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(54) **METHOD FOR ADDING A SOFTENING AND/OR DEBONDING AGENT TO A HYDROENTANGLED NONWOVEN MATERIAL**

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(57) **ABSTRACT**

Method of adding a softening and/or debonding agent to a fiber web of a hydroentangled nonwoven material comprising cellulose pulp fibers. The softening and/or debonding agent is added in an inline manufacturing process of the hydroentangled nonwoven material, subsequent to the hydroentanglement of the nonwoven material. The softening and/or debonding agent is added via a size press or a foulard comprising a soaking step to soak the hydroentangled nonwoven material with the added softening and/or debonding agent, and a pressing step, which causes the added softening and/or debonding agent to penetrate and impregnate the hydroentangled nonwoven material.

METHOD FOR ADDING A SOFTENING AND/OR DEBONDING AGENT TO A HYDROENTANGLED NONWOVEN MATERIAL

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the 35 USC 119(e) benefit of prior U.S. Provisional application 60/530,887 filed on Dec. 22, 2003.

FIELD OF THE INVENTION

[0002] The invention relates to a method of adding a softening and/or debonding agent to a fiber web of a hydroentangled nonwoven material comprising cellulose pulp fibers.

BACKGROUND OF THE INVENTION

[0003] Typical properties of hydroentangled 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 hydroentangled nonwoven to be used for example as cleaning 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.

[0004] The components and added chemicals included in nonwoven material are chosen in accordance with the intended field of use. The softening and/or debonding agents decrease the hydrogen bonding between the cellulose pulp fibers, resulting in higher bulk softness.

[0005] Added chemical agents or additives are in the conventional prior art often applied in the wet end of the process. U.S. Pat. No. 3,736,097 describes a method of producing a nonwoven material with a softening or swelling agent added to the fibers in the wet end. In a first step, the fibers are pretreated with the softening or swelling agent. Subsequently, the fibers are formed into a web in a forming step. Such a web could have a hydroentanglement process step succeeding the forming step.

[0006] Hydroentangling or spuilacing 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 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 fibers and staple fibers. Hydroentangled 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.

[0007] Many of the hydroentangled nonwoven materials are also pressed in order to dewater the material before drying. This process step makes the material stiffer.

[0008] One of the disadvantages of adding chemicals in the wet end of the 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 steps. 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 softening or debonding agents are added in the wet end, which is the case according to the conventional technique, these added chemicals will thus be flushed away in the hydroentanglement due to the low strength of the attraction and consequently therefore also enriched in the water cleaning circulation as well as in the wet end. There might also be charge problems in the wet end circulation and/or in the water filtration.

[0009] The enriched chemicals in the water systems will cause a number of problems, and further it may cause stops in the production process. As the chemicals are cationically charged they will disturb the water cleaning process, especially the flocculation in the flotation filtration, in which most of the dry substance in the entanglement water is separated. For example filters could be clogged. There are also and perhaps mostly problems with formation of foam. The formation of foam is mainly due to surfactants or tensides or that the added agent has a higher charge density. There is also 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. The water cleaning process may be disturbed as well as the different water recirculation systems.

[0010] 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 U.S. Pat. No. 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 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.

[0011] When chemicals 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

[0012] A purpose of the invention is to reduce or remove any of the above-mentioned problems and negative effects.

The invention relates thus to a method of adding a softening and/or debonding agent to a fiber web of a hydroentangled nonwoven material comprising cellulose pulp fibers without encountering the above-mentioned problems. The present invention relates thus to a method of adding the softening and/or debonding agent in an inline manufacturing process of the hydroentangled nonwoven material, subsequent to the. hydroentanglement of the nonwoven material, whereby the softening and/or debonding agent is added by means of a size press or a foulard comprising a soaking step to soak the hydroentangled nonwoven material with the added softening and/or debonding agent, and a pressing step, which causes the added softening and/or debonding agent to penetrate and impregnate the hydroentangled nonwoven 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.

[0013] The added softening and/or debonding agent is preferably a dilute solution, which comprises water and a softening and/or debonding agent or resin. The provided method enables the softening and/or debonding agent to penetrate throughout the whole material and will not only treat the surface of the material. The inline operation will avoid the drawbacks connected to additions of softening and/or debonding agents when they are added in a separate post treatment.

[0014] The manufacturing process is thus an inline operation. 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. Offline processes or operations can according to conventional technique be used in order to achieve the desired bulk and surface softness in the nonwoven material, and the cost will, due to this, increase substantially. Also, any offline treatment will negatively affect the nonwoven material, as it is subjected to two drying operations. When the material is dried, the available hydrogen bonding functional groups at the cellulose molecules will bond within or to other cellulose molecules. Moisture may disrupt or participate in the disruption of hydrogen bonding, but for each time the cellulose molecules are subjected to a drying operation, some covalent bonds to the hydroxyl groups on the cellulose molecules will stay bonded and will not be disrupted and this will lead to a less soft material. Consequently it will also be more difficult to achieve the desired soft feel in the nonwoven material at an offline softness treatment. An inline process on the other hand, according to the claimed method, will manufacture a hydroentangled nonwoven material with improved bulk softness as well as with improved surface softness in one subsequence of following process steps without any disrupting, cost demanding or detonating step where the nonwoven material is substantially dried as it would be in an offline process.

[0015] Pressing is sometimes optional for a hydroentangled nonwoven material comprising cellulose pulp fibers in order to get a smoother web, but it will also lead to a more stiff material. However, when a softening and/or debonding agent is added according to an embodiment of the claimed method in combination with the pressing action a less stiff material is obtained compared to what it would be if it would have been pressed without adding a softening and/or debonding agent. As the hydroentangled nonwoven material is pressed without any addition of a softening and/or debonding agent, the pressing will result in more hydrogen bondings and this in turn will result in a stiffer material. Also, as the material is pressed together with the addition of the softening and/or debonding agent, a very good surface smoothness can be obtained. It is according to an embodiment of the claimed method possible to press and thereby dewater the soaked hydroentangled nonwoven material without that the hydroentangled nonwoven material will be stiffer, on the contrary, it can be softer. Also, by being able to press the hydroentangled nonwoven material, the thickness of the hydroentangled nonwoven material can be determined without the conventional drawbacks such as a more stiff material. There may also be a reduction in linting due to the pressing effect.

[0016] Since a pressing action is possible in the pressing step where the softening and/or debonding agent are added to the hydroentangled nonwoven material according to an embodiment of the claimed method, this will altogether render a softer feel of the hydroentangled nonwoven material and therefore no further pressing is needed. When there is no further pressing step, the natural bulk in the material is kept, which in turn has several positive effects as to absorbency, softness through bulk, drapability stiffness, the elasticity in the web, etc.

[0017] The impregnation of webs with liquid chemicals by means of a size press is known by conventional technique, such as U.S. Pat. Nos. 6,497,787, 4,109,035 and EP-B1-0 678 614. None of these documents mentions any hydroentangled nonwoven or hydroentanglement processes.

[0018] While wishing not to be bound by any theory, it is believed that the following reasoning is part of the understanding of the inventive technique and method. It is believed that it is important for the method claimed that the nonwoven material in question is a hydroentangled nonwoven material that has just been subjected to the hydroentanglement at the point of adding the softening and/or debonding agent. The recently hydroentangled nonwoven material will probably permit the softening and/or debonding agent to penetrate into the fiber to fiber intersections in the hydroentangled nonwoven while the hydroentangled nonwoven still is wet and affected from the recent hydroentanglement. The high-pressure water jets at the hydroentanglement in the preceding hydroentanglement process step will move the fibers in the material and create the integration of the fibers and/or filaments as well as available sites on the cellulose molecules that may create bondings of the fibers and/or filaments to each other. According to an embodiment of the invention the thereafter added softening and/or debonding agents may also occupy sites on the cellulose molecule that would otherwise form hydrogen bonds within or between the cellulose molecules. It is an advantage that the material is kept wet since the available sites on the cellulose molecules well as the newly formed bondings still has many water molecules surrounding the hydrogen bonding functional groups at the cellulose molecules as the hydroentangled nonwoven material is kept in its wet state. Also, the surrounding water molecules may disrupt or participate in the disrupture of the already formed hydrogen bonding. There are thus many available sites on the cellulose molecule as the recently hydroentangled nonwoven is still wet from the hydroentanglement step and consequently these sites are more available to the softening and/or debonding agent than it would be if the hydrogen bondings within and between the cellulose molecules already would have been formed and firmly established once as the nonwoven material would have been dried. For each time the material is dried the number of available sites will decrease. This makes the hydroentangled nonwoven material sensitive and susceptible to drying actions.

[0019] The claimed method would make it possible to get the added softening and/or debonding agent into the fiber-to-fiber intersections of the nonwoven material. The preceding hydroentanglement has thus opened up a way and a possibility to force the added softening and/or debonding agent into these fiber to fiber intersections by the soaking of the size press or foulard and the penetrative and impregnation effect of the pressing step. The added softening and/or debonding agent will penetrate into and throughout the whole material, get into the bulk and not only treat the surface. The desired soft feel in the hydroentangled nonwoven material is achieved by means of a treatment according to an embodiment of the invention subsequent to the hydroentanglement step.

[0020] During the soaking step and the pressing step causing the penetration and impregnation of the hydroentangled nonwoven material performed during a preferred method, the softening and/or debonding agent added to the wet fiber web is to some extent replaced with the preferred dilute solution of the softening and/or debonding agent. In one embodiment of the invention the softening and/or debonding agent is applied in an amount such that an exchange and saturation of the dilute solution comprising the softening and/or debonding agent can take place in the fiber web. It is most probably the capillary water in pores and capillary that can be replaced. A preferred method according to the invention results in a good retention of the chemical softening and/or debonding agent. As liquid is replaced, one of the more important driving forces is the affinity between the cationically charged agent and the anionically charged cellulose pulp fibers. There will thus be a good affinity between the cationically charged agent and the anionically charged cellulose pulp fibers. The high retention of the softening and/or debonding agent added in the material has naturally a high influence of the softening effect of the hydroentangled nonwoven material comprising cellulose pulp fibers.

[0021] A penetration is especially desirable since the bulk properties are enhanced as the hydrogen bonds at the fiber-to-fiber intersections are broken in the material or at least softened or loosened up by the softening and/or debonding agent. Decreasing or reducing the interfiber bonding within the web when the nonwoven web comprises cellulose pulp 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 and/or debonders will influence the fibers throughout the material. The effect of the additive will be greater since substantially most of the fibers and fiber intersections are treated and not only the surface of the nonwoven material.

[0022] According to an embodiment of the invention the softening and/or debonding agent is either used as a separate agent or in combination with other softening and/or debonding resins or agents. The softening and/or debonding agent can be a chemical or chemicals and of course also be a group of chemicals.

[0023] The method according to embodiments of the present invention gives the hydroentangled nonwoven material a number of other desirable features as well as the desired bulk and softening effect. The product manufactured according to an embodiment of the claimed method is rather homogenous. Also, the softness experience of the two sides of the nonwoven material can be pretty much the same on both sides due to the soaking and penetrative impregnation of the softening and/or debonding agent adjacent and subsequent to the hydroentanglement step. Further features of the present invention are disclosed in the description below and also in the claims.

[0024] 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.

DETAILED DESCRIPTION OF THE INVENTION

[0025] In a preferred embodiment there is a dewatering step between the hydroentanglement step and the subsequent step where the softening and/or debonding agent is added. According to one embodiment of the invention the dry content of the material when adding the softening and/or debonding agent is at least about 25% but not more than about 50%, preferably at least about 30% but not more than about 40%. According to different embodiments the softening and/or debonding.agent is either added in the soaking step by means of a size press at the pressing step or the pressing step is subsequent to the soaking step where the softening and/or debonding agent is added by means of a foulard. The invention could be embodied in various ways.

[0026] In an embodiment of the invention the hydroentangled nonwoven material comprises synthetic fibers, such as staple fibers, and/or continuous filaments. Also, the manufacturing process of the hydroentangled nonwoven material may comprises a step where the synthetic fibers and/or filaments are extruded or laid down into a web in one step, and that the cellulose pulp fibers are wetlaid or foamformed onto this thus formed web in a step preceding the hydroentanglement step. In a further embodiment the manufacturing process of the hydroentangled nonwoven material comprises a step where the cellulose pulp fibers are wetlaid or foamformed, and that the synthetic fibers and/or filaments are laid down onto this thus formed web in a step preceding the hydroentanglement step. In a preferred embodiment the cellulose pulp fibers comprises synthetic fibers in the form of staple fibers when being wetlaid or foamformed.

[0027] There are many options for manufacturing a fiber web of nonwoven material to which a softening and/or debonding agent 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.

[0028] 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 U.S. Pat. Nos. 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.

[0029] 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, U.S. Pat. No. 4,443,297 and EP-A-0938 601. The hydroentangled 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.

[0030] 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.

[0031] 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. Many hydroentangled materials today consist of both synthetic fibers or filaments and pulp. The hydroentangled nonwoven material may comprise 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 of hydroentangled nonwoven material comprises at least about 20% dry weight of cellulose pulp 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.

[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 hydrogen fiber to fiber hydrogen bonding of the cellulose pulp fibers is reduced and higher bulk softness is obtained, however at the same time 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 hydroentangled 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 hydroentangled nonwoven material, which have a reinforcement effect of the material. The effect on strength reduction by debonder or softening chemicals is thus less in a hydroentangled 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 hydroentangled nonwoven materials.

[0034] In conventional techniques there are generally several hydroentanglement steps as well as each hydroentanglement step include several hydroentanglement manifolds. Further, there is at least one vacuum-collecting box under the wire carrying the fiber web from the hydroentanglement to the following adjacent step comprising the addition of the softening and/or debonding agent. In one embodiment, there is a dewatering step between the hydroentanglement step and the subsequent step where the softening and/or debonding agent is added. The dry content of the material when adding the softening and/or debonding agent is preferably about 30-40% by weight.

[0035] 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 when measured as drapability stiffness has been evaluated in the following Example.

EXAMPLES

[0036] Pilot trials were conducted in order to simulate a process for adding a softening and/or debonding agent subsequent to the hydroentanglement according to the invention.

[0037] In these trials, a commercially available hydroentangled nonwoven material intended for use in industrial wipes (E-TORK Strong®, manufactured by SCA Hygiene Products AB) was subjected to the different additions. E-TORK Strong® is produced by means of hydroentangling a precursor web consisting of a mixture of bleached softwood sulphate pulp fibers, polyester staple fibers, and polypropylene staple fibers.

[0038] A sample treated without any chemical additives of the hydroentangled nonwoven material was extracted as a control for subsequent testing. In the trials prewetted hydroentangled nonwoven web materials to about 40-45% dry weight were treated with different softening and/or debonding agents in a lab size press at 3 bar. The solutions had a dilute concentration of 0.5% and 1.0% of the softening and/or debonding agent.

[0039] The addition of the softening and/or debonding agent for soaking the hydroentangled nonwoven fiber web is applied in an amount such that an exchange and saturation of the softening and/or debonding agent will take place in the fiber web.

[0040] Three different softening and/ or debonding chemicals were evaluated, Berocell 589 and XP 7026 supplied by Eka Chemicals, and TQ1003 supplied by Hercules AB. The debonder 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 benxyl-dimethylammonium chloride. TQ1003 is a fatty acid amine.

[0041] As the materials were treated with a debonding agent, the experience of a much softer material in the hand was obtained. Softness in relation to the Drapability stiffness can be seen in Table 1 below.

[0042] The material testing was performed with methods, which should be well known to the skilled person. Therefore, the test methods will be described only briefly in the following description.

[0043] 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.

[0044] Table 1 below shows results from drapability stiffness Sqr root (MDCD) [cm] measurements on the different samples by impregnation of wet sheets with a size press with the three different softening and/or debonding agents added.

Sample	Chem. liquid Conc. [%]	Drapability stiffness Sqr root (MDCD) [cm]
Reference	None	8.4
TQ1003	0.5	6.5
TQ1003	1.0	6.6
Berocell 589	0.5	7.0
Berocell 589	1.0	6.6
XP 7026	0.5	6.4
XP 7026	1.0	6.5

[0045] When studying the samples it is clear and obvious that the softening effects obtained effectively show distinctly lower values of drapability stiffness. The result of the decreased values of the drapability stiffness (cm) relates to the experienced felt softness in hand which is correspondingly greater. It could also be worth knowing that even small changes in drapability stiffness have large effects on the experienced soft feel in hand.

[0046] The invention also comprises any evidently suitable method or methods that will involve the claimed method. The invention is also capable of other embodiments and of being carried out in various ways.

1. Method of adding a softening and/or debonding agent to a fiber web of a hydroentangled nonwoven material comprising cellulose pulp fibers, which comprises adding the softening and/or debonding agent in an inline manufacturing process of the hydroentangled nonwoven material, subsequent to the hydroentanglement of the nonwoven material, whereby the softening and/or debonding agent is added via a size press or a foulard comprising a soaking step to soak the hydroentangled nonwoven material with the added softening and/or debonding agent, and a pressing step, which causes the added softening and/or debonding agent to penetrate and impregnate the hydroentangled nonwoven material.

2. The method according to claim 1, further comprising a dewatering step between the hydroentanglement step and the subsequent step where the softening and/or debonding agent is added.

3. The method according to claim 1, wherein the hydroentangled nonwoven material has a dry content when adding the softening and/or debonding agent of at least about 25% but not more than about 50%.

4. The method according to claim 1, wherein the fiber web of the hydroentangled nonwoven material comprises at least about 20% dry weight of cellulose pulp fibers.

5. The method according to claim 1, wherein the softening and/or debonding agent is added in the soaking step via a size press at the pressing step.

6. The method according to claim 1, wherein the pressing step is subsequent to the soaking step where the softening and/or debonding agent is added via a foulard.

7. The method according to claim 1, wherein the hydroentangled nonwoven material comprises at least one of synthetic fibers, staple fibers, and continuous filaments.

8. The method according to claim 7, wherein the manufacturing process of the hydroentangled nonwoven material comprises a step where the synthetic fibers and/or filaments are extruded or laid down into a web in one step, and the cellulose pulp fibers are wetlaid or foamformed onto this thus formed web in a step preceding the hydroentanglement step.

9. The method according to claim 7, wherein the manufacturing process of the hydroentangled nonwoven material comprises a step where the cellulose pulp fibers are wetlaid or foamformed, and the synthetic fibers and/or filaments are laid down onto this thus formed web in a step preceding the hydroentanglement step.

10. The method according to claim 8, wherein the cellulose pulp fibers comprises synthetic fibers in the form of staple fibers when being wetlaid or foamformed.

11. The method according to claim 9, wherein the cellulose pulp fibers comprises synthetic fibers in the form of staple fibers when being wetlaid or foamformed.

12. The method according to claim 1, wherein the hydroentangled nonwoven material has a dry content when adding the softening and/or debonding agent of at least about 30% but not more than about 40%.

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