

DESCRIPTION

AIR CONDITIONING SYSTEM

TECHNICAL FIELD

[0001]

5 The present invention relates to an air conditioning system.

BACKGROUND ART

[0002]

10 A conventionally known air conditioning system conditions indoor air. Examples of such an air conditioning system include one that dehumidifies a room in addition to cooling the room.

[0003]

15 For example, the air conditioning system described in Patent Literature 1 includes a refrigerant circuit to which a compressor, an outdoor heat exchanger, an expansion valve, and an indoor heat exchanger are connected, and is configured to perform a refrigeration cycle in the refrigerant circuit. In the air conditioning system, an evaporation temperature of the indoor heat exchanger is lowered during operation of dehumidifying a room. Thus in the indoor heat exchanger, air is cooled to a temperature lower than a dew point temperature, and moisture in the air is condensed. As a result, the room is dehumidified.

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CITATION LIST

PATENT LITERATURE

[0004]

[Patent Literature 1] JP H9-14724 A

25

SUMMARY OF THE INVENTION

<Technical Problem>

[0005]

30 In the air conditioning system as described above, the indoor humidity (latent heat load) may be high especially at the start of operation. If the indoor humidity can be lowered promptly under such a condition, therefore, comfort in the room can be improved. Meanwhile, if the air is excessively cooled in order to lower the indoor humidity, the indoor temperature is also excessively lowered, resulting in a degraded energy conservation.

[0006]

The present invention has been made in view of such problems, and an object of the present invention is to provide an air conditioning system capable of promptly treating latent heat in a room and enjoying excellent energy conservation.

<Solution to Problem>

5 [0007]

A first invention relates to an air conditioning system including:

a plurality of air conditioners (20, 40) each including an indoor unit (30, 50) and an outdoor unit (21, 41), each of the air conditioners being configured to perform a refrigeration cycle individually and air-condition a same indoor space; and

10 a control device (60) that controls the plurality of air conditioners (20, 40), wherein the control device (60) is configured to perform:

a first operation in which the indoor units (30, 50) of all the air conditioners (20, 40) are controlled such that air is cooled to a dew point temperature or lower; and

15 a second operation in which the indoor unit (30) of at least one air conditioner (20) is controlled such that the air is cooled to the dew point temperature or lower, while the indoor unit (50) of another air conditioner (40) is controlled such that the air is cooled at a temperature higher than the dew point temperature.

[0008]

20 In the first invention, the control device (60) switches operations between the first operation and the second operation, and performs the selected operation. When the first operation is performed, the indoor units (30, 50) of all the air conditioners (20, 40) are controlled such that the air is cooled to the dew point temperature or lower. All the air conditioners (20, 40) are for air-conditioning the same indoor space (11). Therefore, latent heat in the room can be promptly treated through the first operation.

25 [0009]

When the second operation is performed, the indoor unit (30) of a part of the air conditioners (20) is controlled such that the air is cooled to the dew point temperature or lower. At the same time, the indoor unit (50) of the other air conditioner (40) is controlled such that the air is cooled at a temperature higher than the dew point temperature. During 30 the second operation, latent heat of the air is preferentially treated by a part of the air conditioners (20), while sensible heat of the air is treated by the other air conditioner (40). This makes it possible to bring the indoor temperature and humidity close to target values without an excessive decrease in the indoor temperature. Therefore, the operation can be performed with excellent energy conservation.

[0010]

A second invention is an invention according to the first invention, wherein the control device (60) performs the first operation when a condition indicating that at least an indoor humidity is higher than a predetermined value is satisfied.

5 [0011]

In the second invention, the first operation is performed under conditions where the indoor humidity is high. As a result, the latent heat in the room can be treated promptly, and the comfort in the room can be quickly secured.

[0012]

10 A third invention is an invention according to the first or second invention, wherein the control device (60) performs the second operation when a condition indicating that an indoor temperature and the indoor humidity are in a target range is satisfied.

[0013]

15 In the third invention, the second operation is performed when the indoor temperature and humidity reach the target range. As a result, the indoor temperature and humidity can be maintained within the target range while the energy conservation is secured.

[0014]

20 A fourth invention is an invention according to any one of the first to third inventions, wherein the control device (60) is configured to switch modes between a temperature control mode including a normal cooling operation and a temperature and humidity control mode including the first operation and the second operation.

[0015]

25 In the fourth invention, the temperature control mode or the temperature and humidity control mode is selectively executed. The temperature control mode is an operating mode for adjusting the indoor temperature, and includes a normal cooling operation. The temperature and humidity mode is an operating mode for adjusting the indoor temperature and humidity, and includes the first operation for preferentially treating latent heat and the second operation for treating latent heat and sensible heat separately.

[0016]

30 A fifth invention is an invention according to the fourth invention, wherein the control device (60) determines whether to start a next operation including the first operation and the second operation, at a time of starting the temperature and humidity control mode.

[0017]

In the fifth invention, when the temperature and humidity control mode is started, it

is determined whether to start at least the first operation and the second operation.

[0018]

A sixth invention is an invention according to any one of the first to fifth inventions, wherein the control device (60) is configured to perform a third operation in which the indoor units (30, 50) of all the air conditioners (20, 40) are controlled such that the air is cooled at a temperature higher than the dew point temperature.

[0019]

In the sixth invention, when the third operation is performed, the indoor units (30, 50) of all the air conditioners (20, 40) are controlled such that the air is cooled at a temperature higher than the dew point temperature. All the air conditioners (20, 40) are for air-conditioning the same indoor space (11). Therefore, the sensible heat in the room can be treated promptly through the third operation.

[0020]

A seventh invention is an invention according to the sixth invention, wherein the control device (60) performs the third operation when a condition indicating that the indoor humidity is lower than a predetermined value and the indoor temperature is higher than a predetermined value is satisfied.

[0021]

In the seventh invention, the third operation is performed under conditions where only the indoor temperature is high. This makes it possible to only treat the sensible heat in the room without an excessive decrease in the humidity of the air. Therefore, it is possible to bring the indoor temperature and humidity close to target values without a wasteful consumption of energy for treating the latent heat in the room.

<Advantageous Effects of Invention>

[0022]

According to the present invention, in the plurality of air conditioners (20, 40) that air-condition the same indoor space (11), operations are switched between the first operation for preferentially treating latent heat with all the air conditioners (20, 40), and the second operation for treating latent heat and sensible heat substantially separately with the plurality of air conditioners (20, 40). As a result, the latent heat in the room can be promptly treated through the first operation performed under conditions where a latent heat load is high, and the comfort in the room can be secured. The second operation is performed under conditions where the indoor temperature and humidity are in the target range, making it possible to avoid cooling the air to an excessively low temperature. As a result, it is

possible to suppress a wasteful consumption of energy for cooling the air and to suppress a cold draft felt by a user.

BRIEF DESCRIPTION OF THE DRAWINGS

5 [0023]

FIG. 1 is a schematic overall configuration diagram of an air conditioning system according to an embodiment.

FIG. 2 is a schematic piping diagram of a first air conditioner and a second air conditioner of the air conditioning system according to the embodiment.

10 FIG. 3 is a block diagram of the air conditioning system according to the embodiment.

FIG. 4 is a flowchart for describing a flow of transition to a temperature and humidity control mode of the air conditioning system according to the embodiment.

15 FIG. 5 is a flowchart for describing a flow of determination during each operation under the temperature and humidity control mode of the air conditioning system according to the embodiment.

FIG. 6 is a psychrometric chart for describing a relationship between each operation and thresholds or areas used in a first determination at the beginning of the temperature and humidity control mode.

20 FIG. 7 is a psychrometric chart for describing a relationship between each operation and thresholds or areas used in a determination during a dehumidifying operation and an unseparated operation.

FIG. 8 is a psychrometric chart for describing a relationship between each operation and thresholds or areas used in a determination during a latent- and sensible-heat separation operation.

FIG. 9 is a psychrometric chart for describing a relationship between each operation and thresholds or areas used in a determination during a sensible-heat operation.

FIG. 10 is a psychrometric chart for describing a relationship between each operation and thresholds or areas used in a determination during a latent-heat operation.

30 FIG. 11 is a psychrometric chart for describing an evaporation temperature determination during the dehumidifying operation and the latent-heat operation.

DESCRIPTION OF EMBODIMENTS

[0024]

An embodiment of the present invention will be described in detail below with reference to the drawings. The following embodiment is an essentially preferred example, and is not intended to limit the scope of the present invention, matters to which the present invention is applicable, or the usage of the present invention.

5 [0025]

<Overall configuration of air conditioning system>

An air conditioning system (10) of the present embodiment includes a plurality of air conditioners (20, 40). The plurality of air conditioners (20, 40) air-conditions the same indoor space (11). The air conditioning system (10) of the present embodiment is provided
10 with two air conditioners (a first air conditioner (20) and a second air conditioner (40)). Alternatively, the air conditioning system (10) may include three or more air conditioners. The first air conditioner (20) and the second air conditioner (40) have basically the same configuration. The air conditioning system (10) also includes a control device (60) that controls the air conditioners (20, 40).

15 [0026]

<First air conditioner>

As illustrated in FIGS. 1 and 2, the first air conditioner (20) includes a first outdoor unit (21) installed outdoors and a plurality of first indoor units (30) installed indoors. The plurality of first indoor units (30) is connected in parallel to the first outdoor unit (21) via two
20 connection pipes. The number of first indoor units (30) may be one, two, or three or more.

[0027]

The first air conditioner (20) includes a first refrigerant circuit (22) filled with refrigerant. In the first refrigerant circuit (22), a refrigeration cycle is performed based on circulation of the refrigerant. A first compressor (23), a first outdoor heat exchanger (24), a
25 first outdoor expansion valve (25), a first four-way switching valve (26), and a plurality of first indoor heat exchangers (32) are connected to the first refrigerant circuit (22).

[0028]

The first compressor (23), the first outdoor heat exchanger (24), the first outdoor expansion valve (25), and the first four-way switching valve (26) are provided in the first
30 outdoor unit (21). The first compressor (23) is an inverter-type compressor having a variable capacity. An operating frequency (the number of rotations of a motor) of the first compressor (23) is adjustable through control of the output of an inverter device. The first outdoor heat exchanger (24) is, for example, a fin-and-tube heat exchanger. A first outdoor fan (27) is provided near the first outdoor heat exchanger (24). The first outdoor heat

exchanger (24) exchanges heat between the refrigerant and outdoor air blown by the first outdoor fan (27). The first outdoor expansion valve (25) is an electronic expansion valve having a variable opening degree. The first four-way switching valve (26) has first to fourth ports. The first port communicates with a discharge side of the first compressor (23), while
5 the second port communicates with a suction side of the first compressor (23). The third port communicates with a gas-side end of the first outdoor heat exchanger (24), while the fourth port communicates with gas-side ends of the first indoor heat exchangers (32). The first four-way switching valve (26) is switched between a first state (illustrated by the solid lines in FIG. 2) and a second state (illustrated by the broken lines in FIG. 2). In the first
10 state, the first port and the third port communicate with each other while the second port and the fourth port communicate with each other. In the second state, the first port and the fourth port communicate with each other while the second port and the third port communicate with each other.

[0029]

15 Each of the first indoor units (30) includes one first indoor heat exchanger (32). The first indoor heat exchanger (32) is disposed in an air passage in the first indoor unit (30). A first indoor fan (33) is provided near (on the downstream side of) the first indoor heat exchanger (32). The first indoor heat exchanger (32) exchanges heat between the refrigerant and indoor air (suction air) sucked from the indoor space (11). The air subjected to the heat
20 exchange by the first indoor heat exchanger (32) is supplied to the indoor space (11) as blown air.

[0030]

The first indoor fan (33) is, for example, a centrifugal fan, and the air volume of the fan is adjustable. The air volume of the first indoor fan (33) of the present embodiment can
25 be switched in three stages, i.e., an L tap (low air volume), an M tap (medium air volume), and an H tap (high air volume).

[0031]

Each of the first indoor units (30) is provided with one first suction temperature sensor (34) and one first suction humidity sensor (35). The first suction temperature sensor
30 (34) detects the temperature of the suction air. The first suction humidity sensor (35) detects the humidity (absolute humidity) of the suction air.

[0032]

The refrigeration cycle performed in the first refrigerant circuit (22) is switched between a first refrigeration cycle (cooling cycle) and a second refrigeration cycle (heating

cycle). In the first refrigeration cycle, the first four-way switching valve (26) is in the first state, where the first compressor (23), the first outdoor fan (27), and the first indoor fan (33) are operated. Thus, in the first refrigeration cycle, the refrigerant dissipates heat (condenses) in the first outdoor heat exchanger (24), is decompressed in the first outdoor expansion valve (25), and evaporates in the first indoor heat exchanger (32). In the second refrigeration cycle, the first four-way switching valve (26) is in the second state, where the first compressor (23), the first outdoor fan (27), and the first indoor fan (33) are operated. Thus, in the second refrigeration cycle, the refrigerant dissipates heat (condenses) in the first indoor heat exchanger (32), is decompressed in the first outdoor expansion valve (25), and evaporates in the first outdoor heat exchanger (24).

[0033]

The first indoor heat exchanger (32) of the first refrigerant circuit (22) is provided with a refrigerant temperature sensor (not illustrated) that detects an evaporation temperature (T_e).

[0034]

<Second air conditioner>

As illustrated in FIG. 2, the second air conditioner (40) includes similar components to those of the first air conditioner (20). That is, the second air conditioner (40) includes a second refrigerant circuit (42) through which refrigerant circulates and to which a second outdoor unit (41) and a plurality of second indoor units (50) are connected.

[0035]

The second outdoor unit (41) is provided with a second compressor (43), a second outdoor heat exchanger (44), a second outdoor expansion valve (45), a second four-way switching valve (46), and a second outdoor fan (47). Each of the second indoor units (50) is provided with a second indoor heat exchanger (52), a second indoor fan (53), a second suction temperature sensor (54), and a second suction humidity sensor (55). The refrigeration cycle in the second refrigerant circuit (42) is switched between the first refrigeration cycle (cooling cycle) and the second refrigeration cycle (heating cycle), in a similar manner to the first refrigerant circuit (22). The configuration of each device of the second air conditioner (40) is similar to that of the first air conditioner (20), and thus the detailed description thereof will be omitted.

[0036]

<Remote controller>

As illustrated in FIG. 1, the first air conditioner (20) is provided with a first remote

controller (36). The second air conditioner (40) is provided with a second remote controller (56). Each remote controller (36, 56) is installed, for example, on a wall in a room and configured to be operable by a user. Each remote controller (36, 56) includes an operation unit with which to turn the power on and off, switch the operating mode, and switch the direction of blown air, for example, for the corresponding air conditioner (20, 40). Each remote controller (36, 56) also includes a display unit on which to display the current operating mode, the set temperature, and the set humidity, for example, of the corresponding air conditioner (20, 40).

[0037]

10 <Control device>

As illustrated in FIGS. 1 and 3, the air conditioning system (10) includes the control device (60) (control system) that controls the air conditioners (20, 40). The control device (60) of the present embodiment includes a first local controller (61), a second local controller (71), a communication terminal (80), a router (85), and a cloud server (90).

15 [0038]

The first local controller (61) is provided corresponding to the first air conditioner (20). The first local controller (61) is configured to control, for example, each component of the first refrigerant circuit (22), and the first indoor fan (33). The first local controller (61) includes a microcomputer and a memory device (specifically, a semiconductor memory) that stores software for operating the microcomputer.

20

[0039]

The first local controller (61) includes a first capability determination unit (62), a first capability control unit (63), and a first communication unit (64). The first capability determination unit (62) is a calculation unit that determines the capability of the first air conditioner (20). The first capability control unit (63) controls the capability of the first air conditioner (20).

25

[0040]

The first communication unit (64) is connected to the Internet (86) via the router (85) and configured to communicate with the cloud server (90) via the Internet (86). The first communication unit (64) may communicate with the router (85) wirelessly or in a wired manner. Such a configuration enables bidirectional exchange of signals, such as operation commands and control parameters, between the first local controller (61) and the cloud server (90).

30

[0041]

The second local controller (71) is provided corresponding to the second air conditioner (40). The second local controller (71) is configured to control, for example, each component of the second refrigerant circuit (42), and the second indoor fan (53). The second local controller (71) includes a microcomputer and a memory device (specifically, a semiconductor memory) that stores software for operating the microcomputer.

[0042]

The second local controller (71) includes a second capability determination unit (72), a second capability control unit (73), and a second communication unit (74). The second capability determination unit (72) is a calculation unit that determines the capability of the second air conditioner (40). The second capability control unit (73) controls the capability of the second air conditioner (40).

[0043]

The second communication unit (74) is connected to the Internet (86) via the router (85) and configured to communicate with the cloud server (90) via the Internet (86). The second communication unit (74) may communicate with the router (85) wirelessly or in a wired manner.

[0044]

The communication terminal (80) is a communication device for the user to activate the operation under the temperature and humidity control mode, which will be described in detail later. The communication terminal (80) includes, for example, a smartphone or a tablet PC. The communication terminal (80) includes a microcomputer and a memory device (specifically, a semiconductor memory) that stores software for operating the microcomputer. The communication terminal (80) further includes a touch panel (81) that serves also as a display unit and an operation unit, and a communication unit (82) connected to the cloud server (90) via the Internet (86).

[0045]

The communication terminal (80) stores a program (control application) for executing the temperature and humidity control mode. By operating the touch panel (81) of the communication terminal (80), the user can activate or deactivate the temperature and humidity control mode, set an indoor target temperature (T_s) under the temperature and humidity control mode, and set an indoor target humidity (R_s) under the temperature and humidity control mode.

[0046]

The cloud server (90) is configured to bidirectionally communicate with the first

local controller (61), the second local controller (71), and the communication terminal (80) via the Internet (86). The cloud server (90) includes a microcomputer and a memory device (specifically, a semiconductor memory) that stores software for operating the microcomputer.
[0047]

5 The cloud server (90) includes an operation determination unit (91) and a capability determination unit (92). The operation determination unit (91) makes a determination for switching various operations (details will be described later) under the temperature and humidity control mode. The capability determination unit (92) determines a target evaporation temperature of each air conditioner (20, 40) and the speed of the indoor fan (fan
10 tap) in each operation under the temperature and humidity control mode. The cloud server (90) transmits the operation parameters thus determined to each local controller (61, 71) via the Internet (86) at predetermined time intervals (for example, every 20 seconds).

[0048]

-Operation-

15 The operation of the air conditioning system (10) will be described in detail.

[0049]

With the air conditioning system (10), a temperature control mode or the temperature and humidity control mode can be selected. The temperature control mode is an operating mode for only adjusting the temperature of indoor air in the indoor space (11),
20 and includes a cooling operation and a heating operation. Control is exercised under the temperature control mode such that the temperature of the indoor air is brought close to a target temperature. The temperature and humidity control mode is an operating mode for adjusting the temperature and humidity of the indoor air in the indoor space (11). The temperature and humidity control mode includes 1) a dehumidifying operation, 2) an
25 unseparated operation, 3) a latent- and sensible-heat separation operation, 4) a sensible-heat operation, and 5) a latent-heat operation. Under the temperature and humidity control mode, the operations 1) to 5) are automatically switched and performed in accordance with the indoor air state (temperature and humidity). The details of these operations will be described later.

30 [0050]

-Cooling operation under temperature control mode-

The cooling operation under the temperature control mode will be described. During the cooling operation, the first refrigeration cycle described above is performed in each air conditioner (20, 40). That is, the refrigerant compressed by the compressors (23,

43) is condensed by the outdoor heat exchangers (24, 44) and dissipates heat to the outdoor air. The condensed refrigerant is decompressed by the outdoor expansion valves (25, 45), and then flows through the indoor heat exchangers (32, 52). In the indoor heat exchangers (32, 52), the refrigerant absorbs heat from the indoor air and evaporates. As a result, the suction air is cooled in the indoor units (30, 50). The evaporated refrigerant is sucked into the compressors (23, 43) and compressed again. The air cooled by the indoor heat exchangers (32, 52) is supplied to the indoor space (11) as blown air.

[0051]

During the cooling operation, the capability of each air conditioner (20, 40) is controlled in accordance with a difference ΔT between the temperature of the suction air of each indoor unit (30, 50) and the set temperature. As this ΔT increases, the target evaporation temperature of each air conditioner (20, 40) decreases, and the operating frequency of each compressor (23, 43) increases. Conversely, as ΔT decreases, the target evaporation temperature of each air conditioner (20, 40) increases, and the operating frequency of each compressor (23, 43) decreases.

[0052]

-Temperature and humidity control mode-

During the operation under the temperature and humidity control mode, the indoor temperature is brought close to the target temperature (T_s) and the indoor humidity is brought close to the target humidity (R_s). Under the temperature and humidity control mode, various operations are switched in accordance with a current air state point (C), such that the current indoor temperature and humidity are each brought close to a target point (S) (see FIG. 6). The temperature and humidity control mode is achieved by mutual signal exchange among the local controllers (61, 71), the cloud server (90), and the communication terminal (80). Transmission and reception of signals between these terminals are performed at predetermined time intervals (for example, every 20 seconds).

[0053]

<Control exercised until transition to temperature and humidity control mode>

Control exercised until transition to the temperature and humidity control mode will be described with reference to FIG. 4. When the user activates the application of the communication terminal (80) and selects "ON" of the "temperature and humidity control mode" on the touch panel (81), a signal indicating this selection is output to the cloud server (90). At the same time, the target temperature (T_s) and the target humidity (R_s) set in the communication terminal (80) are input to the cloud server (90). As described above, upon

the instruction to start the temperature and humidity control mode, the processing proceeds from step St1 to step St2.

[0054]

Next, the cloud server (90) transmits the received target temperature (Ts) and target humidity (Rs) to the local controllers (61, 71) or the remote controllers (36, 56) of the air conditioners (20, 40). The local controllers (61, 71) determine whether to activate (thermo-on) the air conditioners (20, 40) based on the suction air temperature and the target temperature (Ts) detected by the air conditioners (20, 40). Alternatively, the local controllers (61, 71) may determine whether to activate the air conditioners (20, 40) based on the suction air humidity and the target humidity (Rs) detected by the air conditioners (20, 40).

[0055]

As described above, when the thermo-on condition is satisfied, the processing proceeds from step St2 to step St3, that is, proceeds to the temperature and humidity control mode.

[0056]

<First determination>

As illustrated in FIG. 5, a first determination is made (step St51) after the transition to the temperature and humidity control mode. In the first determination, the operation determination unit (91) determines which of 1) dehumidifying operation, 3) sensible-heat operation, 4) sensible-heat operation, and 5) latent-heat operation is to be performed. That is, 2) unseparated operation is not selected in the first determination. The target temperature (Ts) set in the communication terminal (80), the target humidity (Rs) set in the communication terminal (80), and the current air state in the indoor space (11) are used for the determination. Here, a current air temperature (T) in the indoor space (11), a current air humidity (R) in the indoor space (11), and a current discomfort index (DI) in the indoor space (11) are used as indices indicating the current air state.

[0057]

The air temperature (T) to be used is the highest air temperature (Tmax) among the detected temperatures of the plurality of first suction temperature sensors (34) and the detected temperatures of the plurality of second suction temperature sensors (54). The air humidity (R) is a detected humidity corresponding to the highest air temperature (Tmax), among the detected humidities of the plurality of first suction humidity sensors (35) and the detected humidities of the plurality of second suction humidity sensors (55). In other words, the air temperature (T) and the air humidity (R) respectively correspond to the suction

temperature sensor (34, 54) and the suction humidity sensor (35, 55), which constitute a pair in the corresponding indoor unit (30, 50).

[0058]

The discomfort index (DI) is determined based on the air temperature (T) and the air humidity (R). Here, the discomfort index is one of the thermal indices representing the thermal sensation of a human body, and can be calculated by a relational expression including a temperature and a humidity.

[0059]

In the determination, a plurality of thresholds for determining the transition to one of the operations is used. These thresholds are determined based on the target values of the indoor air state (i.e., the target temperature (Ts) and the target humidity (Rs)).

[0060]

Specifically, as will be conceptually described with reference to the psychrometric chart of FIG. 6, the operation determination unit (91) calculates a first temperature threshold (Ts1), a second temperature threshold (Ts2), a third temperature threshold (Ts3), a fourth temperature threshold (Ts4), and a thermo-off determination temperature (Toff) based on the target temperature (Ts). The first temperature threshold (Ts1) is a value obtained by adding a predetermined temperature $\Delta t1$ (for example, 0.5°C) to the target temperature (Ts). The second temperature threshold (Ts2) is a value obtained by adding a predetermined temperature $\Delta t2$ (for example, 1.5°C) to the target temperature (Ts). The third temperature threshold (Ts3) is a value obtained by adding a predetermined temperature $\Delta t3$ (for example, 2.0°C) to the target temperature (Ts). The fourth temperature threshold (Ts4) is a value obtained by subtracting a predetermined temperature $\Delta t4$ (for example, 0.5°C) from the target temperature (Ts). The thermo-off determination temperature (Toff) is a value obtained by subtracting a predetermined temperature (for example, 2°C) from the target temperature. In the present embodiment, $\Delta t1$ and $\Delta t4$ are equal.

[0061]

The operation determination unit (91) calculates a first humidity threshold (Rs1), a second humidity threshold (Rs2), a third humidity threshold (Rs3), and a fourth humidity threshold (Rs4) based on the target humidity (Rs). Here, the first humidity threshold (Rs1) is a value obtained by adding a predetermined humidity $\Delta r1$ (for example, $1.0\text{ g/kg (dry-air)}$) to the target humidity (Rs). The second humidity threshold (Rs2) is a value obtained by adding a predetermined humidity $\Delta r2$ (for example, $2.0\text{ g/kg (dry-air)}$) to the target humidity (Rs). The third humidity threshold (Rs3) is a value obtained by subtracting a predetermined

humidity Δr_3 (for example, 1.0 g/kg (dry-air)) from the target humidity (R_s). The fourth humidity threshold (R_{s4}) is a value obtained by subtracting a predetermined humidity Δr_4 (for example, 2.0 g/kg (dry-air)) from the target humidity (R_s). In the present embodiment, Δr_1 and Δr_3 are equal, and Δr_2 and Δr_4 are equal.

5 [0062]

The operation determination unit (91) calculates a target discomfort index (DI_{s1}) of the indoor space (11) based on the target temperature (T_s) and the target humidity (R_s). In the psychrometric chart of FIG. 6, the discomfort index increases toward the upper right section of the chart (as the temperature and humidity increase), and the discomfort index decreases toward the lower left section of the chart (as the temperature and humidity decrease). Therefore, in the psychrometric chart, the target discomfort index (DI_{s1}) is represented by a line extending toward the upper left section of the chart, and the target discomfort index (DI_{s1}) is defined as a first discomfort index threshold. Furthermore, the operation determination unit (91) determines a value, obtained by adding a predetermined value (for example, 0.5) to the target discomfort index (DI_{s1}), as a second discomfort index threshold (DI_{s2}).

[0063]

The operation determination unit (91) compares each threshold described above with the current air state point (C) (i.e., the air temperature (T) and the air humidity (R)), and determines one of the operations to which the air conditioning system is to transition.

20 [0064]

Specifically, in a case where the current air state point (C) is in an area E1 surrounded by a thick line, the operation determination unit (91) determines the transition to the latent- and sensible-heat separation operation. That is, the transition to the latent- and sensible-heat separation operation is determined in a case where the air temperature (T) is lower than the second temperature threshold (T_{s2}), and the air humidity (R) is equal to or higher than the third humidity threshold (R_{s3}) but lower than the first humidity threshold (R_{s1}). The operation determination unit (91) determines the transition to the latent- and sensible-heat separation operation also in a case where the current discomfort index (DI) of air is lower than the target discomfort index (DI_{s1}) and the air humidity (R) is equal to or higher than the third humidity threshold (R_{s3}).

30 [0065]

In a case where the current air state point (C) is in an area E2 surrounded by a thick line, the operation determination unit (91) determines the transition to the sensible-heat

operation. That is, the transition to the sensible-heat operation is determined in a case where the air temperature (T) is equal to or higher than the second temperature threshold (Ts2) and the air humidity (R) is lower than the first humidity threshold (Rs1). The operation determination unit (91) determines the transition to the sensible-heat operation also in a case
5 where the air temperature (T) is lower than the second temperature threshold (Ts2) and the air humidity (R) is lower than the third humidity threshold (Rs3).

[0066]

In a case where the current air state point (C) is in an area E3 surrounded by a thick line, the operation determination unit (91) determines the transition to the latent-heat
10 operation. That is, the transition to the latent-heat operation is determined in a case where the air temperature (T) is lower than the first temperature threshold (Ts1), the air humidity (R) is equal to or higher than the first humidity threshold (Rs1), and the discomfort index (DI) is equal to or higher than the target discomfort index (DI_{s1}).

[0067]

In a case where the current air state point (C) is in an area E4, the operation determination unit (91) determines the transition to the dehumidifying operation. That is,
15 the transition to the dehumidifying operation is determined in a case where the air temperature (T) is equal to or higher than the first temperature threshold (Ts1) and the air humidity (R) is equal to or higher than the first humidity threshold (Rs1).

[0068]

As illustrated in FIG. 5, in the present embodiment, when a predetermined time (for example, 120 seconds) elapses in step St56 after the dehumidifying operation is started, the processing proceeds to step St57 where the dehumidifying operation is switched to the unseparated operation.

[0069]

<Outline of second and subsequent determinations>

In the second and subsequent determinations after the transition to the temperature and humidity control mode (step St58), the operation determination unit (91) determines which of the operations other than the dehumidifying operation (i.e., 2) unseparated operation,
30 3) sensible-heat operation, 4) sensible-heat operation, and 5) latent-heat operation) is to be performed. That is, under the temperature and humidity control mode, the dehumidifying operation is performed only in the case where the current air is in the area E4 in the first determination immediately after the temperature and humidity control mode has started.

[0070]

The second and subsequent determinations are made at predetermined time intervals (for example, every 20 seconds) during each operation. The basic determination criteria for the second and subsequent determinations are the same as those for the first determination described above. In the second and subsequent determinations, however, the thresholds for determining the next operation are different from those used in the first determination, depending on the current operation being performed.

[0071]

<Determination during dehumidifying operation and unseparated operation>

The thresholds used for the determination during the dehumidifying operation and the unseparated operation are those illustrated in FIG. 7. In these operations, the humidity range of the area E1 corresponding to the latent- and sensible-heat separation operation is expanded toward the lower side (low humidity side) as compared to the other determinations, although the detailed description is omitted. Moreover, in these operations, the threshold of the discomfort index in the range equal to or higher than the first humidity threshold (Rs1) does not exist in the area E1 corresponding to the latent- and sensible-heat separation operation.

[0072]

<Determination during latent- and sensible-heat separation operation>

The thresholds used for the determination during the latent- and sensible-heat separation operation are those illustrated in FIG. 8. During the latent- and sensible-heat separation operation, the area E2 corresponding to the sensible-heat operation and the area E3 corresponding to the latent-heat operation are smaller than those in the first determination, although the detailed description is omitted. In a case where the current air state point (C) is in an area E5 during the latent- and sensible-heat separation operation, the transition to the unseparated operation is determined. The range of the area E5 during the latent- and sensible-heat separation operation is smaller than that of the area E4 in the first determination (the range for determining the transition to the dehumidifying operation). As described above, in the determination during the latent- and sensible-heat separation operation, the area E1 for continuing the latent- and sensible-heat separation operation is larger than the area E1 in the first determination. This makes it possible to prevent another operation from starting again (so-called hunting), which would otherwise be caused by a slight increase in the air temperature (T) and the air humidity (R) after the transition to the latent- and sensible-heat separation operation.

[0073]

<Determination during sensible-heat operation>

The thresholds used for the determination during the sensible-heat operation are those illustrated in FIG. 9. During the sensible-heat operation, there is an area E6 (hatched area) that is not included in the other determinations, although the detailed description is omitted. The area E6 is, like the area E5, an area for determining the transition to the unseparated operation. Note that, in a case where the air state point (C) is in the area E5 in the determination during the sensible-heat operation, the operation immediately transitions to the unseparated operation. Meanwhile, in a case where the air state point (C) is in the area E6 in the determination during the sensible-heat operation, this state continues for a predetermined time (for example, 180 seconds), after which the operation transitions to the unseparated operation. With such time constraints provided in the area near the boundary between the sensible-heat operation and the unseparated operation, the hunting between the sensible-heat operation and the unseparated operation can be avoided.

[0074]

<Determination during latent-heat operation>

The thresholds used for the determination during the latent-heat operation are those illustrated in FIG. 10. During the latent-heat operation, the humidity range of the area E1 corresponding to the latent- and sensible-heat separation operation is expanded toward the lower side (low humidity side) as compared to the first determination, although the detailed description is omitted.

[0075]

<Outline of each operation>

Next, each operation performed under the temperature and humidity control mode will be described. The operation under the temperature and humidity control mode is roughly classified into the following first to third operations. In the first operation, all of the plurality of air conditioners (20, 40) operate as latent heat machines. In the second operation, a part of the plurality of air conditioners (in this example, the first air conditioner (20)) operates as a latent heat machine, and the other air conditioners (in this example, the second air conditioner (40)) operate as a sensible heat machine. In the third operation, all of the plurality of air conditioners (20, 40) (in this example, the first air conditioner (20) and the second air conditioner (40)) operate as sensible heat machines. The first operation includes the dehumidifying operation, the unseparated operation, and the latent-heat operation. The latent- and sensible-heat separation operation corresponds to the second operation, and the sensible-heat operation corresponds to the third operation.

[0076]

The “latent heat machine” refers to an air conditioner controlled such that the indoor heat exchanger (32, 52) of the indoor unit (30, 50) cools the air to the dew point temperature or lower. Therefore, when the air is cooled by the indoor unit (30, 50) of the latent heat machine, the moisture in the air condenses, and the condensed water is collected in a drain pan or the like. As a result, both the temperature and the humidity of the air decrease in the indoor unit (30, 50) of the latent heat machine.

[0077]

The “sensible heat machine” refers to an air conditioner controlled such that the indoor heat exchanger (32, 52) of the indoor unit (30, 50) cools the air at a temperature higher than the dew point temperature. Therefore, when the air is cooled by the indoor unit (30, 50) of the sensible heat machine, the moisture in the air does not condense, and only the temperature of the air decreases.

[0078]

<Dehumidifying operation>

The dehumidifying operation is for rapidly lowering the absolute humidity in the room under the conditions where the indoor humidity and temperature are high. During the dehumidifying operation, both the first air conditioner (20) and the second air conditioner (40) operate as latent heat machines.

[0079]

Upon transition to the dehumidifying operation, the cloud server (90) transmits, to each local controller (61, 71), a signal for controlling the air volume of the indoor fan (33, 53) of the corresponding air conditioner (20, 40). During the dehumidifying operation, a signal for controlling the air volume of the indoor fan (33, 53) to the L tap is transmitted. As a result, during the dehumidifying operation, the air volumes of all the indoor fans (33, 53) become low, and the dehumidifying performance of each indoor unit (30, 50) is improved.

[0080]

The cloud server (90) appropriately determines a target evaporation temperature (TeS) of each air conditioner (20, 40), and transmits the determined target evaporation temperature (TeS) to each local controller (61, 71). Here, during the dehumidifying operation, the target evaporation temperature (TeS) is calculated based on the current air state through the following processing (target evaporation temperature determination processing). Specifically, the capability determination unit (92) calculates the target evaporation temperature (TeS) using a function expression stored in the memory. Here, this function

expression includes a saturation curve, the current air temperature (T), and the current air humidity (R) illustrated on the psychrometric chart of FIG. 11. Specifically, as illustrated in FIG. 11, this function expression is for calculating a temperature (T_p) corresponding to a contact point (P) between the saturation curve on the psychrometric chart and a straight line M passing through the current air state point. Here, the current air state point (C) corresponds to the current air temperature (T) and the current air humidity (R). The temperature (T_p) corresponding to the contact point (P) is calculated by this function expression, and this temperature (T_p) is set as the target evaporation temperature (T_{eS}). During the dehumidifying operation, such target evaporation temperature determination processing is performed, in principle, at predetermined time intervals (every 20 seconds).

[0081]

The target evaporation temperature (T_{eS}) determined in this manner is appropriately transmitted to each local controller (61, 71) via the Internet (86). As a result, each air conditioner (20, 40) controls the operating frequency of the corresponding compressor (23, 43) such that the current evaporation temperature (T_e) is brought close to the target evaporation temperature (T_{eS}) received at predetermined time intervals.

[0082]

The target evaporation temperature (T) is determined in this manner during the dehumidifying operation, making it possible to prevent an excessive increase or decrease in the target evaporation temperature (T_{eS}). If the target evaporation temperature (T_{eS}) is too high, the temperature at which the air can be cooled becomes high, and the amount of moisture that can be condensed from the air decreases. This makes it difficult to dehumidify the indoor air quickly, and to bring the indoor temperature and humidity close to the target point (S) quickly. As a result, the comfort of the indoor space (11) is impaired.

[0083]

If the target evaporation temperature (T_{eS}) is too low, on the other hand, the air is to be dehumidified in an area where a sensible heat ratio of the air is large (area where the inclination of the arrow a in FIG. 11 is small). In this area, the proportion of latent heat to be treated to the total amount of heat to be treated is small, which is disadvantageous for dehumidification. When the air is cooled in this area, therefore, the dehumidification efficiency is lowered, and thus energy conservation is degraded.

[0084]

To address this issue, as illustrated in FIG. 11, the temperature (T_p) corresponding to the contact point (P) is set as the target evaporation temperature (T_{eS}), whereby an excessive

increase or decrease in the target evaporation temperature (TeS) is prevented. As a result, it is possible to achieve both indoor comfort and energy conservation of the air conditioning system (10).

[0085]

5 An upper limit value is set to the target evaporation temperature (TeS) determined during the dehumidifying operation, such that each latent heat machine can reliably cool the air to the dew point temperature or lower. Therefore, during the dehumidifying operation, the temperature of the air cooled by each latent heat machine does not rise above the dew point temperature.

10 [0086]

During the dehumidifying operation, as described above, the target evaporation temperature determination processing is performed, in principle, at predetermined time intervals (every 20 seconds). Note that, in order to protect the compressor (23, 43) and prevent hunting of the evaporation temperature (Te), the following update determination is performed before each target evaporation temperature determination processing.

[0087]

In the update determination, it is determined whether the target evaporation temperature processing is to be performed again. In the update determination, in a case where one or both of Condition 1-A and Condition 1-B are satisfied, the target evaporation temperature determination processing is performed and the target evaporation temperature (TeS) is updated.

[0088]

1-A: Current $|Te - TeS| \leq E1$

1-B: $|(Current |Te - TeS| - Previous |Te - TeS|)| \leq E2$

25 [0089]

Here, Current $|Te - TeS|$ represents an absolute value of the difference between the current evaporation temperature (Te) and the current target evaporation temperature (TeS). Previous $|Te - TeS|$ corresponds to the value of $|Te - TeS|$ calculated in the previous update determination, the one just before the current update determination. E1 and E2 represent determination thresholds set in advance.

[0090]

In the case where Condition 1-A is satisfied, it can be determined that the actual evaporation temperature (Te) has converged to the target evaporation temperature (TeS). In the case where Condition 1-A is satisfied, therefore, the target evaporation temperature

determination processing is performed again to recalculate the target evaporation temperature (TeS).

[0091]

In the case where Condition 1-B is satisfied, it can be determined that a decreasing
5 change amount of the difference between the evaporation temperature (Te) and the target evaporation temperature (TeS) is small, and the evaporation temperature (Te) tends to converge to the target evaporation temperature (TeS). Also in the case where Condition 1-B is satisfied, therefore, the target evaporation temperature determination processing is performed again to recalculate the target evaporation temperature (TeS).

[0092]

In a case where neither Condition 1-A nor Condition 1-B is satisfied, it can be determined that the evaporation temperature (Te) has not converged to the target evaporation temperature (TeS), and the evaporation temperature (Te) has largely changed. In the case where these conditions are not satisfied, therefore, the target evaporation temperature
15 determination processing is prohibited, and the target evaporation temperature (TeS) is not recalculated. This makes it possible to restrict the target evaporation temperature (TeS) from being changed again when the evaporation temperature (Te) has changed relatively largely. Therefore, it is possible to avoid a significant change in the operating frequency of the compressor (23, 43), and the hunting of the evaporation temperature (Te).

[0093]

<Unseparated operation>

Like the dehumidifying operation, the unseparated operation is for lowering the absolute humidity in the room under the conditions where the indoor humidity and temperature are high. During the unseparated operation, both the first air conditioner (20)
25 and the second air conditioner (40) operate as latent heat machines. However, as described above, the unseparated operation is not performed in the first determination (see FIG. 5). During the unseparated operation, both the first air conditioner (20) and the second air conditioner (40) operate as latent heat machines.

[0094]

30 Upon transition to the unseparated operation, the cloud server (90) transmits, to each local controller (61, 71), a signal for controlling the air volume of the indoor fan (33, 53) of the corresponding air conditioner (20, 40). During the unseparated operation, a signal for controlling the air volume of the indoor fan (33, 53) to the M tap is transmitted. Thus, during the unseparated operation, all the indoor fans (33, 53) have a medium air volume.

[0095]

The cloud server (90) appropriately determines a target evaporation temperature (TeS) of each air conditioner (20, 40), and transmits the determined target evaporation temperature (TeS) to each local controller (61, 71). Here, the target evaporation temperature (TeS) during the unseparated operation is determined by a method similar to that used during the cooling operation of the temperature control mode.

[0096]

That is, in the evaporation temperature determination processing during the unseparated operation, the target evaporation temperature (TeS) is calculated in accordance with a difference ΔTrs between the current air temperature (T) and the target temperature (Ts) set in the communication terminal (80). As ΔTrs increases, the target evaporation temperature (TeS) decreases in order to increase the capability of each air conditioner (20, 40). Conversely, as ΔTrs decreases, the target evaporation temperature (TeS) increases in order to decrease the capability of each air conditioner (20, 40).

[0097]

An upper limit value is set to the target evaporation temperature (TeS) determined during the unseparated operation, such that each latent heat machine can reliably cool the air to the dew point temperature or lower. Therefore, during the unseparated operation, the temperature of the air cooled by each latent heat machine does not rise above the dew point temperature.

[0098]

During the unseparated operation, as in the dehumidifying operation, the update determination is made as to whether the target evaporation temperature (TeS) is to be updated. This can protect the compressor (23, 43) and avoid the hunting of the evaporation temperature (Te).

[0099]

<Latent-heat operation>

The latent-heat operation is for lowering the absolute humidity in the room under the conditions where the indoor humidity is particularly high. During the latent-heat operation, both the first air conditioner (20) and the second air conditioner (40) operate as latent heat machines. The latent-heat operation is basically subject to the same control as the dehumidifying operation.

[0100]

During the latent-heat operation, a signal for controlling the air volume of the indoor

fan (33, 53) to the M tap is transmitted. Thus, during the latent-heat operation, all the indoor fans (33, 53) have a medium air volume.

[0101]

In the evaporation temperature determination processing during the latent-heat operation, the target evaporation temperature (TeS) is determined based on the temperature (Tp) corresponding to the contact point (P), as in the dehumidifying operation. Unlike the dehumidifying operation, however, the update determination of the target evaporation temperature (TeS) is not made during the latent-heat operation. During the latent-heat operation, therefore, the target evaporation temperature (TeS) is constantly recalculated at predetermined time intervals (for example, every 20 seconds).

[0102]

The latent-heat operation is performed in the case where the air state point (C) is in the area E3 as described above, and the area E3 is near the thermo-off area. If, during the latent-heat operation, recalculation of the target evaporation temperature (TeS) is prohibited as in the dehumidifying operation, the air may be excessively cooled during the operation, and the air temperature (T) may fall far below the target evaporation temperature (TeS). In this case, the air temperature (T) may reach the thermo-off area.

[0103]

In the present embodiment, in contrast, the target evaporation temperature (TeS) is constantly updated during the latent-heat operation. Therefore, the target evaporation temperature (TeS) can be adjusted before the air temperature (T) is excessively lowered. This makes it possible to prevent the air temperature (T) from reaching the thermo-off area. During the latent-heat operation, the evaporation temperature (Te) is more likely to converge to the target evaporation temperature (TeS) than in the dehumidifying operation; therefore, the operating frequency of the compressor (23, 43) and the evaporation temperature (Te) do not significantly change even without the restrictions imposed by the update determination.

[0104]

<Outline of latent- and sensible-heat separation operation>

During the latent- and sensible-heat separation operation (simultaneous operation), when the indoor temperature and humidity are in a range close to the target point (S), latent heat and sensible heat in the room are treated separately in each air conditioner (20, 40). During the latent- and sensible-heat separation operation of the present embodiment, the first air conditioner (20) operates as a latent heat machine, and the second air conditioner (40) operates as a sensible heat machine. Therefore, during the latent- and sensible-heat

separation operation, the indoor unit (30, 50) of the first air conditioner (20) cools and dehumidifies the air and, at the same time, the indoor unit (30, 50) of the second air conditioner (40) only cools the air. As described above, through simultaneous operation of the latent heat machine and the sensible heat machine, it is possible to bring the indoor temperature and humidity close to the target range while avoiding an excessive decrease in the indoor temperature.

[0105]

During the latent- and sensible-heat separation operation, it is necessary for the cloud server (90) to send different control signals to a local controller corresponding to the latent heat machine (in this example, the first local controller (61)) and to a local controller corresponding to the sensible heat machine (in this example, the second local controller (71)). This is because different control is performed between the sensible heat machine and the latent heat machine. Therefore, device information is registered in the cloud server (90), the device information indicating which air conditioner (20, 40) operates as the latent heat machine and which air conditioner (20, 40) operates as the sensible heat machine during the latent- and sensible-heat separation operation. In this example, device information indicating that the first air conditioner (20) operates as the latent heat machine during the latent- and sensible-heat separation operation, and device information indicating that the second air conditioner (40) operates as the sensible heat machine during the latent- and sensible-heat separation operation are registered in the cloud server (90). For example, such information is transmitted from the communication terminal (80) or each local controller (61, 71) to the cloud server (90) via the Internet (86).

[0106]

<Control of latent heat machine during latent- and sensible-heat separation operation>

During the latent- and sensible-heat separation operation, the cloud server (90) transmits a signal for controlling the air volume of the first indoor fan (33), to the first local controller (61) corresponding to the first air conditioner (20) that operates as the latent heat machine. During the latent- and sensible-heat separation operation, the air volume of the first indoor fan (33) in the first air conditioner (20) is switched between two levels (for example, between the L tap and the M tap). For example, the first indoor fan (33) may be switched between two levels of the M tap and the H tap.

[0107]

The cloud server (90) transmits, to the first local controller (61), the target evaporation temperature (first target evaporation temperature (TeS1) for controlling the

evaporation temperature (T_e) of the first air conditioner (20).

[0108]

The evaporation temperature determination processing of the latent heat machine during the latent- and sensible-heat separation operation is performed by a method similar to that used during the dehumidifying operation. Specifically, the capability determination unit (92) sets, as the first target evaporation temperature (T_{eS1}), a temperature corresponding to the contact point between the saturation curve on the psychrometric chart and the straight line passing through the target point (S). In other words, the dehumidifying operation and the latent- and sensible-heat separation operation are different in the following: during the dehumidifying operation, the current air state point (C) (i.e., the air temperature (T) and the air humidity (R)) is used to determine the contact point with the saturation curve, whereas during the latent- and sensible-heat separation operation, the target point (S) (i.e., the target temperature (T_s) and the target humidity (R_s)) is used for that purpose. The target point (S) is determined based on the setting value of the communication terminal (80), and thus basically does not change, unlike the state point (C). Therefore, when the contact point is determined based on the target point (S), the first target evaporation temperature (T_{eS1}) does not significantly change. This makes it possible to avoid a situation where the current air state point (C) deviates from the area E1 in FIG. 8 due to such change in the first target evaporation temperature (T_{eS1}), and to suppress the switching from the latent- and sensible-heat separation operation to another operation.

[0109]

In the evaporation temperature determination processing of the latent heat machine during the latent- and sensible-heat separation operation, the update determination is performed in a similar manner to the dehumidifying operation. This can protect the compressor (23, 43) and prevent the hunting of the evaporation temperature (T_e).

[0110]

During the latent- and sensible-heat separation operation, the first target evaporation temperature (T_{eS1}) of the latent heat machine is adjusted stepwise based on the current air state point (C), the target point (S), and the immediately preceding change in the air state point (C) (air temperature (T) and air humidity (R)), although the detailed description is omitted.

[0111]

<Control of sensible heat machine during latent- and sensible-heat separation operation>

During the latent- and sensible-heat separation operation, the cloud server (90)

transmits a signal for controlling the air volume of the second indoor fan (53), to the second local controller (71) corresponding to the second air conditioner (40) that operates as the sensible heat machine. During the latent- and sensible-heat separation operation, the air volume of the second indoor fan (53) in the second air conditioner (40) is controlled to, for example, the M tap or the H tap.

[0112]

The cloud server (90) transmits, to the second local controller (71), the target evaporation temperature (TeS) (second target evaporation temperature (TeS2)) for controlling the evaporation temperature (Te) of the second air conditioner (40).

[0113]

In the evaporation temperature determination processing of the sensible heat machine during the latent- and sensible-heat separation operation, the second target evaporation temperature (TeS2) is determined such that the temperature of the air to be treated by the sensible heat machine becomes higher than the dew point temperature.

Specifically, a dew point temperature (Tdew-s) corresponding to the air is calculated based on the air state point (target temperature (Ts) and target humidity (Rs)) corresponding to the current target point (S). That is, the dew point temperature (Tdew-s) is a temperature at which dew condensation occurs from the air at the target point (S) in a case where the air is cooled. Then, in the evaporation temperature determination processing, the dew point temperature (Tdew-s) is set as the second target evaporation temperature (TeS2).

[0114]

The latent- and sensible-heat separation operation is performed when the current air state point (C) is in the area E1 including the target point (S). Therefore, a large difference in the temperature and humidity of the air does not occur between the current air state point (C) and the target point (S). It is substantially impossible that the air cooled by the second indoor heat exchanger (52) of the sensible heat machine is cooled to a temperature equal to or lower than the evaporation temperature. For this reason, with the dew point temperature (Tdew-s) corresponding to the target point (S) set as the second target evaporation temperature (TeS2), the sensible heat machine substantially cools the air at a temperature higher than the actual dew point temperature.

[0115]

The target point (S) is determined based on the setting value of the communication terminal (80), and thus basically does not change, unlike the state point (C). Therefore, when the dew point temperature is determined based on the target point (S), the second target

evaporation temperature ($TeS2$) does not significantly change. This makes it possible to avoid a situation where the current air state point (C) deviates from the area E1 in FIG. 8 due to such change in the second target evaporation temperature ($TeS2$), and to suppress the switching from the latent- and sensible-heat separation operation to another operation.

5 [0116]

<Sensible-heat operation>

The sensible-heat operation is for lowering the indoor temperature under the conditions where the indoor temperature is particularly high. During the sensible-heat operation, both the first air conditioner (20) and the second air conditioner (40) operate as
10 sensible heat machines.

[0117]

Upon transition to the sensible-heat operation, the cloud server (90) transmits, to each local controller (61, 71), a signal for controlling the air volume of the indoor fan (33, 53) of the corresponding air conditioner (20, 40). During the sensible-heat operation, a signal
15 for controlling the air volume of the indoor fan (33, 53) to the M tap is transmitted. Thus, during the sensible-heat operation, all the indoor fans (33, 53) have a medium air volume.

[0118]

The cloud server (90) transmits, to each local controller (61, 71), the target evaporation temperature (TeS) for controlling the evaporation temperature (Te) of the
20 corresponding air conditioner (20, 40).

[0119]

In the evaporation temperature determination processing during the sensible-heat operation, the target evaporation temperature (TeS) is determined such that the temperature of the air to be treated by the sensible heat machine becomes higher than the dew point
25 temperature. Specifically, a dew point temperature (T_{dew-c}) corresponding to the current air is calculated based on the current air state point (C) (air temperature (T) and air humidity (R)). That is, the dew point temperature (T_{dew-c}) is a temperature at which dew condensation occurs from the air at the current state point in a case where the air is cooled. Then, in the evaporation temperature determination processing, the dew point temperature
30 (T_{dew-c}) is set as the second target evaporation temperature ($TeS2$).

[0120]

The sensible-heat operation is performed when the current air state point (C) is in the area E2 apart from the target point (S). Therefore, the current air state point (C) is at a relatively higher temperature than the target point (S). For this reason, during the sensible-

heat operation, unlike the control of the latent heat machine during the latent- and sensible-heat separation operation, the dew point temperature ($T_{\text{dew-c}}$) corresponding to the current air state point (C), not the target point (S), is set as the target evaporation temperature (T_{eS}). That is, if the dew point temperature ($T_{\text{dew-s}}$) corresponding to the target point (S) is set as the target evaporation temperature during the sensible-heat operation, the target evaporation temperature (T_{eS}) becomes excessively low, and the air may be cooled to the actual dew point temperature or lower. During the sensible-heat operation, in contrast, the dew point temperature ($T_{\text{dew-c}}$) corresponding to the current air state point (C) is set as the target evaporation temperature (T_{eS}), making it possible to reliably prevent dehumidification of the air during the sensible-heat operation.

[0121]

<Thermo-off operation>

During each operation described above, in principle, when each suction temperature sensor (34, 54) of the air conditioners (20, 40) detects a temperature equal to or lower than the thermo-off determination temperature (T_{off}), the corresponding indoor unit (30, 50) enters thermo-off.

[0122]

During the latent- and sensible-heat separation operation, however, all the indoor units (30, 50) are prohibited from entering thermo-off until at least all the suction temperature sensors (34, 54) of the plurality of indoor units (30, 50) in operation detect a temperature equal to or lower than the thermo-off determination temperature (T_{off}). Therefore, during the latent- and sensible-heat separation operation, the indoor units (30, 50) do not enter thermo-off even when the suction temperature sensor (34, 54) of only a part of the indoor units (30, 50) detects a temperature equal to or lower than the thermo-off determination temperature (T_{off}).

[0123]

During the latent- and sensible-heat separation operation, the temperature of the blown air is different between the sensible heat machine and the latent heat machine. For this reason, the temperature tends to become uneven in the indoor space (11). Due to this phenomenon, the temperature detected by the suction temperature sensor (34, 54) of a part of the indoor units (30, 50) may become extremely low, making it difficult to continue the latent- and sensible-heat separation operation. To address this issue, the above-mentioned thermo-off determination is made, whereby the latent- and sensible-heat separation operation can be continued until the temperature of the entire indoor space (11) becomes equal to or

lower than the thermo-off determination temperature.

[0124]

-Effect of embodiment-

In the above embodiment, in a case where a condition indicating that the indoor
5 humidity is higher than a predetermined value (a condition in which the indoor humidity (R)
is, for example, equal to or higher than the first humidity threshold (Rs1) or the second
humidity threshold (Rs2)) is satisfied, the first operation (dehumidifying operation,
unseparated operation, or latent-heat operation) is performed with all the air conditioners (20,
40) operating as latent heat machines. Therefore, under the condition of a high indoor
10 humidity load, this humidity load can be treated promptly and the comfort in the room can be
secured.

[0125]

In a case where a condition indicating that the indoor temperature and humidity are
within a target range (a condition in which the air state point (C) is in the area E1) is satisfied,
15 the second operation (latent- and sensible-heat separation operation) is performed with the
first air conditioner (20) operating as a latent heat machine and the second air conditioner
(40) operating as a sensible heat machine. Therefore, in a case where the indoor
temperature and humidity are in an optimum range, the latent heat and the sensible heat can
be treated separately. This can prevent the energy conservation from being impaired due to
20 excessive cooling of the indoor air, and protect a user from feeling a cold draft.

[0126]

In a case where a condition indicating that the indoor humidity is lower than a
predetermined value and the indoor temperature is higher than a predetermined value (for
example, a condition in which the indoor humidity (R) is lower than the first humidity
25 threshold (Rs1) and the indoor temperature (T) is equal to or higher than the second
temperature threshold (Ts2)) is satisfied, the third operation (sensible-heat operation) is
performed with the first air conditioner (20) and the second air conditioner (40) operating as
sensible heat machines. Therefore, when only the indoor temperature is high, only the
sensible heat in the room can be promptly treated without lowering the humidity.

30 [0127]

Under the temperature and humidity control mode, the above operations are
switched in accordance with the temperature and humidity of the indoor air, whereby the state
point (C) can be converged to the first area E1, and the latent- and sensible-heat separation
operation can be performed as long as possible. This makes it possible to perform the

operation with excellent energy conservation while securing indoor comfort.

[0128]

<Air volume control>

In the embodiment described above, it is preferable to control the volumes of blown
5 air from the latent heat machine and the sensible heat machine as follows.

[0129]

As described above, the air conditioner (20, 40) operating as the latent heat machine
is controlled such that the air is cooled to the dew point temperature or lower. The air
conditioner (20, 40) operating as the sensible heat machine is controlled such that the air is
10 cooled at a temperature higher than the dew point temperature. For this reason, the
temperature of the blown air from the latent heat machine is lower than the temperature of the
blown air from the sensible heat machine. When the blown air from the latent heat machine
directly hits a person in the room, the person in the room feels a draft. During the latent-
and sensible-heat separation operation, therefore, the control device (60) exercises control
15 such that the volume of the blown air from the air conditioner (20, 40) operating as the latent
heat machine becomes smaller than the volume of the blown air from the air conditioner (20,
40) operating as the sensible heat machine. Specifically, during the latent- and sensible-heat
separation operation, the air volume of the indoor fan (33, 53) of the air conditioner (20, 40)
operating as the latent heat machine is set to, for example, the M tap (medium air volume),
20 and the air volume of the indoor fan (33, 53) of the air conditioner (20, 40) operating as the
sensible heat machine is set to, for example, the H tap (high air volume). This makes the
blown air from the latent heat machine reach a shorter distance, thus suppressing the low-
temperature air directly hitting the person in the room. In contrast, the blown air from the
sensible heat machine reaches a longer distance. Therefore, the relatively high-temperature
25 air is blown onto the person in the room, thus improving the comfort of the person in the
room.

[0130]

During the latent- and sensible-heat separation operation, the temperature
distribution of the indoor space may become uneven due to the difference between the
30 temperature of the blown air from the latent heat machine and the temperature of the blown
air from the sensible heat machine. To address this issue, the volume of the blown air from
the air conditioner (20, 40) operating as the sensible heat machine is made larger than the
volume of the blown air from the air conditioner (20, 40) operating as the latent heat machine.
This makes it possible to promote mixing of the blown air from the latent heat machine with

the blown air from the sensible heat machine. As a result, the unevenness in the temperature distribution of the indoor space can be suppressed during the latent- and sensible-heat separation operation.

[0131]

5 <Wind direction control>

In the embodiment described above, it is preferable to control the wind direction of the latent heat machine as follows.

[0132]

As described above, if the blown air from the latent heat machine directly hits the person in the room, the person in the room feels a draft. Accordingly, the control device (60) controls a wind direction adjustment blade (flap) of the air conditioner (20, 40) operating as the latent heat machine, such that the wind direction of the blown air from the air conditioner (20, 40) becomes substantially horizontal. This makes it possible to prevent the blown air from the latent heat machine from directly hitting the person in the room. Such wind direction control can be adopted as long as at least one of the air conditioners (20, 40) operates as the latent heat machine. Specifically, the latent heat machine can blow air horizontally during the dehumidifying operation, the unseparated operation, the latent-heat operation, and the latent- and sensible-heat separation operation described above.

[0133]

Depending on the layout of the room, for example, it may be inconvenient for the latent heat machine to blow air horizontally. Therefore, it is preferable to provide a wind direction setting unit that enables the user to arbitrarily change the wind direction of the blown air from the latent heat machine. For example, the wind direction setting unit can be provided in the remote controller (36, 56) or the communication terminal (80) described above.

[0134]

<<Other embodiments>>

The control device (60) of the above embodiment includes the cloud server (90), the communication terminal (80) and the like, and achieves the temperature and humidity control mode via the Internet (86). Alternatively, the control device (60) may control the air conditioners (20, 40) only with the local controllers, not via the Internet.

[0135]

Although the air conditioning system (10) of the above embodiment includes the two air conditioners (20, 40) used for air-conditioning the same indoor space (11), the number of

air conditioners (20, 40) may be three or more. Also in this case, which air conditioner operates as the latent heat machine and which air conditioner operates as the sensible heat machine during the latent- and sensible-heat separation operation, is registered in advance. For the latent- and sensible-heat separation operation, a ratio between the number of latent
5 heat machines and the number of sensible heat machines is determined based on the registered information.

[0136]

10 In the air conditioning system (10) of the above embodiment, for example, the air conditioner may be of a so-called multi-type for a building, having three or more indoor units and in which a refrigerant circuit in each indoor unit is provided with an indoor expansion valve.

INDUSTRIAL APPLICABILITY

[0137]

15 As described above, the present invention is useful for an air conditioning system.

REFERENCE SIGNS LIST

[0138]

10	Air conditioning system
20	20 First air conditioner
21	First outdoor unit
30	First indoor unit
40	Second air conditioner
41	Second outdoor unit
25	50 Second indoor unit
60	Control device

CLAIMS

1. An air conditioning system comprising:

a plurality of air conditioners (20, 40) each including an indoor unit (30, 50) and an outdoor unit (21, 41), each of the air conditioners being configured to perform a refrigeration cycle individually and air-condition a same indoor space; and

a control device (60) that controls the plurality of air conditioners (20, 40),

wherein the control device (60) is configured to perform:

a first operation in which the indoor units (30, 50) of all the air conditioners (20, 40) are controlled such that air is cooled to a dew point temperature or lower; and

a second operation in which the indoor unit (30) of at least one air conditioner (20) is controlled such that the air is cooled to the dew point temperature or lower, while the indoor unit (50) of another air conditioner (40) is controlled such that the air is cooled at a temperature higher than the dew point temperature.

2. The air conditioning system according to claim 1,

wherein the control device (60) performs the first operation when a condition indicating that at least an indoor humidity is higher than a predetermined value is satisfied.

3. The air conditioning system according to claim 1 or 2,

wherein the control device (60) performs the second operation when a condition indicating that an indoor temperature and the indoor humidity are in a target range is satisfied.

4. The air conditioning system according to any one of claims 1 to 3,

wherein the control device (60) is configured to switch modes between a temperature control mode including a normal cooling operation and a temperature and humidity control mode including the first operation and the second operation.

5. The air conditioning system according to claim 4,

wherein the control device (60) determines whether to start a next operation including the first operation and the second operation, at a time of starting the temperature and humidity control mode.

6. The air conditioning system according to any one of claims 1 to 5,

wherein the control device (60) is configured to perform a third operation in which the indoor units (30, 50) of all the air conditioners (20, 40) are controlled such that the air is cooled at a temperature higher than the dew point temperature.

7. The air conditioning system according to claim 6,

wherein the control device (60) performs the third operation when a condition indicating that the indoor humidity is lower than a predetermined value and the indoor

temperature is higher than a predetermined value is satisfied.