



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
06.07.2005 Bulletin 2005/27

(51) Int Cl.7: **D04H 1/46, D04H 3/02**

(21) Application number: **04029656.8**

(22) Date of filing: **15.12.2004**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR**
Designated Extension States:
AL BA HR LV MK YU

(72) Inventors:
• **Stralin, Anders**
423 38 Torslanda (SE)
• **Rucinska, Ewa**
413 13 Göteborg (DE)
• **Strandqvist, Mikael**
437 36 Lindome (SE)

(30) Priority: **22.12.2003 SE 0303510**

(71) Applicant: **SCA Hygiene Products AB**
405 03 Göteborg (SE)

(74) Representative: **Egeröd, Lisbeth et al**
Valea AB
Lindholmospiren 5
417 56 Göteborg (SE)

(54) **Method for adding chemicals to a nonwoven material**

(57) The invention comprises a method of adding a chemical additive to a fiber web of nonwoven material comprising cellulose pulp fibers and synthetic fibers and/or filaments. A hydrojet liquid comprising the chemical additive is used in at least one hydrojet treatment

step, which comprises at least one vacuum collecting box, which hydrojet liquid is applied to the fiber web for penetrating the fiber web at a pressure of at least 5 bar but not more than 100 bar, in such a manner so that the chemical additive is penetrated into the fiber to fiber intersections of the nonwoven material.

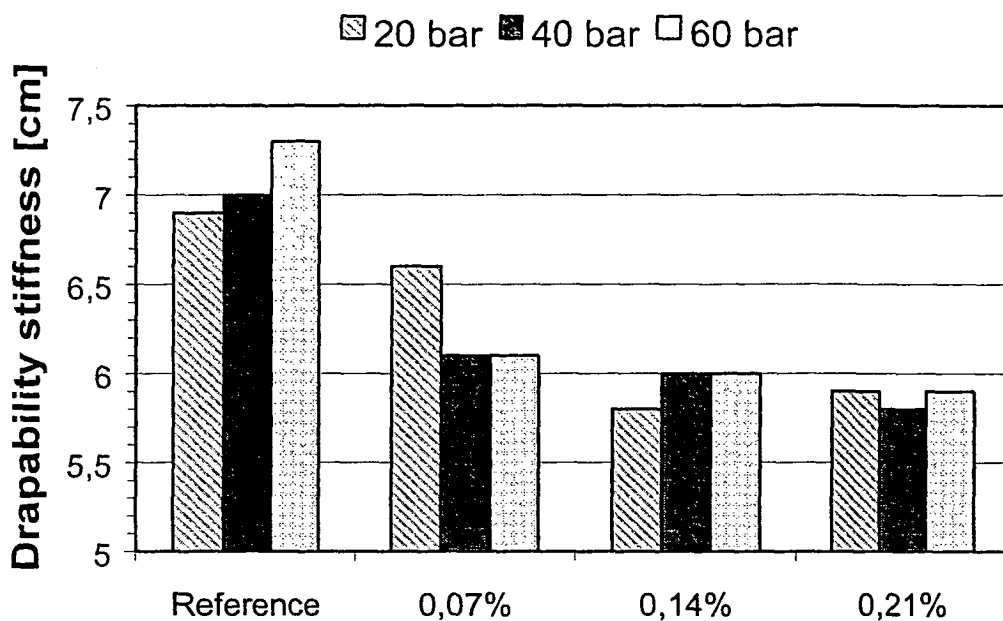


FIG. 1

Description**Technical Field**

5 **[0001]** The invention relates to a method for adding a chemical additive to a fiber web of nonwoven material comprising cellulose pulp fibers and synthetic fibers and/or filaments.

Background of the invention

10 **[0002]** Typical properties of nonwoven include the ready ability to absorb tensile stress energy, their drapability, and good textile-like flexibility, properties that are frequently referred to as bulk softness, a high surface softness, and a high specific volume with a perceptible thickness. Further desirable properties are as high a liquid absorbency as possible and, depending on the application, a suitable wet and dry strength as well as an attractive visual appearance of the outer product surface. These properties, among others, allow nonwoven to be used for example as cleaning
 15 wipes: paper or nonwoven wipe, windscreen cleaning wipe, kitchen paper, etc, sanitary products: e.g. toilet paper, paper or nonwoven handkerchiefs, household towels, towels, cosmetic wipes: facials and as serviettes or napkins just to mention some of the products that can be used.

[0003] The components and added chemicals included in nonwoven material are chosen in accordance with the intended field of use. Softening and/or debonding agents as well as wet strength agents, various lint-preventing agents and all kind of different additives are in the conventional prior art applied in the wet end of the manufacturing process. The softening or debonding agents decrease the hydrogen bonding between the fibers, resulting in higher bulk softness but also in a strength reduction. The lint-preventing agents reduce the fiber linting from the material surface and bulk. If fibers are released from the nonwoven material surface or from the bulk they will during use eventually end up on
 20 the object that is wiped, something highly undesirable in many applications.

25 **[0004]** EP-B1-0 602 881 describes a method of producing a nonwoven material with a wet strength agent added in the wet end of the process. In a first step, a fiber dispersion comprising water, fibers, and a wet strength agent is prepared. Subsequently, the fibers are formed into a web in a forming step. A hydroentanglement process step succeeds the forming step.

[0005] Many nonwoven materials are hydroentangled. Hydroentangling, or spunlacing as it is also called, is a technique introduced during the 1970'ies, see e.g. CA patent no. 841 938. The method involves forming a fiber web, which is either drylaid or wetlaid, after which the fibers are entangled by means of very fine water jets under high pressure. Several rows of water jets are directed against the fiber web, which is supported by a movable fabric or drum. The fibers are thereby subjected to a mechanically entangling and intertwining action of the fibers as to form the nonwoven web. The entangled fiber web is then dried. The fibers that are used in the nonwoven web can be synthetic or regenerated cellulose staple fibers, e.g. polyester, polyamide, polypropylene, rayon or the like, pulp fibers or mixtures of pulp
 30 fibers and staple fibers. Spunlace materials of high quality can be produced to a reasonable cost and have a high absorption capacity. They can be used as wiping materials for household or industrial use, for hygiene purposes or as disposable materials in medical care or hygiene products, etc.

[0006] One of the disadvantages of adding chemicals in the wet end of the manufacturing process is that the retention of different chemicals added in the wet end onto the fibers is generally relatively poor. Also, to be able to add chemicals in the wet end, the attraction between the fibers and the chemicals has to be strong enough to withstand the subsequent hydroentanglement. However, the low strength of the bond between the added chemical and the fiber does not withstand the hydroentanglement process step. If chemicals, such as wet strength agents, softening or debonding agents are added in the wet end, which is the case according to the conventional technique, these added chemicals will thus
 35 be flushed away due to the low strength of the attraction and consequently therefore also enriched in the hydroentanglement water.

[0007] The enriched chemicals in the hydroentanglement water cleaning system will cause a number of problems. For example, filters could be clogged, e.g. in cases of wet strength agents are added, and further it may cause stops in the production process. When for example surfactants are added, there might also be problems with foam formation, and also there is a risk that the flocks in the flocculation are broken, etc. In addition to all this, the chemical cost may be very expensive. Further, the yield and efficiency of the chemical additive is very low.

[0008] It is also common that softening agents are applied onto paper by spraying onto the surface of the material. In this case the surface is lubricated and friction between fibers at the surface and friction between the surface of the material and the hand of the user is reduced. Through US 5,484,453 it is known to spray water based treatment liquors onto textile materials, where the used liquors contain deaeration components, which are foam-free in order to thoroughly
 40 wet the textile material almost immediately. A coating process is known from EP-B1-594 983 which comprises a brush spray application method, in which the material to be treated is passed through a path of fluid spray emitted from the brush spray applicator.

[0009] When chemicals on the other hand are added after the hydroentanglement, e.g. by spraying, the smoothness of the surface will be improved, but only limited improvement of the softness as to e.g. drapability stiffness and bulk softness will be obtained. Also, only the fibers at the surface of the material will be affected.

Summary of the invention

[0010] A purpose of the invention is to reduce or remove any of the above-mentioned problems and negative effects. The present invention relates thus to a method of adding a chemical additive to a fiber web of nonwoven material comprising cellulose pulp fibers and synthetic fibers and/or filaments. The chemical additive is added to the fiber web by penetration into the fiber-to-fiber intersections in at least one hydrojet treatment step where the hydrojet liquid is applied at a pressure of at least 5 bar but not more than 100 bar. Each hydrojet treatment step may include several hydroentanglement manifolds and comprises at least one vacuum collecting box. The provided method for adding a chemical additive to a nonwoven in a hydroentanglement process enables an addition of a chemical additive without encountering the above-mentioned problems.

[0011] The hydrojet liquid comprises the chemical additive. The chemical additive is thus added to a fiber web of nonwoven material by using a high-pressure liquid, preferably water, e.g. via at least one separate hydroentanglement manifold. The hydroentanglement treatment, which is a high-pressure treatment, comprising the chemical additive according to the claimed method will be called the hydrojet treatment. The hydrojet liquid is preferably a dilute solution used in the hydrojet treatment step and the dilute solution comprises preferably water and the chemical additive. The claimed method will allow penetration of the chemicals, the chemical additive, through the whole material and will not only treat the surface of the material. Other objects and advantages of the present invention will become apparent to those skilled in the art from the following description and practice of the invention.

[0012] The chemical additive is added to give a certain desired effect in the nonwoven material. All the desired features according to the invention where one wish to enhance certain properties and get the added chemicals into the bulk will prosper from the claimed method. The invention permits the chemical additive to penetrate into the fiber-to-fiber intersections in the nonwoven material. The added chemical additive is forced into the fiber-fiber intersections by the high-pressure fluid jets, such as water jets. The high pressure water jets created by the hydrojet assembly in the hydrojet treatment will move the fibers in the material and will thus allow the chemical additive to go into the fiber to fiber intersections. The chemical additive will penetrate into and throughout the whole material and not only treat the surface.

[0013] The hydrojet liquid used in the hydrojet treatment step for penetrating the fiber web is preferably applied in an amount such that the hydrojet liquid replaces exchangeable water within the fiber web, whereby the fiber web is saturated with the hydrojet liquid comprising the chemical additive. Since the machine speeds are high it is most probable that it is the capillary water in pores and capillaries, which is exchanged. The method according to the invention results in a good retention of the chemical additive. The high retention of the chemicals added in the material has a high influence of the nonwoven material properties, such as linting as well as the softening effect of course.

[0014] The hydrojet liquid is applied in an amount corresponding to at least about 2 gram of liquid per gram of dry fiber web material weight but not more than about 10 gram of liquid per gram of dry fiber web material weight.

[0015] According to an embodiment of the invention the chemical additive is selected from one or more of the following groups of wet or dry strength agents, lint-preventing agents, copolymer dispersions, latex, debonders or softeners, or mixtures thereof. The wet strength agent can also be a temporary wet strength agent. The chemical additive can be a chemical or chemicals and of course also be a group of chemicals.

[0016] The hydrojet liquid used according to the claimed method is preferably a dilute solution comprising the chemical additive. The hydrojet liquid is applied at a pressure of at least 5 bar, preferably at least 20 bar but not more than 100 bar, preferably not more than 80 bar, more preferably not more than 60 bar and most preferably not more than 40 bar.

[0017] In order to obtain a uniform distribution of the added chemical additive throughout the web, the hydrojet liquid is preferably a dilute solution comprising the chemical additive, which is mixed with water before it penetrates the fiber web. The nonwoven material is preferably hydroentangled with a dilute solution of the chemical additive.

[0018] In the embodiment where the chemical additive comprises a softening agent, penetration is especially desirable since the bulk properties are enhanced as the hydrogen bonds at the fiber-fiber intersections are broken in the material or at least softened or loosened up by the softening chemicals. Decreasing or reducing the inter-fiber bonding within the web when the nonwoven web comprises cellulose fibers to a certain degree can thus increase the softness and bulk. But also the stiffness of the material will be lower as the softeners will influence the fibers throughout the material. Also for other chemical additives such as wet strength agents, the effect of the additives will be greater since all of the fiber to fiber intersections are treated and not only the surface of the nonwoven material web.

[0019] Wet strength agents are primarily added to reduce the linting. The expression "low linting" means a low release of fibers from a web, i.e. that a wipe, for example, does not release fibers onto the object that is wiped. Wet strength

agents can also enhance the wet strength, especially when a high content of cellulose pulp is used in the nonwoven material. The term 'wet strength' also refers to the ability of the material to maintain its integrity and function in a wet condition.

[0020] It is also worth to emphasize that the nonwoven material with its improved properties preferably could be produced in an inline process. This provides many advantages; among others that there is no need to dry the material several times, since all is done in the same process. Pressing is sometimes optional to get a smoother web, but when chemicals are added according to the claimed method, there is no need for such a pressing action. The nonwoven material web treated with softeners or debonders will already have a softer feel and therefore no pressing is needed. When there is no pressing step, the natural bulk in the material is kept, which in turn have several positive effects to absorbency, softness through bulk, drapability stiffness, the elasticity in the web, etc.

[0021] Further features of the present invention are disclosed in the description below and also in the dependent claims.

[0022] It is to be understood that the invention is not limited in its application to the details of construction and the arrangements of components set forth in the following description. The invention could be embodied in various ways.

Brief description of the drawings

[0023] Tables 1-6 show the different results from the laboratory experiments, evaluating some chemical additives.

[0024] Figures 1-2 show how the softness of nonwoven webs measured as drapability stiffness is affected when debonders are used as a chemical additive.

Detailed description of embodiments of the invention

[0025] There are many options for manufacturing a fiber web of nonwoven material to which a chemical additive could be added according to the claimed method. The synthetic component, i.e. fibers and/or filaments, can preferably be synthetic staple fibers and/or continuous filaments. Continuous filaments can preferably be laid down directly or extruded on a forming wire where they form into a web in one step. The cellulose pulp fibers alone or together with synthetic fibers are either drylaid or wetlaid. When the synthetic component comprises continuous filaments, the cellulose pulp fibers, with or without synthetic fibers, are drylaid or wetlaid in a preceding step or onto the web of continuous filaments in a subsequent step. The wetlaying step can be a conventional step or a foam-forming step. Subsequent to the forming of the fiber web of the nonwoven material comprising cellulose pulp fibers there could preferably be at least one hydroentanglement step. The formed fibrous web is hydroentangled while it is still supported by the wire. The entangling wire may optionally be patterned in order to form a patterned nonwoven material.

[0026] The filaments can be manufactured in different ways. Extruding a molten polymer through a spinneret to form discrete filaments produces spunlaid fibers. Subsequently, the filaments are cooled and stretched out to an appropriate diameter in a mechanic or pneumatic way so that they form a fiber web of continuous filaments. The fiber diameter is usually above 10 μm , e.g. between 10 and 100 μm . Meltblown fibers are formed by means of meltblown equipment, for example of the kind shown in the US patents 3,849,241 or 4,048,364. The method shortly involves that a polymer melt is extruded through a nozzle in very fine streams. When the polymer melt discharges from the nozzle, it is stretched out into thin, continuous filaments by means of converging air streams in a high-pressure fluid, such as hot air or vapor, which are directed towards the polymer streams. The fibers can be microfibers or macrofibers depending on their dimension. Microfibers have a diameter of up to 20 μm . The extrusion method can thus be carried out, for example, by means of a meltblowing or spunbonding technique.

[0027] According to one embodiment of the invention the cellulose pulp fiber fraction is laid on top of the continuous filaments as an aqueous or a foamed fibrous dispersion from a head box. In wetlaying technique the fibers are dispersed in water and the fiber dispersion is dewatered on a forming fabric to form a wetlaid fibrous web. Foam forming is an alternative to the wetforming of the fiber web. In foam forming, a foam forming surfactant is added to the fiber dispersion, hereafter the fiber dispersion is dewatered on a wire in corresponding way as in wetforming. A foamformed fibrous web has a very uniform fiber formation; the foam forming technique is described in for example WO 96/02701, GB 1,329,409, US 4,443,297 and EP-A-0938 601.

[0028] The nonwoven material can use different fibers in various mixing proportions. The synthetic fibers and/or filaments used in the nonwoven material can be fibers such as e.g. polyester, polypropylene, polyamide, polyethylene, and polylactides. Copolymers of these polymers may of course also be used, as well as natural polymers with thermoplastic properties. Further the nonwoven material can be formed of rayon, lyocell etc, but also of natural fibers, such as cellulose or cotton fibers, or a mix of different fibers. The synthetic component may be continuous filaments in the form of meltblown and/or spunbond fibers, or prefabricated fibers of a finite length, as synthetic fibers produced in situ or in the form of staple fibers. As an alternative to synthetic fibers, natural fibers with a long fiber length can be used, e.g. above 12 mm, such as seed hair fibers, e.g. cotton, kapok and milkweed; leaf fibers, e.g. sisal, abaca, pineapple,

New Zealand hamp, or bast fibers, e.g. flax, hemp, ramie, jute, kenaf. Varying fiber lengths can be used.

[0029] Cellulose pulp fibers that can be used in accordance with the invention may be of any kind available. Some of the conventional available chemical pulps may be sulphite, sulphate or organosolve pulp. Mechanical cellulose pulp can be grinded, refined, thermo-mechanical, high thermo-mechanical, chemi-mechanical and so on. The pulp may be of any kind: coniferous, deciduous or any other alternative source of cellulose fibers or the like. Another important pulp source is recycled fibers, both from internal rejects and brokes as well as from external recycled fibers.

[0030] The fiber web of nonwoven material to which a chemical additive is added according to the invention may thus use any synthetic fibers. Further, fibers of many different kinds and in different mixing proportions of varying fiber lengths can be used for making the wetlaid, drylaid or foam formed fibrous web. Cellulose pulp fibers, synthetic fibers or mixtures thereof can be used.

[0031] Many spunlace nonwoven materials today consist of synthetic fibers and/or filaments and pulp. The nonwoven material hydrojet treated according to the invention, comprises cellulose pulp fibers and synthetic fibers and/or filaments. The cellulose pulp makes the material cheaper to produce since synthetic fibers are expensive. Further, the pulp may be necessary in order to be able to reach the right material properties depending on the manufacturing process. In one preferred embodiment the fiber web comprises at least about 20% dry weight of cellulose fibers. There is a visible and clear change in the nonwoven product when the cellulose pulp reaches and exceeds the amount of about 20% by dry weight. The cellulose pulp contributes with absorbent properties to the material, but it also makes the material stiffer mainly due to the strong hydrogen bonding. The fibers in the cellulose pulp fills up the holes in the network and thereby contributes to the strength and the integrity and opacity of a much more solid material, however it also makes the problem with linting much bigger.

[0032] The softeners and/or debonders used according to an embodiment of the invention could be any of the commercially available softeners and/or debonders. Examples of often used softeners and/or debonders are chemicals containing one or more substances such as cationic and/or nonionic surfactants, quaternary ammonium compounds, polyhydroxy compounds and imidazolinium quaternary compounds, polysiloxanes, or mixtures thereof.

[0033] The strength of tissue paper consisting mainly of cellulose fibers depends very much on the fiber-to-fiber bond. Therefore, when a material with cellulose pulp fibers is treated with softeners or debonders, the fiber-to-fiber hydrogen bonding of the cellulose pulp fibers is reduced and higher bulk softness is obtained at the same time as the material tends to lose some or even much of its original strength which may adversely affect the strength of the product. However, the strength in spunlace nonwoven materials depend more on the hydroentanglement of the pulp and the synthetic staple fibers and/or the continuous filaments. The strength is of course also highly dependent of any continuous filaments in the spunlace nonwoven material, which have a reinforcement effect of the material. The effect on strength reduction by a debonding or softening agent is thus less in a nonwoven material, especially in a spunlace nonwoven material compared with tissue paper manufactured in a conventional paper machine. Therefore, the chemical treatments to improve softness and bulk have a great potential in nonwoven materials and especially in spunlace nonwoven materials.

[0034] The lint-preventing agent refers to an agent, such as the wet strength agent, which prevents linting of the nonwoven material, i.e. fiber linting from the material surface and bulk. One way of avoiding this is to add a substance that forms a fiber network with itself around the fibers. This fiber network prevents fiber linting. Another way is to add a substance, which is capable of reacting with functional groups on the fibers, and to form bonds between the fibers in this way. Some examples of wet strength agents can be given in the following group of chemicals: poly(amido-amine)-epichlorohydrin (PAE), polyacrylamides, styrene-butadiene lattices; insolubilized polyvinyl alcohol; ureaformaldehyde; polyethyleneimine; chitosan polymers and mixtures thereof. Other examples are glyoxylated polyacrylic amide (GPAM) and carboxymethyl cellulose (CMC), or mixtures thereof. Some of the temporary wet strength agents may be chosen from the group of dialdehyde starch or other resins with aldehyde functionality.

[0035] According to a preferred embodiment there could be several hydrojet process steps as well as each hydrojet step include several hydroentanglement manifolds. In one preferred embodiment there are one or more hydroentanglement steps of which at least one precedes the hydrojet treatment step in which the penetration of the fiber web with the hydrojet liquid comprising the chemical additive takes place. In one embodiment, there is one or more hydroentanglement step of which there is one main hydroentanglement step, which in turn comprises one or more hydroentanglement steps, and that the penetration of the fiber web with the hydrojet liquid comprising the chemical additive takes place in a hydrojet treatment step subsequent to the main hydroentanglement step. There may also be a dewatering step between the preceding hydroentanglement step or steps and the subsequent hydrojet treatment step. Further, there is at least one vacuum collecting box under the wire carrying the fiber web for the hydrojet step including the chemical additive so that the hydrojet liquid may have a separate loop and its own hydrojet liquid recirculation.

[0036] According to an alternative embodiment of the invention, the fiber web is corona-treated after the hydroentanglement step as a post treatment step. This is done in order to increase the liquid absorption capacity of the nonwoven material, and in order to further increase the wet strength of the material.

[0037] There are many ways to characterize softness. There is for example a relation between the softness and the

measured values of the bulk, the drapability stiffness and also the tensile stiffness. To measure the parameters of the bulk, the drapability stiffness and the tensile stiffness have therefore been considered important when the softness is to be characterized. The effect of the softness has been evaluated in Example 1. The effect of a wet-linting agent is evaluated in Example 2.

Examples

[0038] A wetlaid spunlace material was used in the examples that comprised about 40% short cut polyester staple fibers 1.7 dtex, 19 mm long and about 60% pulp with a basis weight of about 87 g/m². The hydrojet treatment was made in laboratory equipment comprising a hydroentanglement device on the inside of the rotating drum, dewatered by vacuum. The hydroentanglement was performed by one row hydroentanglement strip with holes of 120 µm in diameter and a hole-to-hole distance of 0.6 mm at a speed of about 140 m/min.

[0039] The spunlace material was wet before the hydrojet treatment and contained an amount of water before as well as after the treatment that was about 3 g/g, i.e. gram of water/gram of dry fiber web weight. The hydrojet pressure was 20, 40 and 60 bar. The spunlace material was saturated with a corresponding amount of hydrojet liquid of about 3, 4 and 4.8 gram water per gram dry fiber material weight. Thereby the hydrojet liquid used in the hydrojet assembly for penetrating the fiber web was applied in an amount such that an exchange and saturation of the hydrojet liquid comprising the chemical additive took place in the fiber web as the exchangeable water within the fiber web was replaced. In an industrial process the amount of water in the fiber web before and after this treatment could be between 2 and about 4 or 5 g water/g dry fiber material weight. Therefore, the hydrojet liquid was applied in an amount corresponding to at least about 2 gram of water per gram of dry fiber material weight but not more than about 10 gram of water per gram of dry fiber material weight.

[0040] The wetlaid nonwoven material is preferably hydroentangled with a dilute solution of functional chemicals. As a reference to the examples a wetlaid spunlace nonwoven material was hydrojet treated with pure water. Further, there is also a wet end addition as a comparison in the first example. Also, in the second example there is another comparative reference where the chemical additive has been sprayed upon the surface of the material.

[0041] The methods used for the different measurements should be well known to the skilled person. Therefore, the test methods will be described only briefly in the following description.

[0042] The method for determining the drapability stiffness is based on Edana, 50.2-80. A rectangular shaped test specimen is cut from the nonwoven material and will be bent under its own weight to a specific angle. The test specimen is brought over the edge of a measuring instrument and the length of the material will be determined as the intersecting point of the test specimen and an imagined sloped plane of a specific angle is reached.

[0043] The method for determining the tensile stiffness is based on SCAN-P 44:81. Tensile stiffness was calculated from the stress/strain-data recorded in the dry strength measurements by means of the following formula:

$$St = \frac{\Delta F}{\Delta \epsilon} \cdot \frac{1}{W}$$

Where

St = tensile stiffness, N/m

F = tensile force, N

E = elongation in %

W = sample specimen width, m

The Tensile stiffness index $\sqrt{MD \times CD}$ shown in Table 2 was calculated by means of the formula:

$$(\sqrt{(\text{tensile stiffness MD} \times \text{tensile stiffness CD})}) / \text{basis weight.}$$

The MD and CD stands for machine and cross direction respectively.

[0044] The wet linting measurements on the different samples were performed on dried nonwoven material samples by means of a method called "Bi-axial Shake Linting". This method is based on Standard Test Method IST 160:2 (95) (Aqueous Method for Determining Release of Particles) and is suitable for determining the linting level of nonwoven materials in a wet state. A test specimen is cut from the nonwoven material and is placed in water at the bottom of the container below the water surface. The plastic container is placed on bi-axial shaking table where it is subjected to shaking. Fibers and particles (>20 µm), which are present in the water, are counted. The results are reported as particles/cm² material, wherein the surface area includes both sides of the test specimen.

Example 1a

[0045] In Example 1, two different softening agents which enhances bulk softness and surface smoothness were evaluated, Berocell 589 and XP 7026 supplied by Eka Chemicals. The Berocell 589 is an additive in the manufacture of fluff pulp and is a mixture of cationic and nonionic surfactants and comprises alkyl-benzyl-dimethyl ammonium chloride and fatty alcohol ethoxylate. XP 7026 is a softener for tissue and also a mixture of cationic and nonionic surfactants and comprises benzyl-dimethylammonium chloride. The concentration of the softening agents in the hydroentanglement water was 0.07%, 0.14% and 0.21% by volume. This would result in a corresponding concentration of about maximum 0.2%, 0.4% and 0.6% by weight in the fiber material, if a complete exchange to the hydrojet liquid occurs.

[0046] As the spunlace materials were treated with a softening agent, the experience of a much softer material in the hand was obtained. Softness in relation to the drapability stiffness and the tensile stiffness can be seen in the Tables 1-3 below and in Figures 1-2.

Sample	Max. Chem. Conc. of Berocell 589 [%]	Drapability stiffness Sqr root (MDCD) [cm]		
		20 bar	40 bar	60 bar
Reference	None	6.9	7	7.3
Berocell 0.07	0.2	6.6	6.1	6.1
Berocell 0.14	0.4	5.8	6	6
Berocell 0.21	0.6	5.9	5.8	5.9

Table 1. Drapability Stiffness Sqr root (MDCD) [cm] measured at different hydrojet pressures with the chemical additive being Berocell 589 added at the hydrojet process step.

Sample	Max. Chem. Conc. of Berocell 589 [%]	Tensile stiffness [Nm/g]		
		20 bar	40 bar	60 bar
Reference	None	137	125	112
Berocell 0.07	0.2	108	95	90
Berocell 0.14	0.4	94	74	92
Berocell 0.21	0.6	93	75	98

Table 2. Tensile Stiffness index [Nm/g] measured at different hydrojet pressures with the chemical additive as Berocell 589 added at the hydrojet process step.

Sample	Max. Chem. Conc. of XP 7026 [%]	Drapability stiffness Sqr root (MDCD) [cm]		
		20 bar	40 bar	60 bar
Reference	None	6.9	7	7.3
XP 7026 0.07	0.2	5.9	5.7	6
XP 7026 0.14	0.4	5.6	5.7	5.8
XP 7026 0.21	0.6	5.3	5.4	5.6

Table 3. Drapability Stiffness Sqr root (MDCD) [cm] measured at different hydrojet pressures with the chemical additive as XP 7026 was added at the hydrojet process step.

[0047] The result of drapability stiffness for the wetlaid spunlace hydrojet material treated with different softening agents is respectively shown in Figures 1-2 and Table 1 and 3 as a function of different chemical concentrations and hydrojet pressures. Figures 1 and 2 shows thus the drapability stiffness with Berocell 589 and XP 7026 respectively as a softening agent. The decreased values of the drapability stiffness (cm) as well as the decreased values of the tensile stiffness both relates to the experienced felt softness in hand, which in turn is increased. The nonwoven material usually becomes stronger and stiffer and less soft as the hydroentanglement pressure increases. With this background, it is really interesting to see the results in such a surprisingly high and until now unknown effect of the material as the chemical additive; the softening agent in this case, is added according to an embodiment of the invention, even as the hydroentanglement pressure increases.

Example 1b

[0048] In order to even more show the surprising results and effects of the method in accordance to the invention, it was also compared to results achieved by conventional technique where the chemical additive is added in the wet end.

[0049] The reference used and shown in table 4 has of course the same corresponding nonwoven material, fiber composition and basis weight as used in example 1a as well as in example 2. The reference is thus a nonwoven web with a basis weight of about 87 g/m² consisting of 60% cellulose pulp fibers and 40% polyester fibers (T-100) supplied by KOSA, 1.7 dtex, 19 mm long. The web was prepared by wet laid technology in a dynamic sheet former and subsequently bonded by hydroentanglement at high pressure of about 100 bar on both sides and about 300 kWh/ton at a speed of about 140 m/min.

[0050] For the first sample no chemical was added to the wet end or to the hydroentanglement water. In the second sample a softening agent was added to the slurry. The softening agent, Berocell 589, corresponding to 0.4% by weight on the dry weight was added in the wet end at the fiber formation to the fiber dispersion. In the third sample 0.14% of Berocell 589 in the hydroentanglement water was used in a subsequent hydrojet treatment of 40 bar to introduce the chemical into the material according to an embodiment of the inventive method.

[0051] As shown by the results in Table 4 below, no major effect of the softening effect in the nonwoven material was obtained as the sample was treated with the softening agent in the wet end compared to the reference, which have no addition of a softening agent. The subsequent hydroentanglement treatment obviously flushed out the chemical additive added in the wet end and therefore no real effect was obtained. However, it is obvious that when the chemical additive is added at the hydrojet treatment step, the values of drapability stiffness as well as the tensile stiffness representing the softening effect shows some real effect. When studying the sample that had the softening agent added at the hydrojet step, it is thus clear and obvious that the softening effects obtained effectively show distinctly lower values of both drapability stiffness as well as tensile stiffness.

Sample	Max. Chem. Conc. of Berocell 589 [%]	Drapability stiffness Sqr root (MDCD) [cm]	Tensile stiffness [Nm/g]
Reference	None	9	134
Wet end addition	0.4	8.7	130
Hydrojet addition Berocell 0.14	0.4	6.9	86

Table 4. Drapability Stiffness Sqr root (MDCD) [cm] and Tensile Stiffness index [Nm/g] measured at a hydrojet pressures of about 40 bar with the chemical additive as the softening agent Berocell 589 added at the pulp slurry in the wet end and in the hydrojet process step respectively.

Example 2

[0052] In the second example the chemical tested and evaluated was a wet strength resin, Kenores 1445, a polyamidoamine-epichlorohydrin resin (PAE), supplied by EKA chemicals.

[0053] Three different dilute solutions of the wet strength resin in the hydrojet liquid were used corresponding to 0.07%, 0.14% and 0.21% by volume. This would result in a corresponding concentration of about maximum 0.2%, 0.4% and 0.6% by weight in the material, if a complete exchange to the dilute solutions used in the hydrojet treatment

occurs. The hydrojet treatment was done at three different hydrojet pressures corresponding to 20, 40 and 60 bars.

[0054] When the spunlace nonwoven materials were treated with the wet strength resin, a significant reduction of linting was observed. The wet linting method used to characterize the linting was the bi-axial shake linting. The results of the bi-axial linting are shown for the wetlaid spunlace material hydrojet treated with Kenores 1445 wet strength resin as a function of chemical concentrations and hydroentanglement pressure.

[0055] The reference used and shown in table 5 and 6 has of course the same corresponding nonwoven material, fiber composition and basis weight as used in example 1a and 1b. As another comparison, dilute solutions of about 0,9% Kenores 1445, (PAE), were sprayed onto the corresponding spunlace nonwoven material consisting of pulp and polyester at a basis weight of about 87 g/m². The spraying nozzle was traversing over the material at constant speed. Two different spraying nozzles were used resulting in dry PAE weights corresponding 0.16 and 0.33 g/m² respectively. This corresponds to a chemical concentration in the material of about 0.19 and 0.38 % respectively. The sprayings were made onto dry as well as prewetted materials with about 2.7 g/g water on the dry weight to simulate process conditions and conditions used in the example where the wet strength agent was added with the hydrojet liquid.

Sample	Max. Chem. Conc. of Kenores 1445 [%]	Bi-Axial Shake-Linting [part/cm ²]		
		20 bar	40 bar	60 bar
Reference	None	350		
Hydrojet addition Kenores 0.07	0.2	70		
Hydrojet addition Kenores 0.14	0.4	46	49	46
Hydrojet addition Kenores 0.21	0.6	47		

Table 5. Bi-Axial Shake-linting [part/cm²] measured at different hydroentanglement pressures with the chemical additive being the wet strength agent Kenores 1445 added at the hydrojet process step.

Sample	Max. Chem. Conc. of Kenores 1445 [%]	Bi-Axial Shake-Linting [part/cm ²]	
		Spraying Dry fiber web	Spraying Wet fiber web
Reference	None	350	
Kenores sprayed	0.2	177	100
Kenores sprayed	0.4	142	73

Table 6. Bi-Axial Shake-linting [part/cm²] with the chemical additive being the wet strength agent Kenores 1445 added at a dry and wet fiber web respectively by spraying.

[0056] As shown by the results in Table 5-6, linting is reduced as material is sprayed with the wet strength resin, but the effect obtained is clearly not as high as that obtained by the method according to the invention. It is by these results evident and shown that the chemical additive has penetrated the material thoroughly by the means of the inventive method, which in turn results in some strong and positive effects also regarding the linting.

Claims

1. Method of adding a chemical additive to a fiber web of nonwoven material comprising cellulose pulp fibers and

synthetic fibers and/or filaments, **characterized in that** a hydrojet liquid comprising the chemical additive is used in at least one hydrojet treatment step, which comprises at least one vacuum collecting box, said hydrojet liquid is applied to the fiber web for penetrating the fiber web at a pressure of at least 5 bar but not more than 100 bar, in such a manner so that the chemical additive is penetrated into the fiber to fiber intersections of the nonwoven material.

2. A method according to claim 1, **characterized in that** the hydrojet liquid is applied at a pressure of preferably at least 20 bar but preferably not more than 80 bar, more preferably not more than 60 bar and most preferably not more than 40 bar.
3. A method according to any one of the preceding claims, **characterized in that** the hydrojet liquid used in the hydrojet treatment step for penetrating the fiber web is applied in an amount such that exchangeable water within the fiber web is replaced by the hydrojet liquid, whereby the fiber web is saturated with the hydrojet liquid comprising the chemical additive.
4. A method according to any one of the preceding claims, **characterized in that** the hydrojet liquid is applied in an amount corresponding to at least about 2 gram of liquid per gram of dry fiber web material weight but not more than about 10 gram of liquid per gram of dry fiber web material weight.
5. A method according to any one of the preceding claims, **characterized in that** the chemical additive is selected from one or more of the following groups: wet or dry strength agents, lint-preventing agents, copolymer dispersions, latex, debonders or softeners, or mixtures thereof.
6. A method according to any one of the preceding claims, **characterized in that** the hydrojet liquid is a dilute solution comprising the chemical additive, mixed with water before it penetrates the fiber web.
7. A method according to any one of the preceding claims, **characterized in that** the fiber web comprises at least about 20 % dry weight of cellulose fibers.
8. A method according to any one of the preceding claims, **characterized in that** the synthetic fibers and/or filaments comprise synthetic staple fibers and/or continuous filaments.
9. A method according to any one of the preceding claims, **characterized by** one or more hydroentanglement steps of which at least one precedes the hydrojet treatment step in which the penetration of the fiber web with the hydrojet liquid comprising the chemical additive takes place.
10. A method according to any one of the preceding claims, **characterized in that** there is one or more hydroentanglement steps of which there is one main hydroentanglement step, which in turn comprises one or more hydroentanglement steps, and that the penetration of the fiber web with the hydrojet liquid comprising the chemical additive takes place in a hydrojet treatment step subsequent to the main hydroentanglement step.
11. A method according to claim 9 or 10, **characterized in that** there is a dewatering step between the preceding hydroentanglement step or steps and the subsequent hydrojet treatment step.

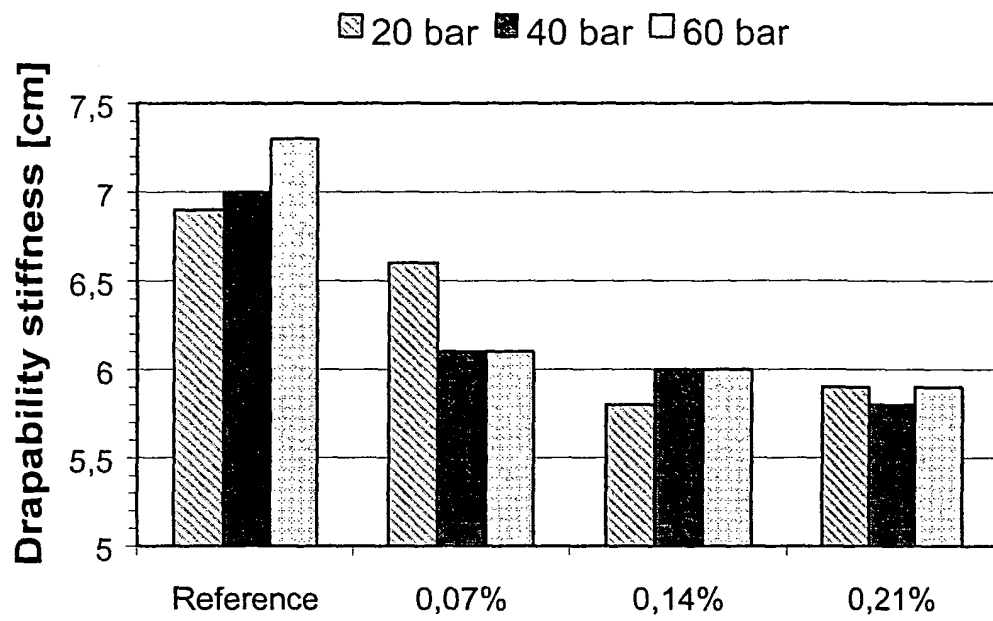


FIG. 1

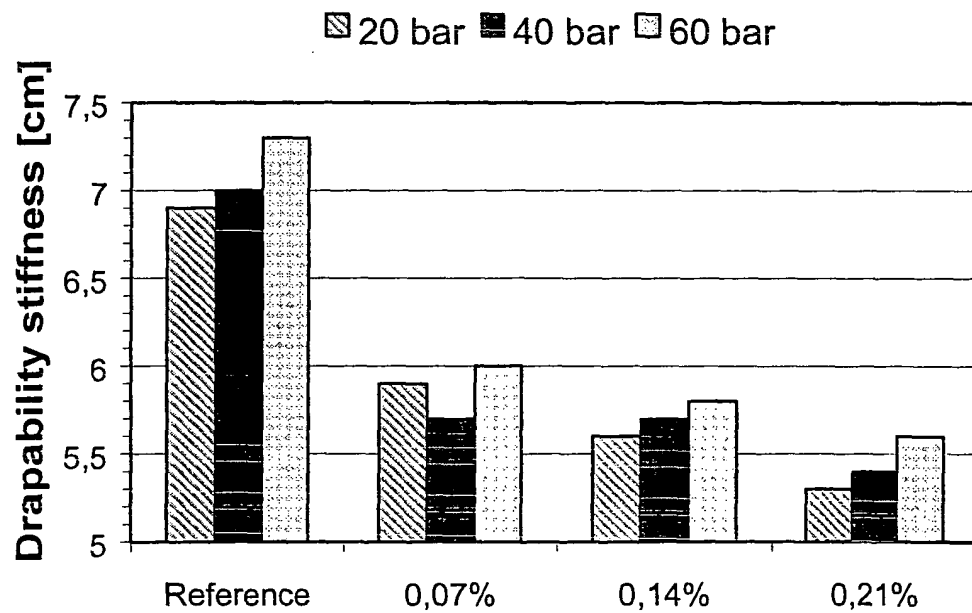


FIG. 2



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 02 9656

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A,D	US 5 484 453 A (BAEHR ET AL) 16 January 1996 (1996-01-16) * column 6, lines 39-63 *	1-11	D04H1/46 D04H3/02
A	US 5 292 581 A (VIAZMENSKY ET AL) 8 March 1994 (1994-03-08) * column 3, line 39 - column 4, line 49 *	1-11	
A	US 6 163 943 A (JOHANSSON ET AL) 26 December 2000 (2000-12-26) * column 2, line 49 - column 3, line 64 *	1-11	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			D04H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 April 2005	Examiner Lanniel, G
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03-82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 04 02 9656

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-04-2005

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5484453	A	16-01-1996	DE 4202720 A1	05-11-1992
			BR 9205952 A	02-08-1994
			WO 9219806 A1	12-11-1992
			EP 0513571 A1	19-11-1992
			EP 0582619 A1	16-02-1994
			JP 6507213 T	11-08-1994
			KR 220269 B1	15-09-1999
			TR 25842 A	01-09-1993

US 5292581	A	08-03-1994	AU 663281 B2	28-09-1995
			AU 5210293 A	30-06-1994
			BR 9305052 A	21-06-1994
			DE 69319557 D1	13-08-1998
			DE 69319557 T2	15-04-1999
			EP 0602881 A1	22-06-1994
			JP 3369690 B2	20-01-2003
			JP 6339449 A	13-12-1994

US 6163943	A	26-12-2000	AT 211193 T	15-01-2002
			AU 734656 B2	21-06-2001
			AU 9770598 A	17-05-1999
			BR 9813271 A	22-08-2000
			CA 2308784 A1	06-05-1999
			CN 1107753 C	07-05-2003
			DE 69803035 D1	31-01-2002
			DE 69803035 T2	29-08-2002
			EP 0938601 A1	01-09-1999
			ES 2170531 T3	01-08-2002
			HU 0004252 A2	28-04-2001
			JP 2001521075 T	06-11-2001
			PL 340215 A1	15-01-2001
			RU 2215835 C2	10-11-2003
			SE 9703886 A	25-04-1999
			WO 9922059 A1	06-05-1999
			SK 5502000 A3	09-04-2001
			TR 200001120 T2	21-09-2000

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82