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(19) **United States**(12) **Patent Application Publication**
Lee(10) **Pub. No.: US 2012/0255702 A1**(43) **Pub. Date: Oct. 11, 2012**(54) **SENSIBLE HEAT EXCHANGING ROTOR****Publication Classification**(76) Inventor: **Dae-Young Lee, Seoul (KR)**(51) **Int. Cl.**
F28D 19/04 (2006.01)(52) **U.S. Cl.** **165/8**(21) Appl. No.: **13/213,275**(57) **ABSTRACT**(22) Filed: **Aug. 19, 2011**(30) **Foreign Application Priority Data**

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A sensible heat exchanging rotor includes a rotor body rotatably mounted between a first channel and a second channel, and a heat storage medium disposed in the rotor body and configured to suck thermal energy from a fluid passing through the first channel, and configured to transfer the sucked thermal energy to a fluid passing through the second channel, wherein the heat storage medium is formed of a polymer material.

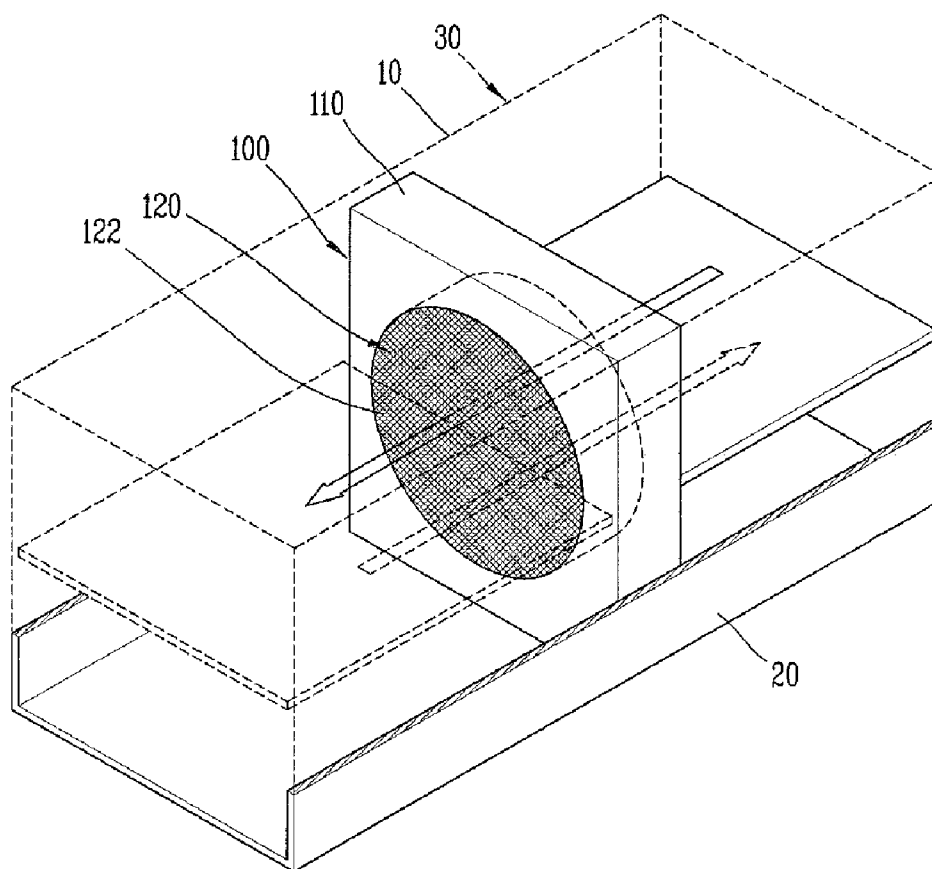


FIG. 1

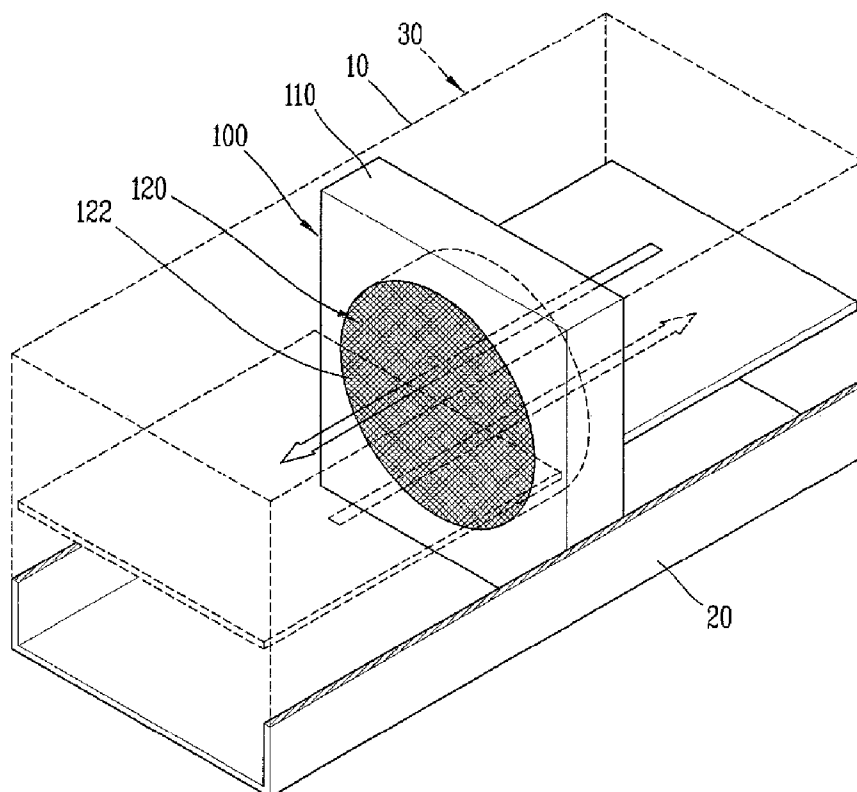


FIG. 2

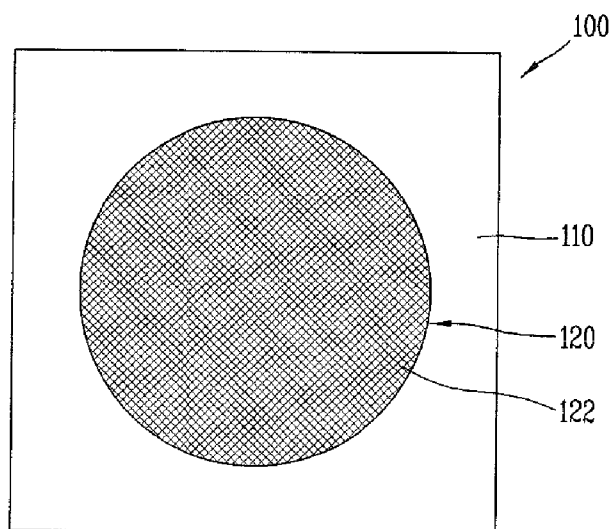


FIG. 3

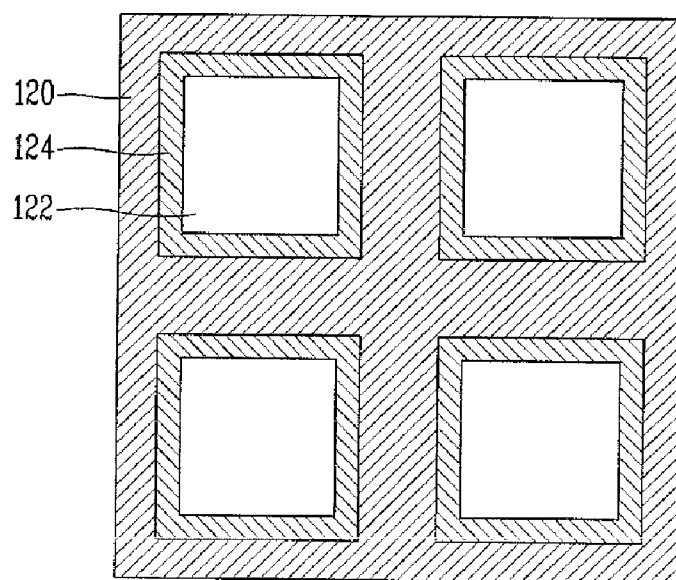


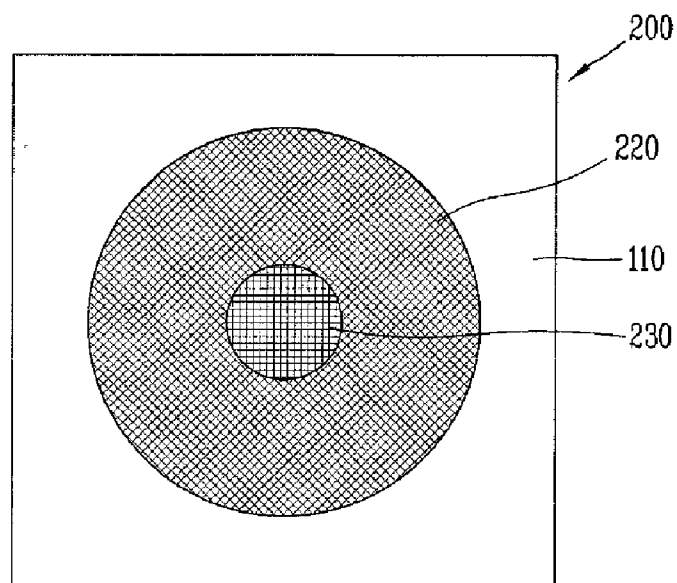
FIG. 4

	ρ_m (kg/m ³)	C_m (kJ/kgK)	$\rho_m C_m$ (kJ/m ³ K)
ALUMINUM	2,700	0.90	2,400
STEEL	8,000	0.45	3,600
COPPER	8,900	0.37	3,300
POLYTHYLENE	960	2.1	2,000
POLYPROPYLENE	1,200	1.9	2,300
POLYVINYLCHLORIDE	1,700	1.1	1,900
WATER	1,000	4.2	4,200

FIG. 5

$\delta = 0.1 \text{ mm}$	$\alpha_m \text{ (m}^2/\text{s)}$	$t_{\text{pen}} \text{ (s)}$
ALUMINUM	8×10^{-6}	1.3×10^{-4}
STEEL	$0.4 \sim 1.9 \times 10^{-5}$	$5.3 \sim 25 \times 10^{-4}$
COPPER	11×10^{-5}	0.91×10^{-4}
POLYTHYLENE	1.6×10^{-7}	0.063
POLYPROPYLENE	0.75×10^{-7}	0.13
POLYVINYLCHLORIDE	0.51×10^{-7}	0.20
WATER	1.5×10^{-7}	0.067

FIG. 6



SENSIBLE HEAT EXCHANGING ROTOR

CROSS-REFERENCE TO RELATED APPLICATION

[0001] Pursuant to 35 U.S.C. §119(a), this application claims the benefit of earlier filing date and right of priority to Korean Application No. 10-2011-0031393, filed on Apr. 5, 2011, the contents of which is incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This specification relates to a sensible heat exchanging rotor, and particularly, to a sensible heat exchanging rotor capable of recovering heat from exhaust air by being applied to a heat recovery ventilation apparatus, an air conditioning system, a dehumidifying cooler, and so on.

[0004] 2. Background of the Invention

[0005] According to recent efforts to efficiently utilize energy in many fields, various types of energy recycling apparatuses are being developed.

[0006] Generally, a sensible heat exchanging rotor applied to a rotary heat exchanger uses a heat exchange medium formed of a metallic material. The rotary heat exchanger exchanges indoor air with outdoor air by flowing high-temperature exhaust air generated from a building or a factory and supply air required for equipment in opposite directions, by rotating a sensible heat rotor. More concretely, the sensible heat rotor is installed between an exhaust air channel and a suction air channel. And, the sensible heat rotor is configured to maintain indoor air in a desired state, with a minimized loss of thermal energy by sucking thermal energy of air exhausted through the exhaust air channel and then transferring the sucked thermal energy to air sucked through the suction air channel.

[0007] Generally, this sensible heat rotor has a structure in which a heat storage medium is installed in a rotor body. As the heat storage medium, a metallic material such as aluminum or steel has been used for enhanced heat transfer. This sensible heat rotor provided with the heat storage medium formed of a metallic material is advantageous in the aspect of heat exchange efficiency, owing to its excellent heat transfer property. However, the sensible heat rotor is required to have a supporting structure for stable support against its heavy weight. In case of industrial facility where a large space and large equipment are provided, the weight of the sensible heat rotor does not matter. However, when applying the sensible heat rotor to a dwelling space (residing space) such as a detached house or an apartment, a ceiling of the dwelling space is formed of a panel material which does not have a sufficient strength. Accordingly, the sensible heat rotor may have a limitation in being applied to a dwelling space due to its heavy weight.

SUMMARY OF THE INVENTION

[0008] Therefore, an aspect of the detailed description is to provide a sensible heat exchanging rotor capable of having a heat transfer performance for houses and capable of having a lighter weight than the conventional one.

[0009] To achieve these and other advantages and in accordance with the purpose of this specification, as embodied and broadly described herein, a sensible heat exchanging rotor includes a rotor body rotatably mounted between a first chan-

nel and a second channel, and a heat storage medium disposed in the rotor body, and configured to suck thermal energy from a fluid passing through the first channel and to transfer the sucked thermal energy to a fluid passing through the second channel, wherein the heat storage medium is formed of a polymer material.

[0010] The heat storage medium may have a plurality of air holes for passing through the fluids which pass through the first and second channels.

[0011] The heat storage medium may have a porosity corresponding to 0.8~0.9 times of an area of the heat storage medium.

[0012] The polymer material may be formed of one of polyethylene, polypropylene, PVC, a super absorbent polymer (SAP) and a super desiccant polymer (SDP).

[0013] A surface of the heat storage medium may be coated with a hardening agent.

[0014] The heat storage medium may be coated with the hardening agent in a thickness of 1 mm~5 mm.

[0015] The heat storage medium may have a structure in which a plurality of heat storage layers formed of different polymer materials are radially arranged.

[0016] The present invention may have the following advantages.

[0017] Firstly, the heat storage medium may be formed of a polymer material rather than the conventional metallic material. This may implement a sensible heat exchanging rotor capable of providing a sufficient heat transfer performance for houses and capable of having a much lighter weight than the conventional one. This sensible heat exchanging rotor may be widely applied and may be easily fabricated.

[0018] Further scope of applicability of the present application will become more apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from the detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate exemplary embodiments and together with the description serve to explain the principles of the invention.

[0020] In the drawings:

[0021] FIG. 1 is a perspective view of an air conditioning system to which a sensible heat exchanging rotor according to one embodiment of the present invention has been applied;

[0022] FIG. 2 is a planar view of the sensible heat exchanging rotor of FIG. 1;

[0023] FIG. 3 is an enlarged sectional view of a heat storage medium of FIG. 1;

[0024] FIG. 4 shows a table illustrating a density, a specific heat and a heat capacity per unit volume of each conventional metallic material and each polymer material of the present invention;

[0025] FIG. 5 shows a table illustrating a thermal diffusion coefficient and time taken to perform thermal absorption and emission with respect to each conventional metallic material and each polymer material of the present invention; and

[0026] FIG. 6 is a planar view of a sensible heat exchanging rotor according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0027] Description will now be given in detail of the exemplary embodiments, with reference to the accompanying drawings. For the sake of brief description with reference to the drawings, the same or equivalent components will be provided with the same reference numbers, and description thereof will not be repeated.

[0028] Hereinafter, a sensible heat exchanging rotor according to the present invention will be explained in more details with reference to the attached drawings.

[0029] FIG. 1 is a perspective view of an air conditioning system to which a sensible heat exchanging rotor according to one embodiment of the present invention has been applied, FIG. 2 is a planar view of the sensible heat exchanging rotor of FIG. 1, and FIG. 3 is an enlarged sectional view of a heat storage medium of FIG. 1.

[0030] Referring to FIGS. 1 to 3, the sensible heat exchanging rotor 100 is installed at a duct 30 formed by a first channel 10 and a second channel 20. The first channel 10 is configured to exhaust air to the outside, and the second channel 20 is disposed below the first channel 10 and configured to suck air to the inside from the outside.

[0031] The duct 30 is disposed between a finish material for a ceiling of a dwelling space and a ceiling body, and is connected to indoor side ends of the first and second channels by louvers (not shown). The duct 30 is configured to suck indoor air, or to supply outdoor air introduced from the outside to the inside.

[0032] The sensible heat exchanging rotor 100 includes a rotor body 110 formed to have an approximate same shape as an inner space of the duct 30, and a heat storage medium 120 rotatably mounted in the rotor body 110. The heat storage medium 120 is rotatably mounted in the rotor body 110 by a motor (not shown) provided at an intermediate portion thereof. A structure of this sensible heat exchanging rotor has been well-known to those skilled in the art, and thus its detailed explanations will be omitted.

[0033] The heat storage medium 120 is provided with a plurality of air holes 122. The air holes 122 are penetratingly formed at the heat storage medium 120. While passing through the air holes 122, air transmits its thermal energy to the heat storage medium, or absorbs thermal energy of the heat storage medium, due to a temperature difference. For instance, when air passing through the first channel has a temperature higher than that of air passing through the second channel, the air passing through the first channel transmits thermal energy to the heat storage medium 120 while passing through the air holes 122. Then, the heat storage medium heated by the air passing through the first channel is rotated to move to the second channel. Then, the heat storage medium having moved to the second channel transmits thermal energy to the air passing through the second channel.

[0034] A ratio of an area occupied by the air holes with respect to an entire area of the heat storage medium, a porosity is preferably in the range of 0.8–0.9. When the porosity is less than 0.8, a flow resistance of air is increased to badly influence on a heat transfer performance. On the other hand, when the porosity is more than 0.9, the entire volume of the heat storage medium is decreased to badly influence on a heat transfer performance, too.

[0035] The heat storage medium is formed of a polymer material. This polymer material may include one of polyethylene, polypropylene, PVC, a super desiccant polymer (SDP) and a super absorbent polymer (SAP), or a combination thereof.

[0036] Generally, a polymer material has lower thermal conductivity than a metallic material. Accordingly, the polymer material has been recognized as a material not suitable for heat transfer, a material which cannot be utilized as a heat storage medium. However, the present inventor has researched that the polymer material can be utilized as a heat storage medium in a dwelling space, etc. where a temperature of air is less than 100° C.

[0037] FIG. 4 shows a table illustrating a density, a specific heat and a heat capacity per unit volume of general metallic materials including aluminum, iron and copper, and polymer materials which may be used in the present invention, such as polyethylene, polypropylene and PVC, and water.

[0038] Referring to FIG. 4, each polymer material has a density much lower than that of each metallic material, but has a specific heat much higher than that of each metallic material. Accordingly, each polymer material has a heat capacity per unit volume which is not much lower than that of each metallic material. More concretely, each polymer material has a heat capacity per unit volume corresponding to 60–90% of a heat capacity per unit volume of each metallic material. Especially, polypropylene and polyethylene have heat capacities corresponding to 96% and 83% of a heat capacity of aluminum, respectively. Accordingly, the polypropylene and the polyethylene are not much lower than the aluminum in the aspect of a heat capacity. Even if the heat capacities of the polypropylene and the polyethylene are not much lower than the heat capacity of the aluminum, an rpm of the heat storage medium has only to be increased for enhanced heat transfer.

[0039] As shown in FIG. 4, water has a largest heat capacity. If an SAP or an SDP having high absorptiveness with respect to water is used as a heat storage medium, the SAP or the SDP may have an increased heat capacity by absorbing moisture included in air. Accordingly, the SAP or the SDP may serve as a heat storage medium.

[0040] Furthermore, the polypropylene and the polyethylene have densities corresponding to 44% and 36% of a density of the aluminum, the lightest metal, respectively. This may implement a light weight.

[0041] Utilization as a heat storage medium may be determined by another factor, a thermal diffusion coefficient. If a thermal diffusion coefficient is small, a thermal absorption-emission speed is slow. Accordingly, even if a heat capacity of a heat storage medium is large, the entire heat capacity cannot be utilized. A relation between a thermal diffusion coefficient and time taken to perform thermal absorption and emission may be defined as follows.

$$t_{pen} \approx \delta^2 / \alpha_m$$

t_{pen} : Time taken to perform thermal absorption and emission

δ : Thickness of heat storage medium

α_m : Thermal diffusion coefficient

[0042] FIG. 5 illustrates a thermal diffusion coefficient and time taken to perform thermal absorption and emission with respect to each of the materials shown in FIG. 4. Referring to FIG. 5, it takes a much longer time for polymer materials to perform thermal absorption and emission than metallic materials. More concretely, it takes about 0.1 seconds for the polymer materials to perform thermal absorption and emis-

sion. When compared with time (2-5 seconds) taken for the conventional sensible heat exchanging rotor to rotate once, the 0.1 seconds are significantly short. Accordingly, even if the polymer materials have a longer time in performing thermal absorption and emission than the metallic materials, the polymer materials do not have a degraded performance as the sensible heat exchanging rotor.

[0043] Furthermore, as well as the aforementioned advantage of a light weight, the polymer materials may be molded more easily than the metallic materials. Accordingly, the polymer materials have advantages in the aspects of productivity and costs.

[0044] Besides, it is general for air exhausted from a dwelling space to have a temperature much less than 100° C. This exhaust air does not influence on the polymer materials which are thermally degraded at a high temperature.

[0045] The polymer materials have a lower strength than the metallic materials. However, the polymer materials may be used without any problems within the range of lifespan thereof. Furthermore, the low strength of the polymer materials may be enhanced by forming a hardening layer **124** by depositing a hardening agent on the surface of the heat storage medium with a thickness of 1~5 mm.

[0046] A coupling part of the heat storage medium with a driving motor is required to have a relatively high strength. Accordingly, as shown in FIG. 6, a sensible heat exchanging rotor **200** has a heat storage medium consisting of a plurality of layers radially laminated on each other. Here, an outer layer **220** may be formed of a material having a high heat transfer performance since a relatively high strength is not required. On the other hand, an inner layer **230** may be formed of a material having a relatively high strength. In some cases, only the inner layer **230** may be formed of a metallic material.

[0047] The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting the present disclosure. The present teachings can be readily applied to other types of apparatuses. This description is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art. The features, structures, methods, and other characteristics of the exemplary embodiments described herein may be combined in various ways to obtain additional and/or alternative exemplary embodiments.

[0048] As the present features may be embodied in several forms without departing from the characteristics thereof, it should also be understood that the above-described embodi-

ments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalents of such metes and bounds are therefore intended to be embraced by the appended claims.

what is claimed is:

1. A sensible heat exchanging rotor, comprising:

a rotor body rotatably mounted between a first channel and a second channel; and

a heat storage medium disposed in the rotor body, and configured to suck thermal energy from a fluid passing through the first channel and to transfer the sucked thermal energy to a fluid passing through the second channel,

wherein the heat storage medium is formed of a polymer material.

2. The sensible heat exchanging rotor of claim **1**, wherein the heat storage medium has a plurality of air holes for passing through the fluids which pass through the first and second channels.

3. The sensible heat exchanging rotor of claim **1**, wherein the heat storage medium may have a porosity corresponding to 0.8~0.9 times of an area of the heat storage medium.

4. The sensible heat exchanging rotor of claim **1**, wherein the polymer material includes one of polyethylene, polypropylene, PVC, a super absorbent polymer (SAP) and a super desiccant polymer (SDP).

5. The sensible heat exchanging rotor of claim **1**, wherein a surface of the heat storage medium is coated with a hardening agent.

6. The sensible heat exchanging rotor of claim **5**, wherein the heat storage medium is coated with the hardening agent in a thickness of 1 mm~5 mm.

7. The sensible heat exchanging rotor of claim **1**, wherein the heat storage medium has a structure in which a plurality of heat storage layers formed of different polymer materials are radially arranged.

8. The sensible heat exchanging rotor of claim **7**, wherein a layer positioned at a central portion among the plurality of heat storage layers has a higher strength than the rest layers.

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