

"Humidity and/or heat exchange device, e.g. a plate heat exchanger, sorption rotor, adsorption dehumidifying rotor or the like"

The invention relates to a humidity and/or heat exchange device, e.g. a plate heat exchanger, a sorption rotor, an adsorption dehumidifying rotor or the like, provided with humidity and/or heat exchange surfaces which make it possible to introduce humidity and/or heat into a fluid flow and/or to remove them therefrom and/or to exchange said humidity and/or heat between fluid flows, and with a coating with which the humidity and heat exchange surfaces are coated and which consists of a zeolite material and a bonding agent.

Humidity and/or heat exchange devices of this type are often used to bring rooms to a moderate temperature and air-condition them. In addition, other industrial applications for humidity and/or heat exchange devices of this type are also provided.

Humidity and/or heat exchange devices of this type that are known from the prior art have the disadvantage, in particular when humidity is to be removed from a fluid flow or when a fluid flow is to be acted upon with humidity, that the adsorption process and/or the desorption process which takes place or take place in the humidity and/or heat exchange device, require(s) too much time, as a result of which the capacities of such humidity and/or heat exchange devices that are possible per se cannot be realized. Furthermore, the surfaces of the coatings exposed to the fluid flows often exhibit a roughness, the result of which is that particles contained in the fluid flows accumulate, which leads to a considerable loss in the efficiency of corresponding devices or often requires comparatively expensive cleaning and maintenance measures. Moreover, there is often the difficulty of fixing the coating to the material forming the structure or the matrix of the humidity and/or heat exchange device.

Based on the aforementioned prior art, the object of the invention is to create a humidity and/or heat exchange device, e.g. a plate heat exchanger, a sorption rotor, an adsorption dehumidifying rotor or the like, in which the aforementioned disadvantages are avoided and, moreover, which can be produced with a comparatively low technical/structural expenditure.

According to the invention, this object is solved in that a synthetic nano-zeolite, which consists of particles having a particle size of < 1000 nm, is used as material for forming the coating of the humidity and/or heat exchange surfaces. Due to this construction of the zeolite material forming the coating, adsorption kinetics which are considerably increased in comparison to zeolite materials known from the prior art can be realized, the result of which is that the amount of adsorbed or desorbed steam per unit of time is increased from which an increased transfer of humidity results. By using the nano-zeolite according to the invention as a coating material, an enlargement of the specific surface thereof is obtained, and, moreover, said nano-zeolite has a good adhesive capacity on diverse surfaces when used with correspondingly suitable bonding agents. The nano-zeolite used according to the invention as a coating material has a quick regenerative power. As a synthetic nano-zeolite, the zeolite material can be produced with a very uniform particle size distribution. Depending on the selection of the particle size distribution provided for the coating material, the thickness of the coating can be adapted to the most varied requirements. The result of the low particle size of the synthetic nano-zeolite used according to the invention as zeolite material is that the coating on its surface exposed to the fluid flow or flows exhibits a very slight roughness, as a result of which the correspondingly designed humidity and/or heat exchange device is very resistant to contamination. The coatings configured according to the invention can have a high packing density, depending on the more or less uniform particle size selected for the synthetic nano-zeolite. To apply the zeolite

material according to the invention as a coating to the humidity and/or heat exchange surfaces, both spin coating and dip coating processes can be used. The coating designed according to the invention with nano-zeolite can be variably formed with respect to its surface chemistry due to the properties of the nano-zeolite.

If the plates of plate heat exchangers are provided with the coating according to the invention, it can be attained that a liquid, which is to evaporate on the one side of the heat exchanger plate in order to provide cooling energy on the other side of the same heat exchanger plate, is distributed very uniformly on the side of the heat exchanger plate having the coating, so that there is a uniform distribution of cooling energy over its surface on the other side of the same heat exchanger plate. This uniform distribution originates from the fact that, due to the coating of the invention, the liquid drops which strike are distributed very uniformly over the side of the heat exchanger plate having the coating of the invention.

According to an advantageous embodiment of the humidity and/or heat exchange device of the invention, the nano-zeolite is selected such that it has a homogeneous pore size distribution with a pore diameter of < 1.5 nm, preferably 0.4 nm. As a result, it can be ensured that those molecules which, in certain circumstances, can lead to odor problems in long-term operation of the humidity and/or heat exchange device, cannot be absorbed in the coating. However, water vapor can be absorbed exceptionally well in the analogously formed coating or given off by said coating. In this embodiment, the coating made from nano-zeolite according to the invention can thus be used as an especially suitable molecular sieve in association with the operation of humidity and/or heat exchange devices.

For the operation of analogously formed humidity and/or heat exchange devices, it is useful if the thickness of the formed

coating formed according to the invention is 0.2 to 100, preferably 1 to 2 μ (10^{-6} m).

An especially advantageous embodiment of the humidity and/or heat exchange device according to the invention is obtained if an adsorption dehumidifying rotor is made from a paper material suitable therefor and the material matrix that forms the humidity or heat exchange surfaces of this adsorption dehumidifying rotor is impregnated with a suspension containing the synthetic nano-zeolite.

This impregnation can be carried out as long as or to such an extent that - after drying - the material matrix of the adsorption dehumidifying rotor consists of at least 30, preferably 40 to 80% by weight of the nano-zeolite material according to the invention.

Of course, it is also possible to use the coating according to the invention if the material matrix of the humidity and/or heat exchange device is made of other suitable materials, e.g. aluminum foils, ceramic materials or the like.

A dispersion adhesive, e.g. acrylate brine, with an admixture of perhaps colloidal silicon dioxide can be used as a bonding agent. The corresponding bonding agent can also be advantageously used in other materials forming the coating.

The invention will be described in greater detail in the following with reference to embodiments.

In a first example of an embodiment, a humidity and/or heat exchange device formed as an adsorption dehumidifying rotor is provided with the coating according to the invention consisting of a synthetic nano-zeolite having a particle size in the range of 300 nm. A material matrix of the adsorption dehumidifying rotor consists of a suitable paper material. To introduce the

nano-zeolite into the material matrix of the adsorption dehumidifying rotor, the adsorption dehumidifying rotor is impregnated with a suspension which contains the nano-zeolite in the desired particle size. After drying the adsorption dehumidifying rotor, its final weight consists of approximately 50% by weight of nano-zeolite.

In comparison to conventional zeolite materials, the zeolite material used for impregnating the material matrix of the adsorption dehumidifying rotor with particles in nanocrystalline form has considerably quicker adsorption/desorption kinetics. The specific surface of the nano-zeolite according to the invention is larger than in other conventional zeolite materials. The crystalline nano-zeolite forming the coating of the adsorption dehumidifying rotor is comparatively uniform with respect to its pore size and can be designed such that the coating has a uniform pore size with a diameter of e.g. 0.4 nm. Due to this design of the structure of the coating, it can be ensured that the adsorption dehumidifying rotor is permanently protected against accumulating odor-forming molecules, whereas water vapor molecules can be easily absorbed and given off.

Due to the quick adsorption/desorption kinetics, the cooling capacity to be installed for the operation of an adsorption dehumidifying rotor of this type, in particular in tropical climates, can be considerably reduced, namely up to about 50%.

After its coating, the adsorption dehumidifying rotor described above has a uniformly smooth surface; as a result, it is not very susceptible to possible contamination.

The coating can be variably formed with respect to its surface chemistry. It can be applied by means of spin coating and dip coating techniques.

Due to the small and uniform particle size, the coating has a

very large specific surface and it can be applied to diverse surfaces.

A colloidal acrylate polymer and a colloidal, amorphous silicon dioxide which is surface-stabilized with sodium ions can be used as bonding agent.

Sorption rotors, whose material matrix consists of other materials, e.g. of aluminum, can also be provided with the aforementioned coating, whereby similar advantages result as described above in connection with an adsorption dehumidifying rotor with a material matrix of a paper material.

Due to the small particle size, a relatively high packing density is produced for the coating and, consequently, the layer thicknesses can be comparatively slight. A layer thickness of approximately 1 to 2 μ (10^{-6} m) is sufficient in the embodiment described above.

Furthermore, it is possible to use the coating in e.g. plate heat exchangers. When the coating consisting of the aforementioned crystalline nano-zeolite is applied to a side of a heat exchanger plate, it can be attained by this coating that the moistening agent used to moisten this side of the heat exchanger plate is distributed more uniformly on this side of the heat exchanger plate, which is due to the fact that drops striking the coating are distributed more uniformly due to the structure of the coating. As a result, uniform vaporization heat is required on the side of the heat exchanger plate having this coating, which results in that a fluid flow which flows past on the other side of the heat exchanger plate is cooled as desired. In this application of the coating also, the same or similar advantages as those described in association with the adsorption dehumidifying and sorption rotor can be obtained.

PATENT CLAIMS

1. A device for exchanging one of humidity, heat, and both heat and humidity, comprising:

a plurality of one of humidity exchange surfaces, heat exchanges surfaces, and both humidity exchanges surfaces and heat exchange surfaces;

wherein each of the surfaces are provided with a coating, the coating comprising a synthetic nano-zeolite having a particle size of less than 1000 nm and a bonding agent, and the thickness of the coating is 1 to 2 μm .

2. A device for exchanging one of humidity, heat, and both heat and humidity, comprising:

a plurality of one of humidity exchange surfaces, heat exchanges surfaces, and both humidity exchanges surfaces and heat exchange surfaces;

wherein each of the surfaces, comprises a paper material and are provided with a coating, the coating comprising a synthetic nano-zeolite having a particle size of less than 1000 nm and a bonding agent;

wherein the device is at least 30% by weight the synthetic nano-zeolite.

3. The device according to claims 1 or 2, wherein the nano-zeolite has a homogeneous pore size distribution with a pore diameter of less than 1.5 nm.

4. The device according to any one of claims 1 to 3, wherein the nano-zeolite material is present in a nano-crystalline form.

5. The device according to any one of claims 1 to 4, wherein the bonding agent contains dispersion adhesives to which colloidal SiO_2 can be added.

6. The device of claim 1 wherein the device is one of a plate heat exchanger, a sorption rotor, and an adsorption dehumidifying rotor.

7. The device of claim 3 wherein the nano-zeolite has a pore diameter of less than or equal to 0.4 nm.

8. The device of claim 2 wherein the device is 40 to 80% by weight the synthetic nano-zeolite.

9. The device of claim 5, wherein the dispersion adhesives are acrylate brines.