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SPECIFICATION
MOISTURE CONTROL UNIT

The present invention relates to a moisture control unit, more particularly to a dehumidifying/humidifying device and a dehumidifier respectively employing a moisture absorption rotor and not needing a piping work.

There is a dry dehumidifying/humidifying device for dehumidifying and humidifying air.

As a conventional dry dehumidifying/humidifying device, air is dehumidified when the dry dehumidifying/humidifying device absorbs moisture in the air while the air is humidified by generating vapor when the air heated by a heater is permitted to pass through a moisture absorption rotor, and by humidifying the air by the thus generated vapor, wherein the moisture absorption rotor selects a range of air passage through which the air passes when it is rotated by a rotary driving source such as a motor.

However, such a conventional dehumidifying/humidifying device needs a rotary driving source for rotating the moisture absorption rotor or a power transmission means for transmitting power of the rotary driving source to the moisture absorption rotor, which causes problems in that a structure of the device becomes complicated, a manufacturing cost of the device is high, and a maintenance cost of the device is needed because of consumption of power.

There is a conventional dehumidifier for dehumidifying moisture in air which is classified into two types, one is a dry dehumidifier and the other is a wet dehumidifier.

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The dry humidifier is classified into a rotary dehumidifier as shown in Fig. 5 and a stationary dehumidifier as shown in Fig. 6.

The rotary dehumidifier in Fig. 5 comprises a rotary moisture absorption rotor **a**, two fans **b** and **c**, and a heater **d**, wherein air to be dehumidified is sucked by the fan **c** through the moisture absorption rotor **a** so that it is dehumidified, and the air heated by the heater **d** is discharged to another space by the fan **b** through the moisture absorption rotor **a** and a duct, not shown, so that the moisture absorption rotor **a** can be regenerated.

The stationary dehumidifier in Fig. 6 comprises two fans **f** and **g** provided in front of a moisture absorption element **e**, valves **h**, **i**, **k**, and **m** and a heater **j**, wherein air to be dehumidified is supplied to the moisture absorption element **e** by the fan **g** through the valve **h** and the dehumidified and dried air is discharged to space through the valve **i**. When the moisture absorption element **e** is to be regenerated, air under high temperature is supplied to the moisture absorption element **e** by the fan **f** through the heater **j** and the valve **k**, and the air which becomes high in temperature and humidity is discharged to another space through the valve **m** and a duct, not shown.

The wet dehumidifier includes an evaporator, wherein temperature of air which is to be dehumidified is lowered by the evaporator so that the moisture in the air is changed into dew, and dew drop is stored in a container, etc. thereby dehumidifying the air.

However, in the conventional dry dehumidifier, since a plurality of fans are needed and the moisture which is taken out in the course of regenerating the moisture absorption element is discharged to another space, it is not easily installed and costs high since a duct piping work is needed.



The conventional stationary dehumidifier causes such problems that the dehumidifier becomes complicated and costs much since it needs a plurality of valves and control units for controlling the opening and closing of these valves.

In the conventional wet dehumidifier, although a duct is not needed and air can be dehumidified in one space, it needs a heat pump, which causes such problems that the dehumidifier becomes large-scaled and costs much and noise is generated during operation of the dehumidifier. Further, even if the dehumidifier is used in a low temperature range, the surface of the evaporator is frosted, which lowers the dehumidifying capacity.

It is a first object of the invention to improve the drawbacks of the conventional dehumidifying/humidifying device and dehumidifiers, and to provide a moisture control unit which can be simplified in the structure, can be easily small-sized, and can be installed with low cost without needing a piping work.

To achieve the object of the invention, a moisture control unit according to a first aspect of the invention comprises a body which is partitioned by a partition wall into a plurality of chambers, wherein a dehumidifying opening is provided in the chamber and a humidifying opening is provided in the chamber, a moisture absorption rotor which is rotatably provided in the chambers so as to be located in each of the chambers at a part thereof, a heater provided in one of the chambers adjacent to the moisture absorption rotor for evaporating water which is absorbed by the moisture absorption rotor.

In the first aspect of the invention, a part of the moisture absorption rotor which absorbs moisture from air is made heavy to thereby rotate

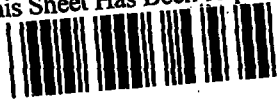


downward owing to weight of water while a part of the moisture absorption rotor which is heated by a heater and from which water is evaporated is made light to thereby rotate upward. As a result, the moisture control rotor can rotate by itself without needing a rotary driving source.

A moisture control unit according to a second aspect of the invention comprises a body, a fan provided on a surface of the body, a moisture absorption rotor rotatably provided in the body, a sensible heat exchanger provided in the body, first and second passages provided in the sensible heat exchanger, and a heater provided in the body, wherein a part of air which is sucked through the fan and is to be dehumidified is supplied to the moisture absorption rotor where it is dehumidified, and then it is discharged outside the body, remaining sucked air in the body is supplied to the moisture absorption rotor after it passes the first passages and the heater so as to regenerate the moisture absorption rotor, and wherein air which is made high in humidity owing to regeneration of the moisture absorption rotor is supplied to the second passages of the sensible heat exchanger so as to form dew on the sensible heat exchanger, and dew drop is collected to perform dehumidification.

The moisture absorption rotor can be regenerated when the air heated by the heater is permitted to pass through the moisture absorption rotor which is made high in humidity after the moisture absorption rotor is dehumidified.

When air which is made high in humidity at the time of regeneration of the moisture absorption rotor 24 is permitted to pass through the second passages, the same air is cooled by the air which passes through the first passages so as to form dew in the second



passages and dew drop is collected to dehumidify the air without needing a piping work, etc.

Fig. 1 is a view showing a principle of a dry dehumidifying/humidifying device serving as a moisture control unit according to a first aspect of the invention;

Fig. 2 is a perspective view of the moisture control unit of Fig. 1 a part of which is cut away;

Fig. 3 is a perspective view of a dehumidifier serving as a moisture control unit according to a second embodiment of the invention;

Fig. 4 is a view showing the operation of the moisture control unit of Fig. 3; and

Fig. 5 is a view showing the operation of a conventional rotary dehumidifier serving as a moisture control unit; and

Fig. 6 is a view showing the operation of another conventional stationary dehumidifier serving as a moisture control unit.

A moisture control unit according to a first embodiment will be now described with reference to Figs. 1 and 2.

In Fig. 1, a box-shaped body 1 is partitioned by a partition wall 1a into two chambers, i.e. one chamber 1₁ and the other chamber 1₂. A discoidal moisture absorption rotor 2 is accommodated in the chambers 1₁ and 1₂ in such a manner that a substantially half thereof is accommodated in one chamber 1₁ and the other half thereof is accommodated in the other chamber 1₂.

The moisture absorption rotor 2 is made of a member having water vapor permeability such as porous ceramic, porous glass, porous metal, porous high polymer, non woven fabric, paper, and a moisture absorption



material such as calcium chloride, lithium chloride, magnesium chloride, potassium carbonate, magnesium nitrate, sodium hydroxide, magnesium perchlorate, silica gel, activated alumina, molecular sieves, active carbon, wherein the moisture absorption material is impregnated in or coated onto the material having water vapor permeability or made of the member having water vapor permeability per se or the moisture absorption material per se.

The moisture absorption rotor 2 is disposed substantially perpendicularly in a slit 1b formed in the partition wall 1a. Both ends of a rotary shaft 2a provided at the center of the moisture absorption rotor 2 are rotatably supported by a partitioned wall 1a by way of a bearing 3. A dehumidifying opening 4 is defined in the chamber 1₁ and a humidifying opening 5 is defined in the chamber 1₂. A heater 6 is provided in the chamber 1₂ adjacent to the moisture absorption rotor 2 and positioned oppositely to the humidifying opening 5 while the moisture absorption rotor 2 intervenes between the heater 6 and the humidifying opening 5.

The principle of the dehumidifying/humidifying device, i.e. moisture control unit will be now described. Supposing that humidity of air in the chamber 1₁ is the same as that in the chamber 1₂, weight of the moisture absorption rotor 2 per unit of volume is made the same so that the left and right portions of the moisture absorption rotor 2 are balanced with each other about the rotary shaft 2a. As a result, the moisture absorption rotor 2 does not rotate. Successively, when the heater 6 is energized to heat the moisture absorption rotor 2, water in a portion 2₂ positioned in the chamber 1₂ is evaporated so that the balance between the left and right portions of the moisture absorption rotor 2 is lost. As a result, the portion 2₂ in the chamber 1₂ which is made light rotates upward while a portion 2₁ of the moisture absorption rotor 2₁ in the



chamber 1₁ rotates downward, and both portions 2₁ and 2₂ are balanced and stop at a position where they are balanced.

Since the water of the portion 2₂, which is moved from the chamber 1₂ to the chamber 1₁, is evaporated so that the portion 2₂ is dried, the portion 2₂ absorbs moisture from the air in the chamber 1₁ to thereby dehumidifies the chamber 1₁.

Further, since the portion 2₁, which is moved from the chamber 1₂ to the chamber 1₂, is heated by the heater 6 so that the water thereof is evaporated, thereby humidifying the air in the chamber 1₂.

As mentioned above, the moisture absorption rotor 2 can rotate using weight of the water which is absorbed by the moisture absorption rotor 2 but not using a rotary driving source.

Next, the structure and the operation of the moisture control unit of the first embodiment utilizing the aforementioned principle will be now described with reference to Fig. 2.

Elements which are the same as those of Fig. 1 are denoted at the same numerals and explanations thereof are omitted.

In the dehumidifying/humidifying device in Fig. 2, the body 1 is partitioned by vertical and lateral partition walls 1a, 1c and 1d into four chambers, i.e. 1₁, 1₂, 1₃ and 1₄. Air take-in ports 8 and 10 are defined in the chambers 1₃ and 1₄ confronting the openings 4 and 5 which are defined in the chambers 1₁ and 1₂, wherein air 7 to be dehumidified passes through the air take-in port 8 and air 9 to be humidified passes through the air take-in port 10.

Fans 11 and 12 are provided at inner portions of the air take-in ports 8 and 10 for taking the air in the chamber 1₃ and chamber 1₄. The air which is taken in the chamber 1₃ by the fan 11 reaches the moisture absorption rotor 2 and passes through the portion 2₁ which occupies three



quarters of the moisture absorption rotor 2 positioned in the chamber 13, wherein the moisture of the air is absorbed in passages 2b of the moisture absorption rotor 2.

The air, after the removal of the moisture thereof, is dried and discharged from the dehumidifying opening 4.

The air, which is taken in the chamber 14 by the fan 12, is heated by the heater 6 which is positioned adjacent to the moisture absorption rotor 2, and then passes through the portion 22 which occupies substantially one quarter of the moisture absorption rotor 2, wherein the water in the moisture absorption rotor 2 is evaporated by the air which is heated by the heater 6 and made hot.

The air, which is humidified by the evaporated vapor, passes through the chamber 12 and then it is discharged from the humidifying opening 5.

In such a manner, when the dehumidifying opening 4 and the air take-in port 8 are provided at appropriate portions where the air is intended to be dehumidified, the dehumidifying/humidifying device, i.e. the moisture control unit can be used as a dehumidifier, and when the humidifying opening 5 and the air take-in port 10 are provided at appropriate portions where the air is intended to be humidified, the control unit can be used as a humidifier.

Based on the principle as explained with reference to Fig. 1, the moisture absorption rotor 2, from which the water is evaporated, rotates upward and the moisture absorption rotor 2, which absorbs the moisture and is made heavy, rotates downward, so that the moisture absorption rotor 2 can rotate by itself without needing a rotary driving means.

As mentioned in detail above, since the moisture absorption rotor 2, which dehumidifies or humidifies the air, can rotate by itself utilizing



weight of the absorbed water, the moisture control unit of the first aspect of the invention can dispense with a rotary driving means or a power transmission device which have been conventionally used for rotating the moisture absorption rotor 2.

Accordingly, the moisture control unit can be small sized and manufactured with low cost, and can be operated with less noise since noise is not generated from the rotary driving means or the power transmission device. Further, since the power consumption can be reduced, a maintenance cost can be reduced.

A moisture control unit according to a second embodiment will be now described with reference to Figs. 3 and 4, wherein Fig. 3 shows a perspective view of a dehumidifier serving as a moisture control unit, and Fig. 4 shows a view showing the operation of the moisture control unit of Fig. 3.

In Fig. 3, denoted at 21 is a body of a dehumidifier, i.e. moisture control unit composed of a box-shaped case 21a which has an inlet port 22 therein. A fan 23 is provided at an inner portion of the inlet port 22 for sucking fresh air therethrough. Air which is sucked in the case 21a by the fan 23 passes through a passage 21c which is partitioned by a partition wall 21b and reaches a cylindrical moisture absorption rotor 24 which is disposed in the case 21a at the upper portion thereof and a sensible heat exchanger 25 which is disposed in the case 21a at the rear portion of the fan 23.

The moisture absorption rotor 24 has therein a plurality of passages 24a and 24b in which the moisture absorption material such as calcium chloride, lithium chloride, silica gel, molecular sieves is impregnated or on which the moisture absorption material is coated. The moisture absorption rotor 24 is disposed to extend over a passage 21c which is



partitioned by the partition wall 21b and a chamber 21d accommodating the sensible heat exchanger 25 therein. A shaft 24c provided at the center of the moisture absorption rotor 24 is rotatably supported by the partition wall 21b by way of a bearing 26 so that the moisture absorption rotor 24 is freely rotatable in the direction of the arrow in Fig. 3. The air passed through the moisture absorption rotor 24 and dehumidified thereby is discharged outside the case 21a through an air discharge port 27.

The sensible heat exchanger 25 provided in the chamber 21d at the lower portion thereof comprises a plurality of passages 25a and a plurality of passages 25b which are made of material having high water resisting property and stacked on top of one another in layers in the direction to cross at right angles with one another, wherein the air supplied by the fan 23 is permitted to pass through the passages 25a, and the air which passed through a heater 28 provided in the chamber 21d at the upper portion thereof and the moisture absorption rotor 24 and returned to the sensible heat exchanger 25 is permitted to pass through the passages 25b. The sensible heat exchanger 25 has an air discharge port 29 at the lower portion for discharging the dehumidified air and a drop port 30 through which the dew drop at the passages 25b is discharged. A container 31 is detachably mounted under the take-in port 10 for accommodating the dew drop under the drop port 30.

The operation of the moisture control unit having the arrangement as set forth above will be now described.

When a power switch, not shown, is turned on to start the dehumidification, the fan 23 is rotated to suck the air from the inlet port 22. A part of the thus sucked air passes through the passage 21c and reaches the moisture absorption rotor 24. The moisture in the air is absorbed by the moisture absorption rotor 24 to thereby dehumidifies the



air when the air passes through the passages 24b which occupies substantially half of the moisture absorption rotor 24 and positioned at the passage 21c.

The dehumidified and dried air is discharged through the air discharge port 27 while the moisture absorption rotor 24 absorbs the moisture in the air so that substantially half of the moisture absorption rotor 24 at the side of the passage 21c is made heavy. As a result, the moisture absorption rotor 24 rotates by itself in the direction of the arrow as shown in Fig. 3.

The air which is sucked by the fan 23 and still remains in the case 21a passes through the passages 25a of the sensible heat exchanger 25 provided at the rear portion of the fan 23 and reaches the heater 28 where it is heated by the heater 28 to a high temperature, and the thus heated air reaches the passages 24a of the moisture absorption rotor 24 in the chamber 21d. The passages 24b of the moisture absorption rotor 24 absorb the moisture in the air at the side of the passage 21c and made high in humidity at the side of the passage 21c. As a result, the passages 24b are positioned in the passages 24a in the chamber 21d by the self rotation of the moisture absorption rotor 24. Since the hot air which is heated by the heater 28 enters the passages 24a which is under high humidity, the vapor is generated and the air is made high in temperature and humidity.

When the air which was made high in temperature and humidity reaches the sensible heat exchanger 25 and passes through the passages 25b, it is cooled by the air which passes through the passages 25a so that dew is formed on the surface of the passages 25b.

The air which is dehumidified owing to formation of dew is discharged outside the case 21a through the air discharge port 29, and the



dew drop formed in the passages 25b is collected in the drop port 30 through which it drops in the container 31, and it is finally stored in the container 31.

Amount of water which is stored in the container 31 is equal to the dehumidifying amount of the air by this dehumidifier, i.e. moisture control unit. When the water is stored in the container 31 in an appropriate amount, the container 31 is taken out from the case 21a and the water is discharged. As a result, the dehumidification can be performed without needing a piping system such as a duct.

A dehumidifying process of the moisture control unit is illustrated in Fig. 4, where the arrows show direction of the air and the dew.

Although the moisture absorption rotor 24 is cylindrical in the second embodiment, it may be polygonally cylindrical or rectangular parallelepiped body.

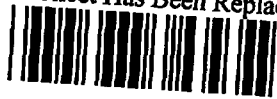
Further, although the moisture absorption rotor 24 is rotatably supported and it rotates by itself owing to weight of the sucked moisture, it may be rotated by the fan 23 which is interlocked with the power transmission means or it may be rotated by a separately provided driving source.

As mentioned above, according to the second embodiment, the moisture in the air is changed to dew so that the air is taken out as the liquid phase. As a result, it does not need the piping system such as a duct which has been employed by the conventional dry dehumidifier. Accordingly, this moisture control unit can be easily installed in a room, a closet, a clog cabinet, a bath room or a rented house where a piping work can not be executed.

Since the air under high temperature and high humidity which is discharged through the dehumidifying material is cooled by the sensible

heat exchanger to form the dew so that the moisture in the air is changed to water, whereby the dehumidification can be performed. As a result, the lower the temperature of the air to be sucked is, i.e. at least 0 °C, the higher the dehumidifying effect is, which overcomes the drawbacks of a conventional heat pump in that the dehumidifying effect is lowered in a low temperature range. Further, since the heat pump is not used, it is possible to realize the dehumidification with low noise.

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CLAIMS

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1. A moisture control unit comprising:

a body (1) which is partitioned by a partition wall (1_a) into a plurality of chambers (1₁, 1₂), wherein a dehumidifying opening (4) is provided in the chamber (1₁) and a humidifying opening (5) is provided in the chamber (1₂);

a moisture absorption rotor (2) which is rotatably provided in the chambers (1₁, 1₂) so as to be located in each of the chambers (1₁, 1₂) at a part thereof; and

a heater 6 provided in one (1₂) of the chambers (1₁, 1₂) adjacent to the moisture absorption rotor (2) for evaporating water which is absorbed by the moisture absorption rotor (2).

2. A moisture control unit according to Claim 1, further comprising fans (11 and 12) provided in the body (1) for supplying air (7) to be dehumidified and air (9) to be humidified to the moisture absorption rotor (2).

3. A moisture control unit comprising:

a body (21);

a fan (23) provided on a surface of the body (21);

a moisture absorption rotor (24) rotatably provided in the body (21);

a sensible heat exchanger (25) provided in the body (21);

first and second passages (25a and 25b) provided in the sensible heat exchanger (25); and

a heater (28) provided in the body (21);

wherein a part of air which is sucked through the fan (23) and is to be dehumidified is supplied to the moisture absorption rotor (24) where it is dehumidified, and then it is discharged outside the body (21),



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remaining sucked air in the body (21) is supplied to the moisture absorption rotor (24) after it passes through the first passages (25a) of the sensible heat exchanger (25) and the heater (28) so as to regenerate the moisture absorption rotor (24); and

wherein air which is made high in humidity owing to regeneration of the moisture absorption rotor (24) is supplied to the second passages (25b) of the sensible heat exchanger (25) so as to form dew on the sensible heat exchanger (25), and dew drop is collected to perform dehumidification.

4. A moisture control unit according to Claim 3, wherein said moisture absorption rotor (24) is rotated by weight of vapor which is sucked thereby.

5. A moisture control unit according to Claim 3, wherein said moisture absorption rotor (24) is rotated by the fan which is interlocked with a power transmission means or by a separately provided driving source.