
5 refrigerant flows through the pipe of the supply air heat exchanger 521. The outdoor air OA flows between the fins of the supply air heat exchanger 521, and thus heat exchange is performed between the outdoor air OA and the refrigerant flowing through the pipe of the supply air heat exchanger
10 521.

[0219]

The outdoor air OA heat exchanged with the refrigerant by the supply air heat exchanger 521 is blown as the supply air SA from the underfloor UF of the building BLD
15 to a room RM1 by the blower BLW.

[0220]

[Exhaust unit 530]

The exhaust unit 530 takes in return air RA from the room RM1 of the building BLD via the attic AT, exchanges
20 heat between the taken-in return air RA and the refrigerant, and exhausts the heat-exchanged return air RA to the outside of the building BLD as exhaust air EA. FIG. 18 is a view schematically illustrating the exhaust unit 530 of the ventilation apparatus 8 according to the eighth embodiment.
25 The exhaust unit 530 is provided on the roof floor RF of the building BLD. The exhaust unit 530 includes the exhaust heat exchanger 531, a blower 532, and a nozzle 533.

[0221]

The exhaust heat exchanger 531 exchanges heat
30 between the return air RA and the refrigerant. The exhaust heat exchanger 531 includes pipes 531p and a filler 531a.

[0222]

The exhaust heat exchanger 531 is connected to the

compressor 10 via the refrigerant pipe 540 and is connected to the supply air heat exchanger 521 included in the supply air unit 520 via the refrigerant pipe 540, so that the refrigerant flows through the pipes of the exhaust heat
5 exchanger 531. The return air RA flows between the pipes 531p of the exhaust heat exchanger 531 and the filler 531a, and thus heat exchange is performed between the return air RA and the refrigerant flowing through the pipes 531p of the exhaust heat exchanger 531.

10 [0223]

The blower 532 blows the return air RA to the exhaust heat exchanger 531. The blower 532 is, for example, a centrifugal blower or an axial blower. The return air RA, which is heat exchanged by the exhaust heat exchanger 531,
15 is discharged outdoors as exhaust air EA.

[0224]

The nozzle 533 sprays the cooling water supplied from a water supply unit 534 toward the exhaust heat exchanger 531. The cooling water sprayed from the nozzle 533
20 is applied to the exhaust heat exchanger 531 to cool the exhaust heat exchanger 531.

[0225]

The water supply unit 534 supplies cooling water to the nozzle 533. The water supply unit 534 includes, for
25 example, a tank 534a that stores the cooling water, a pump that supplies the cooling water from the tank to the nozzle 533 while pressurizing the cooling water, and a pipe 534b that supplies the cooling water from the pump to the nozzle 533.

30 [0226]

The return air RA sent to the exhaust heat exchanger 531 by the blower 532 exchanges heat with the refrigerant by the exhaust heat exchanger 531. The return

air RA, which is subjected to heat exchange by the exhaust heat exchanger 531, is blown to the outside of the building BLD as exhaust air EA.

[0227]

5 In the exhaust unit 530, the cooling water WTR is caused to flow in a direction opposite to the flow of the air AIR. That is, the exhaust unit 530 includes the nozzle 533 on the downstream side of the flow of the air AIR of the exhaust heat exchanger 531.

10 [0228]

[Refrigerant Pipe 540]

 The refrigerant pipe 540 connects the compressor 510, the supply air heat exchanger 521, the exhaust heat exchanger 531, and an expansion valve (not illustrated). The
15 refrigerant flows through the refrigerant pipe 540.

[0229]

[Refrigerant circuit 550]

 The refrigerant circuit 550 is a so-called vapor compression refrigerant circuit. The refrigerant circuit 550
20 includes the compressor 510, the supply air heat exchanger 521, the exhaust heat exchanger 531, the refrigerant pipe 540, and an expansion valve (not illustrated). In the refrigerant circuit 550, the compressor 510, the supply air heat exchanger 521, the exhaust heat exchanger 531, and the
25 expansion valve are connected by the refrigerant pipe 540, and the refrigerant flows inside the refrigerant circuit 550.

[0230]

 The operation of the refrigerant circuit 550 will be described. For example, in summer, when the indoor
30 temperature of the building BLD is lower than the outdoor temperature due to a cooling device or the like, the compressor 510 supplies the compressed refrigerant to the exhaust unit 530. The exhaust heat exchanger 531 included in

the exhaust unit 530 is supplied with the compressed refrigerant and thereby functions as a condenser. On the other hand, the supply air heat exchanger 521 included in the supply air unit 520 functions as an evaporator.

5 [0231]

By having the exhaust heat exchanger 531 function as a condenser and the supply air heat exchanger 521 function as an evaporator, the heat of the return air RA can be collected to cool the outdoor air OA.

10 [0232]

For example, in winter, when the indoor temperature of the building BLD is higher than the outdoor temperature due to a heating device or the like, the compressor 510 supplies the compressed refrigerant to the supply air unit 520. The supply air heat exchanger 521 included in the supply air unit 520 is supplied with the compressed refrigerant and thereby functions as a condenser. On the other hand, the exhaust heat exchanger 531 included in the exhaust unit 530 functions as an evaporator.

20 [0233]

By having the supply air heat exchanger 521 function as a condenser, and the exhaust heat exchanger 531 function as an evaporator, the heat of the return air RA can be collected to heat the outdoor air OA.

25 [0234]

The ventilation apparatus 8 may take in the return air RA from a room RM2. The room RM2 is, for example, a toilet room, a bathroom, a kitchen, or the like. The room RM2 is, for example, a room where odor, harmful gas, or the like is generated. In the room RM2, a part of the return air RA of the room RM1 is supplied to the room RM2 by a pipe provided from the room RM to the attic AT. By supplying the part of the return air RA of the room RM1 to the room RM2,

it is possible to prevent odors, harmful gases, and the like in the room RM2 from leaking into the room RM1. The pressure of the room RM2 may be set at a negative pressure relative to the room RM1.

5 [0235]

The exhaust unit 530 is installed on the roof floor RF of the building BLD, and thus, for example, even when odor, harmful gas, or the like is discharged, the exhaust unit 530 can safely exhaust the odor, the harmful gas, or the like.

10 [0236]

The ventilation apparatus 8 includes a duct for returning a part of return air RA in the room RM1 as supply air SA to the room RM2 and the room RM3 provided separately from the room RM1. The ventilation apparatus 8 includes a filter FLT1 and a filter FLT2 for filtering the air flowing through the duct. The filter FLT1 is, for example, a prefilter for filtering out large dust and the like. The filter FLT2 is, for example, a high capability filter with a MERV (Minimum Efficiency Reporting Value) of 14 or higher. The MERV is defined by the American Society of Heating Refrigeration and Air Conditioning Engineers.

20 [0237]

The ventilation apparatus 8 further includes the filter FLT1 and an air-conditioning heat exchanger EVP for cooling the air that has passed through the filter FLT2. The air whose temperature is adjusted by the air-conditioning heat exchanger EVP is supplied to the room RM1 as supply air SA by the blower BLW.

25 [0238]

FIG. 19 is a diagram illustrating the operation of the ventilation apparatus 8 according to the eighth embodiment. FIG. 19 is a psychrometric diagram. FIG. 19

illustrates a state of the air at the positions POS1, POS2, POS3, POS4, POS5, POS6, and POS7 in FIG. 17. In FIG. 19, the horizontal axis represents the dry-bulb temperature and the vertical axis represents the absolute humidity. FIG. 19 illustrates a case where the evaporation temperature in the supply air heat exchanger 521 is 13.2°C and the condensation temperature in the exhaust heat exchanger 531 is 35.9°C.

[0239]

A position POS1 indicates a position to which the outdoor air OA is supplied. A position POS2 indicates a position where the air has passed through the supply air heat exchanger 521. A position POS3 indicates a position of the room RM1 to which the supply air SA is supplied. A position POS4 indicates a position of the return air RA in the attic AT. A position POS5 indicates a position in front of the exhaust heat exchanger 531 in the exhaust unit 530. A position POS6 indicates a position of the exhaust air EA discharged from the exhaust unit 530. A position POS7 indicates a position of the air that has passed through the air-conditioning heat exchanger EVP.

[0240]

In FIG. 19, as indicated by an arrow from a point indicating the state at the position POS1 to a point indicating the state at the position POS2, the outdoor air OA is cooled by the supply air heat exchanger 521. In FIG. 19, as indicated by an arrow from a point indicating the state at the position POS4 to a point indicating the state at the position POS7, the return air RA is cooled by the air-conditioning heat exchanger EVP. Furthermore, in FIG. 19, as indicated by the arrow from the point indicating the state of the position POS4 to the point indicating the state of the position POS5 and the arrow from the point indicating the state of the position POS5 to the point indicating the

state of the position POS6, the return air RA is heated by the exhaust heat exchanger 531. For example, in the exhaust unit 530, when the exhaust heat exchanger 531 is not sprayed with water, the temperature needs to be 62.5°C to disposed
5 of the condensation exhaust heat as indicated by a point POS6z in FIG. 19.

[0241]

The ventilation apparatus 8 can reduce the temperature of the exhaust air EA and collects heat in the
10 exhaust heat exchanger. The ventilation apparatus 8 can efficiently discharge heat in the exhaust heat exchanger 531, which is a heat exchanger for exhaust air.

[0242]

An exhaust unit 630, which is a modification of
15 the exhaust unit 530, will be described. The exhaust unit 530 sprays the cooling water from the nozzle 533 to the exhaust heat exchanger 531, but the exhaust unit 630 sprays the cooling water to the cooling unit 635 that cools the air supplied to the exhaust heat exchanger 631.

20 [0243]

[Exhaust unit 630]

The exhaust unit 630 takes in return air RA from the room RM1 of the building BLD via the attic AT, exchanges heat between the taken-in return air RA and the refrigerant,
25 and exhausts the heat-exchanged return air RA to the outside of the building BLD as exhaust air EA. FIG. 20 is a view schematically illustrating the exhaust unit 630 which is a modification of the exhaust unit 530 of the ventilation apparatus 8 according to the eighth embodiment. The exhaust
30 unit 630 is provided on the roof floor RF of the building BLD, similarly to the exhaust unit 530. The exhaust unit 630 includes an exhaust heat exchanger 631, a blower 632, a nozzle 633, and a cooling unit 635.

[0244]

The exhaust heat exchanger 631 exchanges heat between the return air RA that has passed through the cooling unit 635 and the refrigerant. The exhaust heat exchanger 631
5 includes pipes 631p. The exhaust heat exchanger 631 may include, for example, a plurality of fins penetrated by the pipes 631p.

[0245]

The refrigerant flows through the pipes 631p of
10 the exhaust heat exchanger 631. The return air RA flows between the pipes 631p of the exhaust heat exchanger 631, and thus heat exchange is performed between the return air RA and the refrigerant flowing through the pipes 631p of the exhaust heat exchanger 631.

15 [0246]

The blower 632 sends the return air RA to the cooling unit 635. The blower 632 is, for example, a centrifugal blower or an axial blower. The return air RA cooled by the cooling unit 635 is heat exchanged by the
20 exhaust heat exchanger 631 and is discharged outdoors as exhaust air EA.

[0247]

The cooling unit 635 holds cooling water and cools the return air RA passing through the cooling unit 635 by
25 heat of evaporation of the cooling water. The cooling unit 635 has a configuration in which the return air RA can pass through the inside. The cooling unit 635 is made of a water absorbing material that absorbs and internally holds water and discharges the held water from the inside to the outside.
30 The cooling unit 635 cools the return air RA passing therethrough by heat of evaporation when water is discharged from the water absorbing material to the outside.

[0248]

The water absorbing material is, for example, silica, a polymer adsorbent, or the like. The absorbing material is desirably a material which swells when absorbing water and shrinks when discharging water.

5 [0249]

In the above example, the water absorbing material that absorbs water has been described. However, the cooling unit 635 may be made of an absorbing material that absorbs and internally holds liquid, and discharges the internally held liquid from inside to the outside, instead of the water absorbing material.

[0250]

The nozzle 633 sprays the cooling water supplied from a water supply unit 634 toward the cooling unit 635. The cooling water sprayed from the nozzle 633 is applied to the cooling unit 635, thereby cooling the return air RA passing through the cooling unit 635.

[0251]

The water supply unit 634 supplies cooling water to the nozzle 633. The water supply unit 634 includes, for example, a tank 634a that stores the cooling water, a pump that feeds the cooling water from the tank to the nozzle 633 while pressurizing the cooling water, and a pipe 634b that feeds the cooling water from the pump to the nozzle 633.

25 [0252]

The return air RA sent to the cooling unit 635 by the blower 632 is cooled by the cooling unit 635, and then exchanges heat with the refrigerant by the exhaust heat exchanger 631. The return air RA that has exchanged heat with the exhaust heat exchanger 631 is blown to the outside of the building BLD as exhaust air EA. The ventilation apparatus 8 using the exhaust unit 630 can efficiently discharge heat in the exhaust heat exchanger 631 which is a heat exchanger

for exhaust air.

[0253]

In the exhaust unit 630, the cooling water WTR is caused to flow in a direction opposite to the flow of the
5 air AIR. That is, the exhaust unit 630 includes the nozzle 633 on the downstream side of the flow of the air AIR of the cooling unit 635.

[0254]

<<Water Spray Unit of Ventilation Apparatus According to
10 Present Embodiment>>

The water spray unit included in the ventilation apparatus according to the present embodiment will be described in detail. FIG. 21 is a diagram schematically illustrating the water spray unit 39 as an example of the
15 water spray unit included in the ventilation apparatus according to the present embodiment. The water spray unit 39a has the same configuration as the water spray unit 39.

[0255]

The water spray unit 39 includes the nozzle 33 and
20 the water supply unit 34. The water supply unit 34 includes a tank 34t and a pump 34p. The tank 34t stores the cooling water. The pump 34p sends the cooling water stored in the tank 34t to the nozzle 33 while pressurizing the cooling water.

25 [0256]

In the ventilation apparatus according to the present embodiment, the water spray unit requires a certain amount of cooling water to cool the heat exchanger and the cooling unit. Therefore, the water spray unit 39, which is
30 an example of the water spray unit included in the ventilation apparatus according to the present embodiment, includes the tank 34t that stores the cooling water.

[0257]

The water supply unit 34 is supplied with cooling water from the outside in order to store a predetermined amount of cooling water (cooling liquid) in the tank 34t. For example, the tap water WS is supplied from the outside to the tank 34t included in the water supply unit 34.
[0258]

The pump 34p sends the cooling water stored in the tank 34t to the nozzle 33 while pressurizing the cooling water. The nozzle 33 sprays the cooling water pressurized by the pump 34p toward the heat exchanger or the cooling unit.
[0259]

In the above example, the cooling water is sprayed from the water spray unit 39, but the liquid to be sprayed is not limited to water. A liquid other than water may be sprayed from the water spray unit 39. That is, the ventilation apparatus 1 may include a spray unit that sprays a cooling liquid, which is a liquid for cooling the exhaust heat exchanger 31, instead of the water spray unit 39.
[0260]

The cooling water (cooling liquid) may be water (liquid) having a temperature as low as possible. By using the cooling water (cooling liquid) having a low temperature, the heat exchanger or the cooling unit can be further cooled. The cooling water (cooling liquid) may be water (liquid) at room temperature that is not heated or cooled. Even when water (liquid) at room temperature is sprayed to the heat exchanger or the cooling unit, the heat exchanger or the cooling unit can be cooled by heat of evaporation of water (liquid) at room temperature. Further, when the cooling water (cooling liquid) is sprayed to the heat exchanger, the cooling water (cooling liquid) may have a temperature lower than the temperature of the heat exchanger. When the cooling water (cooling liquid) has a temperature lower than the

temperature of the heat exchanger, the heat exchanger to which the cooling water (cooling liquid) is sprayed can be cooled.

[0261]

5 <<Modification Example of Water Spray Unit Included in Ventilation Apparatus According to Embodiment>>

A modification of the water spray unit included in the ventilation apparatus according to the present embodiment will be described. FIG. 22 is a diagram
10 schematically illustrating a water spray unit 839 which is a modification of the water spray unit provided in the ventilation apparatus according to the present embodiment. The water spray unit 839 can be applied to the water spray unit 39a or the water spray unit 39.

15 [0262]

The water spray unit 839 includes a nozzle 833 and a water supply unit 834. The water supply unit 834 includes a tank 834t, a pump 834p, and a compressor 834c. The tank 834t stores the cooling water. The pump 834p pressurizes the
20 cooling water stored in the tank 834t and sends the cooling water to the nozzle 833. The compressor 834c supplies compressed air (gas) to the nozzle 833. The nozzle 833 is a two-fluid nozzle that sprays water (liquid) and air (gas) at the same time.

25 [0263]

The nozzle 833 sprays fine mist by simultaneously spraying the cooling water (cooling liquid) supplied from the pump 834p and the air (gas) supplied from the compressor 834c. The nozzle 833 sprays the fine mist, and thus the air
30 passing through the heat exchanger or the cooling unit can be cooled. Further, the fine mist sprayed by the nozzle 833 adheres to the heat exchanger or the cooling unit, and thus the heat exchanger or the cooling unit can be cooled.

[0264]

As with the water spray unit 39, water (liquid) is supplied to the water spray unit 839 from the outside.

[0265]

5 <<Modification Example of Exhaust Unit Included in Ventilation Apparatus According to Embodiment>>

Next, a modification of the exhaust unit included in the ventilation apparatus according to the present embodiment will be described. FIG. 23 is a view schematically
10 illustrating an exhaust unit 930 which is a modification of the exhaust unit provided in the ventilation apparatus according to the present embodiment.

[0266]

The exhaust unit 930 includes the exhaust heat
15 exchanger 31, a water spray unit 939, and the blower 32. The water spray unit 939 includes the nozzle 33, a water supply unit 934, a tray 935, and a purification unit 936.

[0267]

The tray 935 collects the cooling water (cooling
20 liquid) sprayed from the nozzle 33 to the exhaust heat exchanger 31. For example, the tray 935 collects the cooling water (cooling liquid) that is sprayed from the nozzle 33 to the exhaust heat exchanger 31 and falls along the exhaust heat exchanger 31. The tray 935 collects the cooling water
25 (cooling liquid) that has fallen from the nozzles 33 without reaching the exhaust heat exchanger 31.

[0268]

The cooling water (cooling liquid) collected by the tray 935 is purified through the purification unit 936,
30 and then returned to the water supply unit 934 to be reused.

[0269]

The purification unit 936 includes, for example, a filter. The purification unit 936 may be configured to add

a cleaning agent for cleaning the cooling water (cooling liquid), or may be a purification device for purifying the cooling water (cooling liquid).

[0270]

5 The water supply unit 934 supplies the collected cooling water (cooling liquid) to the nozzle 33. The cooling water (cooling liquid) collected by the purification unit 936 is supplied to the nozzle 33, and thus the water spray unit 939 can circulate and reuse the cooling water (cooling liquid). The water supply unit 934 is supplied with water (liquid) from the outside, similarly to the water supply unit 34 and the water supply unit 834.

[0271]

<<Process of Ventilation Apparatus According to Present
15 Embodiment>>

 In the ventilation apparatus according to the first embodiment, the control based on the condensation temperature of the exhaust heat exchanger 31 and the control based on the discharge pressure at which the compressor 10 discharges air toward the exhaust heat exchanger 31 have been described, but the ventilation apparatus according to the present embodiment is not limited to the above-described processes.

[0272]

25 A functional configuration of an example of the process of the ventilation apparatus according to the present embodiment will be described. FIG. 24 is a diagram illustrating a functional configuration of a ventilation apparatus 9 as an example of the ventilation apparatus according to the present embodiment. Note that FIG. 24 illustrates blocks related to the functions of the ventilation apparatus 9, and the structure and the like thereof are the same as those of the ventilation apparatus

and the like according to the first embodiment.

[0273]

The ventilation apparatus 9 includes a control unit 760. The control unit 760 includes a water spray control unit 751, a condensation temperature calculation unit 761, and a discharge pressure calculation unit 762. The control unit 760 corresponds to, for example, the control unit 60 in the ventilation apparatus 1. The ventilation apparatus 9 includes a measuring unit 710 that measures a physical quantity correlated with the condensation temperature in the exhaust heat exchanger. The measuring unit 710 includes a temperature measuring unit 711, a temperature measuring unit 712, a manometer 713, a manometer 714, a rotational speed measuring unit 721, a temperature measuring unit 731, a temperature measuring unit 732, a temperature measuring unit 741, a manometer 742, and a rotational speed measuring unit 743.

[0274]

[Measuring unit 710]

The ventilation apparatus 9 includes a temperature measuring unit 711 that measures an inlet refrigerant temperature in the exhaust heat exchanger (exhaust heat exchanger inlet refrigerant temperature), and a temperature measuring unit 712 that measures an outlet refrigerant temperature in the exhaust heat exchanger (exhaust heat exchanger outlet refrigerant temperature). The temperature measuring unit 711 measures the temperature of the refrigerant flowing into the exhaust heat exchanger. The temperature measuring unit 711 includes a thermometer 31r1, taking the ventilation apparatus 1 as an example. The temperature measuring unit 712 measures the temperature of the refrigerant flowing out of the exhaust heat exchanger. The temperature measuring unit 712 includes the thermometer

31r2, taking the ventilation apparatus 1 as an example.

[0275]

The ventilation apparatus 9 includes the manometer 713 that measures an inlet refrigerant pressure in the exhaust heat exchanger (exhaust heat exchanger inlet refrigerant pressure), and a manometer 714 that measures an outlet refrigerant pressure in the exhaust heat exchanger (exhaust heat exchanger outlet refrigerant pressure). The manometer 713 measures the pressure of the refrigerant flowing into the exhaust heat exchanger. The manometer 713 includes the manometer 31p1, taking the ventilation apparatus 1 as an example. The manometer 714 measures the pressure of the refrigerant flowing out of the exhaust heat exchanger. The manometer 714 includes the manometer 31p2, taking the ventilation apparatus 1 as an example.

[0276]

The ventilation apparatus 9 includes the rotational speed measuring unit 721 that measures the rotational speed of the blower included in the exhaust unit (blower rotational speed). The rotational speed measuring unit 721 measures the rotational speed of the blower that causes the air passing through the exhaust heat exchanger to flow. The rotational speed measuring unit 721 measures the rotational speed of the blower 32, taking the ventilation apparatus 1 as an example.

[0277]

The ventilation apparatus 9 includes the temperature measuring unit 731 that measures an inlet air temperature in the exhaust heat exchanger (exhaust heat exchanger inlet air temperature) and a temperature measuring unit 732 that measures an outlet air temperature in the exhaust heat exchanger (exhaust heat exchanger outlet air temperature). The temperature measuring unit 731 measures

the temperature of the air flowing into the exhaust heat exchanger. The temperature measuring unit 731 includes a thermometer 31a1, taking the ventilation apparatus 1 as an example. The temperature measuring unit 732 measures the temperature of the air flowing out of the exhaust heat exchanger. The temperature measuring unit 732 includes a thermometer 31a2, taking the ventilation apparatus 1 as an example.

[0278]

10 The ventilation apparatus 9 includes the temperature measuring unit 741 that measures an outlet refrigerant temperature in the compressor (compressor outlet refrigerant temperature) and a manometer 742 that measures an outlet refrigerant pressure in the compressor (compressor outlet refrigerant pressure). The ventilation apparatus 9 includes the rotational speed measuring unit 743 that measures the rotational speed of the compressor (compressor rotational speed). The temperature measuring unit 741 measures the temperature of the refrigerant discharged from the compressor. The temperature measuring unit 741 includes the thermometer 10r2, taking the ventilation apparatus 1 as an example. The manometer 742 measures the pressure of the refrigerant discharged from the compressor. The manometer 742 includes a manometer 10p2, taking the ventilation apparatus 1 as an example. The rotational speed measuring unit 743 measures the rotational speed of the compressor. The rotational speed measuring unit 743 measures the rotational speed of the compressor 10, taking the ventilation apparatus 1 as an example.

30 [0279]

[Condensation temperature calculation unit 761]

The condensation temperature calculation unit 761 calculates the condensation temperature in the exhaust heat

exchanger, based on the result measured by the measuring unit 710.

[0280]

5 The condensation temperature calculation unit 761
calculates the condensation temperature in the exhaust heat
exchanger, based on, for example, the compressor outlet
refrigerant temperature, the exhaust heat exchanger inlet
refrigerant temperature, and the exhaust heat exchanger
outlet refrigerant temperature. For example, the
10 condensation temperature calculation unit 761 may include a
table indicating a relationship between the compressor
outlet refrigerant temperature, the exhaust heat exchanger
inlet refrigerant temperature, the exhaust heat exchanger
outlet refrigerant temperature, and the condensation
15 temperature. The condensation temperature calculation unit
761 may calculate the condensation temperature from the
measured compressor outlet refrigerant temperature, the
measured exhaust heat exchanger inlet refrigerant
temperature, and the measured exhaust heat exchanger outlet
20 refrigerant temperature by using the table.

[0281]

25 The condensation temperature calculation unit 761
may calculate the condensation temperature in the exhaust
heat exchanger, based on, for example, the number of
compressor revolutions. For example, the condensation
temperature calculation unit 761 may include a table
indicating a relationship between the compressor rotational
speed and the condensation temperature, and may calculate
the condensation temperature from the measured compressor
30 rotational speed using the table.

[0282]

Further, the condensation temperature calculation
unit 761 may calculate the condensation temperature in the

exhaust heat exchanger, based on, for example, the rotational speed of the blower, the temperature of air at the inlet of the exhaust heat exchanger, and the temperature of air at the outlet of the exhaust heat exchanger. For example, the
5 condensation temperature calculation unit 761 may include a table indicating a relationship between the rotational speed of the blower, the exhaust heat exchanger inlet air temperature, the exhaust heat exchanger outlet air temperature, and the condensation temperature. Then, the
10 condensation temperature calculation unit 761 may calculate the condensation temperature from the measured blower rotational speed, the exhaust heat exchanger inlet air temperature, and the exhaust heat exchanger outlet air temperature by using the table. Instead of the rotational
15 speed of the blower, the amount of air flowing into the exhaust heat exchanger or the amount of air flowing out of the exhaust heat exchanger may be used.

[0283]

The method of calculating the condensation
20 temperature in the condensation temperature calculation unit 761 is not limited to the above-described method. For example, the condensation temperature calculation unit 761 may calculate the condensation temperature using a physical quantity correlated with the condensation temperature. For
25 example, the condensation temperature calculation unit 761 may calculate the condensation temperature using the compressor outlet refrigerant pressure.

[0284]

[Discharge pressure calculation unit 762]

30 The discharge pressure calculation unit 762 calculates the discharge pressure of the refrigerant discharged from the compressor to the exhaust heat exchanger, based on the result measured by the measuring unit 710.

[0285]

The discharge pressure calculation unit 762 calculates the discharge pressure of the refrigerant discharged from the compressor to the exhaust heat exchanger, based on, for example, the compressor outlet refrigerant pressure, the exhaust heat exchanger inlet refrigerant pressure, and the exhaust heat exchanger outlet refrigerant pressure. For example, the discharge pressure calculation unit 762 may include a table indicating the relationship between the compressor outlet refrigerant pressure, the exhaust heat exchanger inlet refrigerant pressure, the exhaust heat exchanger outlet refrigerant pressure, and the discharge pressure. The discharge pressure calculation unit 762 may calculate the discharge pressure from the measured compressor outlet refrigerant pressure, the measured exhaust heat exchanger inlet refrigerant pressure, and the measured exhaust heat exchanger outlet refrigerant pressure by using the table.

[0286]

The discharge pressure calculation unit 762 may calculate the discharge pressure of the refrigerant discharged from the compressor to the exhaust heat exchanger, based on the compressor rotational speed, for example. For example, the discharge pressure calculation unit 762 may include a table indicating the relationship between the compressor rotational speed and the discharge pressure, and may calculate the discharge pressure from the measured compressor rotational speed using the table.

[0287]

Furthermore, the discharge pressure calculation unit 762 may calculate the discharge pressure of the refrigerant discharged from the compressor to the exhaust heat exchanger on the basis of, for example, the rotational

speed of the blower, the temperature of air at the inlet of the exhaust heat exchanger, and the temperature of air at the outlet of the exhaust heat exchanger. For example, the discharge pressure calculation unit 762 may include a table
5 indicating a relationship between the blower rotational speed, the exhaust heat exchanger inlet air temperature, the exhaust heat exchanger outlet air temperature, and the discharge pressure. Then, the discharge pressure calculation unit 762 may calculate the discharge pressure from the
10 measured blower rotational speed, the measured exhaust heat exchanger inlet air temperature, and the measured exhaust heat exchanger outlet air temperature by using the table. Instead of the rotational speed of the blower, the amount of air flowing into the exhaust heat exchanger or the amount of
15 air flowing out of the exhaust heat exchanger may be used.
[0288]

The method of calculating the discharge pressure in the discharge pressure calculation unit 762 is not limited to the above examples. For example, the condensation
20 temperature calculation unit 761 may calculate the condensation temperature using a physical quantity correlated with the discharge pressure. For example, the condensation temperature calculation unit 761 may calculate the condensation temperature using the compressor outlet
25 refrigerant temperature, the exhaust heat exchanger inlet refrigerant temperature, the exhaust heat exchanger outlet refrigerant temperature, and the like.
[0289]

The condensation temperature and the discharge
30 pressure are in a correlation. Therefore, in the above description, the physical quantity used for obtaining the discharge pressure is also a physical quantity correlated with the condensation temperature.

[0290]

Examples of the physical quantity correlated with the condensation temperature include the exhaust heat exchanger inlet refrigerant temperature, the exhaust heat
5 exchanger outlet refrigerant temperature, the exhaust heat exchanger inlet refrigerant pressure, and the exhaust heat exchanger outlet refrigerant pressure, which are measured by the measuring unit 710. The physical quantity correlated with the condensation temperature includes, for example, the
10 rotational speed of the blower, the temperature of air at the inlet of the exhaust heat exchanger, the temperature of air at the outlet of the exhaust heat exchanger, the temperature of refrigerant at the outlet of the compressor, the pressure of refrigerant at the outlet of the compressor,
15 and the rotational speed of the compressor, which are measured by the measuring unit 710. Further, the physical quantity correlated with the condensation temperature includes, for example, the air volume flowing into the exhaust heat exchanger and the air volume flowing out of the
20 exhaust heat exchanger. The physical quantity correlated with the condensation temperature is not limited to the physical quantities listed above, and may be a physical quantity correlated with the condensation temperature, in other words, a physical quantity that affects the
25 condensation temperature.

[0291]

[Water spray control unit 751]

The water spray control unit 751 controls the spraying of water (cooling water) in the water spray unit,
30 based on at least one of the condensation temperature calculation unit 761 or the discharge pressure calculation unit 762.

[0292]

Although the embodiments have been described above, it should be understood that various alterations in embodiments and details may be made therein without departing from the spirit and scope of the claims. Various
5 modifications and improvements such as combinations with or substitutions of a part or all of the other embodiments are possible.

[0293]

The present disclosure also includes disclosure of
10 the following aspects.

[0294]

A ventilation apparatus according to a first aspect comprises:

a compressor;

15 a first heat exchanger provided in a first path and through which first air passes, the first path being a path through which outdoor air is supplied indoors;

a second heat exchanger provided in a second path and through which second air passes, the second path being
20 a path through which indoor air is discharged outdoors;

a refrigerant circuit through which a refrigerant flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by refrigerant pipes;

25 a water spray unit configured to spray cooling water onto the second heat exchanger; and

a control unit configured to control the water spray unit to spray the cooling water onto the second heat exchanger, based on a condensation temperature of the second
30 heat exchanger.

[0295]

According to the ventilation apparatus according to the first aspect, heat can be efficiently exhausted in

the exhaust heat exchanger.

[0296]

5 A ventilation apparatus according to a second aspect is a ventilation apparatus according to the first aspect, wherein the control unit may control the water spray unit to spray the cooling water onto the second heat exchanger when the condensation temperature is equal to or higher than a target temperature set in advance.

[0297]

10 A ventilation apparatus according to a third aspect includes

a compressor;

15 a first heat exchanger provided in a first path and through which first air passes, the first path being a path through which outdoor air is supplied indoors;

a second heat exchanger provided in a second path and through which second air passes, the second path being a path through which indoor air is discharged outdoors;

20 a refrigerant circuit through which a refrigerant flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by refrigerant pipes;

25 a cooling unit provided on an upstream side of the second heat exchanger in the second path and through which the second air passes, the cooling unit being made of a water absorbing material capable of absorbing and internally holding water, and capable of externally discharging the internally held water, and the cooling unit being configured to cool the second air by heat of evaporation when the water
30 is discharged to outside;

a water spray unit configured to spray cooling water onto the cooling unit; and

a control unit configured to control the water

spray unit to spray the cooling water onto the cooling unit, based on a condensation temperature of the second heat exchanger.

[0298]

5 In the ventilation apparatus according to the third aspect, heat can be efficiently exhausted in the exhaust heat exchanger.

[0299]

10 A ventilation apparatus according to a fourth aspect is the ventilation apparatus according to the third aspect, wherein the control unit may control the water spray unit to spray the cooling water onto the cooling unit when the condensation temperature is equal to or higher than a target temperature set in advance.

15 [0300]

 A ventilation apparatus according to a fifth aspect is the ventilation apparatus of the second aspect or the fourth aspect, wherein the control unit may control an amount of the cooling water sprayed from the water spray unit, based on a difference between the condensation temperature and the target temperature.

[0301]

25 A ventilation apparatus according to a sixth aspect is the ventilation apparatus according to the first aspect to the fifth aspect, further including a first temperature detector configured to measure any one of a first temperature of the refrigerant supplied to the second heat exchanger or a second temperature of the refrigerant discharged from the second heat exchanger, wherein the control unit calculates the condensation temperature, based on a measurement result of the first temperature detector.

[0302]

 A ventilation apparatus according to a seventh

aspect is the ventilation apparatus according to the first aspect to the fifth aspect, which may further include a second temperature detector configured to measure a third temperature of the refrigerant discharged from the compressor to the second heat exchanger, wherein the control unit calculates the condensation temperature, based on a measurement result of the second temperature detector.

[0303]

A ventilation apparatus according to an eighth aspect is the ventilation apparatus according to the first aspect to the fifth aspect, wherein the control unit

acquires first learned data on any one of a first temperature of the refrigerant supplied to the second heat exchanger, a second temperature of the refrigerant discharged from the second heat exchanger, or a third temperature of the refrigerant discharged from the compressor to the second heat exchanger;

acquires second learned data for a flow rate of the cooling water sprayed by the water spray unit;

learns a first prediction model that predicts a decrease in the amount of the condensation temperature from any one of the first temperature, the second temperature, or the third temperature, and the flow rate, based on the first learned data and the second learned data; and

calculates the flow rate of the cooling water sprayed from the water spray unit, from any one of the first temperature, the second temperature, or the third temperature, and the condensation temperature used for learning, based on the first prediction model.

[0304]

A ventilation apparatus according to a ninth aspect includes

a compressor;

a first heat exchanger provided in a first path and through which first air passes, the first path being a path through which outdoor air is supplied indoors;

5 a second heat exchanger provided in a second path and through which second air passes, the second path being a path through which indoor air is discharged outdoors;

a refrigerant circuit through which a refrigerant flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by refrigerant
10 pipes;

a water spray unit configured to spray cooling water onto the second heat exchanger; and

a control unit configured to control the water spray unit to spray the cooling water onto the second heat
15 exchanger, based on a discharge pressure at which the compressor discharges the cooling water toward the second heat exchanger.

[0305]

In the ventilation apparatus according to the
20 ninth aspect, the exhaust heat in the exhaust heat exchanger can be efficiently discharged.

[0306]

A ventilation apparatus according to a tenth aspect is the ventilation apparatus according to the ninth
25 aspect, wherein the control unit may control the water spray unit to spray the cooling water onto the second heat exchanger when the discharge pressure is equal to or higher than a preset target pressure.

[0307]

30 A ventilation apparatus according to an eleventh aspect includes

a compressor;

a first heat exchanger provided in a first path

and through which first air passes, the first path being a path through which outdoor air is supplied indoors;

a second heat exchanger provided in a second path and through which second air passes, the second path being
5 a path through which indoor air is discharged outdoors;

a refrigerant circuit through which a refrigerant flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by refrigerant pipes;

10 a cooling unit provided on an upstream side of the second heat exchanger in the second path and through which the second air passes, the cooling unit being made of a water absorbing material capable of absorbing and internally holding water, and capable of externally discharging the
15 internally held water from the inside to the outside, and the cooling unit being configured to cool the second air by heat of evaporation when the water is discharged to outside;

a water spray unit configured to spray cooling water onto the cooling unit; and

20 a control unit configured to control the water spray unit to spray the cooling water onto the cooling unit, based on a discharge pressure at which the compressor discharges the cooling water toward the second heat exchanger.
[0308]

25 In the ventilation apparatus according to the eleventh aspect, heat can be efficiently exhausted in the exhaust heat exchanger.

[0309]

A ventilation apparatus according to a twelfth
30 aspect is the ventilation apparatus according to the eleventh aspect, wherein the control unit may control the water spray unit to spray the cooling water onto the cooling unit when the discharge pressure is equal to or higher than a target

pressure set in advance.

[0310]

5 A ventilation apparatus according to a thirteenth aspect is the ventilation apparatus according to the tenth aspect or the eleventh aspect, wherein the control unit may control the amount of the cooling water sprayed from the water spray unit, based on a difference between the discharge pressure and the target pressure.

[0311]

10 A ventilation apparatus according to a fourteenth aspect is the ventilation apparatus according to the ninth aspect to the thirteenth aspect, which may further include a first pressure detector configured to measure any one of a first pressure of the refrigerant supplied to the second heat exchanger or a second pressure of the refrigerant discharged from the second heat exchanger, wherein the control unit calculates the discharge pressure, based on a measurement result of the first pressure detector.

[0312]

20 A ventilation apparatus according to a fifteenth aspect is the ventilation apparatus according to the ninth aspect to the thirteenth aspect, which may further include a second pressure detector configured to measure a third pressure of the refrigerant discharged from the compressor to the second heat exchanger, wherein the control unit may calculate the discharge pressure, based on a measurement result of the second pressure detector.

[0313]

30 A ventilation apparatus according to a sixteenth aspect is the ventilation apparatus according to the ninth aspect to the thirteenth aspect, wherein the control unit acquires third learned data for any of a first pressure of the refrigerant supplied to the second heat exchanger, a

second pressure of the refrigerant discharged from the second heat exchanger, and a third pressure of the refrigerant discharged from the compressor to the second heat exchanger, acquires fourth learned data for a flow rate of the cooling water sprayed by the water spray unit, learns a second prediction model that predicts a decrease in an amount of the discharge pressure from any one of the first pressure, the second pressure, or the third pressure, and the flow rate, based on the third learned data and the fourth learned data, and calculates the flow rate of the cooling water sprayed from the water spray unit from any of the first pressure, the second pressure, and the third pressure and the discharge pressure used for learning, based on the second prediction model.

[0314]

A ventilation apparatus according to a seventeenth aspect is the ventilation apparatus according to the first aspect to the sixteenth aspect, wherein the second heat exchanger may include internal pipes through which the refrigerant flows, fins connected to the internal pipes, and a liquid holding portion formed on surfaces of the fins, the liquid holding portion being made of a water absorbing material capable of absorbing and internally holding the cooling water sprayed from the water spray unit, and capable of externally discharging the internally held cooling water, and the second heat exchanger may cool the refrigerant by the cooling water evaporating from the water absorbing material.

[0315]

A ventilation apparatus according to an eighteenth aspect is the ventilation apparatus according to the first aspect to the seventeenth aspect may be further includes a third heat exchanger provided on an upstream side of the

second heat exchanger in the second path and connected to the refrigerant circuit.

[0316]

5 A ventilation apparatus according to a nineteenth aspect is the ventilation apparatus according to the first aspect to the eighteenth aspect may further include a fourth heat exchanger provided on a downstream side of the second heat exchanger in the second path and connected to the refrigerant circuit, and a second water spray unit provided
10 between the second heat exchanger and the fourth heat exchanger and configured to spray second cooling water onto the fourth heat exchanger.

[0317]

15 A ventilation apparatus according to a twentieth aspect is the ventilation apparatus according to the first aspect to the nineteenth aspect, which may further include a fourth heat exchanger provided on a downstream side of the second heat exchanger in the second path and connected to the refrigerant circuit; a second cooling unit provided
20 between the second heat exchanger and the fourth heat exchanger, and through which the second air passes, the second cooling unit being made of a water absorbing material capable of absorbing and internally holding water, and capable of externally discharging the internally held water, and the cooling unit being configured to cool the second air
25 by heat of evaporation when the water is discharged to outside; and a second water spray unit configured to spray second cooling water onto the second cooling unit.

[0318]

30 A ventilation method according to a first aspect is a ventilation method using a ventilation apparatus. The ventilation apparatus includes a compressor, a first heat exchanger provided in a first path and through which first

air passes, the first path being a path through which outdoor air is supplied indoors, a second heat exchanger provided in a second path and through which second air passes, the second path being a path through which indoor air is discharged
5 outdoors, and a refrigerant circuit through which a refrigerant flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by refrigerant pipes. The ventilation method includes

spraying cooling water onto the second heat
10 exchanger, based on a condensation temperature of the second heat exchanger.

[0319]

In the ventilation method according to the first aspect, the exhaust heat in the exhaust heat exchanger can
15 be efficiently discharged.

[0320]

A ventilation method according to a second aspect is a ventilation method using a ventilation apparatus. The ventilation apparatus includes a compressor, a first heat
20 exchanger provided in a first path and through which first air passes, the first path being a path through which outdoor air is supplied indoors, a second heat exchanger provided in a second path and through which second air passes, the second path being a path through which indoor air is discharged
25 outdoors, a refrigerant circuit through which a refrigerant flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by refrigerant pipes, and a cooling unit provided on an upstream side of the second heat exchanger in the second path and through
30 which the second air passes, the cooling unit being made of a water absorbing material capable of absorbing and internally holding water, and capable of externally discharging the internally held water, and the cooling unit

being configured to cool the second air by heat of evaporation when the water is discharged to outside. The ventilation method includes

5 spraying cooling water onto the cooling unit,
based on a condensation temperature of the second heat exchanger.

[0321]

 In the ventilation method according to the second aspect, the exhaust heat in the exhaust heat exchanger can
10 be efficiently discharged.

[0322]

 A ventilation method according to a third aspect is a ventilation method using a ventilation apparatus. The ventilation apparatus includes a compressor, a first heat
15 exchanger provided in a first path and through which first air passes, the first path being a path through which outdoor air is supplied indoors, a second heat exchanger provided in a second path and through which second air passes, the second path being a path through which indoor air is discharged
20 outdoors, and a refrigerant circuit through which a refrigerant flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by refrigerant pipes. The ventilation method includes

 spraying the cooling water onto the second heat
25 exchanger, based on a discharge pressure at which the compressor discharges cooling water toward the second heat exchanger.

[0323]

 In the ventilation method according to the third aspect, heat can be efficiently exhausted in the exhaust heat
30 exchanger.

[0324]

 A ventilation method according to a fourth aspect

is a ventilation method using a ventilation apparatus. The ventilation apparatus includes a compressor, a first heat exchanger provided in a first path and through which first air passes, the first path being a path through which outdoor
5 air is supplied indoors, a second heat exchanger provided in a second path and through which second air passes, the second path being a path through which indoor air is discharged outdoors, a refrigerant circuit through which a refrigerant flows and in which the compressor, the first heat exchanger,
10 and the second heat exchanger are connected by refrigerant pipes, and a cooling unit provided on an upstream side of the second heat exchanger in the second path and through which the second air passes, the cooling unit being made of a water absorbing material capable of absorbing and
15 internally holding water, and capable of externally discharging the internally held water, and the cooling unit being configured to cool the second air by heat of evaporation when the water is discharged to outside. The ventilation method includes
20 spraying cooling water onto the cooling unit, based on a discharge pressure at which the compressor discharges cooling water toward the second heat exchanger.
[0325]

In the ventilation method according to the fourth
25 aspect, heat can be efficiently exhausted in the exhaust heat exchanger.
[0326]

The present application claims priority to Japanese Patent Application No. 2022-060522 filed on March
30 31, 2022, the entire contents of which are incorporated herein by reference.

DESCRIPTION OF THE REFERENCE NUMERALS

	[0327]	
	1,2,3,4,5,6,8,9	ventilation apparatus
	10,510	compressor
	10p2	manometer
5	10r2	thermometer
	20,520	supply air unit
	21,521	supply air heat exchanger
	30,130,230,330,430,530,630	exhaust unit
	31,131,531,631	exhaust heat exchanger
10	31p1	manometer
	31p2	manometer
	31r1	thermometer
	31r2	thermometer
	33,533,633	nozzle
15	33a	second nozzle
	34,34a,534,634,834	water supply unit
	35,38,635	cooling unit
	36	second exhaust heat exchanger
	37	third exhaust heat exchanger
20	39,39a,839,939	water spray unit
	41,42,43,44,45,46	refrigerant pipe
	50,55,56,550	refrigerant circuit
	51	expansion valve
	60,760	control unit
25	710	measuring unit
	131f	fin
	131p	pipe
	131w	liquid holding portion
	A1	air
30	A2	air
	BLD	building
	OA	outdoor air
	P1	air supply path

	P2	exhaust path
	R1	refrigerant
	R2	refrigerant
	RA	return air
5	SA	supply air

CLAIMS:

[Claim 1]

- 5 A ventilation apparatus comprising:
 a compressor;
 a first heat exchanger provided in a first path
and through which first air passes, the first path being a
path through which outdoor air is supplied indoors;
10 a second heat exchanger provided in a second path
and through which second air passes, the second path being
a path through which indoor air is discharged outdoors;
 a refrigerant circuit through which a refrigerant
flows and in which the compressor, the first heat exchanger,
15 and the second heat exchanger are connected by refrigerant
pipes; and
 a spray unit to which a liquid is supplied from
outside and configured to spray a cooling liquid onto the
second heat exchanger.

20

[Claim 2]

- The ventilation apparatus according to claim 1,
further comprising:
25 a control unit configured to control the spray
unit to spray the cooling liquid onto the second heat
exchanger, based on a physical quantity correlated with a
condensation temperature in the second heat exchanger.

30

[Claim 3]

- The ventilation apparatus according to claim 2,
wherein the physical quantity is at least one of

a first temperature of the refrigerant
flowing into the second heat exchanger,
a second temperature of the refrigerant
flowing out of the second heat exchanger,
5 a first pressure of the refrigerant flowing
into the second heat exchanger,
a second pressure of the refrigerant flowing
out of the second heat exchanger,
a third temperature of the second air flowing
10 into the second heat exchanger,
a fourth temperature of the second air
flowing out of the second heat exchanger,
an air volume passing through the second heat
exchanger,
15 a first rotational speed of a blower that
causes air passing through the second heat exchanger to flow,
a second rotational speed of the compressor,
a fifth temperature of the refrigerant
discharged from the compressor, or
20 a third pressure of the refrigerant
discharged from the compressor.

[Claim 4]

25 The ventilation apparatus according to claim 3,
wherein the control unit calculates the
condensation temperature in the second heat exchanger from
the physical quantity, and controls the spray unit to spray
the cooling liquid onto the second heat exchanger when the
30 condensation temperature is equal to or higher than a target
temperature set in advance.

[Claim 5]

The ventilation apparatus according to claim 4,
wherein the control unit controls an amount of the
cooling liquid sprayed from the spray unit, based on a
5 difference between the condensation temperature and the
target temperature.

[Claim 6]

10 A ventilation apparatus comprising:
a compressor;
a first heat exchanger provided in a first path
and through which first air passes, the first path being a
path through which outdoor air is supplied indoors;
15 a second heat exchanger provided in a second path
and through which second air passes, the second path being
a path through which indoor air is discharged outdoors;
a refrigerant circuit through which a refrigerant
flows and in which the compressor, the first heat exchanger,
20 and the second heat exchanger are connected by refrigerant
pipes;
a cooling unit provided on an upstream side of the
second heat exchanger in the second path and through which
the second air passes, the cooling unit being made of an
25 absorbing material capable of absorbing and internally
holding a liquid, and capable of externally discharging the
internally held liquid, and the cooling unit being configured
to cool the second air by heat of evaporation when the liquid
is discharged to outside; and
30 a spray unit configured to spray a cooling liquid
onto the cooling unit.

[Claim 7]

The ventilation apparatus according to claim 6,
further comprising:

5 a control unit configured to control the spray
unit to spray the cooling liquid onto the second heat
exchanger, based on a physical quantity correlated with a
condensation temperature in the second heat exchanger.

10 [Claim 8]

The ventilation apparatus according to claim 7,
wherein the physical quantity is at least one of

a first temperature of the refrigerant flowing
into the second heat exchanger,

15 a second temperature of the refrigerant flowing
out of the second heat exchanger,

a first pressure of the refrigerant flowing into
the second heat exchanger,

20 a second pressure of the refrigerant flowing out
of the second heat exchanger,

a third temperature of the second air flowing into
the second heat exchanger,

a fourth temperature of the second air flowing out
of the second heat exchanger,

25 an air volume passing through the second heat
exchanger,

a first rotational speed of a blower that causes
air passing through the second heat exchanger to flow,

a second rotational speed of the compressor,

30 a fifth temperature of the refrigerant discharged
from the compressor, or

a third pressure of the refrigerant discharged
from the compressor.

[Claim 9]

5 The ventilation apparatus according to claim 8,
 wherein the control unit calculates a condensation
temperature in the second heat exchanger from the physical
quantity, and controls the spray unit to spray the cooling
liquid onto the cooling unit when the condensation
temperature is equal to or higher than a target temperature
10 set in advance.

[Claim 10]

15 The ventilation apparatus according to claim 9,
 wherein the control unit controls an amount of the
cooling liquid sprayed from the spray unit, based on a
difference between the condensation temperature and the
target temperature.

20

[Claim 11]

 The ventilation apparatus according to any one of
claims 2 to 5 and claims 7 to 10, further comprising:
 a first temperature detector configured to measure
25 any one of a sixth temperature of the refrigerant supplied
to the second heat exchanger or a seventh temperature of the
refrigerant discharged from the second heat exchanger,
 wherein the control unit calculates the
condensation temperature, based on a measurement result of
30 the first temperature detector.

[Claim 12]

The ventilation apparatus according to any one of claims 2 to 5 and claims 7 to 10, further comprising:

a second temperature detector configured to measure an eighth temperature of the refrigerant discharged from the compressor to the second heat exchanger,

wherein the control unit calculates the condensation temperature, based on a measurement result of the second temperature detector.

10

[Claim 13]

The ventilation apparatus according to any one of claims 2 to 5 and claims 7 to 10,

wherein the control unit
acquires first learned data on any one of a sixth temperature of the refrigerant supplied to the second heat exchanger, a seventh temperature of the refrigerant discharged from the second heat exchanger, or an eighth temperature of the refrigerant discharged from the compressor to the second heat exchanger;

acquires second learned data on a flow rate of the cooling liquid sprayed by the spray unit;

learns a first prediction model that predicts a decrease in an amount of the condensation temperature from a corresponding one of the sixth temperature, the seventh temperature, or the eighth temperature, and the flow rate, based on the first learned data and the second learned data; and

calculates the flow rate of the cooling liquid sprayed from the spray unit from the condensation temperature and the corresponding one of the sixth temperature, the seventh temperature, or the eighth temperature used for learning, based on the first prediction

model.

[Claim 14]

5 The ventilation apparatus according to any one of
claims 1 to 13,

 wherein the second heat exchanger includes:

 internal pipes through which the refrigerant
flows;

10 fins connected to the internal pipes; and

 a liquid holding portion formed on surfaces
of the fins, the liquid holding portion being made of a water
absorbing material capable of absorbing and internally
holding the cooling liquid sprayed from the spray unit, and
15 capable of externally discharging the internally held
cooling liquid, and

 wherein the second heat exchanger cools the
refrigerant by the cooling liquid evaporating from the water
absorbing material.

20

[Claim 15]

 The ventilation apparatus according to any one of
claims 1 to 14, further comprising:

25 a third heat exchanger provided on an upstream
side of the second heat exchanger in the second path and
connected to the refrigerant circuit.

30 [Claim 16]

 The ventilation apparatus according to any one of
claims 1 to 15, further comprising:

 a fourth heat exchanger provided on a downstream

side of the second heat exchanger in the second path and connected to the refrigerant circuit; and

a second spray unit provided between the second heat exchanger and the fourth heat exchanger, the second
5 spray unit being configured to spray a second cooling liquid onto the fourth heat exchanger.

[Claim 17]

10 The ventilation apparatus according to any one of claims 1 to 16, further comprising:

a fourth heat exchanger provided on a downstream side of the second heat exchanger in the second path and connected to the refrigerant circuit;

15 a second cooling unit provided between the second heat exchanger and the fourth heat exchanger and through which second air passes, the second cooling unit being made of a water absorbing material capable of absorbing and internally holding water, and capable of externally
20 discharging the internally held water, and the second cooling unit being configured to cool the second air by heat of evaporation when the water is discharged to outside; and

a second spray unit configured to spray the second cooling liquid onto the second cooling unit.

25

[Claim 18]

A ventilation method using a ventilation apparatus, the ventilation apparatus including a compressor; a first
30 heat exchanger provided in a first path and through which first air passes, the first path being a path through which outdoor air is supplied indoors; a second heat exchanger provided in a second path and through which second air passes,

the second path being a path through which indoor air is discharged outdoors; and a refrigerant circuit through which a refrigerant flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected
5 by refrigerant pipes, the ventilation method comprising:

spraying a cooling liquid onto the second heat exchanger, the cooling liquid containing water supplied from outside.

10

[Claim 19]

A ventilation method using a ventilation apparatus, the ventilation apparatus including a compressor; a first heat exchanger provided in a first path and through which
15 first air passes, the first path being a path through which outdoor air is supplied indoors; a second heat exchanger provided in a second path and through which second air passes, the second path being a path through which indoor air is discharged outdoors; a refrigerant circuit through which a
20 refrigerant flows and in which the compressor, the first heat exchanger, and the second heat exchanger are connected by refrigerant pipes; and a cooling unit provided on an upstream side of the second heat exchanger in the second path and through which the second air passes, the cooling unit being
25 made of a water absorbing material capable of absorbing and internally holding water, and capable of externally discharging the internally held water, and the cooling unit being configured to cool the second air by heat of evaporation when the water is discharged to outside, the
30 ventilation method comprising:

spraying a cooling liquid onto the cooling unit.