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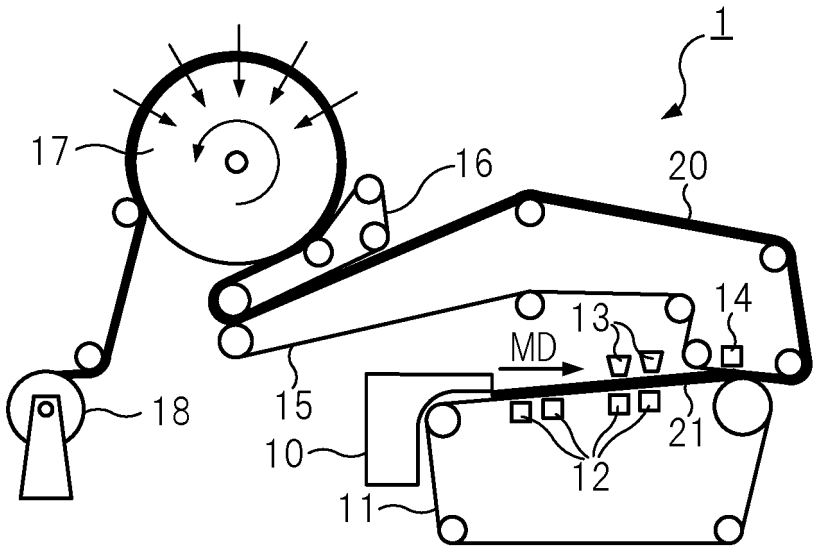
(54) **WATER-DISINTEGRABLE NONWOVEN FABRIC AND PROCESS FOR PRODUCING SAME**

(57) Disclosed is water-disintegrable nonwoven fabric which comprises 15-30 mass% regenerated cellulose fibers having a fiber length of 3-4 mm and a fineness of 0.3 dtex or less and 70-85 mass% pulp, has a basis weight of 35-50 g/m^2, has a tendency to disentanglement of 100 seconds or less when examined by a disentanglement test according to JIS P 4501:1993, and has a wet tensile strength of 1.2 N/25 mm or greater. The water-disintegrable nonwoven fabric combines wet tensile strength during use with water disintegrability after use.

FIG. 1



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Description

FIELD

[0001] The present invention relates to a water-disintegrable nonwoven fabric and a process for producing the same.

BACKGROUND

[0002] It has been proposed to use a water-disintegrable nonwoven fabric as a wiping article such as wet tissue, cleaning wipe, etc., as well as a top sheet for sanitary articles such as a disposable diaper, sanitary napkin, etc. Water disintegrable nonwoven fabrics used in such applications must have a predetermined wet strength to withstand use and a predetermined water disintegrability so that they are capable of being flushed in water after use.

[0003] For example, Patent Document 1 describes a water-disintegrable nonwoven fabric having a sufficient strength in a wet state and capable of being disintegrated upon contacting with a large amount of water. The water disintegrable nonwoven fabric described in Patent Document 1 is composed of regenerated cellulose fibers having a fiber length of 4 to 20 mm and pulp, wherein the fibers are entangled with each other by a high-pressure water jet stream treatment, and this nonwoven fabric has a wet tensile strength of 100 to 800 gf/25 mm, as measured in accordance with JIS P 8135:1998. In order to develop a high wet tensile strength, the water-disintegrable nonwoven fabric described in Patent Document 1 is prepared by forming a web with a wet paper machine, and then spraying a high-pressure water jet stream to one side or both sides of the resulting web at an applied specific energy in a specific range, i.e., from 0.1 to 0.6 kWh/kg per one pass on one side, to strongly entangle the regenerated cellulose fibers with each other. However, the water-disintegrable nonwoven fabric described in Patent Document 1 may clog a piping, such as toilet piping, etc., depending on the size of the piping due to the strongly entangled cellulose fibers, and therefore does not have sufficient disintegrating properties. Further, for water-disintegrable nonwoven fabrics for use in wiping articles and sanitary articles, a sufficient wet tensile strength and good disintegrating properties in water flow as described above, as well as good uniformity and texture are desired.

[Prior Art Documents]

[Patent Documents]

[0004] [Patent Document 1] Japanese Unexamined Patent Publication No. H9-228214

DISCLOSURE OF THE INVENTION

[Problems to be Solved by the Invention]

[0005] The present invention has been made to solve the above problems of the prior art, and an object of the present invention is to provide a water-disintegrable nonwoven fabric having a tensile strength sufficient to withstand the load applied during use, such as cleaning operation and wiping operation, in a wet state with a small amount of water, as well as good disintegrability when it is flushed in water in a flush toilet, etc., after use, and also having improved uniformity and texture (i.e., material texture and tactile feeling, such as skin touch feeling, softness, etc., perceived by a person who touches it), and a process for producing the same.

[Means for Solving the Problems]

[0006] The present inventor has found that the above problems can be solved by a nonwoven fabric comprising 15 to 30 wt% of regenerated cellulose fibers having a fiber length of 3 to 4 mm and a fineness of 0.3 dtex or less and 70 to 85 wt% of pulp, wherein the nonwoven fabric having a basis weight of 35 to 50 g/m^2, and has consequently completed the present invention.

[0007] Specifically, in one embodiment, the present invention is a nonwoven fabric comprising 15 to 30 wt% of regenerated cellulose fibers having a fiber length of 3 to 4 mm and a fineness of 0.3 dtex or less and 70 to 85 wt% of pulp, having a basis weight of 35 to 50 g/m^2, having a disintegrability within 100 sec. as measured in accordance with the disintegrability test of JIS P 4501:1993, and having a wet tensile strength of 1.2 N/25 mm or greater.

[0008] The water-disintegrable nonwoven fabric of the present invention exhibits a sufficient tensile strength at the time of use in a wet state with a small amount of water, as well as a sufficient disintegrability after use, without requiring a binder or paper strengthening agent, even though the regenerated cellulose fibers have a relatively short fiber length of 3 to 4 mm and a relatively low fineness of 0.3 dtex or less. Further, since the water-disintegrable nonwoven fabric of

the present invention comprises superfine regenerated cellulose fibers having a short fiber length in the above-specified amount, as described above, it has a high denseness, and therefore has good uniformity and good texture. Since the water-disintegrable nonwoven fabric of the present invention has good uniformity, it is possible, for example, to relieve the user's psychological anxiety that the soil wiped off with the nonwoven fabric might permeate through the nonwoven fabric and adhere to the user's hand.

[0009] In another embodiment, the present invention provides a process for producing a water-disintegrable nonwoven fabric, comprising:

(A) subjecting a slurry comprising regenerated cellulose fibers having a fiber length of 3 to 4 mm and a fineness of 0.3 dtex or less and pulp at a weight ratio of 15:85 to 30:70 to a wet paper-making operation at a fiber basis weight of 35 to 50 g/m^2,
(B) subjecting the web obtained in step (A) to a hydroentangling treatment with an energy of 0.05 kWh/kg to 0.1 kWh/kg to entangle fibers with each other, and
(C) drying the web subjected to the hydroentangling treatment.

[Effects of the Invention]

[0010] The water-disintegrable nonwoven fabric of the present invention has a wet tensile strength sufficient to withstand the load applied during use in a wet state, as well as good disintegrability when it is flushed in water after use, and also has good uniformity and good texture.

BRIEF DESCRIPTION OF DRAWINGS

[0011]

FIG. 1 shows a schematic view of one embodiment of a nonwoven fabric manufacturing apparatus used in the process for producing the water-disintegrable nonwoven fabric of the present invention.
FIG. 2 is a perspective view illustrating one example of injecting water from injection nozzle 13 to web 20.
FIG. 3 is a view showing one example of the nozzle holes of the injection nozzle.
FIG. 4 is a view for explaining the principle of entanglement of fibers in the web with a water stream injected from the nozzle.
FIG. 5 is a schematic sectional view in the width direction of the web to which water streams were injected.

MODE FOR CARRYING OUT THE INVENTION

[0012] Some of the inventive aspects of the present invention are shown below.

[Aspect 1]

[0013] A nonwoven fabric comprising 15 to 30 wt% of regenerated cellulose fibers having a fiber length of 3 to 4 mm and a fineness of 0.3 dtex or less and 70 to 85 wt% of pulp, having a basis weight of 35 to 50 g/m^2, having a disintegrability within 100 sec. as measured in accordance with JIS P 4501:1993, and having a wet tensile strength of 1.2 N/25 mm or greater.

[0014] According to Aspect 1, it has a wet tensile strength sufficient to withstand the load applied during use in a wet state and exhibits good disintegrability when it is flushed in water after use.

[Aspect 2]

[0015] The water disintegrable nonwoven fabric according to Aspect 1, wherein the regenerated cellulose fibers has a fineness of 0.1 to 0.3 dtex.

[0016] According to Aspect 2, it is difficult to produce regenerated cellulose fibers having a fineness of less than 0.1 dtex with good productivity, and regenerated cellulose fibers having a fineness of greater than 0.3 dtex may result in a nonwoven fabric having poor water-disintegrability.

[Aspect 3]

[0017] A process for producing the water-disintegrable nonwoven fabric according to Aspect 1, comprising:

(A) subjecting a slurry comprising regenerated cellulose fibers having a fiber length of 3 to 4 mm and a fineness of 0.3 dtex or less and pulp at a weight ratio of 15:85 to 30:70 to wet papermaking at a fiber basis weight of 35 to 50 g/m^2,
(B) subjecting the web obtained in step (A) to a hydroentangling treatment with an energy of 0.05 kWh/kg to 0.1 kWh/kg to entangle fibers with each other, and
(C) drying the web subjected to the hydroentangling treatment.

[0018] According to Aspect 3, a water-disintegrable nonwoven fabric having a wet tensile strength sufficient to withstand the load applied during use in a wet state and good disintegrability when it is flushed in water after use.

[0019] The water-disintegrable nonwoven fabric of the present invention has a basis weight of 35 to 50 g/m^2, and comprises 15 to 30 wt%, and preferably 15 to 20 wt%, based on the total weight of the nonwoven fabric, of regenerated cellulose fibers having a fiber length of 3 to 4 mm and a fineness of 0.3 dtex or less and 70 to 85 wt%, and preferably 80 to 85 wt% of pulp. When the water-disintegrable nonwoven fabric of the present invention is brought into contact with a large amount of water, the pulp is detached from the nonwoven fabric due to swelling of the pulp, enabling the entangled regenerated cellulose fibers to easily disintegrate. If the nonwoven fabric contains regenerated cellulose fibers in an amount of more than 30 wt%, the regenerated cellulose fibers entangled with each other are hard to disintegrate due to an excessively large number of the entanglement points among the regenerated cellulose fibers and may clog a piping, such as toilet piping, etc., depending on the size of the piping, and therefore results in insufficient disintegrability. Also, if the number of entanglement points among regenerated cellulose fibers is too much, the skin touch feeling of the nonwoven fabric is impaired. Furthermore, if the basis weight of the nonwoven fabric is 35 g/m^2, it is difficult to achieve a sufficient wet tensile strength. If the basis weight exceeds 50 g/m^2, the regenerated cellulose fibers entangled with each other are hard to disintegrate due to an excessively large number of the entanglement points among the regenerated cellulose fibers and may clog a piping, such as toilet piping, etc., depending on the size of the piping, and therefore does not have sufficient disintegrability.

[0020] In the water-disintegrable nonwoven fabric of the present invention, the regenerated cellulose fiber has a fiber length of 3 to 4 mm. When the regenerated cellulose fiber has a fiber length of less than 3 mm, it is difficult to sufficiently entangle the regenerated cellulose fibers with each other, and consequently it is difficult to achieve a wet tensile strength sufficient to withstand the load applied during use, such as during cleaning operation, wiping operation, etc. Regenerated cellulose fibers having a fiber length of more than 4 mm have a low dispersibility, and therefore result in a nonwoven fabric with unevenness in uniformity and wet tensile strength. Also, due to the low dispersibility of the regenerated cellulose fibers having a fiber length of more than 4 mm, it is difficult for the resulting nonwoven fabric to pass the disintegration test in accordance with JIS P 4501:1993. Since the water-disintegrable nonwoven fabric of the present invention comprises ultrafine regenerated cellulose fibers having a fiber length of 3 to 4 mm, it can remove a soil from fine parts of the object to be wiped when it is used as a wiping article such as a wet tissue, a cleaning wiper, etc. Moreover, the water-disintegrable nonwoven fabric of the present invention has excellent characteristic features that large soil can be easily scraped off by having a concave-convex structure with fine ridges and grooves on a surface thereof by a hydroentangling treatment as described later.

[0021] In the water-disintegrable nonwoven fabric of the present invention, the regenerated cellulose fibers have a fineness of 0.3 dtex or less, and preferably 0.1 to 0.3 dtex. Regenerated cellulose fibers having a fineness of less than 0.1 dtex are difficult to produce with good productivity. Regenerated cellulose fibers having a fineness of more than 0.3 dtex result in a nonwoven fabric having poor water disintegrability. The regenerated cellulose fibers result in a water-disintegrable nonwoven fabric having a smooth surface, since they are ultrafine fibers having a fineness of 0.3 dtex or less, and preferably 0.1 to 0.3 dtex. Further, in general, at the same weight % and the same fiber length, the lower the fineness, the larger the number of fibers per unit area of the nonwoven fabric, and therefore the above fineness of the regenerated cellulose fibers leads to a water-disintegrable nonwoven fabric having good uniformity and texture. Conversely, with the same weight % and the same fiber length, the higher the fineness, the smaller the number of fibers per unit area of the nonwoven fabric, and therefore the number of entanglement points among the regenerated cellulose fibers is decreased. Accordingly, regenerated cellulose fibers having a fiber length of more than 4 mm and a fineness of more than 0.3 dtex are not able to produce a nonwoven fabric having a wet tensile strength of 1.2 N/25 mm or greater.

[0022] The water-disintegrable nonwoven fabric of the present invention has a disintegrability within 100 seconds, preferably within 90 seconds, more preferably within 80 seconds, and even more preferably 70 seconds, as measured in accordance with the disintegrability test of JIS P 4501:1993. The disintegrability of more than 100 seconds may cause clogging of a piping, depending on the size of the toilet piping etc. There is no particular lower limit on the disintegrability. It is described in Table 1 in "2. Quality" of JIS P 4501:1993, "Toilet paper" that toilet paper should satisfy the standard of disintegrability within 100 seconds, and therefore the water-disintegrable nonwoven fabric of the present invention has a disintegrabilty equivalent to that of toilet paper.

[0023] For the water-disintegrable nonwoven fabric of the present invention, the wet tensile strength is measured in accordance with "7.1 General method" of JIS P 8135:1998, "Paper and board - Wet tensile strength test method", except for the following differences.

[0024] Difference: A test strip of 25 mm width × 150 mm length is cut out from a prepared nonwoven raw fabric. The test strip is immersed in distilled water at a weight ratio of 250 wt%, and then the test strip is allowed to stand on a wire netting for one minute. Subsequently, the test strip is set in a Tensilon type tensile tester at a chuck interval of 100 mm and is stretched at a tensile speed of 100 mm/min to measure the tensile strength (N) at break thereof, under conditions of a temperature of 20 °C and a relative humidity of 65%.

[0025] The regenerated cellulose fibers which constitute the water-disintegrable nonwoven fabric of the present invention are not particularly limited as long as they have a fiber length and a fineness within the above ranges. Examples of regenerated cellulose fibers include viscose rayon, cuprammonium rayon, Lyocell®, Tencel®, etc. The water-disintegrable nonwoven fabric of the present invention may contain one or more types of regenerated cellulose fibers.

[0026] The type of the pulp which constitutes the water-disintegrable nonwoven fabric is not particularly limited, and examples of the pulp include wood pulps such as softwood pulps, hardwood pulps, etc., non-wood pulps such as straw pulp, bagasse pulp, reed pulp, kenaf pulp, mulberry pulp, bamboo pulp, hemp pulp, cotton pulp (e.g., cotton linter), etc. The above pulps may be an unbeaten pulp, a beaten pulp, or a combination thereof. Softwood pulps are preferred, in view of disintegrability.

[0027] Non-beaten pulp preferably has a Canadian Standard Freeness (CSF) of 700 mL or more. The Canadian standard freeness is measured in accordance with JIS P 8121-2:2012, "Pulp - Freeness Test Method - Part 2: Canadian Standard Freeness Method". The average fiber length of the non-beaten pulp is not particularly limited, but is generally preferred to be 2 to 4 mm in view of economy and productivity. Beaten pulp is pulp obtained by beating non-beaten pulp by a method such as free beating, viscous beating, etc., and has a main body section and microfiber sections extending from the main body section. An incorporation of a beaten pulp in a wet tissue improves the wet strength and dry strength of the wet tissue. The beaten pulp preferably has a Canadian standard freeness of 500 to 680 mL, and more preferably has a Canadian standard freeness of 550 to 650 mL. A Canadian Standard Freeness of less than the above lower limit is not preferred, since such a Canadian Standard Freeness leads to a rigid nonwoven fabric having poor skin touch feeling and softness. If the Canadian Standard Freeness is greater than the above upper limit, a water-disintegrable nonwoven fabric having sufficient wet tensile strength cannot be obtained.

[0028] The water-disintegrable nonwoven fabric of the present invention has a basis weight of 35 to 50 g/m^2. A basis weight of the nonwoven fabric of less than 35 g/m^2 does not lead to a wet tensile strength sufficient to withstand the load applied during use. A basis weight of greater than 50 g/m^2 leads to a firm nonwoven fabric having inferior feel and softness is produced. The water-disintegrable nonwoven fabric of the present invention preferably has a basis weight of 35 to 45 g/m^2 in view of water disintegrability.

[0029] The water-disintegrable nonwoven fabric of the present invention can be produced by a process comprising:

(A) subjecting a slurry comprising regenerated cellulose fibers having a fiber length of 3 to 4 mm and a fineness of 0.3 dtex or less and pulp at a weight ratio of 15:85 to 30:70 to wet papermaking at a fiber basis weight of 35 to 50 g/m^2,
(B) subjecting the web obtained in step (A) to a hydroentangling treatment with an energy of 0.05 kWh/kg to 0.1 kWh/kg to entangle fibers with each other, and
(C) drying the web subjected to the hydroentangling treatment.

[0030] Hereinafter, the process for producing the water-disintegrable nonwoven fabric of the present invention will be described in more detail with reference to the drawings. The method for producing the water-disintegrable nonwoven fabric of the present invention can be carried out using the nonwoven fabric manufacturing apparatus 1 schematically shown in FIG. 1. FIG. 1 is a view schematically showing one embodiment of the nonwoven fabric manufacturing apparatus which can be used for manufacturing the water-disintegrable nonwoven fabric of the present invention, and the nonwoven fabric manufacturing apparatus is not limited to the embodiment shown in FIG. 1.

[0031] When producing the water-disintegrable nonwoven fabric of the present invention, a slurry containing regenerated cellulose fibers having a fiber length and a fineness as described above and pulp at a weight ratio of 15:85 to 30:70 is prepared first. The resulting slurry is fed from raw material feeding head 10 of nonwoven fabric manufacturing apparatus 1 onto support 11 of a web-forming conveyor and is allowed to deposit on support 11. Support 11 may be composed of, for example, a wire mesh, a blanket, etc. The slurry deposited on support 11 is moderately dehydrated with two suction boxes 12 to form moisture-containing web 20. Next, web 20 is passed between two nozzles 13 arranged above support 11 and two suction boxes 13 arranged at the opposite side of support 11 from nozzles 13 to subject the web to a hydroentangling treatment. In the present invention, the water streams injected from nozzles 13 have a specific energy as described above.

[0032] FIG. 2 is a perspective view illustrating an example of injecting water from nozzle 13 onto web 20. Nozzle 13 injects a plurality of water streams 31 aligned in the width direction (CD) of web 20 toward web 20 on support 11. As a result, a plurality of grooves 22 aligned in the width direction of web 20 and extending in the longitudinal direction or machine direction (MD) is formed on the upper surface of web 20. Further, upon impingement of water streams on web 20, grooves 22 are formed on web 22 as described above, and the fibers in web 20, especially regenerated cellulose

fibers, are entangled with each other, and thereby improves the wet strength of web 20.

[0033] FIG. 3 schematically illustrates an example of nozzle holes provided in nozzle 13. Nozzle holes 121 of nozzle 13 are arranged, for example, in a row in the width direction (CD) of web 20. Nozzle 13 preferably has a hole diameter of 90 to 150 μm. If the hole diameter of nozzle 13 is smaller than 90 μm, the nozzle is more likely to be clogged. Further, if the hole diameter of nozzle 13 is larger than 150 μm, the processing efficiency may be decreased. Nozzle 13 preferably has a hole pitch (distance between the centers of the adjacent holes) of 0.5 to 1.0 mm. A hole pitch of nozzle 13 which is narrower than 0.5 mm may lead to a decrease in pressure resistance of the nozzle, resulting in the breakage of the nozzle. Moreover, a hole pitch of nozzle 13 which is wider than 1.0 mm may lead to insufficient entanglement among fibers. The distance between the tip of nozzle 13 and the upper surface of web 20 is preferably 10 to 20 mm. If the distance between the tip of nozzle 13 and the upper surface of web 20 is smaller than 10 mm, bounced fibers are more likely to adhere to the nozzle tip, and thereby entanglement failure may be more likely to occur. If the distance between the tip of nozzle 13 and the upper surface of web 20 is greater than 20 mm, the water stream energy may be decreased, and consequently the water stream cannot penetrate into the fiber web, resulting in entanglement failure.

[0034] Water streams 31 injected from the nozzle toward web 20 preferably has an energy of 0.05 to 0.1 kWh/kg. This energy is represented by a value converted into an amount per 1 kg of dry weight of the web treated by the water streams. A person with ordinary skill in the art can determine the energy of the water streams, based on the injection pressure at the nozzle tip, the injection rate of the nozzle, the processing speed of the web, the width and basis weight of the web, etc.

[0035] When the energy of the water streams is lower than 0.05 kWh/kg, it is difficult to obtain a water-disintegrable nonwoven fabric having a sufficient wet tensile strength at the time of use. If the energy of the water streams is greater than 0.1 kWh/kg, the resulting nonwoven fabric is too rigid, and therefore it is difficult for the nonwoven fabric to pass the disintegrability test of JIS P 4501:1993, and such a nonwoven fabric also have poor skin touch feeling and softness.

[0036] The principle of entanglement of the fibers in web 21 and the principle of forming a concave-convex structure having fine ridges and grooves on the upper surface of web 20 will be described with referring to FIG. 4, but should not be construed as limiting the present invention. As shown in FIG. 4, when nozzle 13 injects a water stream 31, water stream 31 passes through support 11. As a result, the fibers in web 20 are drawn around portion 42 where water stream 31 passes through the support 11. Consequently, the fibers in web 20 gather toward portion 32 where water stream 31 passes through support 11, and the fibers are entangled with each other. The entanglement of the fibers in web 20 increases the strength of web 20, thus enabling an increase in wet strength thereof, without adding a binder or paper strengthening agent to the slurry. Moreover, a concave-convex structure having fine ridges and grooves is formed on the upper surface of web 20 by the water streams. The concavo-convex structure having the fine ridges and grooves is retained even after web 20 is dried, and consequently a nonwoven fabric having a fine concave-convex structure on a surface thereof is obtained.

[0037] In the concave-convex structure described above, the pitch of the ridges (or the grooves) can be optionally adjusted based on the pitch of nozzles 13 of the nonwoven fabric manufacturing apparatus. In view of ease of formation, wiping properties of wet tissues, etc., the pitch of the ridges (or grooves) is preferably 0.5 to 1.0 mm. In the concave-convex structure, the height of the tops of the ridges and the height of the bottoms of the grooves can be optionally adjusted by the pressure of water injected from the nozzle, etc., but the difference between the height of the tops of the ridges and the height of the bottoms of the grooves is preferably 0.10 mm or more, and more preferably 0.15 to 0.40 mm, in view of wiping properties. The height of the top of the ridges and the height of the bottoms of the grooves are measured with a laser displacement gauge. Examples of the laser displacement system include a high-precision two-dimensional laser displacement gauge LJ-G series (model: LJ-G 030) manufactured by Keyence Corporation.

[0038] FIG. 5 shows a cross section of web 20 in the width direction at a position (position indicated by reference sign 21 in FIG. 1) after passing through between two nozzles 13 and two suction boxes 13. A concave-convex structure having fine ridges and grooves is formed on the upper surface of web 20 by the water streams.

[0039] The web treated by the water streams is then transferred to the first transfer conveyor 15 by suction pickup 14, as shown in FIG. 1. Web 20 is then transferred to the second transfer conveyor 16, and then transferred to the heated cylindrical surface of dryer 17. Dryer 17 can be, for example, a Yankee dryer. Web 20 is dried to a predetermined moisture content with dryer 17. The heating temperature may be, for example, from about 120°C to about 160°C. The dried web 20 is then wound up as a nonwoven fabric by winder 18. The fiber composition, basis weight, etc., of the nonwoven fabric can be adjusted in the manufacture thereof by adjusting the composition of the raw material and the feed rate of the raw material.

[0040] By cutting the nonwoven raw fabric produced as described above to a predetermined size depending on its application, the nonwoven fabric can be suitably used as a wiping article such as a wet tissue, a cleaning wipe, etc., or a top sheet of a sanitary article such as a disposable diaper, a sanitary napkin, etc. When the water-disintegrable nonwoven fabric of the present invention is used as, for example, a wet tissue, the nonwoven raw fabric is cut to a desired size, and the cut sheet is folded over itself and is impregnated with a chemical liquid to complete a wet tissue. The water-disintegrable nonwoven fabric of the present invention can be flushed in water in a flush toilet, etc., after use.

[0041] The above explanation is merely an example of the present invention, and the present invention is not limited

to the above embodiments.

EXAMPLES

[0042] Hereinafter, the present invention will be described in more detail based on examples, but it should be understood that the present invention is not construed as being limited thereto.

[0043] In Examples and Comparative Examples, basis weight, wet tensile strength and water disintegrability were determined by the following methods.

[Basis Weight]

[0044] The basis weight was determined by cutting out ten test strips having a size of 10 cm × 10 cm from the resulting nonwoven raw fabric, measuring the weight of each test strip, calculating a basis weight for each test strip by dividing its weight by its area, and determining an average value for ten measurements.

[Wet Tensile Strength]

[0045] The wet tensile strength was measured in accordance with "7.1 General method" of JIS P 8135:1998, "Paper and board - Wet tensile strength test method", except for the following differences.

[0046] Difference: From the resulting nonwoven raw fabric, test strips of 25 mm width × 150 mm length, having a lengthwise direction which corresponds to the machine direction of the raw fabric and test strips of 25 mm width × 150 mm length, having a lengthwise direction which corresponds to the width direction of the raw fabric are cut out. These test strips are immersed in distilled water at a weight ratio of 250 wt%, and then the test strips are allowed to stand on a wire net for one minute. Subsequently, each test strip is set in a Tensilon type tensile tester at a chuck interval of 100 mm and is stretched at a tensile speed of 100 mm/min to measure the tensile strength (N) at break thereof, under conditions of a temperature of 20 °C and a relative humidity of 65%. For three test strips in each of machine and width directions, an average value of tensile strengths was determined as the wet tensile strength in each of machine and width directions. The wet tensile strength was measured using Autograph, AGS-1kNG manufactured by Shimadzu Corporation, as the tensile testing machine.

[Water Disintegrability]

[0047] Water-disintegrability was evaluated in accordance with the disintegrability test of JIS P 4501:1993, "Toilet Paper". Specifically, test strips having a size of 114 mm × 114 mm were prepared by cutting them out from the resulting nonwoven raw fabric. The test conditions were at a temperature of 20°C and a relative humidity of 65%. A 300 mL beaker containing 300 mL of water (water temperature: 20°C) was placed on a magnetic stirrer (Stirrer TTP for paper disintegrability test manufactured by AS ONE Corporation), the rotational speed of rotor was adjusted to 600 rpm, a test strip described above was charged into water, and a stopwatch was activated. After the rotation speed of the rotor once decreased due to the resistance of the test strip, the rotation speed of the rotor increased as the progress of disintegration of the test strip, and the stopwatch was deactivated when the rotation speed was recovered to 540 rpm and that time was measured in seconds. The test was carried out five times, and the results of disintegrability was expressed by the average value for the five tests. The shorter the measurement time, the higher the disintegrability of the nonwoven fabric. When the rotation speed did not recover to 540 rpm even after the measurement time exceeded 300 seconds, the measurement was interrupted and the result was expressed as "300>".

[0048] Hereinafter, a method for producing a nonwoven fabric of Examples and Comparative Examples will be described.

<Example 1>

[0049] A nonwoven fabric of Example 1 was produced using nonwoven fabric manufacturing apparatus 1 according to one embodiment illustrated in FIG. 1. A raw material slurry containing 80 wt% of a unbeaten softwood bleached kraft pulp (NBKP, CSF: 770 mL) and 20 wt% by of a rayon fiber (fiber length: 3 mm, fineness: 0.3 dtex, Corona manufactured by Daiwabo Rayon Co., Ltd.) was prepared. Then, the slurry was fed onto a web-forming belt (OS 80 manufactured by Nippon Filcon Co., Ltd.) using a raw material head, and the slurry deposited on the web-forming belt was dehydrated by suction boxes to form a web. The moisture content of the web at this time was 80%. Thereafter, water streams having an equal energy were injected from two nozzles toward the web. Each nozzle had a nozzle hole diameter of 92 μm and a nozzle hole pitch of 0.5 mm, the injection pressure at the nozzle tip was 30 kg/cm^2, and the distance between the nozzle tip and the upper surface of the web was 20 mm. The transport speed (web speed) of the web was 80 m/min.

Next, the web was transferred to the first transfer conveyor 15 by suction pickup, and is then transferred to the second transfer conveyor from the first transfer conveyor, and subsequently the web was transferred to the cylindrical surface, which was heated to 120°C, of a Yankee dryer to dry the web. The dried web was then wound up as a nonwoven fabric by a winder.

[0050] For the nozzles used in Example 1 and Examples 2 to 9 and Comparative Examples 1 to 3 described later, the energy E (kWh/kg) of the water streams injected from one nozzle was calculated according to formula (1) shown below, and the calculated energies are listed as hydroentangling treatment energy per one pass in Table 1 below. For the nonwoven fabrics of Examples 2 to 9 and Comparative Examples 1 to 3, the hydroentangling treatment energy was determined in the same manner as in Example 1 and shown in Table 1.

$$E\left(\frac{kWh}{kg}\right) = 1.63 \times \frac{Injection\ pressure\left(\frac{kgf}{cm^2}\right) \times Injection\ rate\left(\frac{m^3}{min.}\right)}{Processing\ speed\left(\frac{m}{min.}\right) \times Sheet\ width(m) \times Basis\ weight\left(\frac{g}{m^2}\right)} \quad (1)$$

where

$$Injection\ rate\left(\frac{m^3}{min.}\right) = 750 \times Orifice\ opening\ total\ area\ (m^2) \times \left(Injection\ pressure\left(\frac{kgf}{cm^2}\right)\right)^{0.495}.$$

<Example 2>

[0051] A nonwoven fabric was prepared in the same manner as in Example 1, except that the fiber length of the rayon fiber was 4 mm.

<Example 3>

[0052] A nonwoven fabric was prepared in the same manner as in Example 1, except that the amount of the rayon fiber was 15 wt% based on the total amount of the pulp and the rayon fiber.

<Example 4>

[0053] A nonwoven fabric was prepared in the same manner as in Example 1, except that the amount of the rayon fiber was 30 wt% based on the total amount of the pulp and the rayon fiber.

<Example 5>

[0054] The nonwoven fabric of Example 5 was prepared in the same manner as in Example 1, except that it had a basis weight of 35 g/m^2.

<Example 6>

[0055] The nonwoven fabric of Example 6 was prepared in the same manner as in Example 1, except that it had a basis weight of 50 g/m^2.

<Example 7>

[0056] A nonwoven fabric was prepared in the same manner as in Example 1, except that a blend of a unbeaten softwood bleached kraft pulp (NBKP, CSF: 770 mL) and a beaten softwood bleached kraft pulp (NBKP, CSF: 600 mL)

at a weight ratio of 50:50 was used as pulp.

<Example 8>

[0057] A nonwoven fabric was prepared in the same manner as in Example 1, except that the hydroentangling treatment energy per one pass was 0.05254 kWh/kg.

<Example 9>

[0058] A nonwoven fabric was prepared in the same manner as in Example 1, except that the hydroentangling treatment energy per one pass was 0.09397 kWh/kg.

<Comparative Example 1>

[0059] A nonwoven fabric was prepared in accordance with Example 1 of Japanese Patent No. 3129192. Specifically, a mixture of 70 wt% of a rayon fiber having a fiber length of 7 mm and a fineness of 1.5 denier and 30 wt% of a beaten softwood bleached kraft pulp fiber with a CSF of 200 mL was subjected to papermaking at a concentration of 0.2% with a laboratory hand-making machine to form a 25 cm $\times$ 25 cm web having a basis weight of 50 g/m^2, and the web was dried to a moisture content of 4%. The resulting web was placed on a transport conveyor comprised of a 25 mesh plain weave wire netting , and a high-pressure water jet stream was injected to the web at a water pressure of 35 kg/cm^2 using three rows of high-pressure water jet stream injecting devices in which nozzle holes having a hole diameter of 0.1 mm were arranged in a zigzag manner at an interval of 0.64 mm so that the water jet streams penetrate through the web from the top surface to the rear surface, while conveying the web at a speed of 15 m/min.
Subsequently, it was dried with a hot air dryer at a temperature of 150°C to obtain a water-disintegrable nonwoven fabric.

<Comparative Example 2>

[0060] A nonwoven fabric was prepared in the same manner as in Example 1, except that the fiber length and the fineness of the rayon fiber were 4 mm and 0.7 dtex, respectively.

<Comparative Example 3>

[0061] A nonwoven fabric was prepared in the same manner as in Comparative Example 2, except that the hydroentangling treatment energy per one pass was 0.18793 kWh/kg.

Table 1

		Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Comp. Ex. 1	Comp. Ex. 2	Com. Ex. 3
Pulp	NBKP (CSF 770 cc)	80%	80%	85%	70%	80%	80%	40%	80%	80%	-	80%	80%
	NBKP (CSF 600 cc)	-	-	-	-	-	-	40%	-	-	-	-	-
	NBKP (CSF 200 cc)	-	-	-	-	-	-	-	-	-	30%	-	-
Rayon	3 mm × 0.3 dtex	-	-	-	-	-	-	-	-	-	-	-	-
	4mmx 0.3 dtex	20%	-	15%	30%	20%	20%	20%	20%	20%	-	-	-
	4mmx 0.7 dtex	-	20%	-	-	-	-	-	-	-	-	20%	20%
	7 mm × 1.7 dtex	-	-	-	-	-	-	-	-	-	70%	-	-
Hydroentangling treatment energy per one pass (kWh/kg)		0.08757	0.08757	0.08757	0.08757	0.08757	0.08757	0.08757	0.05254	0.09397	0.3050	0.08757	0.18793
Basis weight (g/m^2)		45.0	45.0	45.0	45.0	35.0	50.0	45.0	45.0	45.0	50.0	45.0	45.0
Wet tensile strength (N/25 mm)	MD	1.45	1.60	1.27	1.59	1.23	1.63	1.65	1.31	1.48	4.55	0.83	1.34
	CD	1.38	1.57	1.22	1.60	1.21	1.66	1.66	1.22	1.51	4.12	0.77	1.29
Water-disintegrability (s)		68	91	60	94	52	92	77	53	95	300>	77	300>

[0062] Table 1 shows that, with regard to the nonwoven fabrics of Examples 1 to 9, a wet tissue had a tensile strength of 1.2 N/25 mm or greater in the machine direction and the cross-machine direction, and a disintegrability within 100 seconds, and therefore achieved superior wet tensile strength and water-disintegrability. Further, the nonwoven fabrics prepared in Examples 1 to 9 had a concave-convex structure with ridges and grooves on one side thereof, and exhibited excellent wiping properties. Comparative Example 1 according to Example 1 described in Japanese Patent No. 3129192 had a wet tensile strength greater than Example 1, but had a water-disintegrability of "300>", and therefore was hard to disintegrate. Comparative Example 2 had a water-disintegrability comparable to Example 7, but had an insufficient wet tensile strength. Comparative Example 3 had a wet tensile strength greater than Example 1, as in Comparative Example 1, but had a water-disintegrability of "300>", and therefore was hard to disintegrate.

INDUSTRIAL APPLICABILITY

[0063] The water-disintegrable nonwoven fabric of the present invention has sufficient wet tensile strength at the time of use and is capable of being flushed in water after use, and therefore it can be suitably used as a wiping article such as a wet tissue, a cleaning wipe, etc., or a top sheet of a sanitary article such as a disposable diaper, a sanitary napkin, etc.

[Explanation of Symbols]

[0064]

1 Nonwoven fabric manufacturing apparatus
10 Raw material feeding head
11 Support
12 Suction box
13 Nozzle
14 Suction pickup
15 First transfer conveyor
16 Second transfer conveyor
17 Dryer
18 Winder
20 Web

Claims

1. A nonwoven fabric comprising 15 to 30 wt% of regenerated cellulose fibers having a fiber length of 3 to 4 mm and a fineness of 0.3 dtex or less and 70 to 85 wt% of pulp, having a basis weight of 35 to 50 g/m^2, having a disintegrability within 100 sec. as measured in accordance with JIS P 4501:1993, and having a wet tensile strength of 1.2 N/25 mm or greater.

2. The laminated nonwoven fabric according to claim 1, wherein the regenerated cellulose fibers has a fineness of 0.1 to 0.3 dtex.

3. A process for producing the water-disintegrable nonwoven fabric according to claim 1, comprising:

   (A) subjecting a slurry comprising regenerated cellulose fibers having a fiber length of 3 to 4 mm and a fineness of 0.3 dtex or less and pulp at a weight ratio of 15:85 to 30:70 to wet papermaking at a fiber basis weight of 35 to 50 g/m^2,
   (B) subjecting the web obtained in step (A) to a hydroentangling treatment with an energy of 0.05 kWh/kg to 0.1 kWh/kg to entangle fibers with each other, and
   (C) drying the web subjected to the hydroentangling treatment.

FIG. 1

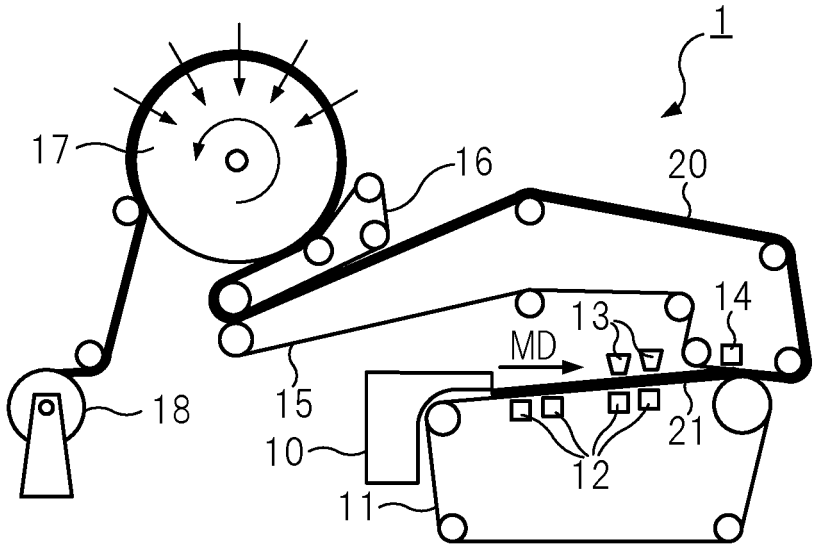


FIG. 2

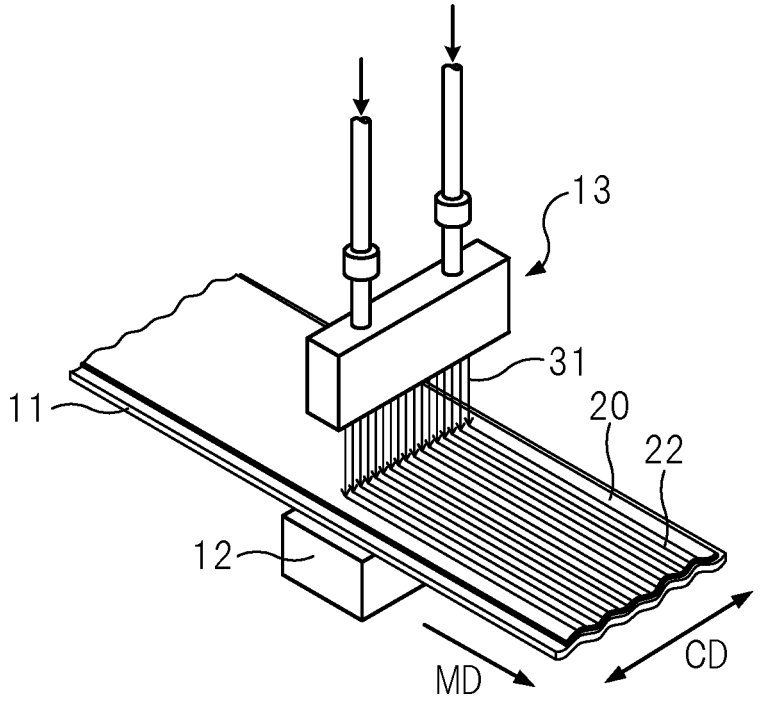


FIG. 3

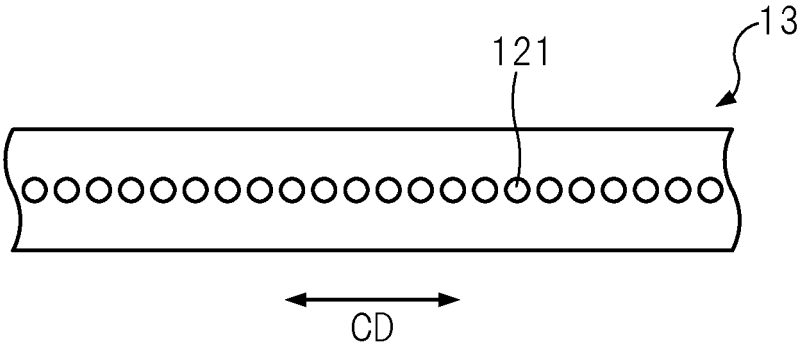


FIG. 4

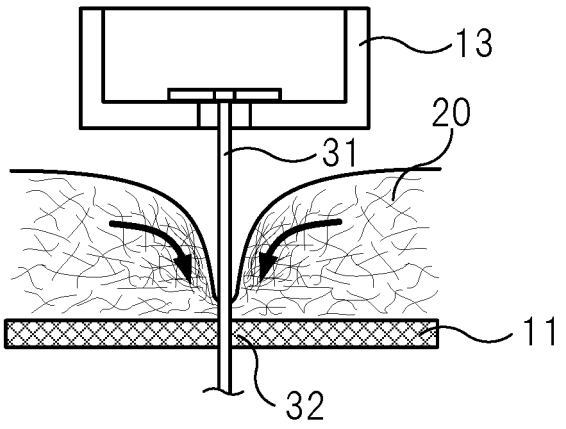
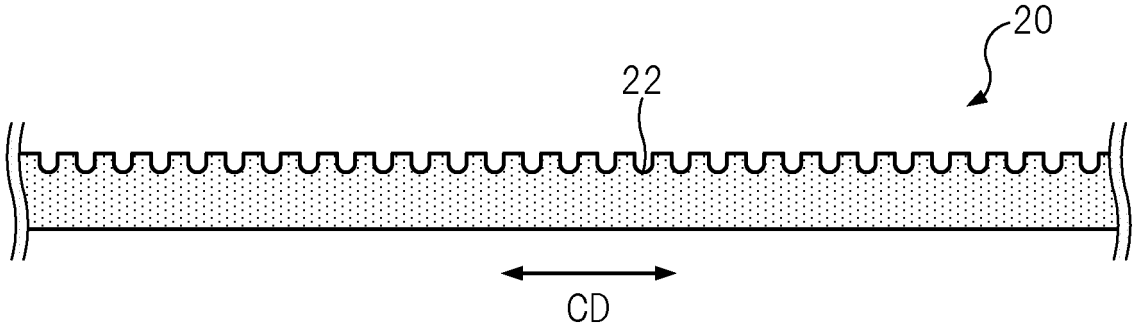


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/084667

A. CLASSIFICATION OF SUBJECT MATTER
D04H1/26(2012.01)i, *D04H1/28*(2012.01)i, *D04H1/492*(2012.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D04H1/00-18/04, D21H11/00-27/42

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
JSTPlus/JST7580/JSTChina(JDreamIII), Japio-GPG/FX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2001-200459 A (Mitsubishi Paper Mills Ltd.), 27 July 2001 (27.07.2001), claims; 0013, 0035 to 0036, 0038; examples 2, 3, 9, 10 (Family: none)	1-3
A	JP 2006-2277 A (Kao Corp.), 05 January 2006 (05.01.2006), (Family: none)	1-3
A	JP 2004-509235 A (Ahlstrom Windsor Locks LLC), 25 March 2004 (25.03.2004), & WO 2002/022352 A1 & DE 60137855 D & ES 2323164 T	1-3

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
15 February 2017 (15.02.17)	28 February 2017 (28.02.17)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/084667

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-93055 A (Oji Paper Co., Ltd.), 06 April 1999 (06.04.1999), (Family: none)	1-3
A	WO 2010/090220 A1 (Uni-Charm Corp.), 12 August 2010 (12.08.2010), & US 2011/0294388 A1 & CN 102362024 A	1-3

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REFERENCES CITED IN THE DESCRIPTION

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- JP 3129192 B **[0059] [0062]**