HEAT AND/OR MOISTURE EXCHANGE ELEMENT

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ABSTRACT

The invention relates to a heat and/or moisture exchange element, such as a heat and/or moisture exchange plate for plate heat and/or moisture exchangers, a storage mass layer for rotation heat and/or moisture exchangers and the like, wherein a greater and more precisely adjustable efficiency in transferring thermal energy and/or moisture is enabled without noticeable increase to the technical design complexity for production. According to the invention, the heat and/or moisture exchange element is designed from a structure penetrated by a plurality of hollow points and designed to be selectively permeable to water and water vapor and/or capable of storage.
HEAT AND/OR MOISTURE EXCHANGE ELEMENT

[0001] The invention concerns a heat- and/or moisture-exchange element, e.g. a heat- and/or moisture-exchange plate for plate heat and/or moisture exchangers, a storage-mass layer for rotary heat- and/or moisture exchangers, and the like.

[0002] Such a prior such exchange elements is usually made from a suitable material that, when the exchange element is provided for a rotary heat- and/or moisture exchanger, is provided with a coating on one or both opposite faces that are exposed to the respective flowing fluids, this coating being constituted according to the respective requirement and, when the exchange element is a heat- and/or moisture-exchange plate for a plate heat- and/or moisture exchanger, is either, for moisture transfer, or the like, is, when only heat is going to be transferred, solid. A metal, e.g. aluminum, or a plastic comparable thereto with respect to the properties that are required for the particular intended use here, is used as the material for the core of the heat- and/or moisture-exchange element.

[0003] Proceeding from the prior art described above, the invention is based on the task of creating a heat- and/or moisture-exchange element, e.g. a heat- and/or moisture-exchange plate for plate heat and/or moisture exchangers, a storage-mass layer for rotary heat and/or moisture exchangers, and the like, which, without noticeably increasing the engineering expense of construction for manufacturing it, allows greater and more precisely adjustable efficiency in the transfer of thermal energy and/or moisture. In particular, a heat- and/or moisture-exchange plate will be mechanically stable and yet permeable to moisture.

[0004] This problem is solved according to the invention by the heat- and/or moisture-exchange element being constructed from a structure perforated by a plurality of hollow spaces and designed to be selectively permeable to water or water vapor and/or storage-capable. The mechanical requirements set, and in this regard the thermal stability, of the heat- and/or moisture-exchange elements can be considered here on a scale not known to date. Depending on the engineering requirements mentioned, the material matrix of the heat- and/or moisture-exchange element can be produced with the properties desired. The different properties and requirements for the transfer of thermal energy and/or moisture at the heat- and/or moisture-exchange element can be considered during the manufacture of the structure.

[0005] Advantageously, the heat- and/or moisture-exchange element according to the invention is sintered from a suitable material. Depending on the requirement profile for the material matrix or the structure of the heat- and/or moisture-exchange element, an appropriate suitable material can be selected and/or worked out.

[0006] The selective permeability to water or water vapor of the heat- and/or moisture-exchange element according to the invention can be achieved by means of a suitable polymeric material.

[0007] Advantageously, the heat- and/or moisture-exchange element according to the invention can have a layer made of this polymeric material. Alternatively, it is possible for the heat- and/or moisture-exchange element to be impregnated with the suitable polymeric material in a layer region.

[0008] A suitable metal, plastic, or ceramic material can be provided as a suitable material for the material matrix or the structure perforated by a plurality of hollow spaces.

[0009] The moisture-storage capacity of the heat- and/or moisture-exchange element can be achieved by means of a drying agent, e.g. by means of lithium chloride, silica gel, zeolite, or the like, which is inserted into the material matrix or into the structure perforated by a plurality of hollow spaces.

[0010] The material matrix can be made of a polyolefin, particularly of a sinterable polyolefin.

[0011] It has proven to be especially advantageous for the material matrix or the structure perforated by a plurality of hollow spaces to be made of a medium-molecular-weight polyolefin.

[0012] According to an advantageous embodiment of the heat- and/or moisture-exchange element according to the invention, its structure perforated by a plurality of hollow spaces can be made of a polyethylene. A sintered material matrix made of a medium-molecular-weight polyethylene powder has proven to be especially advantageous.

[0013] It is also possible to make the material matrix of the heat- and/or moisture-exchange element out of polypropylene or polyvinyl chloride.

[0014] Alternatively, metal compounds, particularly metal oxides and metal carbides, are not out of the question, as a material for the material matrix of the heat- and/or moisture-exchange element.

[0015] The heat- and/or moisture-exchange element can, after, during, or before establishing its structure, be hydrophilically adjusted, in which, when producing the hydrophilic adjustment prior to establishing its structure, the raw material needed to produce its structure is already adjusted to be hydrophilic.

[0016] After, during or before production of the structure of the heat- and/or moisture-exchange element said element can be hydrophilically adjusted, wherein the raw materials required for production of said structure are hydrophilically adjusted already during the hydrophilic adjustment that precedes the production of the structure of said element.

[0017] The hydrophilic adjustment of the already-manufactured material matrix or structure of the heat- and/or moisture-exchange element according to the invention can be accomplished by means of a dipping bath, a spraying process, an application, and/or an input of suitable materials, e.g. of surfactants.

[0018] As an especially suitable plastic for making the material matrix or the structure of the heat- and/or moisture-exchange element according to the invention, a medium-molecular-weight polyethylene powder has been particularly emphasized, which powder is preferably loaded before sintering with an additive that causes hydrophilic adjustment of the heat- and/or moisture-exchange element.

[0019] As a plastic, the plastic Hostalen® GHR 8110 in particular can be provided, and the material Hostapar® SAS 60F for the material providing the hydrophilic adjustment.

[0020] Appropriately, the sintered material matrix of the heat- and/or moisture-exchange element has a density of about 0.5±0.1 g/cm³, preferably of 0.507 to 0.522, and especially of 0.517 g/cm³. The proportion of pores in the sintered material matrix amounts, according to an advantageous embodiment of the invention, to about 34 to 44%, preferably 38.6 to 40.1%, and especially 39.1%, by volume. In addition, the sintered material matrix advantageously exhibits an average pore diameter of 25 to 35 m, preferably 30 m.

[0021] The tensile strength of the sintered material matrix is preferably greater than 2.0 N/mm² and preferably lies between 2.22 to 2.70, particularly 2.45 N/mm².
In order to be able to use the heat- and/or moisture-exchange element in a simple manner for assembling counterflow heat- and/or moisture exchangers, for example, or rotary heat- and/or moisture exchangers, this heat- and/or moisture-exchange element appropriately exhibits a outer three-dimensional structure, e.g., the outer three-dimensional structure of a heat- and/or moisture-exchange plate for counterflow heat- and/or moisture exchangers or the outer three-dimensional structure of a corrugated storage-mass layer, for example, of a rotary heat and/or moisture exchanger, into which the heat- and/or moisture-exchange element can be brought by means of a suitable forming process, e.g., a deep-drawing process under vacuum or with compressed air, form-sintering, stamping, or in the case of a metal material, cold stamping.

The heat- and/or moisture-exchange element according to the invention or the heat- and/or moisture-exchange plate according to the invention can be advantageously used for a counterflow heat and/or moisture exchanger.

If the heat- and/or moisture-exchange element has a base part that forms an openwork structure and a filler that is introduced into the hollow spaces of the openwork structure of the base part, the mechanical requirements set and those relating to the thermal stability of the heat- and/or moisture-exchange element can be taken into consideration using an appropriate design of the base part. Depending on the engineering requirements mentioned, the base part can be constructed with respect to material and design of the openwork structure. The different properties and requirements for the transfer of thermal energy and/or moisture at the heat- and/or moisture-exchange element can be met by the choice of a suitable filler.

According to an advantageous embodiment of the heat- and/or moisture-exchange element according to the invention, the structure of the base part perforated by a plurality of hollow spaces is formed by a fabric, e.g., made of metal threads; a non-woven fabric, e.g., made of metal fibers; a knit, fine threads, or a sintered material.

Alternatively, it is possible to design the base part of the heat- and/or moisture-exchange element as a lattice structure. Such lattice structures can be made with high quality and in identical design at a comparatively low engineering-construction expense. The lattice structure of the base part can, for example, be constructed from a suitable metal material or a suitable plastic.

It is possible to construct a lattice structure for the base part out of metal wires.

The base part can also be constructed from at least one lattice mesh.

If several lattice meshes are provided, it is possible to arrange the hollow spaces of the adjacent lattice meshes staggered in relation to one another resulting in altered perforations in the base part with respect to their flow cross-section.

A suitable polymeric material has proven to be especially advantageous as a filler.

Such a polymeric material can fill in the hollow spaces of the openwork structure of the base part, impregnating the base part with this polymeric material, at comparatively low process-engineering expense.

A suitable Nexar®-polymer material from the firm of Kraton can be provided in particular as a polymeric material, which can be adjusted with regard to its permeability to water, for example, and which in addition preferably exhibits a high wet strength.

In order to be able to use the heat- and/or moisture-exchange element according to the invention in a simple manner for assembling counterflow heat and/or moisture exchangers or rotary heat and/or moisture exchangers, this heat- and/or moisture-exchange element appropriately exhibits an outer three-dimensional structure, e.g., the outer three-dimensional structure of a heat- and/or moisture-exchange plate for counterflow heat and/or moisture exchangers or the outer three-dimensional structure of a corrugated storage-mass layer, for example, of a rotary heat and/or moisture exchanger, into which the heat- and/or moisture-exchange element can be brought by means of a suitable forming process, e.g., by means of stamping.

The heat- and/or moisture-exchange element according to the invention or the heat- and/or moisture-exchange plate according to the invention can be used advantageously for a counterflow heat and/or moisture exchanger.

In a first embodiment of a method for manufacturing a heat- and/or moisture-exchange element according to the invention, the forming process, e.g., stamping, for producing the outer three-dimensional structure of the heat- and/or moisture-exchange element occurs before the filler, e.g., the suitable polymeric material, is introduced into the base part of the heat- and/or moisture-exchange element.

Alternatively, it is possible to carry out the forming process or the stamping for producing the outer three-dimensional structure of the heat- and/or moisture-exchange element after the filler, e.g., the suitable polymeric material, has been introduced into the base part of the heat- and/or moisture-exchange element.

In the following, the invention is explained in detail using embodiment examples.

A heat- and/or moisture-exchange element according to the invention, which can serve as a heat- and/or moisture-exchange plate for a plate heat and/or moisture exchanger, particularly a counterflow heat and/or moisture exchanger, or as a storage-mass layer for a rotary heat and/or moisture exchanger, is constructed from a structure perforated by a plurality of hollow spaces and sintered from a plastic.

A mixture of a medium-molecular-weight polyethylene powder serves as the starting material for the sintering process. A material that will cause a hydrophilic adjustment of the heat- and/or moisture-exchange element is mixed with this medium-molecular-weight polyethylene powder.

The plastic Hostalen® GHR 8110, for example, can be used as the medium-molecular-weight polyethylene powder, and in particular the material Hostapur® SAS 60F as the material causing the hydrophilic adjustment.

The material matrix of the sintered heat- and/or moisture-exchange element has a density that lies between 0.507 and 0.522 g/cm³ or is 0.517 g/cm³.

The proportion of pores in the sintered material matrix lies between 38.6 and 40.1%, preferably 39.1%, by volume.

The average pore-diameter of the material matrix is between 25 and 35 μm, preferably about 30 μm.

The sintered material matrix has a tensile strength of 2.22 to 2.70, especially 2.45, N/mm².

It is also possible, in a specific manner, to make three-dimensionally formed storage-mass layers, particularly
corrugated storage-mass layers, for rotary heat and/or moisture exchangers out of the sintered plastic as previously described.

[0046] A further embodiment of a heat- and/or moisture-exchange element according to the invention has a base part and a filler.

[0047] The base part is constructed as a structure perforated by a plurality of hollow spaces. The filler is introduced into the hollow spaces of the openwork structure.

[0048] The openwork structure of the base part can be constructed from a fabric made of metal threads, for instance; from a non-woven fabric made, e.g., of metal fibers; from a knit, from fine threads, or from a sintered material. It is essential to the design of the base part that it exhibit a plurality of hollow spaces or openings with which the structure of the base part is perforated.

[0049] The base part can accordingly also be constructed as a lattice structure made of a suitable metal material or plastic.

[0050] The lattice structure can, for example, be formed from metal threads.

[0051] Alternatively, the base part can have one or more lattice meshes. Adjacent lattice meshes can be staggered with respect to one another, so that the hollow spaces of adjacent lattice meshes partially overlap easily.

[0052] The fluid permeability and the thermal properties of the heat- and/or moisture-exchange element are adjusted by using a polymeric material that functions as a filler for the heat- and/or moisture-exchange element. In the embodiment examples described, a suitable Nexar®-polymer material from the firm of Kraton that can be quasi-arbitrarily adjusted in terms of its permeability to water, for example, and that also exhibits a high wet strength is used. This polymeric material can be constructed as a non-porous, selectively permeable membrane with the already previously mentioned high wet strength.

[0053] The heat- and/or moisture-exchange element can be provided with an outer three-dimensional structure adjusted to the specific requirements profile, e.g. the outer three-dimensional structure of a heat- and/or moisture-exchange plate for a counterflow heat- and/or moisture exchanger or the outer three-dimensional structure of a corrugated storage-mass layer of a rotary heat- and/or moisture exchanger. A forming process, e.g. stamping, can be used for this. This stamping can be carried out by stamping the base part before the polymeric material is introduced into the base part. It is also possible to form the heat- and/or moisture-exchange element by performing the forming process or the stamping after the base part has been impregnated with the filler.

1-43. (canceled)

44. An element for a plate heat or moisture exchanger, a storage-mass layer for a rotary heat or moisture exchanger, wherein the heat- or moisture-exchange element is formed with a multiplicity of throughgoing pores and is designed to be selectively permeable or capable of storing water or water vapor.

45. The heat- or moisture-exchange element defined in claim 44, sintered from a material.

46. The heat- or moisture-exchange element defined in claim 44, having a layer of a polymer selectively permeable to water or water vapor.

47. The heat- or moisture-exchange element defined in claim 44, having a layer incorporated with a polymer selectively permeable to water or water vapor.

48. The heat- or moisture-exchange element defined in claim 45, wherein the material is a metal, plastic, or ceramic material provided as a suitable material.

49. The heat- or moisture-exchange element defined in claim 44, the element further incorporating a drying agent consisting of lithium chloride, silica gel, or zeolite.

50. The heat- or moisture-exchange element defined in claim 48, wherein the material is a medium-molecular-weight polyolefin.

51. The heat- or moisture-exchange element defined in claim 48, wherein the material is polyethylene.

52. The heat- or moisture-exchange element defined in claim 51, wherein the material is sintered from a medium-molecular-weight polyethylene powder.

53. The heat- or moisture-exchange element defined in claim 48, wherein the material is polypropylene.

54. The heat- or moisture-exchange element defined in claim 48, wherein the material is polyvinylchloride.

55. The heat- or moisture-exchange element defined in claim 48, wherein the material is a metal oxide or a metal carbide.

56. The heat- or moisture-exchange element defined in claim 44, a raw material from which the element is made can be hydrophilically adjusted before or during its production.

57. The heat- or moisture-exchange element defined in claim 56, wherein the hydrophilic adjustment can be carried out by a splashing or spraying process or application or input of surfactants.

58. The heat- or moisture-exchange element defined in claim 45, wherein the element is sintered from a mixture that contains medium-molecular-weight polyethylene powder and an additive that causes hydrophilic adjustment of the heat- or moisture-exchange element.

59. The heat- or moisture-exchange element defined in claim 44, wherein the element has a core in which the pores are formed and a filler that forms the pores in the core and that is preferably a polymer.

60. The heat- or moisture-exchange element defined in claim 59, in which the core has the pores is formed by a knitted, sintered, nonwoven, or woven fabric of metal threads or fibers.

61. The heat- or moisture-exchange element defined in claim 59, wherein the polymer has an outer surface that is that of a heat- or moisture-exchange plate for a counterflow heat- and moisture-exchanger or a corrugated storage-mass layer of a rotary heat or moisture exchanger, and that is formed by a deep-drawing process under vacuum or with compressed air, form sintering, stamping, or in the case of a metal material cold stamping.

62. A counterflow heat- or moisture exchanger, constructed from a plurality of heat- or moisture-exchange elements as defined in claim 44.

63. A method for producing a heat- or moisture-exchange element defined in one of claims 44 through 62, in which the forming process, e.g. the stamping to produce the outer spatial structure of the heat- or moisture-exchange element, is accomplished before or after the filler in the core of the heat- or moisture-exchange element.