

[DESCRIPTION]

[TITLE OF INVENTION]

AIR CONDITIONING SYSTEM

[Technical Field]

5 [0001]

The present invention relates to an air conditioning system.

Priority is claimed on Japanese Patent Application No. 2015-202208, filed October 13, 2015, the content of which is incorporated herein by reference.

[Background Art]

10 [0002]

Recently, a desiccant air conditioning system has been proposed as an air conditioning system that generates cool air for a cooled area without using electric power (for example, see Patent Document 1).

[0003]

15 In a desiccant air conditioning system, humidity control is performed by a desiccant rotor and a humidity controller thereof (hereinafter simply referred to as a desiccant rotor device).

In general, in a desiccant rotor device, a desiccant rotor in which an adsorbent or a sorbent is carried on a cylindrical honeycomb structure rotates, air to be dehumidified
20 passes through, for example, one semicircular portion of the desiccant rotor from a first blow port of the rotating desiccant rotor, and moisture thereof is adsorbed or sorbed. In the desiccant rotor device, heated air (regeneration air) passes through the other semicircular portion of the desiccant rotor from a second blow port of the desiccant rotor and the adsorbent or the sorbent is regenerated by desorbing the moisture of the
25 adsorbent or the sorbent. Air is dehumidified by this circulation.

[Citation List]

[Patent Literature]

[0004]

[Patent Document 1]

5 Japanese Unexamined Patent Application, First Publication No. 2002-126441

[Summary of Invention]

[Technical Problem]

[0005]

As described above, in air conditioning techniques using a desiccant rotor in the
10 related art, dehumidification of indoor air to be air-conditioned is performed, but further
improvement in indoor air quality is required.

Particularly, in countries or regions in which atmospheric air pollution has
become severe, outdoor air may not be able to be directly supplied to a room and indoor
air may be reused. Since persons working indoors discharge carbon dioxide, an amount
15 of carbon dioxide in the air increases with the elapse of time and the discomfort felt by
persons indoors increases. Accordingly, there is demand for a technique of removing
carbon dioxide from indoor air.

[0006]

The present invention is made in consideration of the above-mentioned
20 circumstances and provides an air conditioning system that is capable of removing
carbon dioxide in indoor air and enhancing air quality.

The present inventor has paid attention to the principle in which carbon dioxide
can be absorbed and desorbed from indoor air, for example, using an amine-carrying
solid absorbent as an amine-based absorbent out of the adsorbent and the sorbent which
25 have been used in the related art, newly found configurations and conditions which are

suitable for air conditioning based on this principle, and completed the present invention.

[Solution to Problem]

[0007]

According to the first aspect of the present invention, there is provided an air conditioning system including: a rotor that is partitioned into a processing zone including
5 an absorbent of carbon dioxide which is an amine-carrying solid absorbent and allowing the absorbent to absorb carbon dioxide contained in processing air when the processing air flows therein and a regeneration zone allowing carbon dioxide absorbed by the absorbent to be desorbed to regeneration air when the regeneration air flows therein; a
10 first processing air supply part that is configured to supply air in a room as the processing air to the processing zone; a second processing air supply part that is configured to supply the processing air passing through the processing zone to the room; a regeneration air supply part that is configured to supply outdoor air as the regeneration air to the regeneration zone; and a regeneration air discharge part that is configured to discharge
15 the regeneration air passing through the regeneration zone outside of the room, wherein an enthalpy difference between the processing air supplied to the processing zone and the regeneration air supplied to the regeneration zone is equal to or greater than 30 kJ/kg (DA).

Fig. 1 is a graph showing a relationship between an enthalpy difference between
20 processing air and regeneration air in a rotor having the above-mentioned configuration and a removal efficiency of carbon dioxide. As shown in Fig. 1, as the enthalpy difference between the processing air and the regeneration air increases, the removal efficiency of carbon dioxide increases. When the enthalpy difference between the processing air and the regeneration air is equal to or greater than 30 kJ/kg (DA), the
25 removal efficiency of carbon dioxide is equal to or greater than 30% and removal of

carbon dioxide in a room of a general building is expected to be achieved.

[0008]

In the air conditioning system, since the enthalpy difference between the processing air supplied to the processing zone of the rotor and the regeneration air supplied to the regeneration zone of the rotor is equal to or greater than 30 kJ/kg, a carbon dioxide absorption capability of the amine-carrying solid absorbent is improved. Accordingly, carbon dioxide is favorably removed from the processing air supplied to the rotor from the room by the first processing air supply part, and air from which carbon dioxide has been removed (hereinafter also referred to as processed air) is returned to the room by the second processing air supply part. Through this circulation of air, carbon dioxide in indoor air is removed and air quality is improved.

[0009]

In the air conditioning system according to the second aspect of the present invention, a total heat exchanger and a cooling device may be sequentially provided from upstream to downstream in a supply direction in the first processing air supply part, the regeneration air supply part may share the total heat exchanger, and the total heat exchanger and a heating device may be sequentially provided from upstream to downstream in the supply direction in the regeneration air supply part.

In the air conditioning system according to the third aspect of the present invention, a cooling device may be provided in the first processing air supply part, a heating device may be provided in the regeneration air supply part, and a part of the air of the room may be supplied to the regeneration air supply part upstream from the heating device.

In the air conditioning system according to the fourth aspect of the present invention, an air handling unit and a cooling device may be provided from upstream to

downstream in a supply direction in the first processing air supply part, a part of air supplied from the air handling unit may be supplied to the room, the remaining part of the air supplied from the air handling unit may be supplied to the cooling device, and a heating device may be provided in the regeneration air supply part.

5 The air conditioning system according to a fifth aspect of the present invention may further include a heat pump including a compressor, an expansion valve, a condenser that is configured to condense a heat medium which circulates between the compressor and the expansion valve, and an evaporator that expands the heat medium, the processing air may pass through the evaporator in the first processing air supply part,
10 and the regeneration air may pass through the condenser in the regeneration air supply part.

 The air conditioning system according to a sixth aspect of the present invention, a carbon dioxide removal ratio in the room may be equal to or greater than 30%.

[0010]

15 The above-described air conditioning systems are provided with a configuration for securing an enthalpy difference between the processing air and the regeneration air or increasing the temperature difference between the processing air and the regeneration air as described above in consideration of an existing or newly constructed building or indoor facilities. Accordingly, carbon dioxide in indoor air is removed and air quality is
20 improved.

[Advantageous Effects of Invention]

[0011]

 With the air conditioning system according to the present invention, since an enthalpy difference between processing air and regeneration air is secured, it is possible
25 to improve a carbon dioxide absorption capability of the absorbent of the rotor, to remove carbon dioxide in indoor air, and to improve indoor air quality.

[Brief Description of Drawings]

[0012]

Fig. 1 is the graph showing a relationship between an enthalpy difference between processing air and regeneration air in a rotor of an air conditioning system according to the present invention and a removal efficiency of carbon dioxide.

5 Fig. 2 is the schematic diagram of the rotor of the air conditioning system according to the present invention.

Fig. 3 is the schematic diagram showing a first embodiment of the air conditioning system according to the present invention.

10 Fig. 4 is the schematic diagram showing a second embodiment of the air conditioning system according to the present invention.

Fig. 5 is the schematic diagram showing a third embodiment of the air conditioning system according to the present invention.

Fig. 6 is the schematic diagram showing a fourth embodiment of the air conditioning system according to the present invention.

15 [Description of Embodiments]

[0013]

Hereinafter, an air conditioning system according to the present invention and embodiments thereof will be specifically described with reference to the accompanying drawings.

20 [0014]

As shown in Fig. 2, an air conditioning system according to the present invention includes a rotor 1 which is partitioned into a processing zone 2 including a carbon dioxide absorbent which is an amine-carrying solid absorbent and allowing the amine-carrying solid absorbent to absorb carbon dioxide included in processing air when
25 the processing air flows therein and a regeneration zone 4 allowing carbon dioxide

absorbed by the amine-carrying solid absorbent to be desorbed to regeneration air when the regeneration air flows therein.

[0015]

The rotor 1 is a honeycomb rotor, is a cylindrical member which is formed by corrugating a sheet and winding the corrugated sheet in a rotor shape, and is configured to rotate about an axis in a direction of a black arrow in Fig. 2. The rotor 1 includes an amine-carrying solid absorbent, specifically, a solid absorbent which is formed of a weakly basic ion exchange resin having at least one of a primary amine and a secondary amine as a functional group.

10 [0016]

Air of a room is supplied as processing air to the processing zone 2 of the rotor 1 by a blower or the like which is not shown. When processing air flows into the processing zone 2, carbon dioxide contained in the processing air is absorbed by the amine-carrying solid absorbent of a rotor portion and is separated and removed from the processing air. Accordingly, a concentration of carbon dioxide in the processing air decreases.

Regeneration air is suitably heated or humidified, or heated and humidified by a heater or the like and is then supplied to the regeneration zone 4 of the rotor 1. When regeneration air flows into the regeneration zone 4, carbon dioxide absorbed by the amine-carrying solid absorbent of the rotor portion is desorbed to the regeneration air and the absorbent of the rotor portion passing through the zone is regenerated.

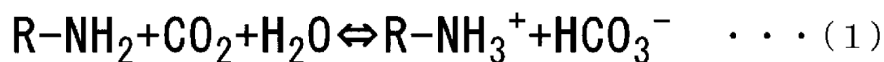
[0017]

Absorption and desorption of carbon dioxide by the amine-carrying solid absorbent are caused by reactions expressed by Equations (1) and (2) which will be described below in a case of a primary amine ($R-NH_2$), and are caused by reactions

expressed by Equations (3) and (4) in case of a secondary amine (R_1R_2-NH).

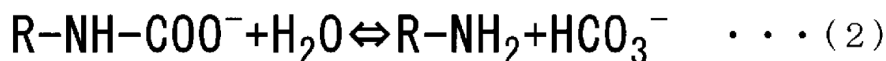
[0018]

[Chem. 1]



5 [0019]

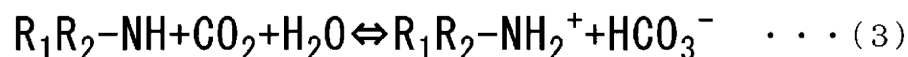
[Chem. 2]



[0020]

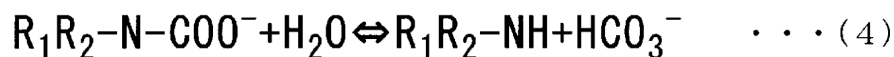
[Chem. 3]

10



[0021]

[Chem. 4]



[0022]

15

When the above-mentioned reactions occur, it is predicted that a continuous derivative model of an amine-carbon dioxide-water system is generated. That is, a solvent as a continuous derivative is produced around HCO_3^- molecules as a solute and a charge distribution of solute molecules causes polarization in the solvent around the solute molecules. In the continuous derivative model, reactivity according to an absorption rate or a desorption rate is enhanced by promoting Equations (1) to (4) in lower temperature conditions due to such solute-solvent interactions. Accordingly,

20

when there is an appropriate humidity at a low regeneration temperature, the solute-solvent interactions are promoted and a carbon dioxide absorption rate of the amine-carrying solid absorbent (that is, a carbon dioxide removal capability of the amine-carrying solid absorbent) is enhanced.

5 [0023]

The air conditioning system according to the present invention includes the rotor 1, a first processing air supply part that supplies air in a room as the processing air to the processing zone 2, a second processing air supply part that supplies the processing air passing through the processing zone 2 to the room, a regeneration air supply part that
10 supplies outdoor air as the regeneration air to the regeneration zone 4, and a regeneration air discharge part that discharges the regeneration air passing through the regeneration zone to the outside of the room. The air conditioning system according to the present invention is configured such that an enthalpy difference between the processing air supplied to the processing zone 2 and the regeneration air supplied to the regeneration
15 zone 4 is equal to or greater than 30 kJ/kg (DA).

That is, in the air conditioning system according to the present invention, since the enthalpy difference between the processing air supplied to the processing zone 2 and the regeneration air supplied to the regeneration zone 4 is equal to or greater than 30 kJ/kg (DA), solute-solvent interactions are promoted and the carbon dioxide absorption
20 rate of the amine-carrying solid absorbent is enhanced. Accordingly, a carbon dioxide removal ratio in the room is equal to or greater than 30%. When the enthalpy difference between the processing air and the regeneration air is equal to or greater than 45 kJ/kg (DA), the carbon dioxide removal ratio in the room is equal to or greater than 40%, which is more preferable.

25 In order to set the enthalpy difference between the processing air and the

regeneration air to be equal to or greater than 30 kJ/kg (DA), it is preferable that a temperature difference between the processing air and the regeneration air be suitably set, for example, in consideration of humidities of the processing air and the regeneration air. Embodiments of the air conditioning system which is configured such that an enthalpy difference between the processing air and the regeneration air is equal to or greater than 30 kJ/kg (DA) will be described below.

[0024]

(First embodiment)

First, a first embodiment of the air conditioning system according to the present invention will be described.

As shown in Fig. 3, an air conditioning system 10A according to the first embodiment includes a fan coil unit 12 that causes air in a room R to circulate. The air conditioning system 10A according to the first embodiment may include a facility such as a packaged air conditioner that is capable of causing air in the room R to circulate instead of the fan coil unit 12.

In a first processing air supply part 14 that connects the room R to a processing air inlet side of the processing zone 2 of the rotor 1, a total heat exchanger 16 and a cooling device 18 are sequentially provided from upstream to downstream in a supply direction of the processing air. Examples of the cooling device 18 include a cold water coil and a cooling coil. A regeneration air supply part 20 that connects outside of the room to a regeneration air inlet side of the regeneration zone 4 of the rotor 1 shares the total heat exchanger 16, and the total heat exchanger 16 and a heating device 22 are sequentially provided from upstream to downstream in the supply direction of the regeneration air in the regeneration air supply part 20. Examples of the heating device 22 include an electric heater, a hot water coil, a steam coil, and a heating type humidifier

(such as a pan type humidifier or a steam humidifier).

The air conditioning system 10A according to the first embodiment includes a second processing air supply part 24 that connects the room R to a processing air outlet side of the processing zone 2 of the rotor 1 and a regeneration air discharge part 26 that connects the outside of the room to a processing air outlet side of the regeneration zone 4 of the rotor 1.

In the room R, supply of outdoor air and discharge of air from the room R are performed independently of circulation of the processing air by the first processing air supply part 14 and the second processing air supply part 24. Accordingly, the air pressure or the like of the room R is appropriately adjusted. The flow rate of air or the like in such ventilation is fixed.

The configuration of the air conditioning system 10A shown in Fig. 3 is considered on the assumption that the enthalpy of the outdoor air is lower than the enthalpy of air in the room R as in the winter season. When the temperature of the outdoor air is higher than the temperature of the air in the room R as in the summer, the total heat exchanger 16 of the first processing air supply part 14 is omitted. In the following description, it is assumed that the total heat exchanger 16 of the first processing air supply part 14 is provided and the enthalpy of the outdoor air is lower than the enthalpy of the air in the room R.

[0025]

In the air conditioning system 10A according to the first embodiment, air in the room R is discharged to the first processing air supply part 14, and is supplied as processing air to the total heat exchanger 16 by the first processing air supply part 14. On the other hand, outdoor air introduced from the outside is supplied as regeneration air to the total heat exchanger 16 by the regeneration air supply part 20. In the total heat

exchanger 16, total heat exchange between the processing air and the regeneration air is performed. That is, exchange of sensible heat (temperature) and latent heat (humidity) is performed. Accordingly, the enthalpy of the processing air decreases and the enthalpy of the regeneration air increases.

5 The processing air of which the enthalpy has decreased in the total heat exchanger 16 is supplied to the cooling device 18 by the first processing air supply part 14, is further cooled to a predetermined temperature at which the processing air is introduced into the processing zone 2 of the rotor 1, and is then supplied to the processing zone 2 of the rotor 1. The regeneration air of which the enthalpy has
10 increased in the total heat exchanger 16 is supplied to the heating device 22 by the regeneration air supply part 20, is further increased in temperature to a predetermined temperature at which the regeneration air is introduced into the regeneration zone 4 of the rotor 1, and is then supplied to the regeneration zone 4 of the rotor 1. The predetermined temperature of the processing air which is introduced into the processing
15 zone 2 and the predetermined temperature of the regeneration air which is introduced into the regeneration zone 4 are set such that the enthalpy difference between the processing air and the regeneration air is equal to or greater than 30 kJ/kg (DA).

 In the air conditioning system 10A according to the first embodiment, in a state in which the enthalpy difference between the processing air and the regeneration air has
20 been imparted as described above, the processing air is supplied to the processing zone 2 and the regeneration air is supplied to the regeneration zone 4.

[0026]

 In the processing zone 2 of the rotor 1, carbon dioxide in processing air is absorbed by the amine-carrying solid absorbent included in the rotor 1 and is separated
25 and removed from the processing air. The portion of the rotor 1 including the

amine-carrying solid absorbent having absorbed carbon dioxide is moved to an area of the regeneration zone 4 by rotation and the absorbed carbon dioxide is desorbed to the regeneration air flowing in the regeneration zone 4. In this way, carbon dioxide is removed from the processing air and carbon dioxide is caused to be contained in the
5 regeneration air.

[0027]

The processed air discharged from the processing zone 2 of the rotor 1 to the second processing air supply part 24 is supplied to the room R by the second processing air supply part 24. The regeneration air discharged from the regeneration zone 4 of the
10 rotor 1 to the regeneration air discharge part 26 is discharged to the outside of the room by the regeneration air discharge part 26.

In consideration of the temperature of the processed air supplied to the room R by the second processing air supply part 24, the temperature of the room R is mainly adjusted and the humidity of the room R is adjusted if necessary by the fan coil unit 12.

15 In an intermediate season between the winter and the summer, settings of the cooling device 18 and the heating device 22 are appropriately changed such that the enthalpy difference between the processing air and the regeneration air is equal to or greater than 30 kJ/kg (DA) in consideration of a difference between the enthalpy of the air in the room R and the enthalpy of the outdoor air.

20 [0028]

An example of setting conditions in the air conditioning system 10A will be described below. As prescribed in building administration laws or the like in Japan, a concentration of carbon dioxide in a room R such as an office is set to be equal to or less than 1000 PPM. For example, it is assumed that the room R has a size of 1400 m³ with
25 floor area 500 m²×height 2.8 m and 75 persons are working in the room R. The amount

of carbon dioxide which is generated in the room R is $15 \text{ m}^3/\text{h}$ ($= 0.02 \text{ m}^3/\text{person}\cdot\text{h}\times 75$ persons). By removing 30% of the carbon dioxide in the room R at $3200 \text{ m}^3/\text{h}$, the concentration of carbon dioxide in the room R can be maintained at 1000 PPM.

It is assumed that the room R is supplied with outdoor air having a concentration
 5 of carbon dioxide of 500 PPM from a blower which is not shown at $1150 \text{ CHM} (\text{m}^3/\text{h})$, and discharge thereof from the room R to the outside is performed under the same conditions.

[0029]

In the above-mentioned conditions, in the winter season, it is assumed that
 10 processing air at $3200 \text{ m}^3/\text{h}$, a temperature of 22°C , and a relative humidity of 40% (an enthalpy of 39 kJ/kg (DA)) is discharged from the room R to the first processing air supply part 14 using a blower or the like which is not shown.

On the other hand, it is assumed that regeneration air at $3200 \text{ m}^3/\text{h}$, a
 temperature of 0°C , and a relative humidity of 50% (an enthalpy of 5 kJ/kg (DA)) is
 15 introduced into the regeneration air supply part 20 from the outside using a blower or the like which is not shown. Using the total heat exchanger 16, the enthalpy of the processing air is decreased to 14 kJ/kg (DA) and the enthalpy of the regeneration air is increased to 29 kJ/kg (DA) .

The cooling device 18 is set to an OFF state, and the processing air with an
 20 enthalpy of 14 kJ/kg (DA) is supplied to the processing zone 2 of the rotor 1. The heating device 22 is set to an ON state, and the temperature of the regeneration air with an enthalpy of 29 kJ/kg (DA) is increased to 45°C to increase the enthalpy to 58 kJ/kg (DA) and is then supplied to the regeneration zone 4 of the rotor 1. Due to the enthalpy difference between the processing air and the regeneration air, the carbon dioxide

removal ratio of the rotor 1 is 39% and the concentration of carbon dioxide in the room R is decreased to 867 PPM.

[0030]

In the above-mentioned conditions, in the summer season, it is assumed that
5 processing air at 3200 m³/h, a temperature of 26°C, and a relative humidity of 50% (an enthalpy of 52 kJ/kg (DA)) is discharged from the room R to the first processing air supply part 14 using a blower or the like which is not shown.

On the other hand, it is assumed that regeneration air at 3200 m³/h, a
temperature of 34°C, and a relative humidity of 60% (an enthalpy of 86 kJ/kg (DA)) is
10 introduced into the regeneration air supply part 20 from the outside using a blower or the like which is not shown. As described above, in the summer season, heat exchange is not performed by the total heat exchanger 16. Accordingly, the enthalpy of the processing air is 52 kJ/kg (DA) and the enthalpy of the regeneration air is 86 kJ/kg (DA). The cooling device 18 is set to an ON state, the processing air is cooled to 14°C, the
15 enthalpy is decreased to 38 kJ/kg (DA), and the resultant processing air is supplied to the processing zone 2 of the rotor 1. The heating device 22 is set to an OFF state and the regeneration air with an enthalpy of 86 kJ/kg (DA) is supplied to the regeneration zone 4 of the rotor 1. Due to the enthalpy difference between the processing air and the regeneration air, the carbon dioxide removal ratio of the rotor 1 is 41% and the
20 concentration of carbon dioxide in the room R is decreased to 837 PPM. Accordingly, even in the summer season, as prescribed in building administration laws, the criterion of limiting the concentration of carbon dioxide in the room R such as an office to 1000 PPM or less is adequately satisfied.

[0031]

With the air conditioning system 10A according to the first embodiment, the enthalpy of the processing air supplied to the processing zone 2 of the rotor 1 is decreased in the first processing air supply part 14 and the enthalpy of the regeneration air supplied to the regeneration zone 4 of the rotor 1 is increased in the regeneration air supply part 20. Particularly, in the winter season, the enthalpy of the processing air is decreased and the enthalpy of the regeneration air is increased by activating the total heat exchanger 16. Accordingly, an enthalpy difference between the processing air and the regeneration air is imparted. In consideration of the temperature or relative humidity of outdoor air, an enthalpy difference between the processing air and the regeneration air of equal to or greater than 30 kJ/kg (DA) is capable of being secured by adjusting settings of the total heat exchanger 16, the cooling device 18, and the heating device 22. As a result, reactions of Equations (1) to (4) in the rotor 1 are promoted and the carbon dioxide absorption capability of the amine-carrying solid absorbent contained in the rotor 1 is improved (see Fig. 1). Accordingly, carbon dioxide is removed well from the processing air and the processed air is returned to the room R by the second processing air supply part 24. Through this circulation of air, it is possible to remove carbon dioxide in the air of the room R and to improve air quality.

Since the air conditioning system 10A according to the first embodiment includes the total heat exchanger 16, enthalpy exchange (both temperature and humidity) is performed between the generation air (that is, the outdoor air) and the processing air (that is, the indoor air). Accordingly, with the air conditioning system 10A according to the first embodiment, better power saving can be achieved than with an air conditioning system in which air of a room R is mixed with outdoor air, for example, as in an air conditioning system 10B according to a second embodiment described later. Since the enthalpy difference between the processing air and the regeneration air is large in the

winter season, it is possible to efficiently increase the carbon dioxide removal capability in the winter season.

[0032]

(Second embodiment)

5 A second embodiment of the air conditioning system according to the present invention will be described below. Among elements of an air conditioning system 10B according to the second embodiment, the same elements as the elements in the air conditioning system 10A according to the first embodiment will be referenced by the same reference signs and a description thereof will not be repeated here.

10 As shown in Fig. 4, in the air conditioning system 10B according to the second embodiment, a cooling device 18 is provided in the first processing air supply part 14, and a heating device 22 is provided in the regeneration air supply part 20 and is configured to supply a part of the air in the room R to the regeneration air supply part 20 upstream from the heating device 22. Specifically, an indoor air discharge part 28 that
15 discharges air from the room R independently of the first processing air supply part 14 is joined to the regeneration air supply part 20 via a bypass part 30. The indoor air discharge part 28, the bypass part 30, and the regeneration air supply part 20 are provided with a damper that adjusts a flow rate of air.

[0033]

20 In the air conditioning system 10B according to the second embodiment, the air in the room R is discharged separately into the first processing air supply part 14 and the indoor air discharge part 28. The air discharged to the indoor air discharge part 28 is able to be directly supplied to the regeneration air supply part 20 by the bypass part 30. Depending on the season or outdoor environments, all the air discharged to the indoor air
25 discharge part 28 is supplied to the regeneration air supply part 20 in the winter season or

the like, and all the air discharged to the indoor air discharge part 28 is discharged to the outside in the summer season or the like. Outdoor air introduced from the outside is mixed with air in the room R from the bypass part 30 to increase the enthalpy in the regeneration air supply part 20.

5 The processing air discharged from the room R is supplied to the cooling device 18 by the first processing air supply part 14, is further cooled to a predetermined temperature at which the processing air is introduced into the processing zone 2 of the rotor 1 to decrease the enthalpy thereof, and is then supplied to the processing zone 2 of the rotor 1. The regeneration air which has been mixed with the air of the room R to
10 increase the enthalpy is supplied to the heating device 22 by the regeneration air supply part 20, is further increased in temperature to a predetermined enthalpy at which the regeneration air is introduced into the regeneration zone 4 of the rotor 1, and is then supplied to the regeneration zone 4 of the rotor 1.

 In a state in which the enthalpy difference between the processing air and the
15 regeneration air has been imparted in this way, the processing air is supplied to the processing zone 2 and the regeneration air is supplied to the regeneration zone 4.

[0034]

 Exchange of carbon dioxide between the processing air and the regeneration air in the rotor 1 and flows of the processed air and the regeneration air having passed
20 through the rotor 1 in the air conditioning system 10B according to the second embodiment are the same as those in the air conditioning system 10A according to the first embodiment.

[0035]

 An example of setting conditions in the air conditioning system 10B will be
25 described below. The size of the room R and conditions for supply of air and discharge

of air are set to the same as in the example of the setting conditions of the air conditioning system 10A according to the first embodiment.

In the above-mentioned conditions, in the winter season, it is assumed that processing air at 3200 m³/h, a temperature of 22°C, and a relative humidity of 40% (an enthalpy of 39 kJ/kg (DA)) is discharged from the room R to the first processing air supply part 14 using a blower or the like which is not shown.

On the other hand, it is assumed that regeneration air at 1250 m³/h, a temperature of 0°C, and a relative humidity of 50% (an enthalpy of 5 kJ/kg (DA)) is introduced into the regeneration air supply part 20 from the outside using a blower or the like which is not shown. 100% of the air of the room R discharged to the indoor air discharge part 28 is introduced into the bypass part 30 and is supplied to the regeneration air supply part 20 with 1150 m³/h, a temperature of 22°C, and a relative humidity of 40% (an enthalpy of 39 kJ/kg (DA)). Accordingly, the enthalpy of the regeneration air is increased to 17 kJ/kg (DA). The cooling device 18 is set to an ON state, and the processing air is cooled to 9°C to decrease the enthalpy to 25 kJ/kg (DA) and is then supplied to the processing zone 2 of the rotor 1. The heating device 22 is set to an ON state, and the regeneration air is heated to 45°C to increase the enthalpy to 55 kJ/kg (DA) and is then supplied to the regeneration zone 4 of the rotor 1. Due to the enthalpy difference between the processing air and the regeneration air, the carbon dioxide removal ratio of the rotor 1 is 31% and the concentration of carbon dioxide in the room R is decreased to 968 PPM.

[0036]

In the above-mentioned conditions, in the summer season, it is assumed that processing air at 3200 m³/h, a temperature of 26°C, and a relative humidity of 50% (an

enthalpy of 52 kJ/kg (DA)) is discharged from the room R to the first processing air supply part 14 using a blower or the like which is not shown.

On the other hand, it is assumed that regeneration air at 3200 m³/h, a temperature of 34°C, and a relative humidity of 60% (an enthalpy of 86 kJ/kg (DA)) is introduced into the regeneration air supply part 20 from the outside using a blower or the like which is not shown.

In the summer season, introduction of air of the room R into the bypass part 30 from the indoor air discharge part 28 is not performed and 100% of the air 3 introduced into the indoor air discharge part 28 is discharged. Similarly to the example of the setting conditions of the air conditioning system 10A according to the first embodiment, the processing air and the regeneration air are supplied to the rotor 1. Due to the enthalpy difference between the processing air and the regeneration air, the carbon dioxide removal ratio of the rotor 1 is 41% and the concentration of carbon dioxide in the room R is decreased to 837 PPM.

[0037]

With the air conditioning system 10B according to the second embodiment, an enthalpy difference between the processing air which is cooled by the cooling device 18 and supplied to the processing zone 2 of the rotor 1 in the first processing air supply part 14 and the regeneration air which is mixed with the air of the room R bypassing from the indoor air discharge part 28 is imparted to increase the enthalpy, is increased in temperature to increase the enthalpy in the heating device 22 in the regeneration air supply part 20, and is supplied to the regeneration zone 4 of the rotor 1. The enthalpy difference between the processing air and the regeneration air can be secured to be equal to or greater than 30 kJ/kg (DA) while adjusting settings of the cooling device 18 and the heating device 22 in consideration of the temperature or the relative humidity of outdoor

air. Accordingly, it is possible to achieve the same advantages as in the air conditioning system 10A according to the first embodiment.

[0038]

(Third embodiment)

5 A third embodiment of the air conditioning system according to the present invention will be described below. Among elements of an air conditioning system 10C according to the third embodiment, the same elements as the elements in the air conditioning system 10A according to the first embodiment or the air conditioning system 10B according to the second embodiment will be referenced by the same
10 reference signs and a description thereof will not be repeated here.

As shown in Fig. 5, in the air conditioning system 10C according to the third embodiment, an air handling unit 32 and a cooling device 18 are provided from upstream to downstream in the supply direction of processing air in the first processing air supply part 14, a part of air supplied from the air handling unit 32 is supplied to the room R, the
15 remaining part of the air supplied from the air handling unit 32 is supplied to the cooling device 18, and a heating device 22 is provided in the regeneration air supply part 20.

An apparatus or a configuration that are generally used in an air conditioning system can be used as the air handling unit 32.

In the regeneration air supply part 20, upstream from the heating device 22, a
20 heating device 34 and a humidifier 36 are provided from upstream to downstream in the supply direction of regeneration air. Accordingly, for example, even in the winter season, it is possible to curb generation of odors or the like and to set the enthalpy difference between the processing air and the regeneration air to be equal to or greater than 30 kJ/kg (DA) without reducing the life span of the rotor 1.

25 [0039]

In the air conditioning system 10C according to the third embodiment, the air in the room R is supplied to the air handling unit 32 by the first processing air supply part 14. A part of the processing air discharged from the air handling unit 32 is returned to the room R. The temperature of the room R is mainly adjusted by the air returned from the air handling unit 32 to the room R, and the humidity of the room R is also adjusted if necessary. In consideration thereof, it is preferable that conditions such as the temperature or the humidity of the processing air which is discharged from the air handling unit 32 be appropriately set.

The remaining part of the processing air discharged from the air handling unit 32 is supplied to the cooling device 18 by the first processing air supply part 14, is further cooled to a predetermined temperature at which the processing air is introduced into the processing zone 2 of the rotor 1, and is then supplied to the processing zone 2 of the rotor 1. On the other hand, the regeneration air is supplied to the heating device 22 by the regeneration air supply part 20, is further increased in temperature to a predetermined temperature at which the regeneration air is introduced into the regeneration zone 4 of the rotor 1, and is then supplied to the regeneration zone 4 of the rotor 1.

In a state in which the enthalpy difference between the processing air and the regeneration air has been imparted in this way, the processing air is supplied to the processing zone 2 and the regeneration air is supplied to the regeneration zone 4.

[0040]

Exchange of carbon dioxide between the processing air and the regeneration air in the rotor 1 and flows of the processed air and the regeneration air having passed through the rotor 1 in the air conditioning system 10C according to the third embodiment are the same as those in the air conditioning system 10A according to the first embodiment.

[0041]

An example of setting conditions in the air conditioning system 10C will be described below. The size of the room R and conditions for supply of air and discharge of air are set to the same as in the example of the design conditions of the air

5 conditioning system 10A according to the first embodiment.

In the above-mentioned conditions, in the winter season, it is assumed that processing air at 13600 m³/h, a temperature of 22°C, and a relative humidity of 40% (an enthalpy of 39 kJ/kg (DA)) is discharged from the room R to the first processing air supply part 14 using a blower or the like which is not shown.

10 On the other hand, it is assumed that regeneration air at 2400 m³/h, a temperature of 0°C, and a relative humidity of 50% (an enthalpy of 5 kJ/kg (DA)) is introduced into the regeneration air supply part 20 from the outside using a blower or the like which is not shown. The conditions of the processing air supplied from the room R to the first processing air supply part 14 are maintained in the air handling unit 32. The

15 cooling device 18 is set to the ON state, and the processing air at a temperature of 22°C adjusted by the air handling unit 32 is cooled to 11°C (with an enthalpy of 27 kJ/kg (DA)) and is then supplied to the processing zone 2 of the rotor 1. The heating device 34, the humidifier 36, and the heating device 22 are set to the ON state, and the enthalpy of the regeneration air is increased to 75 kJ/kg (DA), and the resultant generation air is

20 then supplied to the regeneration zone 4 of the rotor 1. Due to the enthalpy difference between the processing air and the regeneration air, the carbon dioxide removal ratio of the rotor 1 is 41% and the concentration of carbon dioxide in the room R is decreased to 842 PPM.

[0042]

In the above-mentioned conditions, in the summer season, the conditions of the processing air supplied from the room R to the first processing air supply part 14 are appropriately changed by the air handling unit 32, and the processing air and the regeneration air are supplied to the rotor 1 similarly to the example of the setting

5 conditions in the summer season of the air conditioning system 10A according to the first embodiment and the air conditioning system 10B according to the second embodiment. Due to the enthalpy difference between the processing air and the regeneration air, the carbon dioxide removal ratio of the rotor 1 is 41% and the concentration of carbon dioxide in the room R is decreased to 837 PPM.

10 [0043]

With the air conditioning system 10C according to the third embodiment, an enthalpy difference is imparted between the processing air which passes through the air handling unit 32 and is cooled by the cooling device 18 and supplied to the processing zone 2 of the rotor 1 in the first processing air supply part 14 and the regeneration air

15 which is increased in temperature by the heating device 34, the humidifier 36, and the heating device 22 and is supplied to the regeneration zone 4 of the rotor 1 in the regeneration air supply part 20.

In the air conditioning system 10C according to the third embodiment, since a part of the processing air passing through the air handling unit 32 in the first processing

20 air supply part 14 is returned to the room R, it is possible to efficiently perform circulation of air in the room R. In the air conditioning system 10C according to the third embodiment, since the total heat exchanger 16 need not be used similarly to the air conditioning system 10B according to the second embodiment and the air handling unit 32 also functions as the fan coil unit 12, it is possible to achieve more space saving in the

25 air conditioning system 10B with a simple configuration. The fan coil unit 12 is not

necessary.

[0044]

(Fourth embodiment)

A fourth embodiment of the air conditioning system according to the present
5 invention will be described below. Among elements of an air conditioning system 10D
according to the fourth embodiment, the same elements as the elements in the air
conditioning system 10A according to the first embodiment will be referenced by the
same reference signs and a description thereof will not be repeated here.

As shown in Fig. 6, the air conditioning system 10D according to the fourth
10 embodiment includes a fan coil unit 12, a compressor 42, an expansion valve 44 and a
heat pump 40 having a condenser 46 that condenses a heat medium (not shown)
circulating between the compressor 42 and the expansion valve 44 and an evaporator 48
that expands the heat medium. The air conditioning system 10D is configured to cause
processing air to pass through the evaporator 48 in the first processing air supply part 14
15 and to cause regeneration air to pass through the condenser 46 in the regeneration air
supply part 20.

An apparatus and a configuration that are generally used in an air conditioning
system can be used as the heat pump 40.

[0045]

20 In the air conditioning system 10D according to the fourth embodiment, air in
the room R is supplied as processing air to the evaporator 48 of the heat pump 40 by the
first processing air supply part 14 and passes through the evaporator 48. The processing
air is cooled to a predetermined temperature at which the processing air is introduced into
the processing zone 2 of the rotor 1 due to a decrease in temperature of the heat medium
25 which expands in the evaporator 48 and is then supplied to the processing zone 2 of the

rotor 1. On the other hand, the regeneration air is supplied to the condenser 46 of the heat pump 40 by the regeneration air supply part 20 and passes through the condenser 46. The regeneration air is heated to a predetermined temperature at which the regeneration air is introduced into the regeneration zone 4 of the rotor 1 due to heat of the heat medium which is condensed in the condenser 46 and is then supplied to the regeneration zone 4 of the rotor 1.

In a state in which a temperature difference between the processing air and the regeneration air has been imparted in this way, the processing air is supplied to the processing zone 2 and the regeneration air is supplied to the regeneration zone 4. The output of the compressor 42 is capable of generating an enthalpy difference between the processing air and the regeneration air can be determined arbitrarily or optimally by being adjusted using an inverter.

[0046]

As shown in Fig. 6, it is preferable that the humidifier 36 be provided downstream from the condenser 46 in the regeneration air supply part 20 and the evaporator 50 of the heat pump 40 be provided in the regeneration air discharge part 26. In the heat pump 40, by adjusting an amount of air by two-way valves 52 and 54, recovering heat from the evaporator 48 and the evaporator 50, and supplying heat to the condenser 46, necessary heat can be given to the regeneration air even in the winter season in which an amount of heat available is small. The heating temperature in the condenser 46 is limited in view of the principle of the heat pump 40, but the enthalpy of the regeneration air can be further increased at a limit temperature or lower by humidifying the regeneration air using the humidifier 36. Accordingly, it is possible to appropriately adjust the enthalpy difference between the processing air and the regeneration air without excessively cooling the processing air.

[0047]

Exchange of carbon dioxide between the processing air and the regeneration air in the rotor 1 and flows of the processed air and the regeneration air having passed through the rotor 1 in the air conditioning system 10D according to the fourth

5 embodiment are the same as those in the air conditioning system 10A according to the first embodiment.

[0048]

An example of setting conditions in the air conditioning system 10D will be described below. The size of the room R and conditions for supply of air and discharge
10 of air are set to the same as in the example of the design conditions of the air conditioning system 10A according to the first embodiment.

In the above-mentioned conditions, in the winter season, processing air at 3200 m³/h, a temperature of 22°C, and a relative humidity of 40% (an enthalpy of 39 kJ/kg (DA)) is discharged from the room R to the first processing air supply part 14 using a
15 blower or the like which is not shown. On the other hand, regeneration air at 3200 m³/h, a temperature of 0°C, and a relative humidity of 50% is introduced into the regeneration air supply part 20 from the outside. In the evaporator 48 (with an amount of heat of 27 kJ/kg) of the heat pump 40, the processing air of 22°C is cooled to 11°C and is then supplied to the processing zone 2 of the rotor 1. The regeneration air at 0°C is heated to
20 be equal to or higher than 50°C by the condenser 46 of the heat pump 40 and is supplied to the regeneration zone 4 of the rotor 1. Due to the enthalpy difference between the processing air and the regeneration air, the carbon dioxide removal ratio of the rotor 1 is equal to or greater than 30% similarly to an example of design conditions of the air conditioning system 10A according to the first embodiment.

[0049]

In the above-mentioned conditions, in the summer season, the conditions of the evaporator 48 and the condenser 46 are appropriately changed using the compressor 42 and the expansion valve 44 of the heat pump 40, and the processing air and the regeneration air are supplied to the rotor 1 similarly to the example of the setting conditions in the winter of the air conditioning system 10A according to the first embodiment and the like. Due to the enthalpy difference between the processing air and the regeneration air, the carbon dioxide removal ratio of the rotor 1 is 30% or more similarly to the example of the design conditions of the air conditioning system 10A according to the first embodiment and the like. In other words, the conditions and the like of the processing air and the regeneration air are adjusted such that the carbon dioxide removal ratio of the rotor 1 is equal to or greater than 30%.

[0050]

In the air conditioning system 10D according to the fourth embodiment, an enthalpy difference is imparted between the processing air which is cooled by the evaporator 48 of the heat pump 40 in the first processing air supply part 14 and is supplied to the processing zone 2 of the rotor 1 and the regeneration air which is heated by the condenser 46 of the heat pump 40 and is supplied to the regeneration zone 4 of the rotor 1, and the enthalpy difference between the processing air and the regeneration air is secured to be equal to or greater than 30 kJ/kg (DA). Accordingly, the same advantages as in the air conditioning system 10A according to the first embodiment can be obtained.

When a heat pump is already provided in a building or the like, this heat pump is able to be used as the above-mentioned heat pump 40, whereby it is possible to install the air conditioning system 10A by post-installation with a reduced number of facilities to be added and to effectively remove carbon dioxide in a room R of the building or the like.

[0051]

While exemplary embodiments of the present invention have been described above in detail, the present invention is not limited to the specific embodiments and may be modified within the scope of the gist of the present invention described in the
 5 appended claims.

For example, the configuration of the air conditioning system according to the present invention is not limited to these embodiments, and is able to be appropriately modified as long as the enthalpy difference between the processing air and the regeneration air is equal to or greater than 30 kJ/kg (DA). The embodiments may be
 10 appropriately combined depending on facilities or conditions of a building in which the air conditioning system according to the present invention is installed.

[Reference Signs List]

[0052]

- | | | |
|----|--------------------|-----------------------------------|
| | 1 | Rotor |
| 15 | 2 | Processing zone |
| | 4 | Regeneration zone |
| | 10A, 10B, 10C, 10D | Air conditioning system |
| | 14 | First processing air supply part |
| | 16 | Total heat exchanger |
| 20 | 18 | Cooling device |
| | 20 | Regeneration air supply part |
| | 22 | Heating device |
| | 24 | Second processing air supply part |
| | 26 | Regeneration air discharge part |
| 25 | 32 | Air handling unit |

	40	Heat pump
	42	Compressor
	44	Expansion valve
	46	Condenser
5	48	Evaporator

CLAIMS

[Claim 1]

An air conditioning system comprising:

5 a rotor that is partitioned into a processing zone including an absorbent of carbon dioxide which is an amine-carrying solid absorbent and allowing the absorbent to absorb carbon dioxide contained in processing air when the processing air flows therein and a regeneration zone allowing carbon dioxide absorbed by the absorbent to be desorbed to regeneration air when the regeneration air flows therein;

10 a first processing air supply part that is configured to supply air in a room as the processing air to the processing zone;

a second processing air supply part that is configured to supply the processing air passing through the processing zone to the room;

a regeneration air supply part that is configured to supply outdoor air as the regeneration air to the regeneration zone;

15 a regeneration air discharge part that is configured to discharge the regeneration air passing through the regeneration zone to outside of the room; and

a fan coil unit that is separated from the rotor and configured to cause air in the room to circulate,

20 wherein a total heat exchanger and a cooling device are sequentially provided from upstream to downstream in a supply direction in the first processing air supply part,

wherein the regeneration air supply part is configured to share the total heat exchanger,

wherein the total heat exchanger and a heating device are sequentially provided from upstream to downstream in the supply direction in the regeneration air supply part,

wherein the total heat exchanger, the cooling device, the heating device and the fan coil unit are driven so that an enthalpy difference between the processing air supplied to the processing zone and the regeneration air supplied to the regeneration zone is equal to or greater than 30 kJ/kg (DA),

wherein the total heat exchanger and the heating device are set to an OFF state and the cooling device and the fan coil unit are set to an ON state when a temperature of outdoor air is higher than a determined temperature of summer season and humidity of outdoor air is higher than a determined humidity of summer season,

wherein the cooling device is set to an OFF state and the total heat exchanger, the heating device and the fan coil unit are set to an ON state when temperature of outdoor air is lower than a determined temperature of winter season and humidity of outdoor air is lower than a determined humidity of winter season, and

wherein the total heat exchanger, the cooling device, the heating device and the fan coil unit are set to an ON state when temperature of outdoor air is between the determined temperature of winter season and the determined temperature of summer season and humidity of outdoor air is between the determined humidity of winter season and the determined humidity of summer season.

[Claim 2]

An air conditioning system comprising:

a rotor that is partitioned into a processing zone including an absorbent of carbon dioxide which is an amine-carrying solid absorbent and allowing the absorbent to absorb carbon dioxide contained in processing air when the processing air flows therein and a regeneration zone allowing carbon dioxide absorbed by the absorbent to be desorbed to
5 regeneration air when the regeneration air flows therein;

a first processing air supply part that is configured to supply air in a room as the processing air to the processing zone;

a second processing air supply part that is configured to supply the processing air passing through the processing zone to the room;

10 a regeneration air supply part that is configured to supply outdoor air as the regeneration air to the regeneration zone;

a regeneration air discharge part that is configured to discharge the regeneration air passing through the regeneration zone to outside of the room; and

a fan coil unit that is separated from the rotor and configured to cause air in the
15 room to circulate,

processing air supply part, wherein a heating device is provided in the regeneration air supply part,

wherein a part of the air of the room is configured to supply to the regeneration air supply part upstream from the heating device,

20 wherein the cooling device, the heating device and the fan coil unit are driven so that an enthalpy difference between the processing air supplied to the processing zone and the regeneration air supplied to the regeneration zone is equal to or greater than 30 kJ/kg (DA),

wherein the air of the room is configured not to supply upstream to the heating device in the regeneration air supply part when temperature of outdoor air is higher than a determined temperature of summer season and humidity of outdoor air is higher than a determined humidity of summer season, and

5 wherein the air of the room is configured to supply upstream to the heating device in the regeneration air supply part when temperature of outdoor air is lower than a determined temperature of winter season and humidity of outdoor air is lower than a determined humidity of winter season.

10 [Claim 3]

 An air conditioning system comprising:

 a rotor that is partitioned into a processing zone including an absorbent of carbon dioxide which is an amine-carrying solid absorbent and allowing the absorbent to absorb carbon dioxide contained in processing air when the processing air flows therein and a
15 regeneration zone allowing carbon dioxide absorbed by the absorbent to be desorbed to regeneration air when the regeneration air flows therein;

 a first processing air supply part that is configured to supply air in a room as the processing air to the processing zone;

 a second processing air supply part that is configured to supply the processing air
20 passing through the processing zone to the room;

 a regeneration air supply part that is configured to supply outdoor air as the regeneration air to the regeneration zone;

a regeneration air discharge part that is configured to discharge the regeneration air passing through the regeneration zone to outside of the room; and

an air handling unit and a cooling device are provided from upstream to downstream in a supply direction in the first processing air supply part,

5 wherein a part of air supplied from the air handling unit is configured to supply to the room,

 wherein the remaining part of the air supplied from the air handling unit is configured to supply to the cooling device,

 wherein a first heating device, a humidifier and a second heating device are
10 provided from upstream to downstream in a supply direction in the regeneration air supply part,

 wherein the air handling unit, the cooling device, the first heating device, the humidifier and the second heating device are driven so that an enthalpy difference between the processing air supplied to the processing zone and the regeneration air
15 supplied to the regeneration zone is equal to or greater than 30 kJ/kg (DA),

 wherein conditions of the processing air supplied to the air handling unit are changed when temperature of outdoor air is higher than a determined temperature of summer season and humidity of outdoor air is higher than a determined humidity of summer season, and

20 wherein conditions of the processing air supplied to the air handling unit are maintained when temperature of outdoor air is lower than a determined temperature of winter season and humidity of outdoor air is lower than a determined humidity of winter season.

[Claim 4]

An air conditioning system comprising:

- 5 a rotor that is partitioned into a processing zone including an absorbent of carbon dioxide which is an amine-carrying solid absorbent and allowing the absorbent to absorb carbon dioxide contained in processing air when the processing air flows therein and a regeneration zone allowing carbon dioxide absorbed by the absorbent to be desorbed to regeneration air when the regeneration air flows therein;
- 10 a first processing air supply part that is configured to supply air in a room as the processing air to the processing zone;
- a second processing air supply part that is configured to supply the processing air passing through the processing zone to the room;
- a regeneration air supply part that is configured to supply outdoor air as the
- 15 regeneration air to the regeneration zone;
- a regeneration air discharge part that is configured to discharge the regeneration air passing through the regeneration zone to outside of the room,
- a fan coil unit that is separated from the rotor and configured to cause air in the room to circulate; and
- 20 a heat pump including a compressor, an expansion valve, a condenser that is configured to condense a heat medium which circulates between the compressor and the expansion valve, and a first evaporator and a second evaporator that expand the heat medium;

- wherein a humidifier is provided in the regeneration air discharge part,
- wherein the processing air is configured to pass through the first evaporator in the first processing air supply part,
- wherein the regeneration air is configured to sequentially pass through the
- 5 condenser and the humidifier in the regeneration air supply part,
- wherein the regeneration air passed through the regeneration zone is configured to pass through the second evaporator,
- wherein the fan coil unit, the compressor, the expansion valve, a condenser, the first evaporator and the second evaporator are driven so that an enthalpy difference
- 10 between the processing air supplied to the processing zone and the regeneration air supplied to the regeneration zone is equal to or greater than 30 kJ/kg (DA),
- wherein conditions of the condenser and the first evaporator are changed using the compressor and the expansion valve when temperature of outdoor air is higher than a determined temperature of summer season and humidity of outdoor air is higher than a
- 15 determined humidity of summer season, and
- wherein conditions of the condenser and the first evaporator are changed using the compressor and the expansion valve and recovering heat from the first evaporator and the second evaporator when temperature of outdoor air is lower than a determined temperature of winter season and humidity of outdoor air is lower than a determined
- 20 humidity of winter season.

[Claim 5]

The air conditioning system according to claims 1 to 4, wherein a carbon dioxide removal ratio in the room is equal to or greater than 30%.