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PROCESS FOR PREPARING A SOFT AND TENACIOUS NONWOVEN FABRIC

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ABSTRACT OF THE DISCLOSURE

A process for preparing a nonwoven fabric comprising forming a uniform mat of fibers from ½ to 5 inches in length and from 0.5 to 10 in denier, needle-punching said mat from 600 to 6000 times per square inch by means of a needle loom provided with felting needles of from number 30 to number 46 to thereby form a fiber sheet having a weight of at least 150 g./m.^{2} and an apparent density of at least 0.15, impregnating said sheet with a bonding agent liquid comprising an anionic latex of a high molecular weight elastic material, a nonionic surface active agent having a HLB of at least 11 and a cloud point of from 30 to 85° C., and, as an indispensable component, if there is no protecting effect of said surface active agent, an ionizable organic or inorganic metallic salt to coagulate said latex, wherein the content of said high molecular weight elastic material is at least 10% by weight of the total weight of said bonding agent liquid, wherein the content of said nonionic surface active agent is from 5 to 30 parts by weight, per 100 parts by weight of said high molecular weight elastic material, and wherein the amount of said metallic salt is sufficient to coagulate said high molecular weight material, so as to deposit from 20 to 50 parts by weight of said high molecular weight material per 100 parts by weight of fiber component; elevating the temperature of said impregnated bonding agent liquid to a temperature above its coagulation temperature to thereby coagulate substantially all of said high molecular weight material without migration in the direction of the sheet thickness.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to a process for preparing a soft and tenacious nonwoven fabric having excellent air and moisture permeability and one which is particularly suited as a substitute leather or as a foundation thereof.

Description of the prior art

Heretofore, various processes have been employed for preparing nonwoven material suitable for these uses. Among these processes, the following technique is known: needle-punching a mat formed with fibers, impregnating the mat with a solution of a high molecular weight elastic material in a solvent, dipping the mat into a liquid which is miscible with the solvent in the solution and which is a non-solvent for the high molecular weight elastic material to coagulate the solution of the elastic material, thereby depositing a porous high molecular weight elastic material on the fiber structure, and subsequently, after extracting the solvent, drying the mat. However, in general, this technique has the disadvantage that the solvent is expensive and that a relatively long time is required for completely extracting and removing the solvent.

Another known process comprises impregnating a fiber mat with a latex of a synthetic rubber of snythetic resin and then freezing it or treating it with a liquid containing an agent which is capable of coagulating the latex, and thereafter drying it. However, in the freezing method, the apparatus required for continuous freezing is not simple in structure, and in the method in which a coagulating bath is used, it is difficult to coagulate an article uniformly and rapidly in the direction of its thickness, especially when it has a relatively large thickness.

It is a principal object of the present invention to remedy the above-mentioned disadvantages.

SUMMARY OF THE INVENTION

According to the process of the present invention, the coagulation can be rapidly and completely carried out by using a latex type of bonding agent. The nonwoven fabric prepared by the present process has the advantage that, even when the relatively thick fabric is in a stratified form, each layer of fabric has homogeneous properties, since the porous high molecular weight bonding agent is uniformly distributed through the thickness of the fiber foundation. Further, the nonwoven fabric manufactured by the present process has a soft feeling as well as a high tear resistance, because the adhesion of fiber and high molecular weight bonding agent is not in the form of area bonding, rather, in the form of point bonding.

The process of the present invention will be further illustrated below.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present process comprises: forming a uniform mat of natural fibers, regenerated fibers, synthetic fibers or mixtures thereof; passing the mat through a needle loom provided with felting needles of from number 30 to number 46, to form a sheet which has a punching density of from 600 to 6000 times per square inch total; impregnating the sheet with a liquid bonding agent which has the following composition and properties: that is, anionic latex or emulsion of synthetic rubber or elastic synthetic resin, a nonionic surface active agent which is above 11 in HLB (Hydrophile Lipophile Balance; see Griffin, W. C., "Journal of The Society of Cosmetic Chemists," 311 (1947)) and has a cloud point (Cp) in the range from 30 to 85° C., and an inorganic or organic salt which is capable of coagulating the above-mentioned anionic latex if there is no protecting effect of the nonionic surface active agent, the latex or emulsion being above 10% in solid concentration of the above high molecular weight (i.e., at least 10,000) bonding agent and having a viscosity of 10 to 1000 cp.; placing the sheet into an atmosphere which is at a temperature above the coagulation temperature of the impregnating liquid and which has a relative humidity of above 90%, or into a hot water bath, or irradiating the sheet with a high frequency electric wave to rapidly elevate the temperature to a temperature above the coagulation temperature of the bonding agent liquid, thereby immediately eliminating the latex protecting action of the added nonionic surface active agent for a metallic ion of the inorganic or organic salt, and, lastly, coagulating the high molecular weight elastic material to deposit it

within the fibrous network structure, washing it with water and drying it.

As a stock fiber used in the process of the present invention, any conventional textile fiber can be used, however, it is necessary to use a fiber of from 0.5 to 10 in denier and from ½ to 5 inches in length.

If the needle punching density is below 600 times per square inch, it is difficult to obtain the leather-like feeling which is the object of the process of the present invention, and as the needle punching density is increased, the softness of the product is improved and a leather-like feeling is obtained. This effect reaches the maximum point at a density of about 6000 times per square inch, and a needle punching density beyond that is of no use and, in fact, is harmful since this decreases the strength of the product. It is also necessary that the weight of the punched sheet be above 150 g./m.^{2} and above 0.15 in apparent density.

The latex of the high molecular weight bonding agent is required to be one in which an anionic surface active agent is used as a dispersing agent. To satisfactorily attain the rapid and effective coagulation of the high molecular weight component in the wet heat treatment after the impregnation of the bonding agent liquid, which is the chief characteristic of the present invention, the concentration of the high molecular weight component contained in the bonding agent liquid must be above 10%. If the concentration of the high molecular weight component in the impregnating liquid is below 10%, it is not sufficiently coagulated by the heat treatment since the amount of the bonding agent which is washed away is rapidly increased and the remaining gel is semi-flowable, and thus, the desired effect of the present invention cannot be sufficiently displayed.

Useful as a high molecular weight material for the bonding agent are, for example, polybutadiene, polychloroprene, a butadiene-acrylonitrile copolymer, a butadiene-styrene copolymer, polyurethane elastomer, polyacrylic acid ester resin, etc. Two or more of these anionic latexes may be mixed together for use in the present invention. As a nonionic surface active agent to be blended, the following are suitable: an ethylene oxide-propylene oxide copolymer, sorbitane ester, fatty acid ester, an ethylene oxide additive of an alkyl benzene acid, etc. which have a cloud point of from 30 to 85° C. and which are above 11 in HLB. If the cloud point is within this range, the coagulation by heat treatment is rapid and exact and the storage stability of the bonding agent liquid is good. If the HLB is above 11, the produced gel has a sufficient hardness and fills the fibrous network structure in the form of a porous bonding body; however, as the HLB is decreased below 11, the gel becomes semi-flowable and, in the dehydrating step and drying step after coagulation, it moves easily and tends to become hard in feeling. The amount of nonionic surface active agent is suitably more than 1% and preferably from 5 to 30% by weight, based on the weight of high molecular weight material.

In the preparation of the bonding agent liquid, the above nonionic surface active agent is first added to a latex of the bonding agent high molecular weight material and, after sufficient stirring by means of a high speed stirrer such as a propeller mixer, homogenizing mixer, etc. to form a protecting colloid of dispersed high molecular weight particles, a metallic salt is added thereto.

Suitable as a metallic salt for coagulation are, for example, sodium salt, potassium salt and aluminum salt of sulfuric acid, nitric acid, acetic acid, etc., calcium chloride, and alums which, when the above-mentioned nonionic surface active agents has no protecting action, is capable of coagulating the above-mentioned anionic latex or emulsion.

The amount of bonding agent liquid to be impregnated is suitably such an amount that the content of high molecular weight solid to be adhered is 20 to 250 parts, by weight, per 100 parts, by weight, of fiber. As a heat medium used in the heat treatment of the impregnated sheet with the above mentioned heat sensitive bonding agent liquid, heated and dried air is not suitable because its heat capacity and heat conductive coefficient are small and the surface of the sheet is dried. In order to conduct rapid heating while preventing the drying of the water content, the impregnated fiber sheet is placed in hot water at a higher temperature than the coagulation temperature of the bonding agent liquid, or in a superheated saturated vapor, or in air at a temperature of above 80° C. and at a relative humidity of above 90%, and thereby, uniform and rapid coagulation becomes possible. The same effect can be attained by employing high frequency heating without using these heat conductive media.

Thus, the sheet impregnated by the coagulation treatment is then dehydrated to remove some isolated water and, even if dried, can maintain the bonding state existing at the time of coagulation without the movement of bonding agent within the structure of the nonwoven fabric occurring. In general, the nonionic active agents and metallic salts are preferably removed by washing with water before drying, since leaving these materials within the nonwoven fabric is useless and is occasionally harmful for some uses.

According to the process of the present invention as described in detail above, a nonwoven fabric having excellent natural leather-like feeling and strength can be produced by needle punching a web and the synergistic effect of a limited impregnation of bonding agent and a coagulation treatment. Further, according to the process of the present invention, since the high molecular weight bonding agent does not move within the fiber structure of the nonwoven fabric in the manufacturing step but is uniformly distributed and adhered throughout the thickness of the nonwoven fabric, a homogeneous nonwoven fabric product can be obtained and efficient production is possible, even when the product is divided into layers.

The present invention will be further illustrated by the following nonlimiting examples.

EXAMPLE 1

70 parts, by weight, of nylon fiber (2 denier, 51 mm.) and 30 parts, by weight, of rayon fiber (2 denier, 51 mm.) were blended and formed into a mat of about 900 g./m.^{2} in weight by means of a card and a cross folder, and then were passed through a needle loom provided with number 40 felting needles to carry out punching of 2000 times per sq. in. total, from both sides, to obtain a sheet of about 750 g./m.^{2} in weight and about 4 mm. in thickness (that is, an apparent density of about 1.87). The composition of the bonding agent liquid used for impregnating this sheet was as follows:

	Parts by weight
Anionic butadiene acrylonitrile latex (trademark: Hycar 1571; manufactured by Nihon Geon Co., Ltd.)	100
Nonionic surface active agent, HLB 12, Cp 43° C. (trademark: HS 208; manufactured by Nissan Chemical Industry Co., Ltd.)	5
$CaCl_2$	2
Water	30

The bonding agent liquid was prepared as follows:

The nonionic surface active agent was added to the latex and stirred by a propeller mixer for about 20 minutes. Next, $CaCl_2$ was added to water and stirred to completely dissolve it. Then, this aqueous solution was gradually added to the above-mentioned latex while stirring by means of the propeller mixer.

The above-mentioned fiber sheet was impregnated with this bonding agent liquid and squeezed to about 300% of liquid content by means of a squeezing roll and, after

dipping in a hot water bath of about 90° C. for 1 minute, it was squeezed again by means of the squeezing roll. The latex was thereby completely coagulated and, when being squeezed, the discharged liquid was transparent. The impregnated sheet was washed with water to remove the active agent and $CaCl_2$, and then dried to obtain a dense sheet of about 48 mm. in thickness and about 1410 g./m.^{2} in weight. This sheet was divided into 6 sheets by means of a band knife commonly employed in the leather industry, each of which being 0.8 mm. in thickness, to obtain a flexible nonwoven fabric having an excellent leather-like feeling, in which the adhering state of the bonding agent was uniform on each of the 6 sheets, although both outside surfaces were somewhat nappy.

EXAMPLE 2

The needle punched sheet used in Example 1 was impregnated with a bonding agent liquid having the following composition:

	Parts by weight
Anionic polyurethane resin latex (trademark: Bondic 2301; manufactured by Nihon Reichhold Co., Ltd.)	100
Nonionic surface active agent HLB 12, Cp 43° C. (trademark: HS 208; manufactured by Nissan Chemical Industry Co., Ltd.)	4
Nonionic surface active agent HLB 12.6, Cp 41° C. (trademark: Nonipol 85; manufactured by Sanyo Chemical Co., Ltd.)	1
$CaCl_2$	2
Water	25

The bonding agent liquid was prepared by the same method as in Example 1. The above-mentioned fiber sheet was impregnated with this bonding agent liquid, squeezed to about 300% of liquid content, placed in a box at a temperature of 98° C., into which superheated saturated steam was continuously blown, for about 1 minute, and squeezed by means of a squeezing roll to remove water. Thereby, only the isolated water was removed and the latex was completely coagulated. The sheet was further washed with water to remove the active agent and $CaCl_2$ and then dried to obtain a dense sheet of about 4.5 mm. in thickness and 1520 g./m.^{2} in weight. From both sides of the sheet were removed outside layers 0.25 mm. thick by the same method as in Example 1 and the remaining part was divided into 4 sheets, each of which was 1 mm. in thickness, to obtain 4 nonwoven fabrics, each of which had the feeling and strength suitable for a foundation of substitute leather and which was uniform in the adhered amount of bonding agent.

EXAMPLE 3

The sheet of Example 2, after having been impregnated with the bonding agent liquid, was cut into a piece of 30 x 30 cm., placed in an ultra-short wave heating apparatus of 2.4 kw. in output, and treated by irradiation for 10 seconds, and then squeezed by the same roll as in Example 2 to remove water. The coagulation effect of the latex was equivalent to that in Example 2.

What is claimed is:

1. A process for preparing a nonwoven fabric comprising:
   - forming a uniform mat of fibers having a length of from about ½ to 5 inches and a denier of from about 0.5 to 10;
   - forming a fiber sheet having a weight of at least about 150 g./m.^{2} and an apparent density of at least about 0.15 by needle-punching said uniform mat from about 600 to 6,000 times per square inch by means of a needle loom provided with felting needles of from about number 30 to about number 46;
   - impregnating said fiber sheet with from about 20 to 50 parts by weight, based on 100 parts by weight of fiber, of a high molecular weight rubber or elastic synthetic resin by impregnating said fibrous sheet with a liquid bonding agent which consists essentially of:
     - (1) an anionic latex of said high molecular weight synthetic rubber or elastic synthetic resin, said latex being present in an amount of at least about 10% by weight, based on the total weight of said liquid bonding agent;
     - (3) from about 5 to 30 parts by weight, based on the weight of said high molecular weight synethetic rubber or elastic synthetic resin, of a nonionic surface active agent having a Hydrophile Lipophile Balance of above 11 and a cloud point of from about 30 to 85° C.; and
     - (3) an amount of an inorganic or organic metallic salt sufficient to coagulate said anionic latex when the nonionic surface active agent no longer surrounds and protects the particles of said anionic latex from being attacked by cationic metal ions from said metallic salt;
     - (4) rapidly elevating the temperature of the resulting impregnated fiber sheet to a temperative above the coagulation temperature of said anionic latex and depositing said high molecular weight synthetic rubber or elastic synthetic resin within the fibrous network of the impregnated fiber sheet by coagulating said anionic latex;
     - (5) washing the resulting sheet with water; and
     - (6) drying the resulting sheet.

2. A process for preparing a nonwoven fabric as in claim 1, wherein said fibers comprise polyamide fibers.

3. A process for preparing a nonwoven fabric as in claim 1, wherein said fibers comprise polyester fibers.

4. A process for preparing a nonwoven fabric as in claim 1, wherein a butadiene-acrylonitrile copolymer is used as the high molecular weight material.

5. A process for preparing a nonwoven fabric as in claim 1, wherein a butadiene-styrene copolymer is used as the high molecular weight material.

6. A process for preparing a nonwoven fabric as in claim 1, wherein a polyurethane elastomer is used as the high molecular weight material.

7. A process for preparing a nonwoven fabric as in claim 1, wherein the temperature of said impregnated fiber sheet is elevated by immersing said sheet in hot water.

8. A process for preparing a nonwoven fabric as in claim 1, wherein the temperature of said impregnated fiber sheet is elevated by the action of heated water vapor.

9. A process for preparing a nonwoven fabric as in claim 1, wherein the temperature of said impregnated fiber sheet is elevated by the action of high frequency dielectric heating.

10. The process of claim 1 wherein said high molecular weight synthetic rubber or elastic synthetic resin has a molecular weight of at least about 10,000.

11. The process of claim 1 wherein said liquid bonding agent has a viscosity of from about 10 to 1,000 centipoises.

12. The process of claim 1 wherein said high molecular weight synthetic rubber or elastic synthetic resin is selected from the group consisting of polybutadiene, polychloroprene, a butadiene-acrylonitrile copolymer, a butadiene-styrene copolymer, a polyurethane elastomer, a polyacrylic acid ester resin and mixtures thereof.

13. The process of claim 1 wherein said nonionic surface active agent is an ethylene oxide-propylene oxide copolymer, a sorbitane ester, a fatty acid ester or an ethylene oxide additive of an alkyl benzene acid.

14. The process of claim 1 wherein said metallic salt is a sodium, potassium, aluminum or calcium salt of sulfuric acid, nitric acid or acetic acid or alum.

15. The process of claim 1 wherein the temperature of said impregnated fiber sheet is rapidly elevated by plac-

ing the impregnated fiber sheet in air having a temperature of above 80° C. and a relative humidity of above 90%.

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