

NONWOVEN FABRIC AND METHOD FOR PRODUCING SAME

CROSS REFERENCE TO THE RELATED APPLICATION

[0001] This application claims priority to Japanese patent application
5 No. 2018-083226, filed April 24, 2018, the entire disclosure of which is
incorporated by reference into this application.

FIELD OF THE INVENTION

[0002] The present invention relates to a nonwoven fabric excellent in
absorbability and wash durability, and to a production method thereof.

10 BACKGROUND OF THE INVENTION

[0003] In recent years, applications of nonwoven fabrics have been
expanded into a variety of uses such as daily necessities, sanitary or hygiene use,
and medical care use. For example, nonwoven fabrics that are repeatedly
washable and easy to dry come to be increasingly used in consideration of
15 sanitation as wet cloth for wiping tables, although tables have been
conventionally wiped with woven fabrics. Such nonwoven fabrics used for
wiping are required to have wash durability, dimensional stability, and water
retention properties comparable to those of woven fabrics in addition to softness
and absorbability both necessary for wiping.

20 [0004] Patent Document 1 (JP Laid-open Patent Publication No.
2003-230520) describes a nonwoven fabric that contains ultrafine fibers and is
used as wipers, wherein the nonwoven fabric has uneven portions on a surface,
and a binder-adhered region formed on the entire surface of the nonwoven fabric.

[0005] Patent Document 2 (JP Laid-open Patent Publication No.
25 2002-105826) describes a nonwoven fabric with opening holes in which fibers
are three-dimensionally entangled, wherein the nonwoven fabric contains binder
fibers at weight proportions different by at least 5% between a upper surface
layer and a bottom surface layer of the nonwoven fabric; and the binder fibers are
adhered to each other both in the upper surface layer as well as in the bottom

surface layer.

[0006] Patent Document 3 (JP Laid-open Patent Publication No. 2008-213194) describes a nonwoven fabric sheet used for wiping and comprising at least two binder layers on upper and bottom surfaces thereof, wherein the at
5 least one of the binder layers is formed on the entireties of the front and/or bottom surfaces of the nonwoven fabric sheet.

[0007] Patent Document 4 (JP Laid-open Patent Publication No. 2008-115476) describes a net-like nonwoven fabric formed from a fiber web that contains at least rayon fibers and additionally synthetic fibers, wherein an acrylic
10 resin is applied two separate times on an upper surface and a bottom surface of the fiber web.

[0008] Patent Document 5 (JP Laid-open Patent Publication No. H9-266873) describes a thick type wiping cloth excellent in wash durability, softness, and water absorbability, wherein the wiping cloth is obtained by
15 subjecting a web containing hydrophilic fibers as a main material to three-dimensional entanglement such as needlepunching or hydroentanglement so as to have a basis weight of 100 g/m² to 500 g/m², and applying a chemical binder in a dispersed state on both surfaces of the web so that the chemical binder is adhered and fixed.

20 CONVENTIONAL ART DOCUMENT

PATENT DOCUMENT

[0009] [Patent Document 1] JP Laid-open Patent Publication No. 2003-230520

[Patent Document 2] JP Laid-open Patent Publication No.
25 2002-105826

[Patent Document 3] JP Laid-open Patent Publication No. 2008-213194

[Patent Document 4] JP Laid-open Patent Publication No. 2008-115476

[Patent Document 5] JP Laid-open Patent Publication No.
H9-266873

SUMMARY OF THE INVENTION

[0010] However, in Patent Document 1, although the adhered region
5 formed on the nonwoven fabric is capable of scraping off the caked persistent
dirt, such a nonwoven fabric still has a room to be improved for absorbability for
wiping spilled water or the like at once. Further, since the nonwoven fabric in
Patent Document 2 is bound merely by point-to-point adhesion through thermal
fusion of the binder fibers, the nonwoven fabric is not only deformed after
10 washing, but also generates fluff or fallen fibers, so that the nonwoven fabric is
inferior in wash durability. In Patent Documents 3 and 4, the nonwoven fabrics
are subjected to resin application for coating the surfaces thereof, so that the
entire surfaces of the nonwoven fabrics are coated with the resin (adhesive).
Accordingly, the nonwoven fabrics deteriorate in water retention properties and
15 absorbability, and thus are not preferably used as wiping nonwoven fabric.
Meanwhile, although the nonwoven fabric of Patent Document 5 is evaluated as
having an excellent water absorbability measured by the Byreck method, Patent
Document 5 fails to evaluate more practical absorbability, such as evaluation of
wiping spilled water or the like at once. Therefore, the nonwoven fabrics of
20 Patent Document 5 have a room to be improved in absorbability and wash
durability as a comprehensive evaluation.

[0011] Therefore, an object of the present invention is to provide a
nonwoven fabric that has favorable absorbability (liquid-wiping property and
liquid-retention property) and wash durability; and a method for producing the
25 same.

[0012] The inventors of the present invention have made extensive
study in order to achieve the above-mentioned object, and as a result, have found
that (i) the binder treatment to make the binder distributed to cover the surface of
the nonwoven fabric does not enhance absorbing property of the nonwoven

fabric, so that the binder treatment fails to achieve both wash durability and absorbability. Meanwhile the inventors have found that (ii) it is possible to achieve a specific binder distribution in the thickness direction of the cross-sectional surface of the nonwoven fabric, by a production method of a nonwoven fabric in which upper and bottom surfaces of a binder-impregnated nonwoven fabric are alternately dried in contact with separate hot rolls in sequence. Then, as a result of further study, the inventors have found that (iii) the specific binder distribution generates the specific relationship between the binder and the fibers so as to affect wash durability and absorbability of the nonwoven fabric, that is, a higher proportion of fibers bound by the binder in the nonwoven fabric surface portion than that of fibers bound by the binder in the nonwoven fabric inner portion contributes to improvement in wash durability; and that a plurality of fiber bundles in each of which fibers are bound by a binder and unified contribute to improvement in absorbability, contrary to inferior absorbability by continuous distribution of the binder throughout the nonwoven fabric. The inventors thus achieved the present invention.

[0013] That is, the present invention may include the following aspects.

Aspect 1

A nonwoven fabric having a binder-adhered region, wherein the nonwoven fabric comprises a plurality of fiber bundles in each of upper, central and bottom layer portions of the nonwoven fabric, each of the fiber bundles contains a plurality of single fibers bound by the binder and unified; the upper, central and bottom layer portions are determined as equally divided three portions in the thickness direction of a randomly selected cross-sectional plane in the binder-adhered region; the nonwoven fabric satisfies formulae:

$$N_u/N_c > 1.10 \text{ and } N_b/N_c > 1.10$$

(preferably $N_u/N_c > 1.20$ and $N_b/N_c > 1.20$, and more preferably $N_u/N_c > 1.30$ and $N_b/N_c > 1.30$)

in which Nu, Nc, and Nb represents the number of fibers in the bundles in the upper, central, and bottom layer portions, respectively.

Aspect 2

The nonwoven fabric according to aspect 1, wherein the nonwoven fabric has a binder-applied amount (dry weight) of 5 to 50% by mass (preferably 10 to 45% by mass, and more preferably 20 to 40% by mass).

Aspect 3

The nonwoven fabric according to aspect 1 or 2, wherein the binder contains at least one selected from acrylic resins, polyurethane resins, and styrene resins.

Aspect 4

The nonwoven fabric according to aspect 3, wherein the binder further comprises a pigment.

Aspect 5

The nonwoven fabric according to any one of aspects 1 to 4, which has a mesh structure with an aperture proportion of 10 to 50% (preferably 15 to 45%, and more preferably 20 to 40%).

Aspect 6

The nonwoven fabric according to any one of aspects 1 to 5, wherein the nonwoven fabric comprises hydrophilic fibers as subject fibers.

Aspect 7

The nonwoven fabric according to any one of aspects 1 to 6, wherein the nonwoven fabric satisfies formulae:

$$Nu/Bu > Nc/Bc \text{ and } Nb/Bb > Nc/Bc$$

in which Bu, Bb, and Bc represents the number of bundles in the upper, bottom, and central portions, respectively.

Aspect 8

The nonwoven fabric according to any one of aspects 1 to 7, wherein the nonwoven fabric satisfies a formula:

$N_c/B_c \leq 6.00$ (preferably $N_c / B_c \leq 5.00$)

in which B_c represents the number of bundles in the central portion.

Aspect 9

The nonwoven fabric according to any one of aspects 1 to 8, wherein
5 the nonwoven fabric comprises a non-binder-adhered region.

Aspect 10

The nonwoven fabric according to any one of aspects 1 to 9, wherein
the nonwoven fabric is used for cleaning or wiping.

Aspect 11

10 A method for producing the nonwoven fabric according to any one of
aspects 1 to 10, at least comprising:

a coating or dip-nipping step (A) in which at least one surface of a
pre-coated or pre-dipped nonwoven fabric is coated or dip-nipped with a binder;
and

15 a drying step (B) of drying the coated or dip-nipped nonwoven fabric
using heated rolls by alternately bringing each of the upper and bottom surfaces
of the coated or dip-nipped nonwoven fabric into contact with each of the heated
rolls in sequence.

Aspect 12

20 The method for producing a nonwoven fabric according to aspect 11,
wherein the heated rolls have a temperature of 100°C or higher (preferably
110°C or higher, and more preferably 120°C or higher) in the drying step (B),
and each of the upper and bottom surfaces of the pre-coated or pre-dipped fabric
is dried twice or more.

25 Aspect 13

The method for producing a nonwoven fabric according to aspect 11
or 12, wherein the step (A) comprises applying a binder to one or both surfaces
of the pre-coated or pre-dipped nonwoven fabric having a moisture content
adjusted to 50 to 450% (preferably 80 to 350%, more preferably 100 to 200%).

Aspect 14

The method for producing a nonwoven fabric according to aspect 11 or 12, wherein the step (B) comprises dipping a binder into the pre-coated or pre-dipped nonwoven fabric so as to adjust the binder content of the dipped
5 nonwoven fabric to have 50 to 800% (preferably 80 to 500%, more preferably 100 to 250%).

Aspect 15

The method for producing a nonwoven fabric according to any one of aspects 11 to 14, wherein the nonwoven fabric has a basis weight of 10 g/m² or
10 more and less than 100 g/m² (preferably 20 to 95 g/m², more preferably 30 to 90 g/m²).

[0014] The present invention encompasses any combination of at least two features disclosed in the claims and/or the specification and/or the drawings. In particular, any combination of two or more of the appended claims should be
15 equally construed as included within the scope of the present invention.

EFFECT OF THE INVENTION

[0015] Since the fibers of the nonwoven fabric according to the present invention are bound (constrained) by the binder in a specific relationship, the nonwoven fabric has, for example, excellent shape retention after washing, less
20 surface fluffing after washing, and excellent absorbability on the upper and bottom surfaces. Therefore, the nonwoven fabric can be used for various applications as/for daily necessities, clothing materials, medical care materials, beauty materials, sanitary or hygiene materials, industrial materials, and others, and is particularly suitable as a nonwoven fabric for cleaning or wiping.

25 BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The present invention will be more clearly understood from the following description of preferred embodiments thereof, when taken in conjunction with the accompanying drawings. However, the embodiments and the drawings are given only for the purpose of illustration and explanation, and

are not to be taken as limiting the scope of the present invention in any way whatsoever, which scope is to be determined by the appended claims. In the figures,

[0017] Fig. 1 is a schematic diagram for explaining one embodiment of the producing method of the present invention;

Fig. 2 is a schematic diagram of a test machine for measuring absorbability;

Fig. 3 is an SEM image (magnification: 150 times) of a cross section of the nonwoven fabric obtained in Example 1;

Fig. 4 is an SEM image (magnification: 150 times) of a cross section of the nonwoven fabric obtained in Comparative Example 1;

Fig. 5 is an SEM image (magnification: 150 times) of a cross section of the nonwoven fabric obtained in Comparative Example 3; and

Fig. 6 is an SEM image (magnification: 150 times) of a cross section of the nonwoven fabric obtained in Comparative Example 7.

DESCRIPTION OF THE EMBODIMENTS

[0018] Nonwoven Fabric

A nonwoven fabric according to the present invention has a binder-adhered region(s). The binder-adhered region refers to a region in which the binder is applied so as to be recognizable as adhered portion in a plan view, where the region is also included in the thickness direction of the nonwoven fabric. The nonwoven fabric according to the present invention may have a binder-adhered region over the entire nonwoven fabric. Alternatively, the nonwoven fabric according to the present invention may partly have a binder-adhered region and also have a non-adhered region. Here, the non-adhered region refers to a region where the binder adhesion is unrecognizable in a plan view, and non-adhered region is also included in the thickness direction of the nonwoven fabric. It should be noted that where the nonwoven fabric has a mesh structure, opening holes in the mesh structure are

not included in the non-adhered region.

[0019] The nonwoven fabric according to the present invention includes a plurality of fiber bundles in each of upper, central and bottom layer portions of the nonwoven fabric, where each of the fiber bundles contains a plurality of single fibers bound (constrained) by the binder and unified. The upper, central and bottom layer portions are determined as equally divided three portions in the thickness direction of a randomly selected cross-sectional plane in the binder-adhered region. It should be noted that each of the portions may include single fibers that are independently present without being bound by the binder. The present inventors have found that where fibers in each of the plurality of fiber bundles in each of the portions of the cross-sectional plane have a specific relationship regarding the number of fibers (N_u) in the bundles in the upper layer portion, the number of fibers (N_c) in the bundles in the central layer portion, and the number of fibers (N_b) in the bundles in the bottom layer portion, the nonwoven fabric achieves not only strength but also softness, and further improved absorbability imparted by gaps formed between the fiber bundles.

[0020] The total number of the fibers in the fiber bundles is counted in the following manner. That is, an image of the cross-sectional plane of the nonwoven fabric obtained using a magnifying instrument such as a scanning electron microscope (SEM) or microscope is observed to count the number of the fibers in the fiber bundles bound by the binder in a visual way in which the image is enlarged at such a magnification that the entirety of the nonwoven fabric in the thickness direction is observable. In the present specification, a “fiber bundle bound and unified” means single fibers that are bound by the binder in which, in the cross-sectional plane, the bundle is outlined by outer peripheries of cross sections of single fibers in contact to each other directly or via binder therebetween. It should be noted that even if single fibers are bound by the binder in a portion other than the cross-sectional plane, for example, in a side surface portion rather than in the cross sectional portion, such a fiber bundle is

not regarded as “fiber bundle bound and unified” where, in the cross-sectional plane, single fibers are not bound by the binder, i.e., outer peripheries of cross sections of single fibers are not in contact to each other directly or via binder therebetween. In addition, in the cross-sectional plane, where outer peripheries of cross sections of single fibers are obviously apart from each other and the binder merely exists between the single fibers in a thread form, such single fibers are also not regarded as constituting the “fiber bundle bound and unified”. Further, if the cross-sectional plane includes a bundle in which a plurality of single fibers are impregnated with the binder so that outer peripheries of cross sections of some of the single fibers are unrecognizable, only single fibers having recognizable cross sections are counted as single fibers included in the fiber bundle. The magnification varies depending on the thickness of the nonwoven fabric. For example, if the thickness of the nonwoven fabric is about 0.30 to 0.50 mm, the magnification may be about 100 to 150 times.

The cross-sectional plane refers to a cross-sectional plane of the nonwoven fabric cut in a direction perpendicular to the flow direction (machine direction) in the nonwoven fabric production.

[0021] The nonwoven fabric according to the present invention satisfies formulae $N_u/N_c > 1.10$ and $N_b/N_c > 1.10$. These formulae indicate that the total number of the fibers bound by the binder in each of the surface portions (each of the upper layer portion and the bottom layer portion) of the nonwoven fabric is 1.10 times greater than the total number of fibers in the middle portion (central layer portion) of the nonwoven fabric. The above-mentioned structure of the nonwoven fabric imparts the nonwoven fabric to have more fibers bound by the binder to form firmer bundles in each of the surface portions of the nonwoven fabric than those in the middle portion of the nonwoven fabric so as to inhibit fluff generation as well as deformation after washing, leading to have excellent wash durability. Furthermore, the plurality of fiber bundles in the nonwoven fabric ensures not only softness of the

nonwoven fabric but also excellent absorbability due to gaps between the plurality of fiber bundles using capillary phenomenon. In addition, since the number of the fibers bound by the binder is smaller in the middle portion of the nonwoven fabric than in each of the surface portions of the nonwoven fabric, the gaps between the fibers in the middle portion can be wider than those in each of the surface portions of the nonwoven fabric. As a result, the gaps can improve absorbability (liquid-wiping property and liquid retention property) in combination (collaboration) with the fibers that are separately present. The nonwoven fabric may preferably satisfy formulae $Nu/Nc > 1.20$ and $Nb/Nc > 1.20$, and more preferably $Nu/Nc > 1.30$ and $Nb/Nc > 1.30$.

[0022] Although the upper limits for Nu/Nc and Nb/Nc are not particularly limited, the nonwoven fabric may satisfy formulae $Nu/Nc < 5.00$ and $Nb/Nc < 5.00$, preferably $Nu/Nc < 4.00$ and $Nb/Nc < 4.00$, and $Nu/Nc < 3.00$ and more preferably $Nb/Nc < 3.00$ from the viewpoint of forming gaps between the fiber bundles in the surface portions to improve absorbability.

[0023] In addition, the nonwoven fabric according to the present invention may satisfy the parameter of $0.40 < Nu/Nb < 2.50$, and preferably $0.50 < Nu/Nb < 2.00$, from the viewpoint of similar absorbability between the upper and bottom surfaces.

[0024] The number of fibers (Nu) in the bundles in the upper layer portion, the number of fibers (Nb) in the bundles in the bottom layer portion, and the number of fibers (Nc) in the bundles in the central layer portion are the total number of fibers in all the fiber bundles in the upper layer portions, the total number of fibers in all the fiber bundles in the bottom layer portions, the total number of fibers in all the fiber bundles in the central layer portions, respectively, where the cross-sectional plane of the nonwoven fabric is divided into three portions equally in the thickness direction and the three portions are respectively referred to as the upper layer portion, the bottom layer portion, and the central layer portion of the nonwoven fabric. If a fiber bundle is present over two or

more layers, the fiber bundle is regarded as belonging to a layer that includes majority of the total number of the fibers in the fiber bundle, and the total number of the fibers in the fiber bundle is regarded as being included in the number of fibers in the fiber bundle in the layer to which the fiber bundle
5 belongs.

[0025] In addition, the nonwoven fabric according to the present invention may satisfy a specific relationship regarding fiber bundles in the upper layer portion, the bottom layer portion, and the central layer portion, i.e., where the number of the fiber bundles in the upper layer portion, the number of the
10 fiber bundles in the bottom layer portion, and the number of the fiber bundles in the central layer portion are respectively referred to as the number of bundles (Bu) in the upper portion, the number of bundles (Bb) in the bottom layer portion, and the number of bundles (Bc) in the central layer portion, an average of fibers (Nu/Bu) in the bundles in the upper layer portion, an average of fibers (Nb/Bb) in
15 the bundles in the bottom layer portion, and an average of fibers (Nc/Bc) in the bundles in the central layer portion may satisfy formulae $Nu/Bu > Nc/Bc$ and $Nb/Bb > Nc/Bc$ from the viewpoint of improving wash durability. The average of fibers in the bundles refers to the average number of the fibers per fiber bundle bound by the binder. A larger value of the average of fibers in the bundles
20 indicates that the sizes of the fiber bundles bound by the binder are large on average. Thus, the above-described inequalities indicate that the fiber bundles (Nu/Bu and Nb/Bb) in the surface portions (the upper layer portion and the bottom layer portion) of the nonwoven fabric are larger than the fiber bundles (Nc/Bc) in the middle portion (central layer portion) of the nonwoven fabric on
25 average. By employing such a structure, strength can be imparted to the surfaces of the nonwoven fabric, whereby wash durability can be further improved.

[0026] In addition, where the number of the fiber bundles in the central layer portion is referred to as the number of bundles (Bc) in the central layer

portion, the nonwoven fabric according to the present invention may satisfy, regarding the average of fibers (N_c/B_c) in the bundles in the central layer portion, the parameter of $N_c/B_c \leq 6.00$ from the viewpoint of further improvement in absorbability (liquid-wiping property and liquid retention property) due to gaps
5 between the fibers by decreasing sizes of the fiber bundles in the central layer portion of the nonwoven fabric. The parameter indicates that the average number of the fibers included in the fiber bundles bound by the binder in the central layer portion is 6.00 or less. The nonwoven fabric may preferably satisfy the parameter of $N_c/B_c \leq 5.00$. Although the lower limit of the average
10 of fibers (N_c/B_c) in the bundles in the central layer portion is not particularly limited, the nonwoven fabric may satisfy the parameter of, for example, $N_c/B_c \geq 2.00$, and preferably $N_c/B_c \geq 2.50$ from the viewpoint of ensuring form stability of the nonwoven fabric.

[0027] The nonwoven fabric according to the present invention may be
15 a dry-laid nonwoven fabric in which a web of predetermined fibers given by a carding method or an air-laid method is three-dimensionally entangled mechanically by a hydroentangling method, a needlepunching method, or the like. For example, in view of imparting softness to the nonwoven fabric and forming a mesh structure, the nonwoven fabric is preferably a hydroentangled nonwoven
20 fabric obtained through a hydroentangling method to cause physical bonding between fibers by an entangling treatment via water jet.

[0028] Although the basis weight of the nonwoven fabric according to the present invention can be determined as appropriate depending on intended use and is not particularly limited, the basis weight may be, for example, about
25 10 to 250 g/m², preferably about 20 to 200 g/m², more preferably about 30 to 150 g/m², and even more preferably not lower than 30 g/m² and lower than 100 g/m², from the viewpoint, for example, of strength. The basis weight is a value measured in accordance with a method described in Examples described later, and is a value inclusive of the weight of the binder.

[0029] Although the thickness of the nonwoven fabric according to the present invention can be determined as appropriate depending on intended use and is not particularly limited, the thickness may be, for example, about 0.1 to 2.0 mm, preferably about 0.2 to 1.5 mm, and more preferably about 0.3 to 1.0 mm, from the viewpoint, for example, of softness. The thickness is a value measured in accordance with a method described in Examples described later.

[0030] From the viewpoint of the absorbability and wash durability, the nonwoven fabric according to the present invention may have a mesh structure with an aperture proportion (a proportion of opening hole areas based on the surface area) of 10% to 50%, preferably 15 to 45%, and more preferably 20 to 40%. The aperture proportion is a value measured in accordance with a method described in Examples described later.

[0031] In the case where the nonwoven fabric according to the present invention has a non-binder-adhered region (that is, the case where the binder is not entirely but partly applied to the nonwoven fabric to cause a region without binder application), a ratio of binder-exposed area of one surface relative to that of the other surface may be 2 or lower, preferably 1.5 or lower, and more preferably 1.3 or lower, from the viewpoint of similarity in absorbability between the upper surface and the bottom surface, wash durability, and designability. In the case where the binder-exposed area on the upper surface is equal to the binder-exposed area on the bottom surface, the ratio of the binder-exposed area between upper and bottom surfaces is 1. Here, the ratio of the binder-exposed area between upper and bottom surfaces is represented by a ratio of a larger binder-exposed area with respect to a smaller binder-exposed area between the binder-exposed area (S_u) on the surface of the upper layer portion and the binder-exposed area (S_b) on the surface of the bottom layer portion. Specifically, where S_u is larger than S_b , the ratio is calculated as S_u/S_b , while S_b is larger than S_u , the ratio is calculated as S_b/S_u .

[0032] The nonwoven fabric according to the present invention is

applicable to various uses such as uses as/for daily necessities, clothing materials, medical care, beauty materials, sanitary or hygiene materials, industrial materials, and others. In particular, the nonwoven fabric is useful as a nonwoven fabric for cleaning. For example, the nonwoven fabric can be used as: a wiper for use
5 in, for example, wiping dirt or stains on noble metals such as jewels, tableware (crockery and cutlery), tables, glass materials, electrical products, furniture, gas cooking stoves, and the like; and paper towel or kitchen paper, used for cooking preparation making use of, for example, absorption of liquids (drips) oozing from edible meat at the time of defrosting or the like as well as fresh fish; paper towel,
10 kitchen paper, used also for, for example, wiping chopping boards, cooking devices, tableware, cooking tables, sinks, and the like as well as removing water droplet thereof; filtering oil; and so on. Wiper, paper towel, kitchen paper, and the like comprising the nonwoven fabric according to the present invention are excellent in wash durability, and can be repeatedly used. Accordingly, they are
15 not only advantageous in terms of cost, but also have excellent absorbability, and thus are useful for cleaning of various kinds of dirt, stains and others.

[0033] Constituent Fibers of Nonwoven Fabric

As the nonwoven fabric according to the present invention, there may be used a dry-laid nonwoven fabric, a wet-laid nonwoven fabric and the like, and
20 a dry-laid nonwoven fabric is preferable from the viewpoint of ensuring softness. The fiber length of the constituent fibers of the nonwoven fabric may be, for example, about 20 to 70 mm, preferably about 25 to 65 mm, more preferably about 30 to 60 mm, and further preferably about 35 to 55 mm.

[0034] From the viewpoint of ensuring softness, the nonwoven fabric
25 of the present invention has a fineness of constituent fibers of, for example, about 1.0 to 3.5 dtex, preferably about 1.3 to 3 dtex, and more preferably 1.5 to 2.5 dtex.

[0035] The fibers constituting the nonwoven fabric according to the present invention may contain hydrophilic fibers from the viewpoint of ensuring

absorbability and water retention. Preferably, hydrophilic fibers may be included as the subject fibers. The species of hydrophilic fibers are not particularly limited to the specific one, and may be exemplified as natural fibers, regenerated fibers, semi-synthetic fibers, or synthetic fibers. Moreover, the
5 hydrophilic fibers may be fibers to which hydrophilicity is imparted by post-processing. The hydrophilic fibers may be used alone or in combination of two or more. Examples of the hydrophilic natural fibers may include natural cellulose fibers such as cotton, hemp, wool, pulp, and the like. Examples of the hydrophilic regenerated fibers may include regenerated cellulose fiber such as
10 rayon, lyocell such as Tencel (registered trademark), polynosic, cupra, and the like. Examples of the hydrophilic semi-synthetic fibers may include semi-synthetic cellulose fibers such as acetate, triacetate, and the like. Examples of the hydrophilic synthetic fiber may preferably include synthetic fibers of thermoplastic resin containing a hydrophilic functional group and/or a
15 hydrophilic bond, the hydrophilic functional group may be exemplified as hydroxyl group, carboxyl group, sulfonic acid group; the hydrophilic bond may be exemplified as amide bond.

[0036] The hydrophilic fibers may preferably be cellulose fibers such as natural cellulose fibers, regenerated cellulose fibers, or semi-synthetic
20 cellulose fibers. Among regenerated cellulose fibers, rayon fibers (for example, viscose rayon) and solvent-spun cellulose fibers (for example, lyocell such as Tencel) may be more preferably used.

[0037] The proportion of the hydrophilic fibers (particularly, the hydrophilic fibers as the subject fibers) is, based on the fibers constituting the
25 nonwoven fabric of the present invention, for example, 50% by mass or more, preferably 60% by mass or more, more preferably 70% by mass or more, from the viewpoint of ensuring sufficient absorbability and water retention. The upper limit of the proportion of hydrophilic fibers is not particularly limited, and may be 100% by mass or less, for example.

[0038] The fibers constituting the nonwoven fabric according to the present invention may contain various synthetic fibers and natural fibers other than hydrophilic fibers. Examples of synthetic fibers other than the hydrophilic fibers may include polyolefin resins such as polyethylene and polypropylene, 5 fibers of polyester resins such as polyethylene terephthalate, polybutylene terephthalate, and polylactic acid, and others. The nonwoven fabric may include, for example, heat-fusible fibers in order to improve shape stability. The nonwoven fabric may be subjected to thermal bonding method in addition to the chemical bonding method using a binder. The heat-fusible fiber only needs 10 to have a melting point that can be melted or a heat distortion temperature at a treatment temperature in thermal bonding, and may be, for example, a non-conjugate fiber comprising a low melting point resin having a melting point or a heat distortion temperature equal to or lower than the treatment temperature. Alternatively, the heat-fusible fiber may be a conjugate fiber comprising the 15 above-described low melting point resin and a high melting point resin having a higher melting point than the low melting point resin.

[0039] In the case of the conjugate fiber, conjugate fibers may preferably include, for example, a conjugate fiber having a core-sheath structure in which a lower melting point resin constitutes the sheath component and a 20 higher melting point resin constitutes the core component. The low melting point resin and the high melting point resin can be appropriately selected, depending on the treatment temperature of the thermal bond, from polyolefin resins such as polyethylene and polypropylene, polyester resins such as polyethylene terephthalate, polybutylene terephthalate, and polylactic acid.

25 [0040] The fineness of the synthetic fiber as well as the heat-fusible fiber may be, for example, about 1.0 to 3.5 dtex, preferably about 1.3 to 3 dtex, and more preferably about 1.5 to 2.5 dtex. Further, the fiber length thereof may be, for example, about 30 to 80 mm, preferably about 35 to 60 mm, so that the fibers can be arranged in linear portions.

[0041] From the viewpoint of ensuring strength in addition to sufficient absorbability and water retention, the nonwoven fabric according to the present invention may comprising hydrophilic fibers in addition to synthetic fibers or heat-fusible fibers at a mass ratio of (hydrophilic fibers)/(synthetic fibers or
5 heat-fusible fibers) of, for example, 50/50 to 95/5, preferably 60/40 to 90/10, and more preferably 70/30 to 85/15.

[0042] Binder

The binder contains at least an adhesive component. Examples of the adhesive components may include an acrylic resin (a copolymer of acrylic
10 acid ester, etc.), a polyurethane resin, a vinyl acetate copolymer resin, an epoxy resin, a styrene resin (a copolymer of styrene and acrylic resin, etc.). The binder may preferably contain at least one selected from acrylic resins, polyurethane resins, and styrene resins.

[0043] The binder may further contain at least one selected from the
15 group consisting of pigments, penetrants, and thickeners, if necessary. As the pigments, penetrants, and thickeners, generally known or conventional pigments, penetrants and thickeners can be used depending on the purpose and constitution. Where the binder contains a pigment, partial coating with the binder allows the nonwoven fabric according to the present invention to have a desired pattern.
20 As described above, where a ratio of binder-exposed area of one surface relative to that of the other surface is smaller, it is possible to obtain a nonwoven fabric having a uniform pattern between upper and bottom surfaces, achieving excellent aesthetic view.

[0044] The nonwoven fabric according to the present invention may
25 have a binder-applied amount (dry weight) of 5 to 50% by mass, preferably 10 to 45% by mass, and more preferably 20 to 40% by mass from the viewpoint of achieving both wash durability and absorbability.

[0045] Production Method of Nonwoven Fabric

The method of producing a nonwoven fabric according to the present

invention at least comprises a coating or dip-nipping step (A) in which at least one surface of a pre-coated or pre-dipped nonwoven fabric is coated or dip-nipped with a binder, and a drying step (B) of drying the coated or dip-nipped nonwoven fabric using heated rolls by alternately bringing each of the
5 upper and bottom surfaces of the coated or dip-nipped nonwoven fabric into contact with each of the heated rolls in sequence.

[0046] Pre-Coated or Pre-dipped Nonwoven Fabric

A pre-coated or pre-dipped nonwoven fabric can be prepared by the following procedure.

10 First, predetermined fibers are formed into a web by a carding or an air-laid process. The web may be shaped into a random web, a semi-random web, or a parallel web.

[0047] Next, in order to impart practical strength, fibers in the obtained web are mechanically and/or chemically bound with each other to obtain a
15 pre-coated or pre-dipped nonwoven fabric. As the mechanical binding, there may be mentioned to use a method to entangle fibers three-dimensionally such as a hydroentanglement method or a needlepunching method. From the viewpoint of imparting softness to the nonwoven fabric and forming a mesh structure, it is preferable to use hydroentanglement in which the fibers are entangled through a
20 hydroentanglement process.

[0048] In hydroentanglement, onto a web placed on a porous support, are injected high-pressure water jets (curtains) from a nozzle having fine holes, then the water jets passing through the web hit to a steel plate so as to be reflected to the web. The reciprocal water jets give the energy to fibers in the
25 web to be entangled and bound with each other.

[0049] A plurality of porous supports may be used, for example, for entangling fibers in a three-dimensional shape by using a first porous support, and for imparting a desired mesh structure to the fiber-entangled web by using a second porous support. In this case, the second porous support has a pattern

shape in accordance with the desired mesh structure.

[0050] From the viewpoint of adjusting to a specific binder distribution, the pre-coated or pre-dipped nonwoven fabric may have a basis weight of, for example, 10 g/m² or more and less than 100 g/m², preferably about 20 to 95 g/m²,
5 and more preferably about 30 to 90 g/m². Where the basis weight of the pre-coated or pre-dipped nonwoven fabric is too large, movement of solidable components such as adhesive components may be restricted in the drying step (B) described later so as to the solidable components retained in inner portion (middle layer) of the nonwoven fabric, resulting in difficulty in adjusting Nu/Nc
10 and Nb/Nc ratio in predetermined ratios.

[0051] Step A

The method for producing a nonwoven fabric of the present invention includes a step (A) of coating or dip-nipping in which at least one surface of a pre-coated or pre-dipped nonwoven fabric is coated or dip-nipped with a binder.
15 The step (A) provides the nonwoven fabric with a binder-adhered region in the pre-coated or pre-dipped nonwoven fabric. In the case of coating, the binder is applied to a coated surface of the fabric; in the case of dip-nip, the binder is applied to the entire fabric. The applied binder is movable in the thickness direction of the fabric in the drying step (B) described below so as to be
20 permeated toward inner portion. The inner portion of the fabric may be a central layer portion when the raw fabric is divided into three equal parts in the thickness direction, i.e., an upper layer portion, a bottom layer portion, and a central layer portion.

[0052] If necessary, the binder may be used as an emulsion in which
25 the above-mentioned adhesive component and other optional component(s) are dispersed in an aqueous solvent such as water. The viscosity of the binder when used as an emulsion can be appropriately determined, depending on the method of applying the binder as well as the amount of binder to be applied, by adjusting the solid content concentration and the like. For example, the solid content

concentration can be selected from the range of 0.2% by mass to 60% by mass, and the viscosity can be selected from the range of 1 to 500 mPa·s.

[0053] When the binder is applied, the binder may be applied to the entire surface of the fabric or may be applied partially. Examples of the coating
5 method may include print coating, spray coating, foam coating, and the like, and the print coating is preferable in view of easy control of the coated region with the binder.

[0054] In the print coating, the pre-coated or pre-dipped nonwoven fabric comes into contact with a binder-retaining roll so as to apply the binder to
10 a fabric surface in contact with the roll. By using a roll with a pattern in contact with the fabric surface, a nonwoven fabric after the drying step (B) can partly have a binder-adhered region.

[0055] Where the binder is applied by print coating, spray coating, foam coating, or the like, the pre-coated nonwoven fabric is preferably controlled
15 to have a moisture content of 50 to 450% by mass before binder application. By controlling the moisture content of the pre-coated nonwoven fabric to a specific value before binder application, it is possible to allow the surface-coated binder to be dispersed in the water contained in the fabric and to be permeated sufficiently toward the inside of the fabric. Where the moisture content of the
20 pre-coated fabric is less than 50%, the permeation of the binder into the fabric may be insufficient, and in some cases, the obtained nonwoven fabric cannot distribute the binder in a desired way so as to fail to distribute the binder through the nonwoven fabric to the opposite side of the coated surface. Where the moisture content of the pre-coated fabric exceeds 450%, the binder may be
25 dispersed into too large distribution so that the binder may be dispersed not only in the thickness direction but also in the plane (horizontal) direction. Where the binder is dispersed in the plane direction, the desired binder distribution may not be realized, and the nonwoven fabric partially coated with the binder fails to achieve uniform absorbability between the upper surface and bottom surface.

The moisture content of the raw fabric before coating may be preferably 80 to 350%, more preferably 100 to 200%.

[0056] When the binder is dip-nipped, the dip-nip may be a treatment of dipping (immersing) a pre-dipped nonwoven fabric with the binder and then
5 nipping (squeezing) the dipped nonwoven fabric using, for example, a mangle. In this case, the binder can be distributed (penetrated) entirely in the nonwoven fabric from both surfaces to inside of the nonwoven fabric.

[0057] When the dip-nip treatment is performed, the pre-dipped nonwoven fabric before being dipped in the binder may be dried and used in a
10 state to have a moisture content of 0%. Further, the binder content of the dip-nipped nonwoven fabric may be controlled to 50 to 800% by mass, more preferably 80 to 500%, and further preferably 100 to 250%. The binder content of the fabric may be controlled by, for example, adjusting the transfer speed for dipping the fabric or the nipping pressure of the dipped fabric.

15 [0058] Drying Step B

In the drying step (B), the coated or dip-nipped nonwoven fabric that has been subjected to the above step (A) is dried using heated rolls by alternately bringing each of the upper and bottom surfaces of the coated or dip-nipped nonwoven fabric into contact with each of the heated rolls in sequence. Thus,
20 the binder can be moved toward a fabric surface in contact with the heated roll accompanying the moisture movement inside the fabric. Specifically, water in a portion in contact with the heated roll evaporates from the fabric surface, and in order to compensate deficiency of water, the water-evaporated portion let water in other portion in the fabric be introduced into the water-evaporated portion by
25 water diffusion. As a result, solid components such as adhesive components dispersed in water are also introduced into the fabric surface in contact with the heated roll. Thereafter, the opposite surface of the fabric comes into contact with a next heated roll, so that the opposite fabric surface in contact with the next heated roll is more strongly heated, resulting in reverse direction of the water

diffusion. Along with the movement of water, solid components such as adhesive components are also moved to the surface in contact with the hot roll. Therefore, even if the binder is applied only to one surface of the pre-coated nonwoven fabric, the binder can be moved to the opposite surface. Then, the upper and bottom surfaces are alternately brought into contact with different heated rolls to be dried, so that solid components such as adhesive components are movable through inside of the fabric between the upper and bottom surfaces. As a result, it is possible to distribute higher amount of binder in both of the upper and bottom surface portions than in the central portion after drying procedure. Further, in the drying step (B), a plurality of fiber bundles bound by the binder can be formed due to the movement of the solid components such as the adhesive components.

[0059] For example, as shown in Fig. 1, a binder is applied only to one surface of a pre-coated nonwoven fabric 10 so as to form a coated surface 11 and a non-coated surface 12 which is the opposite surface to the coated surface 11. In the drying step (B), the non-coated surface 12 is brought into contact with a first heated roll 30, and then the coated surface 11 is brought into contact with a second heated roll 31. Further, the non-coated surface 12 is brought into contact with a third heated roll 32, and then the coated surface 11 is brought into contact with a fourth heated roll 33. If necessary, the non-coated surface 12 and the coated surface 11 may be alternately brought into contact with other heated roll(s) for further dry procedure. In the drying step (B), by firstly bringing the non-coated surface into contact with a first heated roll, solid components in the binder highly distributed in the side of the coated surface can be more easily introduced into the side of the non-coated surface, because the nonwoven fabric still contains a large amount of water which serves as a medium for movement of the solid components during a first contact to the heated roll. Accordingly, the uniformity in distribution amount of the binder on both surfaces of the resultant nonwoven fabric can be improved.

[0060] In the drying step (B), the temperature of the heated roll may be 100°C or higher (for example, about 100 to 150°C), preferably 110°C or higher (for example, about 110 to 145°C (e.g., about 110 to 140°C)), and more preferably 120°C or higher (e.g., about 120 to 140°C) from the viewpoint of
5 controlling the applied binder in a specific distribution. Each of the upper and bottom surfaces of the fabric may be dried twice or more, preferably three times or more. The upper limit of drying each of the upper and bottom surfaces of the fabric is not particularly limited, but may be 8 times or less (preferably 7 times or less), for example, from the viewpoint of productivity.

10 EXAMPLES

[0061] Hereinafter, the present invention will be described in more detail with reference to Examples. However, the Examples are not intended to limit the present invention whatsoever. Various physical properties in the Examples and Comparative Examples were determined in accordance with the
15 following methods.

[0062] Measurement of Binder Viscosity

A viscosity at a liquid temperature of 20°C was measured using a viscometer “VISCOMETER TVB-10 type, Rotor M1” produced by Toki Sangyo Co., Ltd. at 12 rpm under an environment of a room temperature of 22°C and a
20 humidity of 60%.

[0063] Basis Weight

A basis weight (g/m^2) of a nonwoven fabric was measured in accordance with JIS L 1913 “Test methods for nonwovens” 6.2.

[0064] Thickness

25 A thickness of a nonwoven fabric was measured using a measuring device providing a presser plate with a diameter of 1.0 inch at a pressure of 12 g/cm^2 in accordance with JIS L 1913 “Test methods for nonwovens” 6.1.

[0065] Aperture proportion

A nonwoven fabric was cut into a size of 3 cm x 5 cm to obtain a test

piece, and the obtained test piece was placed on a black stand. Using a digital microscope “RH-2000” produced by Hirox Co., Ltd., was obtained an image of the test piece surface that was magnified to 5 times. The obtained image was observed to measure an area having a gradation density of 103% or less (the area
5 where the black base of the black stand was visible) that was defined as opening hole area so as to calculate an aperture proportion based on the entire area of the observed test piece.

[0066] Absorbability

An acrylic plate was set on the stage of the test machine shown in Fig.
10 2 and the acrylic plate was used as a surface to be wiped. Onto the acrylic plate, was dropped 90 mg of India ink (Chinese ink) as a target to be wiped. In order to measure an absorbability (wiping property) of a nonwoven fabric that was allowed to slide during wiping, a nonwoven fabric was cut into a 5 cm×5 cm square to obtain a test piece. The test piece was first allowed to stand still on
15 the India ink droplet on the acrylic plate for about 5 seconds, then an edge of the test piece was pinched by a clip, and the clip was pulled using a motor at a speed of 600 mm/sec. where a load of 200 g was placed on top of the test piece, so that the test piece was moved in one direction one time as a wiping procedure. After the wiping procedure, the ink droplet residue remaining on the acrylic plate was
20 completely dried so as to measure a transmittance of the acrylic plate using a color difference meter. That is, the transmittance values of the acrylic plate before and after the wiping procedure were measured using a color difference meter (300A produced by Nippon Denshoku Industries Co., Ltd.), and difference in transmittance of the acrylic plate was calculated by the formula of $a_1 - a_0$ as
25 an index of the absorbability, where a_1 represented a transmittance value after wiping procedure and a_0 represented a transmittance value before wiping procedure. Transmittance values were evaluated according to the following criteria. It should be noted that the evaluation was performed both on the upper surface and the bottom surface of the test piece, and the surface having poor

absorbability was used for evaluation.

A: 80% or more

B: 60% or more and less than 80%

C: less than 60%

5 [0067] Wash durability (Change in Shape)

In accordance with JIS L 0217 103 method, change in configuration (shape, tear, etc.) of the nonwoven fabric after washing 5 times was visually evaluated according to the following criteria.

A: no change in shape

10 B: slight change in shape

C: severe change in shape

[0068] Wash durability (Surface Fluffing)

In the above wash durability test, the fluffing generated on the surface of the nonwoven fabric after washing 5 times was visually evaluated according to
15 the following criteria.

A: surface appearance was not much changed

B: surface appearance was slightly changed

C: surface appearance was drastically changed

[0069] Number of Fiber Bundles, Total Number of Fibers in Bundles

20 The binder-adhered region of the nonwoven fabric was cut using a razor blade in a direction perpendicular to the flow direction (MD direction) of production to obtain a test piece (5 mm x 10 mm). The test piece was attached to a sample stand and was coated using a sample coater (DII-29010SCTR Smart Coater) produced by JEOL Ltd. Using a desk-top scanning electron microscope
25 (JMC-6000Plus) produced by JEOL Ltd., the cut cross section of the test piece was observed as an enlarged view at a magnification of 150 times in which the entire sample in the thickness direction was displayed. Regarding the enlarged image photograph, the cross-sectional view of the nonwoven fabric was divided into three portions as upper, central, and bottom portions in the thickness

direction, and the number of bundles (pieces) bound by the binder, and the total number of fibers in each of the bundle were counted, so that Nu/Nc , Nb/Nc , Nu/Bu , Nc/Bc , Nb/Bb and Nu/Nb in each of the portions were calculated from the number (B) of fiber bundles and the total number (N) of fibers in the bundles.

5 [0070] Example 1

First, 100% by mass of rayon fibers ("Corona" produced by Daiwabo Rayon Co., Ltd.) having a fineness of 1.7 dtex and a fiber length of 40 mm were subjected to semi-random carding to obtain a fibrous web having a basis weight of 60.0 g/m^2 .

10 Then, the obtained fibrous web was subjected to hydroentangling treatment to obtain a pre-coated nonwoven fabric having a mesh structure.

The pre-coated nonwoven fabric entangled by hydroentangling treatment was adjusted to have a moisture content of 120% by mass, and then partially coated with a binder (acrylic emulsion) adjusted to have a solid content concentration of 20% and a viscosity of 100 to 150 mPa·s from one side as a coated surface by print coating. Thereafter, using a cylinder type dryer provided using heated rolls each having a surface temperature set to 140°C , the opposite surface to the coated surface of the nonwoven fabric was brought into contact with a first heated roll to be dried, followed by bringing the further opposite surface (coated surface) into contact with a second heated roll to be dried. The drying treatment was repeated 6 times. The various properties of the obtained nonwoven fabric are shown in Table 1. An enlarged cross-sectional view of the obtained nonwoven fabric is shown in Fig. 3. As is clear from Fig. 3, the obtained nonwoven fabric contained more binder-bound single fibers in the upper layer portion and the bottom layer portion than those in the central layer portion.

25 [0071] Example 2

A nonwoven fabric was produced in the same manner as that of Example 1, except that 70% by mass of rayon fibers ("Corona" produced by

Daiwabo Rayon Co., Ltd.) having a fineness of 1.7 dtex and a fiber length of 40 mm, and 30% by mass of PET fibers (“Tetron (registered trademark) 471” produced by Toray Industries, Inc.) having a fineness of 1.6 dtex and a fiber length of 51 mm were subjected to semi-random carding to obtain a fibrous web
5 having a basis weight of 55.0 g/m². The various properties of the obtained nonwoven fabric are shown in Table 1.

[0072] Example 3

A nonwoven fabric was produced in the same manner as that of Example 1, except that the hydroentangling treatment was performed to give the
10 aperture proportion of 45% to the finally obtained nonwoven fabric. The various properties of the obtained nonwoven fabric are shown in Table 1.

[0073] Example 4

A nonwoven fabric was produced in the same manner as that of Example 1, except that the pre-dipped nonwoven fabric obtained after the
15 hydroentangling treatment was dried using a cylinder dryer to adjust the moisture content to 0% by mass, and that the obtained nonwoven fabric was soaked in the binder (acrylic emulsion) adjusted to have a solid content concentration of 10% and a viscosity of 10 mPa·s to have a binder content of 150% by the dip-nip method. The various properties of the obtained nonwoven fabric are shown in
20 Table 1.

[0074] Comparative Example 1

A nonwoven fabric was produced in the same manner as that of Example 1, except that the pre-coated nonwoven fabric obtained after the hydroentangling treatment was adjust to have a moisture content to 0% by mass.
25 The various properties of the obtained nonwoven fabric are shown in Table 1. An enlarged cross-sectional view of the obtained nonwoven fabric is shown in Fig. 4. As is clear from Fig. 4, in the obtained nonwoven fabric, many binder-bound single fibers were found in the central layer and the bottom layer portions, and almost no binder-bound single fibers were seen in the upper layer

portion.

[0075] Comparative Example 2

A nonwoven fabric was produced in the same manner as that of Example 1, except that the pre-coated nonwoven fabric obtained after the hydroentangling treatment was adjust to have a moisture content of 30% by mass. The various properties of the obtained nonwoven fabric are shown in Table 1.

[0076] Comparative Example 3

A nonwoven fabric was produced in the same manner as that of Example 1, except that the pre-coated nonwoven fabric obtained after the hydroentangling treatment was adjust to have a moisture content of 500% by mass. The various properties of the obtained nonwoven fabric are shown in Table 1. An enlarged cross-sectional view of the obtained nonwoven fabric is shown in Fig. 5. As is clear from Fig. 5, in the obtained nonwoven fabric, the binder-bound single fibers were found in the upper layer portion, the central layer portion and the bottom layer portion, so that the binder was diffused throughout the nonwoven fabric.

[0077] Comparative Example 4

A nonwoven fabric was produced in the same manner as that of Example 1, except that 100% by mass of PET fibers ("Tetron (registered trademark) 471" produced by Toray Industries, Inc.) having a fineness of 1.6 dtex and a fiber length of 51 mm were subjected to semi-random carding to obtain a fibrous web having a basis weight of 60.0 g/m², and that a pre-coated nonwoven fabric obtained after the hydroentangling treatment was adjust have a moisture content of 30% by mass. The various properties of the obtained nonwoven fabric are shown in Table 1.

[0078] Comparative Example 5

A nonwoven fabric was produced in the same manner as that of Example 1, except that the drying was performed by hot air drying. The various properties of the obtained nonwoven fabric are shown in Table 1.

[0079] Comparative Example 6

A nonwoven fabric was produced in the same manner as that of Example 4, except that the drying was performed by hot air drying. The various properties of the obtained nonwoven fabric are shown in Table 1.

5 [0080] Comparative Example 7

This comparative example is an example corresponding to Example 1 of JP Laid-open Patent Publication No. H9-266873, which was obtained by overlaying a web into three layers to be treated. As for each of the upper layer and bottom layers, 100% by mass of rayon fibers (“Corona” produced by Daiwabo Rayon Co., Ltd.) having a fineness of 1.7 dtex and a fiber length of 40 mm were subjected to semi-random carding to obtain a fibrous web having a basis weight of 40.0 g/m². As for the central layer, 50% by mass of rayon fibers (“Corona” produced by Daiwabo Rayon Co., Ltd.) having a fineness of 1.7 dtex and a fiber length of 40 mm, and 50% by mass of PET fibers (“Tetron (registered trademark) 471” produced by Toray Industries, Inc.) having a fineness of 1.6 dtex and a fiber length of 51 mm were subjected to semi-random carding to obtain a fibrous web having a basis weight of 40.0 g/m².

Next, the obtained fibrous web was subjected to hydroentangling treatment to obtain a pre-coated nonwoven fabric having a mesh structure.

20 The pre-coated nonwoven fabric entangled by hydroentangling treatment was adjusted to have a moisture content of 120% by mass, and then partially coated with a binder (acrylic emulsion) adjusted to have a solid content concentration of 15% and a viscosity of 100 to 150 mPa·s from one side as a coated surface by print coating. Thereafter, using a cylinder type dryer provided using heated rolls each having a surface temperature set to 140°C, the opposite surface to the coated surface of the nonwoven fabric was brought into contact with a first heated roll to be dried, followed by bringing the further opposite surface (coated surface) into contact with a second heated roll to be dried. The drying treatment was repeated 6 times.

Next, the treated product was immersed with water to have a moisture content adjusted to 120% by mass. Thereafter the binder (acrylic emulsion) adjusted to have a solid content concentration of 15% and a viscosity of 100 to 150 mPa·s was applied to be partially printed from one side (the opposite side to the previously coated side) by print coating. Then, using the cylinder type dryer provided using heated rolls each having a surface temperature set to 140°C, the opposite surface to the coated surface of the nonwoven fabric was brought into contact with a first heated roll to be dried, followed by bringing the further opposite surface into contact with a second heated roll to be dried. The drying treatment was repeated 6 times.

The various properties of the obtained nonwoven fabric are shown in Table 1. An enlarged cross-sectional view of the obtained nonwoven fabric is shown in Fig. 6.

[0081]

[Table 1]

	Constituent fibers	Raw fabric moisture content	Binder-containing emulsion applying method	Drying method	Basis weight	Thickness	Aperture proportion	Dry amount of binder	Absorbability	Wash durability		Nu/Nc	Nb/Nc	Nu/Bu	Nc/Bc	Nb/Bb	Nu/Nb
		%			g/m ²	mm/ply	%			Shape change	Surface fluffing						
Ex. 1	Rayon 100%	120	Partially coating	Heated roll	65	0.36	30	20	A	A	A	1.96	2.35	17.44	3.48	17.09	0.84
Ex. 2	Rayon 70% Polyester 30%	120	Partially coating	Heated roll	55	0.34	25	20	B	B	A	1.93	1.93	5.40	2.92	7.94	1.00
Ex. 3	Rayon 100%	120	Partially coating	Heated roll	65	0.42	45	20	B	A	A	1.71	2.76	13.43	5.00	11.69	0.62
Ex. 4	Rayon 100%	0	Dip-nipping	Heated roll	75	0.30	30	40	B	A	A	1.31	1.32	3.79	2.79	2.97	0.99
Com. Ex. 1	Rayon 100%	0	Partially coating	Heated roll	60	0.34	30	20	C	C	C	0.12	0.83	2.50	10.38	13.80	0.14
Com. Ex. 2	Rayon 100%	30	Partially coating	Heated roll	65	0.46	30	10	C	C	C	0.51	0.58	3.06	3.13	4.67	0.88
Com. Ex. 3	Rayon 100%	500	Partially coating	Heated roll	60	0.41	30	20	B	C	B	1.14	0.83	21.88	11.85	10.67	1.37
Com. Ex. 4	Polyester 100%	30	Partially coating	Heated roll	60	0.45	30	10	C	C	C	0.75	1.25	4.80	2.00	3.33	0.60
Com. Ex. 5	Rayon 100%	120	Partially coating	Hot air drying	65	0.49	30	20	C	C	C	0.14	1.44	2.50	4.50	26.00	0.10
Com. Ex. 6	Rayon 100%	0	Dip-nipping	Hot air drying	70	0.50	30	20	C	C	C	2.40	0.85	4.00	2.50	2.43	2.82
Com. Ex. 7	Rayon 100%/ Rayon 50% Polyester 50%/ Rayon 100%	120	Partially coating	Heated roll	140	0.65	20	20	B	C	B	1.03	1.53	3.29	6.42	7.87	0.67

[0082] As shown in Table 1, in Examples 1 to 4, the total number of fibers in the bundles in the upper layer portion, the total number of fibers in the bundles in the bottom layer portion, and the total number of fibers in the bundles in the central layer portion have a specific relationship with each other. Therefore, the nonwoven fabrics of Examples 1 to 4 were prevented from shape changes and fluffing after washing, were excellent in wash durability, and had good absorbability. In particular, the nonwoven fabric of Example 1 was excellent in all of the shape stability and surface fluffing in the wash durability, as well as absorbability.

10 [0083] On the contrary, in Comparative Examples 1 to 7, since the total number of fibers in the bundles in the upper layer portion, the total number of fibers in the bundles in the bottom layer portion, and the total number of fibers in the bundles in the central layer portion failed to have a specific relationship, a drastic shape change occurred after washing and fluffing on the surface was observed. Moreover, the nonwoven fabrics in Comparative Examples were also inferior in absorbability.

INDUSTRIAL APPLICABILITY

[0084] As described above, the nonwoven fabric of the present invention can be used for various uses such as uses as/for daily necessities, clothing materials, medical care materials, beauty materials, sanitary or hygiene materials, industrial materials, and others. In particular, the nonwoven fabric is useful as a nonwoven fabric for cleaning because it has excellent wash durability and absorbability. For example, the nonwoven fabric can be advantageously used as: a wiper for use in, for example, wiping dirt or stains on noble metals such as jewels, tableware (crochery and cutlery), tables, glass materials, electrical products, furniture, gas cooking stoves, and the like; and paper towel or kitchen paper, used for cooking preparation making use of, for example, absorption of liquids (drips) oozing from edible meat at the time of defrosting or the like as well as fresh fish; paper towel, kitchen paper, used also for, for example, wiping

chopping boards, cooking devices, tableware, cooking tables, sinks, and the like as well as removing water droplet thereof; filtering oil; and so on.

[0085] Preferred embodiments of the present invention are shown and described with reference to the accompanying drawings. It is to be understood
5 that various changes, modifications and omissions may be made without departing from the spirit of the present invention and are encompassed in the scope of the claims.

Reference Numerals

	[0086]	10... pre-coated or pre-dipped nonwoven fabric
10		11... coated surface
		12... non-coated surface
		20... pattern roll
		30, 31, 32, 33... heated roll
		1... test piece
15		2... India ink
		3... acrylic plate
		4... motor
		5... load
		6... stage
20		7...test machine

What is claimed is:

1. A nonwoven fabric having a binder-adhered region, wherein
the nonwoven fabric comprises a plurality of fiber bundles in each of
upper, central and bottom layer portions of the nonwoven fabric,
5 each of the fiber bundles contains a plurality of single fibers bound by
the binder and unified;
the upper, central and bottom layer portions are determined as equally
divided three portions in the thickness direction of a randomly selected
cross-sectional plane in the binder-adhered region;
10 the nonwoven fabric satisfies formulae:
$$Nu/Nc > 1.10 \text{ and } Nb/Nc > 1.10$$

in which Nu, Nc, and Nb represents the number of fibers in the
bundles in the upper, central, and bottom layer portions, respectively.
2. The nonwoven fabric according to claim 1, wherein the nonwoven
15 fabric has a binder-applied amount (dry weight) of 5 to 50% by mass.
3. The nonwoven fabric according to claim 1 or 2, wherein the binder
contains at least one selected from acrylic resins, polyurethane resins, and styrene
resins.
4. The nonwoven fabric according to claim 3, wherein the binder further
20 comprises a pigment.
5. The nonwoven fabric according to any one of claims 1 to 4, which
has a mesh structure with an aperture proportion of 10 to 50%.
6. The nonwoven fabric according to any one of claims 1 to 5, wherein
the nonwoven fabric comprises hydrophilic fibers as subject fibers.
- 25 7. The nonwoven fabric according to any one of claims 1 to 6, wherein
the nonwoven fabric satisfies formulae:
$$Nu/Bu > Nc/Bc \text{ and } Nb/Bb > Nc/Bc$$

in which Bu, Bb, and Bc represents the number of bundles in the
upper, bottom, and central portions, respectively.

8. The nonwoven fabric according to any one of claims 1 to 7, wherein the nonwoven fabric satisfies a formula:
- $$N_c/B_c \leq 6.00$$
- in which B_c represents the number of bundles in the central portion.
- 5 9. The nonwoven fabric according to any one of claims 1 to 8, wherein the nonwoven fabric comprises a non-binder-adhered region.
10. The nonwoven fabric according to any one of claims 1 to 9, wherein the nonwoven fabric is used for cleaning or wiping.
11. A method for producing the nonwoven fabric according to any one of
- 10 claims 1 to 10, at least comprising:
- a coating or dip-nipping step (A) in which at least one surface of a pre-coated or pre-dipped nonwoven fabric is coated or dip-nipped with a binder; and
- a drying step (B) of drying the coated or dip-nipped nonwoven fabric
- 15 using heated rolls by alternately bringing each of the upper and bottom surfaces of the coated or dip-nipped nonwoven fabric into contact with each of the heated rolls in sequence.
12. The method for producing a nonwoven fabric according to claim 11, wherein the heated rolls have a temperature of 100°C or higher in the drying step
- 20 (B), and each of the upper and bottom surfaces of the pre-coated or pre-dipped fabric is dried twice or more.
13. The method for producing a nonwoven fabric according to claim 11 or 12, wherein the step (A) comprises applying a binder to one or both surfaces of the pre-coated or pre-dipped nonwoven fabric having a moisture content
- 25 adjusted to 50 to 450%.
14. The method for producing a nonwoven fabric according to claim 11 or 12, wherein the step (B) comprises dipping a binder into the pre-coated or pre-dipped nonwoven fabric so as to adjust the binder content of the dipped nonwoven fabric to have 50 to 800%.

15. The method for producing a nonwoven fabric according to any one of claims 11 to 14, wherein the nonwoven fabric has a basis weight of 10 g/m² or more and less than 100 g/m².