METHOD FOR STITCH-BONDING OR FINISHING A MATERIAL WEB BY MEANS OF HIDRODYNAMIC NEEDLING, AND PRODUCT PRODUCED ACCORDING TO THIS METHOD

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ABSTRACT

The aim of the invention is to subject a non-woven, which consists, at least in part, of metal fibers, to a stitch-bonding or surface finishing by means of hydrodynamic needling. The respective material web can be produced exclusively from metal fibers but can also be produced from a blend consisting of metal fibers and textile fibers. The hydrodynamic water pressure during needling depends on the desired pore volume after stitch-bonding.
METHOD FOR STITCH-BONDING OR FINISHING A MATERIAL WEB BY MEANS OF HYDRODYNAMIC NEEDLING, AND PRODUCT PRODUCED ACCORDING TO THIS METHOD

[0001] The invention relates to a nonwoven, woven fabric or knitted fabrics consisting of metal fibers or filaments, which is to be stitch-bonded or finished.

[0002] The stitch-bonding of nonwovens made of textile fibers such as organic and inorganic materials and natural and synthetic polymers by means of the spumelace method is known where the fibre structure is subjected to a hydrodynamic needling.

[0003] Metal fibers are produced, for example, using the bundle cold-drawing method (U.S. Pat No. 3,379,000), a cutting method (shaving the rolled edge of a roll of metal foil according to U.S. Pat No. 4,930,199) or directly from the melt, for example, by extrusion, as described in U.S. Pat. No. 5,524,704.

[0004] The formation of nonwovens from, for example, 100% metal fibers is currently carried out using mechanical methods of forming nonwovens using carding rollers, the aerodynamic nonwoven formation method and the wet nonwoven method and requires special know-how.

[0005] Disadvantages with the manufacture of slivers, combed yarns and carded yarns from metal fibers especially arise from the fact that a fraction of textile carrier fibers is absolutely essential to maintain the thread formation process. In this case, threads comprising homogeneous mixtures over the thread cross-section can be achieved but also the manufacture of multifilament cover yarns with metal fibers in the core and textile fibers in the sheath is practiced.

[0006] The manufacture of fabrics from such filamentous structures is known, as is described for example in DE 699 01 941 T2. According to this, knitted fabrics are made of yarns having different metal fibre contents. In this case, in addition to the complex thread formation process, it is also necessary to use textile fibre materials to maintain the knitting process.

[0007] The stitch-bonding of aerodynamically formed nonwovens using the mechanical needling method is likewise known. Thus, the burner membrane described in DE 698 03 085 T2 contains at least one mechanically needled metal fibre layer. A disadvantage with mechanical needling, besides the discontinuous operating mode, is also the need to achieve a large minimum mass or thickness in order to be able to achieve a stitch-bonding effect.

[0008] A disadvantage with all said mechanical stitch-bonding methods, in addition to the aforementioned difficulties during the processing of metal fibers, is the high wear of the stitch-bonding elements such as knitting, felting needles etc. They must be replaced by new stitch-bonding elements after a short time of usage as a result of which costs are additionally incurred for the material exposed to wear and the down times resulting from the exchange of worn parts cause the manufacturing costs of a stitch-bonded metal fibre nonwoven to increase.

[0009] It is thus the object of the invention to provide a nonwoven during the manufacture of which the complex laborious and time-consuming thread formation process can be bypassed, material webs comprising preferably 100% metal fibers without any textile carrier fibers can be used, at least in part, the wear of stitch-bonding elements is reduced or completely eliminated and thin fabrics having a high pore volume but with small pore sizes can be achieved.

[0010] This object is solved by the fact that a material web consisting, at least in part, of metal fibers or metal filaments is stitch-bonded and/or finished by means of high-energy water jets to form a material web ready for use such as cloth or the like.

[0011] As a result of the progress made in the refinement of metal fibers on the one hand and as a result of the improvement in the formation of nonwovens on the other hand, it was surprisingly established in conjunction with the application of high working medium pressures that hydrodynamic stitch-bonding of metal fibre nonwovens using high-energy water jets can be carried out using the known spumelace method.

[0012] According to the invention, the object is solved by achieving high impact forces or impulse forces by using working medium pressures >200 bar or by using special nozzle geometries (e.g. cylindrical, conical, double-cone, cylindrical and conical combined in different ratios), using bore diameters, for example, between 0.08 and 0.5 mm, selecting a number of nozzles per inch of working width according to the intended use, using at least 2 to 8 nozzle beams, using single- to four-row nozzle beams in a uniform or nonuniform arrangement of capillaries applying the stitch-bonding medium from both sides, e.g. alternately after each nozzle beam or only after passing a plurality of nozzle beams, using a carrier belt or an open-work drum having an open area of 20 to 50%—or a screen covering or 20 to 100 mesh, preferably 60 mesh for removing the stitch-bonding medium.

[0013] A thin, a closed or spumelace nonwoven having an open-work surface according to a pattern, also comprising 100% metal fibers, is provided according to the invention without textile carrier fibers being required during its manufacture, laborious and time-consuming thread formation being required, lubrication being required to avoid static charging and to ensure good fibres sliding properties between fibre/fibre, fibre/stitch-bonding elements and fibre/transport units, and without any wear to the stitch-bonding elements since water is used as the stitch-bonding agent.

[0014] However, the joint use of non-metallic textile fibre materials is possible without any problems from the purely technical point of view. It is therefore also consistent with the inventive idea that if special product properties are required, textile fibers can be used in any mixing ratio.

[0015] The invention is explained in detail in exemplary embodiments.

Exemplary Embodiment 1

[0016] A 300 g/m² heavy, aerodynamically formed nonwoven consisting of 100% metal fibers is supplied to the spumelace installation. The normal density of the alloy of the metal fibers was determined as 8 g/cm³. The 12 µm thick stainless fibers in this case consist of a chromium-iron alloy. The metal fibre nonwoven is stitch-bonded using high-energy water jets. The water emerges from a nozzle sheet comprising nozzles having a diameter of 0.14 mm arranged in a row, in a capillary density of 40 items/inch of working
width and at a process water pressure of 20 bar on the first nozzle beam and 300 bar on the second nozzle beam. These stitch-bonding parameters yield maximum tensile forces of 19 N in the longitudinal direction and 26 N in the transverse direction with maximum elongations under tensile force of 34% in the longitudinal direction and 53% in the transverse direction.

Exemplary Embodiment 2

[0017] The arrangement and the type of nonwoven corresponds to those of Example 1. In contrast to Example 1, nozzle sheets comprising nozzles of 0.10 mm diameter and 40 items/inch of working width are used. The stitch-bonding medium is at a working pressure of 20 to 400 bar. The metal fibre nonwoven stitch-bonded under these parameters has maximum tensile forces of 24 N in the longitudinal direction and 32 N in the transverse direction with maximum elongations under tensile force of 31% in the longitudinal direction and 33% in the transverse direction.

Exemplary Embodiment 3

[0018] The arrangement and the type of nonwoven corresponds to those of Example 2. In contrast to Example 2, 36 nozzles per inch of working width are used. The maximum tensile forces are 42 N in the longitudinal direction and 49 N in the transverse direction with maximum elongations under tensile force of 37% in the longitudinal direction and 43% in the transverse direction.

[0019] The spunlace nonwoven in this example has completely identical stress-strain values for the longitudinal and transverse directions in the initial and medium stressing range, i.e., it is absolutely isotropic over this range. Likewise, the porosity of the metal fibre nonwoven can be adjusted over a wide range by selecting the stitch-bonding parameters. The pore volume is 97-99%. However, a pore volume of 60 to 99% can also be achieved according to process data.

Exemplary Embodiment 4

[0020] The arrangement and the type of nonwoven corresponds to those of Example 3. In contrast to Example 2, three nozzle sheets in corresponding nozzle beams are used at a working medium pressure of 20/500/500 bar. The maximum tensile forces are 89 N in the longitudinal direction and 78 N in the transverse direction with maximum elongations under tensile force of 29% in the longitudinal direction and 34% in the transverse direction. With this example it can be shown that a higher strength can be achieved in the longitudinal direction than in the transverse direction.

Exemplary Embodiment 5

[0021] The arrangement and the type of nonwoven corresponds to those of Example 3. In contrast to Example 3, the stitch-bonding process by high-energy water jets is followed by a pressing or calibrating process. The strength and the porosity of the metal fibre nonwoven can be thereby influenced in addition to the stitch-bonding by means of water jets.

[0022] These exemplary embodiments show that the maximum tensile force in the longitudinal direction (HZKL) and in the transverse direction (HZKQ) can be specifically controlled and the ratio of maximum longitudinal tensile force to maximum transverse tensile force can be adjusted from >1 through =1 to <1. It is of major importance that the stress-strain behavior in the initial and medium stressing range can be configured as completely isotropic by using selected stitch-bonding parameters. Equally, it is possible to adjust the porosity of the metal fibre nonwoven over a wide range.

Exemplary Embodiment 6

[0023] The metal fibre nonwoven to be stitch-bonded is subjected to a spunlace treatment using 36 nozzles per inch of working width having a diameter of 0.10 mm, an underlay screen of 20 mesh fineness and a working medium pressure of 500 bar and perforated, according to a pattern for use as a burner surface or the like.

Exemplary Embodiment 7

[0024] A metal wire mesh positioned between two metal fibre nonwovens having a mesh width of 10x10 mm, for example, is subjected to a spunlace treatment using 36 nozzles per inch of working width having a diameter of 0.10 mm, an underlay screen of 60 mesh and a working medium pressure of 500 bar. In this case, the nonwoven is stitch-bonded to give a smooth surface with small pore openings whilst at the same time accommodating the metal mesh. Such metal composites are used for filtering tasks where a high thermal loading occurs. In this case, the stitch-bonded metal fibre nonwoven is intended to fulfill the filtering tasks and the metal mesh fulfills the function of strength carrier.

[0025] Nonwovens having a thickness between 1.5 and 3.4 mm were prepared in the experiments. The gross density was about 8 mm. The density of the spunlace nonwovens was between 0.1 and 0.2 g/cm³. The attainable porosity is between 60 and 99%.

[0026] The nonwovens described can be used in filter and burner technology, especially where high thermal loads occur, in the EMC area, to achieve protection from explosions etc.

1. A method for producing a stitch-bonded material web by means of hydrodynamic needling, characterized in that a material web consisting at least partly of metal fibers or metalofilaments is stitch-bonded and/or finished by means of high-energy water jets to form a material web ready to use such as cloth or the like.

2. The method according to claim 1, characterized in that the material web is formed as woven fabric at least partly avoiding yarn formation from unspun metal fibers and such a material web is exposed to this hydrodynamic needling for finishing.

3. The method according to claim 1, characterized in that the material web is formed as woven fabric or knitted fabric at least partly using spun yarns of metal fibers and such a material web is exposed to this hydrodynamic needling for finishing.

4. The method according to claim 1, characterized in that textile fibers are mixed in the material web of metal fibers or metalofilaments and both are together exposed to the hydrodynamic needling for stitch bonding or finishing.

5. The method according to claim 1, characterized in that the material web consists of 100% metal fibers or filament
and such a material web is exposed to the hydrodynamic needling for stitch bonding or finishing.

6. The method according to claim 1, characterized in that the hydrodynamic needling is carried out at a pressure >200 bar.

7. The method according to claim 1, characterized in that a woven fabric, knit fabric, knitted fabric, stitch-bonded materials, stitch-bonded nonwoven, needle-punched nonwoven as material web manufactured at least partly of metal fibers or filaments are subjected to a water jet treatment to modify properties such as, for example, post-stitch bonding, density variation, smoothing, roughening etc.

8. The method according to claim 1, characterized in that metal fibre nonwovens with woven fabrics, knit fabrics, knitted fabrics, stitch-bonded materials, stitch-bonded nonwovens, needle-punched nonwovens etc. consisting of 100% metal fibers but also of combinations of metal fibers and textile fibers are combined to form composites by means of hydrodynamic needling.

9. The method according to claim 1, characterized in that the water jet stitch bonding is followed by a pressing and/or calibration process.

10. A nonwoven characterized in that it consists at least partly of unspun metal fibers or filaments and is treated by means of hydrodynamic needling for stitch bonding.

11. The nonwoven according to claim 1, characterized in that it consists of 100% unspun metal fibers or filaments and is treated by means of hydrodynamic needling for stitch bonding.

12. The spunlace nonwoven according to claim 10, characterized in that the metal fibers or filaments are interlaced, entangled or hooked with one another or into one another without forming meshes.

13. A spunlace nonwoven of metal fibers according to claim 10, characterized in that the fibers to be stitch-bonded consist of a homogeneous mixture of metal fibers and textile fibers.

14. The spunlace nonwoven of metal fibers according to claim 10, characterized in that the fibers to be stitch-bonded are a component of laminated nonwovens wherein the laminated nonwovens are composed of two or more layers.

15. The spunlace nonwoven of metal fibers according to claim 14, characterized in that the layers consist of metal fibers or textile fibers or in turn of homogeneous mixtures of metal fibers and textile fibers.

16. The spunlace nonwoven according to claim 10, characterized in that no filamentous material is present.

17. The spunlace nonwoven according to claim 10, characterized in that thread material is additionally worked in.

18. The spunlace nonwoven according to claim 10, characterized in that additional fabrics such as, for example, knit fabric, knit fabric, needle-punched nonwoven etc. consisting of metallic materials or textile fibrous substances are worked in or attached laterally.

19. The spunlace nonwoven according to claim 10, characterized in that the pore volume, the pore size and the thickness is also varied by a pressing and/or calibrating process following the water jet stitch bonding.

20. The spunlace nonwoven according to claim 10, characterized in that it has perforations as required according to a pattern.

21. Woven fabric, knit fabric, knitted fabric, stitch-bonded materials, stitch-bonded nonwoven, needle-punched nonwoven etc., characterized in that a modification of properties such as, for example, post-stitch bonding, density variation, smoothing, roughening etc. has occurred as a result of an aftertreatment with high-energy water jets.

22. Composites characterized in that metal fibre nonwovens are combined with woven fabrics, knit fabric, knitted fabrics, stitch-bonded materials, stitch-bonded nonwovens and/or needle-punched nonwoven etc. made of metal fibers or metal filaments in various combinations by means of hydrodynamic needling to form a composite.

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