Title: IMPROVED METHOD FOR USING WATER INSOLUBLE CHEMICAL ADDITIVES WITH PULP AND PRODUCTS MADE BY SAID METHOD

Abstract: Pulp fibers can be treated with water insoluble chemical additives resulting in a minimal amount of unretained water insoluble chemical additives present after exposing the treated pulp fibers to process water, liquids, or solutions used in products. One embodiment of the present invention is a method for preparing chemically treated pulp fiber. A fiber slurry is created comprising process water and pulp fibers. The fiber slurry is transported to a web-forming apparatus of a pulp sheet machine thereby forming a wet fibrous web. The wet fibrous web is dried to a predetermined consistency thereby forming a dried fibrous web. The dried fibrous web is treated with a water insoluble chemical additive thereby forming a chemically treated dried fibrous web containing chemically treated pulp fibers. The chemically treated pulp fibers have an improved level of chemical retention of the water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the water insoluble chemical additive when the chemically treated pulp fibers are exposed to a liquid, such as water. The chemically treated pulp fibers are used to form a fibrous non-woven material.
IMPROVED METHOD FOR USING WATER INSOLUBLE CHEMICAL ADDITIVES WITH PULP AND PRODUCTS MADE BY SAID METHOD

BACKGROUND OF THE INVENTION

Fibrous non-woven materials and fibrous non-woven composite materials are widely used as products, or as components of products, such as wet-wipes because they may be manufactured inexpensively and made to have specific characteristics. These products may be manufactured so inexpensively that they may be viewed as disposable, as opposed to reusable.

One approach to making fibrous non-woven composite materials for wet-wipes is the use of homogeneous mixtures of materials such as air laid webs of fibers mixed with cellulosic fibers or another absorbent material. Other wet-wipes have been prepared by joining different types of non-woven materials in a laminate or formed as a layered structure. These products may be prepared from plastic materials such as plastic sheets, films and non-woven webs, prepared by extrusion processes such as, for example, slot film extrusion, blown bubble film extrusion, meltblowing of non-woven webs and spinbonding.

The non-woven materials and laminated non-woven materials that are useful for consumer products should meet minimum product standards for strength, moisture level, size, flexibility, thickness, softness and texture. However, if one of these parameters is changed this may affect another of the parameters. Thus, a goal for these materials is to produce a product that may mimic a soft cloth-like feel or at least get closer to a soft cloth-like feel than has been previously possible while still maintaining acceptable strength and other characteristics.

Such a soft cloth-like feel is often characterized by, among other things, one or more of the following: thickness, bulk density, flexibility, texture, softness, density, and durability of the non-woven materials. These materials are suitable for disposable products such as, for example, disposable diapers, disposable tissues and disposable wipes, for example, disposable wet-wipes.

In the manufacture of products containing pulp fibers, it is often desirable to enhance physical and/or optical properties of the pulp fibers and/or fibrous nonwoven material by the addition of chemical additives onto the pulp fibers and/or fibrous nonwoven material. Typically, chemical additives such as softeners, colorants, brighteners, strength agents, etc. are added to the fiber slurry upstream of the headbox in a paper making
machine during the manufacturing or converting stages of production to impart certain attributes to the finished product. These chemical additives are usually mixed in a stock chest or stock line where the fiber slurry has a fiber consistency of from between about 0.15 to about 5 percent or spraying the wet or dry paper or tissue during production.

One disadvantage of adding a chemical additive at each manufacturing, such as papermaking, machine is that the manufacturer has to install equipment on each paper machine to accomplish the chemical additive addition. This, in many cases, is a costly proposition. In addition, the uniformity of the finished product coming off of each manufacturing machine may vary depending upon how the chemical additive was added, variations in chemical additive uniformity and concentrations, the exact point of chemical additive introduction, water chemistry differences among the manufacturing machines as well as personnel and operational differences of each manufacturing machine.

Another difficulty associated with wet end chemical additive in a solution addition, such as to a pulp slurry, is that the water soluble or water dispersible chemical additives are suspended in water and are not completely adsorbed or retained onto the fibers prior to formation of the wet mat. To improve adsorption of wet end chemical additives, the chemical additives are often modified with functional groups to impart an electrical charge when in water. The electrokinetic attraction between charged chemical additives and the anionically charged fiber surfaces aids in the deposition and retention of chemical additives onto the fibers. Nevertheless, the amount of the chemical additive that can be adsorbed or retained in the manufacturing machine wet end generally follows an adsorption curve exhibiting diminishing incremental adsorption with increasing concentration, similar to that described by Langmuir. As a result, the adsorption of water soluble or water dispersible chemical additives may be significantly less than 100 percent, particularly when trying to achieve high chemical additive loading levels. The use of water insoluble chemical additives in the water systems of manufacturing processes is even more problematic and typically provides even poorer loading levels. Water insoluble chemical additives or water nondispersible chemical additives cannot typically be used in such water systems unless in the form of an emulsion.

Consequently, at any chemical addition level, and particularly at high addition levels, a fraction of the chemical additive is retained on the fiber surface. The remaining fraction of the chemical additive remains dissolved or dispersed in the suspending water phase. These unadsorbed or unretained chemical additives can cause a number of problems in the manufacturing process. The exact nature of the chemical additive will determine the specific problems that may arise, but a partial list of problems that may result from unadsorbed or unretained chemical additives includes: foam, deposits,
contamination of other fiber streams, poor fiber retention on the machine, compromised chemical layer purity in multi-layer products, dissolved solids build-up in the water system, interactions with other process chemicals, felt or fabric plugging, excessive adhesion or release on dryer surfaces, physical property variability in the finished product.

Therefore, what is lacking and needed in the art is a fibrous non-woven material or a fibrous non-woven composite material containing pulp fibers wherein water insoluble chemical additives are applied onto the pulp fibers, providing more consistent water insoluble chemical additive additions to the pulp fiber and a reduction or elimination of unretained water insoluble chemical additives in the process water on a paper machine.

The present invention minimizes the associated manufacturing and finished product quality problems that would otherwise occur with conventional wet end chemical addition at the manufacturing machine.

DEFINITIONS

For the purposes of the present application, the following terms shall have the following meanings:

As used herein the term "chemical additive" refers to a single treatment compound or to a mixture of treatment compounds. It is also understood that a chemical additive used in the present invention may be an adsorbable chemical additive.

As used herein the term "non-woven web" means a structure or a web of material which has been formed without use of weaving processes to produce a structure of individual fibers or threads which are intermeshed, but not in an identifiable, repeating manner. Non-woven webs have been, in the past, formed by a variety of conventional processes such as, for example, meltblowing processes, spinbonding processes, film apertureting processes and staple fiber carding processes.

As used herein, the term "meltblown fibers" means fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into a high velocity gas (e.g. air) stream which attenuates the filaments of molten thermoplastic material to reduce their diameter, which maybe to microfiber diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface to form a web of randomly disbursed meltblown fibers. Such a process is disclosed, for example, in U.S. Patent No. 3,849,241 to Butin.

As used herein, the term "spunbonded fibers" refers to small diameter fibers which are formed by extruding a molten thermoplastic polymeric material as filaments from a
plurality of fine, usually circular, capillaries of a spinnerette with the diameter of the extruded filaments then being rapidly reduced as by, for example, eductive drawing or other well-known spun-bonding mechanisms. The production of spun-bonded non-woven webs is illustrated in patents such as, for example, in U.S. Patent No. 4,340,583 to Appel et al., and U.S. Patent No. 3,692,618 to Dorschner et al.

As used herein, the term "coform" means a non-woven composite material of air-formed matrix material comprising thermoplastic polymeric meltblown fibers such as, for example, microfibers having an average fiber diameter of less than about 10 microns, and a multiplicity of individualized absorbent fibers such as, for example, wood pulp fibers disposed throughout the matrix of polymer microfibers and engaging at least some of the microfibers to space the microfibers apart from each other. The absorbent fibers are interconnected by and held captive within the matrix of microfibers by mechanical entanglement of the microfibers with the absorbent fibers, the mechanical entanglement and interconnection of the microfibers and absorbent fibers alone forming a coherent integrated fibrous structure. These materials are prepared according to the descriptions in U.S. Patent No. 4,100,324 to Anderson et al. U.S. Patent No. 5,508,102 to Georganer et al. and U.S. Patent No. 5,385,775 to Wright.

As used herein, the term "microfibers" means small diameter fibers having an average diameter not greater than about 100 microns, for example, having an average diameter of from about 0.5 microns to about 50 microns, or more particularly, microfibers may have an average diameter of from about 4 microns to about 40 microns.

As used herein, the term "autogenous bonding" means bonding provided by fusion and/or self-adhesion of fibers and/or filaments without an applied external adhesive or bonding agent. Autogenous bonding may be provided by contact between fibers and/or filaments while at least a portion of the fibers and/or filaments are semi-molten or tacky. Autogenous bonding may also be provided by blending a tackifying resin with the thermoplastic polymers used to form the fibers and/or filaments. Fibers and/or filaments formed from such a blend may be adapted to self-bond with or without the application of pressure and/or heat. Solvents may also be used to cause fusion of fibers and filaments which remains after the solvent is removed.

As used herein, the term "machine direction (MD)" refers to the direction of travel of the forming surface onto which fibers are deposited during formation of a non-woven fibrous web.

As used herein, the term "cross-machine direction (CD)" refers to the direction which is essentially perpendicular to the machine direction defined above.
As used herein, the term "tensile strength" refers to the maximum load or force (i.e., peak load) encountered while elongating the sample to break. Measurements of peak load are made in the machine and cross-machine directions using wet samples.

As used herein, the term "wet-wipe" refers to a fibrous sheet which, during its manufacture, has a liquid applied thereto so that the liquid may be retained on or within the fibrous sheet until its utilization by a consumer. The liquid may include a fragrance and/or an emollient and may serve to aid the fibrous sheet in retention of materials which are to be wiped up during its utilization.

As used herein, the terms "fibrous non-woven material" and "fibrous non-woven composite material" refer to material that may be used as the sheet or substrate for a consumer product, such as a wet-wipe or wipe-type product, which has a liquid applied thereto that may be retained on or within the fibrous sheet until it is utilized by a consumer.

As used herein, the terms "stretch-bonded laminate" or "composite elastic material" refers to a fabric material having at least one ply of non-woven web being elastic and at least one ply of the non-woven web being non-elastic, e.g., a gatherable ply. The elastic non-woven web ply(s) are joined or bonded in at least two locations to the non-elastic non-woven web ply(s). Preferably, the bonding is at intermittent bonding points or areas while the non-woven web ply(s) are in juxtaposed configuration and while the elastic non-woven web ply(s) have a tensioning force applied thereto in order to bring the elastic non-woven web to a stretched condition. Upon removal of the tensioning force after joining of the web plies, an elastic non-woven web ply will attempt to recover to its unstretched condition and will thereby gather the non-elastic non-woven web ply between the points or areas of joining of the two plies. The composite material is elastic in the direction of stretching of the elastic ply during joining of the plies and may be stretched until the gathers of the non-elastic non-woven web or film ply have been removed. A stretch-bonded laminate may include more than two plies. For example, the elastic non-woven web or film may have a non-elastic non-woven web ply joined to both of its sides while it is in a stretched condition so that a three ply non-woven web composite is formed having the structure of gathered non-elastic (non-woven web or film) /elastic (non-woven web or film) /gathered non-elastic (non-woven web or film). Yet other combinations of elastic and non-elastic plies may also be utilized. Such composite elastic materials are disclosed, for example, by U.S. Patent No. 4,720,415 to Vander Wielen et al., and U.S. Patent No. 5,385,775 to Wright.

As used herein "thermal point bonding" involves passing a material such as two or more webs of fibers to be bonded between a heated calendar roll and an anvil roll. The calender roll is usually, though not always, patterned in some way so that the entire fabric is not bonded across its entire surface, and the anvil roll is usually flat or crowned. As a
result, various patterns for calender rolls have been developed for functional as well as
aesthetic reasons. In one embodiment of this invention the bond pattern allows void
spaces in the machine direction to allow a gatherable ply to gather when the web retracts.

As used herein the term "unretained" refers to any portion of the chemical additive
that is not retained by the pulp fiber and thus remains suspended in the process water.

As used herein the term "web-forming apparatus" includes fourdrinier former, twin
wire former, cylinder machine, press former, crescent former, and the like used in the pulp
stage known to those skilled in the art.

As used herein the term "water" refers to water or a solution containing water and
other treatment additives desired in the manufacturing process or in the finished wet-wipe
product.

As used herein the term "superabsorbent" refers to a water swellable, substantially
insoluble organic or inorganic material capable of absorbing at least 10 times its weight of
an aqueous solution containing 0.9 wt % of sodium chloride.

As used herein the term "palindromic" means a multi-ply laminate, for example a
stretch-bonded laminate, which is substantially symmetrical. Examples of palindromic
laminates could have ply configurations of A/B/A, A/B/B/A, A/A/B/B/A/A, A/B/C/B/A, and
the like. Examples of non-palindromic ply configurations would include A/B/C, A/B/C/A,
A/B/C/D, etc.

As used herein the term "polymer" generally includes, but is not limited to,
homopolymers, copolymers, such as, for example, block, graft, random and alternating
copolymers, terpolymers, etc. and blends and modifications thereof. Furthermore, unless
otherwise specifically limited, the term "polymer" shall include all possible geometrical
configurations of the material. These configurations include, but are not limited to, isotactic,
syndiotactic and random symmetries.

As used herein the term "pulp fiber" is used herein to broadly include fiber used in
writing paper, printing paper, wrapping paper, sanitary paper, and industrial papers,
newsprint, linerboard, tissue, bath tissue, facial tissue, napkins, wipers, wet-wipes, towels,
absorbent pads, intake webs in absorbent articles such as diapers, bed pads, meat and
poultry pads, feminine care pads, and the like made in accordance with any conventional
process for the production of such products. With regard to the use of the term "pulp fiber"
as used herein includes any fibers used in any fibrous web containing cellulosic fibers
alone or in combination with other fibers, natural or synthetic. It may be plied or unplied,
layered or unlayered, creped or uncreped, and may consist of a single ply or multiple plies.

In addition, the fibrous web may contain reinforcing fibers for integrity and strength.
As used herein the term "softening agent" refers to any chemical additive that may be incorporated into products such as tissue to provide improved tactile feel and reduce stiffness of the product. A softening agent may be selected from the group consisting of quaternary ammonium compounds, quaternized protein compounds, phospholipids, polysiloxane compounds, quaternized, hydrolyzed wheat protein/dimethicone phosphocopolyol copolymer, organoreactive polysiloxanes, polyhydroxy compounds, and silicone glycols. These chemical additives may also act to reduce the stiffness of the product or may act solely to improve the surface characteristics of product, such as by reducing the coefficient of friction between the surface of the product and the hand.

As used herein the term "dye" refers to any chemical that may be incorporated into fibrous non-woven materials or fibrous non-woven composite material based products, such as wet-wipes, bathroom tissue, facial tissue, paper towels, and napkins, to impart a color. Depending on the nature of the chemical, dyes may be classified as acid dyes, basic dyes, direct dyes, cellulose reactive dyes, or pigments. All classifications are suitable for use in conjunction with the present invention.

As used herein the term "polyhydroxy compounds" refers to compounds selected from the group consisting of glycerol, sorbitols, polyglycerols having a weight average molecular weight of from about 150 to about 800, polyoxyethylene glycols and polyoxypropylene glycols having a weight average molecular weight from typically about 200 to about 10,000, more typically about 200 to about 4,000.

As used herein the term "water soluble" refers to solids or liquids that will form a solution in water, and the term "water dispersible" refers to solids or liquids of colloidal size or larger that may be dispersed into an aqueous medium. As used herein the term "water insoluble" refers to solids or liquids that will not form a solution in water.

As used herein the term "bonding agent" refers to any chemical that may be incorporated into tissue to increase or enhance the level of interfiber or intrafiber bonding in the sheet. The increased bonding may be either ionic, hydrogen or covalent in nature. It is understood that a bonding agent refers to both dry and wet strength enhancing chemical additives.

**SUMMARY OF THE INVENTION**

The problem of a fibrous non-woven material lacking desired characteristics or properties, such as softness or cloth-like feel may be addressed by the application of water insoluble chemical additives to pulp fibers at high and/or consistent levels with little
or no migration of the water insoluble chemical additive into the process water or product solutions.

It has now been discovered that water insoluble chemical additives can be applied to pulp fibers at high and/or consistent levels with reduced amounts of unretained water insoluble chemical additives present in the manufacturing process water, such as papermaking, after the treated pulp fiber has been exposed to a liquid, such as water. This is accomplished by treating a fibrous web prior to the finishing operation at a pulp mill with a water insoluble chemical additive, completing the finishing operation, and using the finished chemically treated pulp in the production of a fibrous non-woven material or fibrous non-woven composite material. As used herein, the term "fibrous non-woven material" is understood to include fibrous non-woven composite material(s).

Hence in one aspect, the invention resides in a method for preparing chemically treated pulp fibers contained in a fibrous non-woven material. The method comprises creating a fiber slurry comprising process water and virgin pulp fibers. The fiber slurry is transported to a web-forming apparatus of a pulp sheet machine and formed into a wet fibrous web. The wet fibrous web is dried to a predetermined consistency thereby forming a dried fibrous web. The dried fibrous web is treated with a water insoluble chemical additive thereby forming a chemically treated dried fibrous web containing chemically treated pulp fibers wherein the chemically treated pulp fibers have an increased or improved level of chemical retention of the water insoluble chemical additive and have a level of chemical retention of the water insoluble chemical additive is between about 25 to about 100 percent retention of the applied amount of the water insoluble chemical additive when the chemically treated pulp fibers are exposed to a liquid, such as water or product solution. The chemically treated pulp fibers are used to form the fibrous non-woven material. The level of chemical retention of the water insoluble chemical additive may range from between about 60 to about 100 percent or between about 80 to about 100 percent retention of the water insoluble chemical additive. The improved level of chemical retention of the water insoluble chemical additive, measured as the change in the level of chemical retention of adding by typical wet-end addition, may range from a lower limit of about 5 percent, about 15 percent, about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, and about 75 percent to a higher limit of about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, about 75 percent, about 85 percent, about 95 percent, and about 100 percent retention of the water insoluble chemical additive. It is understood that the value for the lower limit is less than
the value for the upper limit. The chemically treated pulp fiber may be then used in a separate process to produce paper products.

In another aspect, the invention resides in a method for applying a water insoluble chemical additive to a fibrous non-woven material. The method comprises mixing pulp fibers with process water to form a fiber slurry. The fiber slurry is transported to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web. The wet fibrous web is dewatered to a predetermined consistency thereby forming a dewatered fibrous web. A water insoluble chemical additive is applied to the dewatered fibrous web, thereby forming a chemically treated dewatered fibrous web containing chemically treated pulp fibers wherein the chemically treated pulp fibers have an increased or improved level of chemical retention of the water insoluble chemical additive wherein the level of chemical retention of the water insoluble chemical additive is between about 25 to about 100 percent of the applied amount of the water insoluble chemical additive when the chemically treated pulp fibers are exposed to a liquid. The chemically treated pulp fibers are used to form the fibrous non-woven material. The level of chemical retention of the water insoluble chemical additive may range from between about 60 to about 100 percent or between about 80 to about 100 percent retention of the water insoluble chemical additive. The improved level of chemical retention of the water insoluble chemical additive, measured as the change in the level of chemical retention of adding by typical wet-end addition, may range from a lower limit of about 5 percent, about 15 percent, about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, and about 75 percent to a higher limit of about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, about 75 percent, about 85 percent, about 95 percent, and about 100 percent retention of the water insoluble chemical additive. It is understood that the value for the lower limit is less than the value for the upper limit.

According to another embodiment of the present invention is a method for applying a water insoluble chemical additive to the pulp fibers to be incorporated into a fibrous non-woven material during the pulp processing stage. During the pulp processing stage, upstream of a manufacturing machine, one can obtain chemically treated pulp fiber. Furthermore, the chemically treated pulp fiber can be transported to several different manufacturing machines that may be located at various sites, and the quality of the finished product from each manufacturing machine will be more consistent. Also, by chemically treating the pulp fiber before the pulp fiber is made available for use on multiple manufacturing machines or multiple runs on a manufacturing machine, the need to install equipment at each manufacturing machine for the water insoluble chemical additive addition can be eliminated.
The method of the present invention allows for the production or processing of pulp fibers also enables higher and more uniform concentrations of the water insoluble chemical additive to be retained by the pulp fibers while at the same time maintaining significantly lower levels of unretained water insoluble chemical additive in the water phase of a manufacturing machine compared to paper machine wet end chemical additive additions.

The consistency of the dried fibrous web is from about 65 to about 100 percent. In other embodiments, the consistency of the dried fibrous web is from about 80 to about 100 percent or from about 85 to about 95 percent. The consistency of the dewatered fibrous web is from about 20 to about 65 percent. In other embodiments, the consistency of the dewatered fibrous web is from about 40 to about 65 percent or from about 50 to about 65 percent. The consistency of the crumb form is from about 20 to about 85 percent. In other embodiments, the consistency of the crumb form is from about 30 to about 60 percent or from about 30 to about 45 percent.

The present method allows for the production of pulp fibers to be incorporated into a fibrous non-woven material that is useful for making products such as wet-wipe products. One aspect of the present invention is a uniform supply of chemically treated pulp fiber, replacing the need for costly and variable chemical treatments at one or more manufacturing machines. Another aspect of the invention resides in a pulp fiber that has a higher water insoluble chemical additive loading than could otherwise be achieved in combination with either no or a relatively low level of unretained water insoluble chemical additive in the process water on a manufacturing machine. This is because water insoluble chemical additive loading via wet end addition is often limited by the level of unadsorbed or unretained water insoluble chemical additive and/or contact time, as well as its associated processing difficulties such as foam, deposits, chemical interactions, felt plugging, excessive dryer adhesion or release or a variety of product physical property control issues caused by the presence of unadsorbed or unretained water insoluble chemical additive in the process water on the manufacturing machines. Another aspect of the invention is the ability to deliver pulp fiber treated with water insoluble chemical additives that would not otherwise be retained when added in the wet end of a manufacturing operation or product solutions.

According to one embodiment of the present invention, the method comprises adding at least a first chemical additive to pulp fiber. Pulp fibers are mixed with process water thereby forming a fiber slurry. The fiber slurry is transported to a web-forming apparatus of a pulp sheet machine. The fiber slurry is dewatered thereby forming a crumb pulp. A water insoluble chemical additive is applied to the crumb pulp thereby forming a
chemically treated crumb pulp containing chemically treated pulp fibers. The chemically treated pulp fibers have an increased or improved level of chemical retention of the water insoluble chemical additive and have the level of chemical retention of the water insoluble chemical additive that is between about 25 to about 100 percent retention of the applied amount of the water insoluble chemical additive when the chemically treated pulp fibers are exposed to a liquid. The chemically treated pulp having the water insoluble chemical additive retained thereon is used to form a fibrous non-woven material. The level of chemical retention of the water insoluble chemical additive may range from between about 60 to about 100 percent or between about 80 to about 100 percent retention of the water insoluble chemical additive. The improved level of chemical retention of the water insoluble chemical additive, measured as the change in the level of chemical retention of adding by typical wet-end addition, may range from a lower limit of about 5 percent, about 15 percent, about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, and about 75 percent to a higher limit of about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, about 75 percent, about 85 percent, about 95 percent, and about 100 percent retention of the water insoluble chemical additive. It is understood that the value for the lower limit is less than the value for the upper limit.

Another aspect of the present invention resides in a method for applying water insoluble chemical additives to pulp fiber. The method comprises creating a fiber slurry comprising process water and pulp fibers. The fiber slurry is transported to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web. The wet fibrous web is dewatered to a predetermined consistency thereby forming a dewatered fibrous web. A first water insoluble chemical additive is applied to the dewatered fibrous web to form a chemically treated dewatered fibrous web of chemically treated pulp fibers. A second water insoluble chemical additive is applied to the chemically treated dewatered fibrous web thereby forming a dual chemically treated dewatered fibrous web containing dual chemically treated pulp fibers wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the first water insoluble chemical additive and have a level of chemical retention of the first water insoluble chemical additive that is between about 25 to about 100 percent retention of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid and wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the second water insoluble chemical additive and have a level of chemical retention of the second water insoluble chemical additive that is between about 25 to about 100 percent retention of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid. The
chemically treated pulp having the first and second water insoluble chemical additives retained thereon is used to form a fibrous non-woven material. The level of chemical retention of the first and/or second water insoluble chemical additive may range from between about 60 to about 100 percent or between about 80 to about 100 percent retention of the applied amount of the first and/or second water insoluble chemical additive. The improved level of chemical retention of the first and/or second water insoluble chemical additive, measured as the change in the level of chemical retention of adding by typical wet-end addition, may range from a lower limit of about 5 percent, about 15 percent, about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, and about 75 percent to a higher limit of about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, about 75 percent, about 85 percent, about 95 percent, and about 100 percent retention of the first and/or second water insoluble chemical additive, respectively. It is understood that the value for the lower limit is less than the value for the upper limit.

Another aspect of the present invention resides in a method for applying water insoluble chemical additives to pulp fiber. The method comprises mixing pulp fibers with process water to form a fiber slurry. The fiber slurry is transported to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web. The wet fibrous web is dewatered to a predetermined consistency thereby forming a dewatered fibrous web. The dewatered fibrous web is dried to a predetermined consistency thereby forming a dried fibrous web. A first water insoluble chemical additive is applied to the dried fibrous web and applying a second water insoluble chemical additive to the dried fibrous web, thereby forming a dual chemically treated dewatered fibrous web containing dual chemically treated pulp fibers wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the first water insoluble chemical additive and have a level of chemical retention of the first water insoluble chemical additive is between about 25 to about 100 percent retention of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid and wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the second water insoluble chemical additive and have a level of chemical retention of the second water insoluble chemical additive is between about 25 to about 100 percent retention of the applied second water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid. The chemically treated pulp having the first and second water insoluble chemical additives retained thereon is used to form a fibrous non-woven material. The level of chemical retention of the first and/or second water insoluble chemical additive may range from between about 60 to about 100 percent or
between about 80 to about 100 percent retention of the applied amount of the first and/or second water insoluble chemical additive. The improved level of chemical retention of the first and/or second water insoluble chemical additive, measured as the change in the level of chemical retention of adding by typical wet-end addition, may range from a lower limit of about 5 percent, about 15 percent, about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, and about 75 percent to a higher limit of about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, about 75 percent, about 85 percent, about 95 percent, and about 100 percent retention of the first and/or second water insoluble chemical additive, respectively. It is understood that the value for the lower limit is less than the value for the upper limit. A finished product having enhanced qualities due to the retention of the chemical additive by the pulp fibers may be produced.

Another aspect of the present invention resides in a method for applying water insoluble chemical additives to pulp fiber. The method comprises mixing pulp fibers with process water to form a fiber slurry. The fiber slurry is transported to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web. The wet fibrous web is dewatered to a predetermined consistency thereby forming a dewatered fibrous web. Applying a first water insoluble chemical additive to the dewatered fibrous web to the dewatered fibrous web thereby forming a chemically treated dewatered fibrous web. The chemically treated dewatered fibrous web is dried to a predetermined consistency thereby forming a chemically treated dried fibrous web. A second water insoluble chemical additive is applied to the chemically treated dried fibrous web, thereby forming a dual chemically treated dried fibrous web containing dual chemically treated pulp fibers wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the first water insoluble chemical additive and have a level of chemical retention of the first water insoluble chemical additive that is between about 25 to about 100 percent retention of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid and wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the second water insoluble chemical additive and have a level of chemical retention of the second water insoluble chemical additive that is between about 25 to about 100 percent retention of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid. The chemically treated pulp having the first and second water insoluble chemical additives retained thereon is used to form a fibrous non-woven material. The level of chemical retention of the first and/or second water insoluble chemical additive may range from between about 60 to about 100 percent or
between about 80 to about 100 percent retention of the applied amount of the first and/or second water insoluble chemical additive. The improved level of chemical retention of the first and/or second water insoluble chemical additive, measured as the change in the level of chemical retention of adding by typical wet-end addition, may range from a lower limit of about 5 percent, about 15 percent, about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, and about 75 percent to a higher limit of about 25 percent, about 35 percent, about 45 percent, about 55 percent, about 65 percent, about 75 percent, about 85 percent, about 95 percent, and about 100 percent retention of the first and/or second water insoluble chemical additive, respectively. It is understood that the value for the lower limit is less than the value for the upper limit. A finished product having enhanced qualities due to the retention of the chemical additive by the pulp fibers may be produced.

The present invention is particularly useful for adding water insoluble chemical additives such as softening agents to the pulp fibers, allowing for the less problematic and lower cost production of finished products having enhanced qualities provided by the retained water insoluble chemical additives by the pulp fibers.

Hence, another aspect of the present invention resides in fibrous non-woven materials and products made therefrom formed from pulp fibers that have been chemically treated to minimize the amount of residual, unretained water insoluble chemical additives in the process water on a manufacturing machine or in the product solutions.

The method for applying water insoluble chemical additives to the pulp fibers may be used in a wide variety of pulp finishing processing, including dry lap pulp, wet lap pulp, crumb pulp, and flash dried pulp operations. By way of illustration, various pulp finishing processes (also referred to as pulp processing) are disclosed in *Pulp and Paper Manufacture: The Pulping of Wood*, 2nd Ed., Volume 1, Chapter 12. Ronald G. MacDonald, editor, which is incorporated by reference. Various methods may be used to apply the water insoluble chemical additives in the present invention, including, but not limited to: spraying, dipping, coating, foaming, printing, size pressing, or any other method known in the art.

In addition, in situations where more than one water insoluble chemical additive is to be employed, the water insoluble chemical additives may be added to the fibrous web in sequence to reduce interactions between the water insoluble chemical additives.

Many pulp fiber types may be used for the present invention including hardwood or softwoods, straw, flax, milkweed seed floss fibers, abaca, hemp, kenaf, bagasse, cotton, reed, and the like. All known papermaking fibers may be used, including bleached and unbleached fibers, fibers of natural origin (including wood fiber and other cellulose fibers,
cellulose derivatives, and chemically stiffened or crosslinked fibers), some component portion of synthetic fiber (synthetic papermaking fibers include certain forms of fibers made from polypropylene, acrylic, aramids, acetates, and the like), virgin and recovered or recycled fibers, hardwood and softwood, and fibers that have been mechanically pulped (e.g., groundwood), chemically pulped (including but not limited to the kraft and sulfite pulp processings), thermomechanically pulped, chemithermomechanically pulped, and the like. Mixtures of any subset of the above mentioned or related fiber classes may be used. The pulp fibers can be prepared in a multiplicity of ways known to be advantageous in the art. Useful methods of preparing fibers include dispersion to impart curl and improved drying properties, such as disclosed in U.S. Patents 5,348,620 issued September 20, 1994 and 5,501,768 issued March 26, 1996, both to M. A. Hermans et al. and U.S. Patent 5,656,132 issued August 12, 1997 to Farrington, Jr. et al.

According to the present invention, the chemical treatment of the pulp fibers may occur prior to, during, or after the drying phase of the pulp processing. The generally accepted methods of drying include flash drying, can drying, flack drying, through air drying, Infra-red drying, fluidized bed, or any method of drying known in the art. The present invention may also be applied to wet lap pulp processes without the use of dryers.

Numerous features and advantages of the present invention will appear from the following description. In the description, reference is made to the accompanying drawings which illustrate preferred embodiments of the invention. Such embodiments do not represent the full scope of the invention. Reference should therefore be made to the claims herein for interpreting the full scope of the invention.

**BRIEF DESCRIPTION OF THE DRAWINGS**

**Figure 1** depicts a schematic process flow diagram of a method according to the present invention for treating pulp fibers with a single water insoluble chemical additive.

**Figure 2** depicts a schematic process flow diagram of a method according to the present invention for treating pulp fibers with multiple water insoluble chemical additives.

**Figure 3** depicts a schematic process flow diagram of a method of making a fibrous non-woven material.

**Figure 4** depicts a fluidized bed apparatus for applying water insoluble chemical additives to pulp fibers.

**Figure 5** depicts a fluidized bed apparatus for applying water insoluble chemical additives to pulp fibers.
DETAILED DESCRIPTION

The present invention provides a fibrous non-woven material or fibrous non-woven composite material adapted to provide improved softness and cloth-like feel in a finished product, such as a wet-wipe. The feel of a wet-wipe is often characterized by one or more of the following attributes of the fibrous non-woven materials that comprise them: thickness, bulk density, flexibility, texture, softness, and durability. In preparing a wet-wipe having a soft cloth-like feel, it is important to balance the properties of the non-woven material or non-woven composite material, e.g., cup crush, density, and tensile strength. However, this is a difficult task because these properties may be interdependent, i.e., changing one property may affect another property (and the overall feel of the wet-wipe). Typically, when the basis weight is decreased, the cup-crush is decreased, and tensile strength is decreased. When the basis weight is increased then the reverse changes occur. Thus, when a property is varied, to enhance the softness, careful attention should be paid to the results obtained to avoid a resultant product having less desirable overall properties. It is understood that the fibrous non-woven material or fibrous non-woven composite material may be layered and that discussions regarding a ply or plies may also be applied to a layer or layers.

The wet-wipes of the present invention include at least one ply of fibrous non-woven material or fibrous non-woven composite material. The preferred CD tensile strength of the fibrous non-woven material or the fibrous non-woven composite material of the wet-wipe is of greater than about 0.70 lbs. A more preferred CD tensile strength is of greater than about 0.75 lbs. A slightly more preferred CD tensile strength is of greater than about 0.80 lbs. A yet more preferred CD tensile strength is of greater than about 0.85 lbs. A much more preferred CD tensile strength is of greater than about 0.90 lbs. A very much more preferred CD tensile strength is of greater than about 0.95 lbs. The most preferred CD tensile strength is of greater than about 1.0 lbs.

The basis weight (in grams per square meter, g/m² or gsm) of the fibrous non-woven material of the wet-wipe is calculated by dividing the dry weight by the area (in square meters). The density of the fibrous non-woven material or fibrous non-woven composite material of the wet-wipe, as used herein, is a “wet density” and is calculated as the basis weight (in grams per square meter, g/m² or gsm) divided by the thickness of the wet-wipe after wetting with the solution.

The wet-wipes of the present invention comprise a fibrous non-woven material or a fibrous non-woven composite material and a liquid. The liquid may be any solution which may be absorbed into the wet-wipe composite elastic material and may include any suitable components which provide the desired wiping properties. For example, the
components may include water, emollients, surfactants, fragrances, preservatives, chelating agents, pH buffers or combinations thereof as are well known to those skilled in the art. The liquid may also contain lotions and/or medicaments.

The amount of liquid contained within each wet-wipe may vary depending upon the type of material being used to provide the wet-wipe, the type of liquid being used, the type of container being used to store the wet-wipes, and the desired end use of the wet-wipe. Generally, each wet-wipe may contain from about 150 to about 600 weight percent and preferably from about 250 to about 450 weight percent liquid based on the dry weight of the wipe for improved wiping. In a more preferred aspect, the amount of liquid contained within the wet-wipe is from about 300 to about 400 weight percent and desirably about 330 weight percent based on the dry weight of the wet-wipe. If the amount of liquid is less than the above-identified ranges, the wet-wipe may be too dry and may not adequately perform. If the amount of liquid is greater than the above-identified ranges, the wet-wipe may be oversaturated and soggy and the liquid may pool in the bottom of the container.

Each wet-wipe is generally rectangular in shape and may have any suitable unfolded width and length. For example, the wet-wipe may have an unfolded length of from about 2.0 to about 80.0 centimeters and desirably from about 10.0 to about 25.0 centimeters and an unfolded width of from about 2.0 to about 80.0 centimeters and desirably from about 10.0 to about 25.0 centimeters. Preferably, each individual wet-wipe is arranged in a folded configuration and stacked one on top of the other to provide a stack of wet-wipes or interfolded in a configuration suitable for pop-up dispensing. Such folded configurations are well known to those skilled in the art and include c-folded, z-folded, quarter-folded configurations and the like. The stack of folded wet-wipes may be placed in the interior of a container, such as a plastic tub, to provide a package of wet-wipes for eventual sale to the consumer. Alternatively, the wet-wipes may include a continuous strip of material which has perforations between each wipe and which may be arranged in a stack or wound into a roll for dispensing.

The fibrous non-woven material or fibrous non-woven composite material of the wet-wipes of the present invention may include at least two plies of material having different physical properties. The different physical properties which a ply may be configured to provide by selecting the appropriate materials include softness, resiliency, strength, flexibility, integrity, toughness, absorbency, liquid retention, thickness, tear resistance, surface texture, drapability, hand, wetability, wicking ability and the like and combinations thereof. Preferably, the fibrous non-woven materials and/or fibrous non-woven composite materials used in a plied wet-wipe are configured to provide softness and flexibility while maintaining adequate strength, integrity and resiliency, particularly
when wetted. For example, the wet-wipes may include at least one ply of fibrous non-woven material or fibrous non-woven composite material which is configured to provide strength and resilience to the wet-wipe and at least one other ply of a fibrous non-woven material or fibrous non-woven composite material which is configured to provide a soft, gentle wiping surface to the wet-wipe. Preferably, the wet-wipes include a soft ply on each side of a strong and resilient ply such that both exposed surfaces of the wipe provide a soft, gentle surface for contact with the skin.

The fibrous non-woven material or fibrous non-woven composite material may be formed by the microfibers and wood pulp fibers without any adhesive, molecular or hydrogen bonds between the two different types of fibers. The absorbent fibers are preferably distributed uniformly throughout the matrix of microfibers to provide a homogeneous material. The material is formed by initially forming a primary air stream containing the melt blown microfibers, forming a secondary air stream containing the wood pulp fibers, merging the primary and secondary streams under turbulent conditions to form an integrated air stream containing a thorough mixture of the microfibers and wood pulp fibers, and then directing the integrated air stream onto a forming surface to air form the fabric-like material. The microfibers are in a soft nascent condition at an elevated temperature when they are turbulently mixed with the wood pulp fibers in air.

In one embodiment of the present invention, the ply(s) of fibrous non-woven material or fibrous non-woven composite material may have from about 20 to about 50 wt. % of the polymer fibers and from about 80 to about 50 wt. % of the pulp fibers. A more specific ratio of the polymer fibers to the pulp fibers may be from about 25 to about 40 wt. % of the polymer fibers and from about 75 to about 60 wt. % of the pulp fibers. A more specific ratio of the polymer fibers to the pulp fibers may be from about 30 to about 40 wt. % of the polymer fibers and from about 70 to about 60 wt. % of the pulp fibers. The most specific ratio of the polymer fibers to the pulp fibers may be about 35 wt. % of the polymer fibers and about 65 wt. % of the pulp fibers.

Non-limiting examples of the polymers suitable for practicing the invention are polyolefin materials such as, for example, polyethylene, polypropylene and polybutylene, including ethylene copolymers, propylene copolymers and butylene copolymers thereof. A particularly useful polypropylene is Basell PF-105. Additional polymers are disclosed in U.S. Patent No. 5,385,775.

Pulp fibers of diverse natural origin are applicable in the present invention. Digested cellulose fibers from softwood (derived from coniferous trees), hardwood (derived from deciduous trees) or cotton linters may be utilized. Pulp fibers from Esparto grass, bagasse, kemp, flax, and other lignaceous and cellulose fiber sources may also be
utilized as raw material in the present invention. For reasons of cost, ease of manufacture and disposability, preferred fibers are those derived from wood pulp (i.e., cellulose fibers). A commercial example of such a wood pulp material is available from Weyerhaeuser as CF-405. Generally wood pulp fibers may be utilized. Applicable wood pulps include chemical pulps, such as Kraft (i.e., sulfate) and sulfite pulps, as well as mechanical pulps including, for example, groundwood, thermomechanical pulp (i.e., TMP) and chemithermomechanical pulp (i.e., CTMP). Completely bleached, partially bleached and unbleached fibers are useful herein. It may frequently be desired to utilize bleached pulp for its superior brightness and consumer appeal.

Also useful in the present invention are fibers derived from recycled paper, which may contain any or all of the above categories as well as other non-fibrous materials such as fillers and adhesives used to facilitate the original paper making process.

The ply(s) of fibrous non-woven material or fibrous non-woven composite material may be non-woven materials such as, for example, spunbonded webs, meltblown webs, air laid ply webs, bonded carded webs, hydroentangled webs, wet-formed webs or any combination thereof. In one embodiment of the present invention, one or more plies of a multi-ply fibrous non-woven material and/or fibrous non-woven composite material having, for example, at least one ply of spunbonded web joined to at least one ply of meltblown web, bonded carded web or other suitable material.

One or both of the plies of a multi-ply product may be a composite material made of a mixture of two or more different fibers or a mixture of fibers and particulates. Such mixtures may be formed by adding fibers and/or particulates to the gas stream in which meltblown fibers are carried so that an intimate entangled commingling of meltblown fibers and other materials, e.g., wood pulp, staple fibers and particulates such as, for example, hydrocolloid (hydrogel) particulates commonly referred to as superabsorbent materials, occurs prior to collection of the meltblown fibers upon a collecting device to form a coherent web of randomly dispersed meltblown fibers and other materials such as disclosed in U.S. Patent No. 4,100,324, to Anderson et al.

A suitable material for practicing the present invention is a fibrous non-woven composite material commonly referred to as “coform.” Coform is an air-formed matrix material of thermoplastic polymeric meltblown fibers such as, for example, microfibers having an average fiber diameter of less than about 10 microns, and a multiplicity of individualized absorbent pulp fibers such as, for example, wood pulp fibers disposed throughout the matrix of polymer microfibers and engaging at least some of the microfibers to space the microfibers apart from each other. The absorbent pulp fibers are interconnected by and held captive within the matrix of microfibers by mechanical
entanglement of the microfibers with the absorbent pulp fibers, the mechanical
entanglement and interconnection of the microfibers and absorbent pulp fibers alone
forming a coherent integrated fibrous non-woven structure.

The coherent integrated fibrous structure may be formed by the microfibers and
absorbent pulp fibers without any adhesive, molecular or hydrogen bonds between the two
different types of fibers. The absorbent pulp fibers are typically distributed uniformly
throughout the matrix of microfibers to provide a homogeneous material. The fibrous non-
woven material is formed by initially forming a primary air stream containing the melt
blown microfibers, forming a secondary air stream containing the wood pulp fibers,
merging the primary and secondary streams under turbulent conditions to form an
integrated air stream containing a thorough mixture of the microfibers and wood pulp
fibers, and then directing the integrated air stream onto a forming surface to air form the
fabric-like material. The microfibers are in a soft nascent condition at an elevated
temperature when they are turbulently mixed with the wood pulp fibers in air.

In one embodiment of the present invention, the plies of fibrous non-woven
material or fibrous non-woven composite material are coform plies having from about 20 to
about 50 wt. % of the polymer fibers and from about 80 to about 50 wt. % of the pulp fibers.
A more specific ratio of the polymer fibers to the pulp fibers may be from about 25 to about
40 wt. % of the polymer fibers and from about 75 to about 60 wt. % of the pulp fibers. A
more specific ratio of the polymer fibers to the pulp fibers may be from about 30 to about
40 wt. % of the polymer fibers and from about 70 to about 60 wt. % of the pulp fibers. The
most specifically the ratio of the polymer fibers to the pulp fibers is about 35 wt. % of the
polymer fibers and about 65 wt. % of the pulp fibers.

One of the plies of fibrous non-woven material may be made of pulp fibers,
including wood pulp fibers, to form a material such as, for example, a tissue ply.
Additionally, the plies of fibrous non-woven material or fibrous non-woven composite
material may be plies of hydraulically entangled fibers such as, for example, hydraulically
entangled mixtures of wood pulp and staple fibers such as disclosed in U.S. Patent No.
4,781,966, to Taylor.

The plies of fibrous non-woven material or fibrous non-woven composite material
may be joined together or to other plies of material in at least two places by any suitable
means such as, for example, thermal bonding or ultrasonic welding which softens at least
portions of at least one of the materials. The joining may be produced by applying heat
and/or pressure to the materials of the plies by heating these portions to at least the
softening temperature of the material with the lowest softening temperature to form a
reasonably strong and permanent bond between the re-solidified softened portions of the materials of the plies.

As may be appreciated, the bonding between the plies may be a point bonding. Various bonding patterns may be used, depending upon the desired tactile properties of the final composite laminate of the plies. The bonding points are preferably evenly distributed over the bonding area of the plies.

With regard to thermal bonding, one skilled in the art will appreciate that the temperature to which the materials comprising the plies, or at least the bond sites thereof, are heated for heat-bonding will depend not only on the temperature of the heated roller(s) or other heat sources but on the residence time of the materials on the heated surfaces, the compositions of the materials comprising the plies, the basis weights of the materials of the plies and the specific heats and thermal conductivities of the materials of the plies. Typically, the bonding may be conducted at a temperature of from about 40° to about 80° C. Specifically, the bonding may be conducted at a temperature of from about 55° to about 75° C. More specifically, the bonding may be conducted at a temperature of from about 60° to about 70° C. The typical pressure range, on the rollers, may be from about 18 to about 56.8 Kg per linear cm (KLC). The specific pressure range, on the rollers, may be from about 18 to about 24 Kg per linear cm (KLC). However, for a given combination of materials of the plies, and in view of the herein contained disclosure the processing conditions necessary to achieve satisfactory bonding may be readily determined by one of skill in the art.

The present invention will now be described in greater detail with reference to the Figures. A variety of conventional pulping apparatuses and operations can be used with respect to the pulping phase, pulp processing, and drying of pulp fiber. It is understood that the pulp fibers could be virgin pulp fiber or recycled pulp fiber. Nevertheless, particular conventional components are illustrated for purposes of providing the context in which the various embodiments of the present invention can be used. Improved retention of chemical additives by the pulp fibers may be obtained by treating the pulp fibers according to the present invention rather than treating the pulp fibers in wet end additions at manufacturing machines. In addition, the present invention allows for quick pulp fiber grade changes at the manufacturing mills.

**Figure 1** depicts pulp processing preparation equipment used to apply water insoluble chemical additives to pulp fibers according to one embodiment of the present invention. A fiber slurry 10 is prepared and thereafter transferred through suitable conduits (not shown) to the headbox 28 where the fiber slurry 10 is injected or deposited into a fourdrinier section 30 thereby forming a wet fibrous web 32. The wet fibrous web 32
may be subjected to mechanical pressure to remove process water. It is understood that
the process water may contain process chemicals used in treating the fiber slurry 10 prior
to a web formation step. In the illustrated embodiment, the fourdrinier section 30 precedes
a press section 44, although alternative dewatering devices such as a nip thickening
device, or the like may be used in a pulp sheet machine. The fiber slurry 10 is deposited
onto a foraminous fabric 46 such that the fourdrinier section filtrate 48 is removed from the
wet fibrous web 32. The fourdrinier section filtrate 48 comprises a portion of the process
water. The press section 44 or other dewatering device known in the art suitably
increases the fiber consistency of the wet fibrous web 32 to about 30 percent or greater,
and particularly about 40 percent or greater thereby creating a dewatered web 33. The
process water removed as fourdrinier section filtrate 48 during the web forming step may
be used as dilution water for dilution stages in the pulp processing or discarded.

The dewatered fibrous web 33 may be further dewatered in additional press
sections or other dewatering devices known in the art. The suitably dewatered fibrous
web 33 may be transferred to a dryer section 34 where evaporative drying is carried out
on the dewatered fibrous web 33 to an airdry consistency, thereby forming a dried fibrous
web 36. The dried fibrous web 36 is thereafter wound on a reel 37 or slit, cut into sheets,
and baled via a baler (not shown) for delivery to manufacturing machines 38 (shown in
Figure 3).

A water insoluble chemical additive 24 may be added or applied to the dewatered
fibrous web 33 or the dried fibrous web 36 at a variety of addition points 35a, 35b, 35c,
and 35d as shown in Figure 1. It is understood that while only four addition points 35a,
35b, 35c, and 35d are shown in Figure 1, the application of the water insoluble chemical
additive 24 may occur at any point between the point of initial dewatering of the wet
fibrous web 32 to the point the dried fibrous web 36 is wound on the reel 37 or baled for
transport to the manufacturing machines 38. The addition point 35a shows the addition of
the water insoluble chemical additive 24 within press section 44. The addition point 35b
shows the addition of the water insoluble chemical additive 24 between the press section
44 and the dryer section 34. The addition point 35c shows the addition of the water
insoluble chemical additive in the dryer section 34. The addition point 35d shows the
addition of the water insoluble chemical additive 24 between the dryer section 34 and the
reel 37 or baler (not shown).

The amount of water insoluble chemical additive retained by the chemically treated
pulp fibers is about 0.1 kilogram per metric ton or greater. In particularly desirable
embodiments, the amount of retained water insoluble chemical additive is about 0.5
kg/metric ton or greater, particularly about 1 kg/metric ton or greater, and more particularly
about 2 kg/metric ton or greater. Once the chemically treated pulp fibers are exposed to a liquid, the amount of unretained water insoluble chemical additive in the process water phase or product solution is between 0 and about 50 percent, particularly between 0 and about 30 percent, and more particularly between 0 and about 10 percent, of the amount of water insoluble chemical additive retained by the chemically treated pulp fibers.

Chemistries suitable for use in the present invention include those not soluble in water. Particularly useful are those water insoluble chemistries that provide a product enhancement benefit when incorporated into a fibrous non-woven material and products made therefrom. Even more useful are those water insoluble chemistries that will not extract with water after having been adsorbed onto cellulosic fiber surfaces. Chemical classifications suitable for use in the invention include, but are not limited to, mineral oil, petrolatum, olefins, alcohols, fatty alcohols, ethoxylated fatty alcohols, esters, high molecular weight carboxylic and polycarboxylic acids and their salts, polydimethylsiloxane and modified polydimethylsiloxane. Modified polydimethylsiloxanes can include amino-functional polydimethylsiloxanes, alkylene oxide-modified polydimethylsiloxane, organomodified polysiloxanes, mixtures of cyclic and non-cyclic modified polydimethylsiloxanes and the like. It should be recognized that water insoluble chemical additives can be applied as dispersions or emulsions and still fall within the scope of the present invention.

A list of water insoluble chemical additives that can be used in conjunction with the present invention include: dry strength agents, wet strength agents, softening agents, debonding agents, adsorbency agents, sizing agents, dyes, optical brighteners, chemical tracers, opacifiers, dryer adhesive chemicals, and the like. Additional water insoluble chemical additives may include: pigments, emollients, humectants, viricides, bactericides, buffers, waxes, fluoropolymers, odor control materials and deodorants, zeolites, perfumes, vegetable and mineral oils, polysiloxane compounds, surfactants, moisturizers, UV blockers, antibiotic agents, lotions, fungicides, preservatives, aloe-vera extract, vitamin E, or the like.

- Polysiloxanes encompass a very broad class of compounds. They are characterized in having a backbone structure:

\[
\begin{array}{c}
\text{R}^+ \\
\text{Si} \\
\text{O} \\
\text{R}^-
\end{array}
\]

\[n\]
where R' and R" can be a broad range of organo and non-organo groups including mixtures of such groups and where n is an integer ≥2. These polysiloxanes may be linear, branched or cyclic. They include a wide variety of polysiloxane copolymers containing various compositions of functional groups, hence, R' and R" actually may represent many different types of groups within the same polymer molecule. The organo or non-organo groups may be capable of reacting with cellulose to covalently, ionic or hydrogen bond the polysiloxane to the cellulose. These functional groups may also be capable of reacting with themselves to form crosslinked matrices with the cellulose. The scope of the invention should not be construed as limited by a particular polysiloxane structure so long as that polysiloxane structure delivers the aforementioned product or process benefits.

While not wishing to be bound by theory, the softness benefits that polysiloxanes deliver to cellulose containing products is believed to be, in part, related to the molecular weight of the polysiloxane. Viscosity is often used as an indication of molecular weight of the polysiloxane as exact number or weight average molecular weights are often difficult to determine. The viscosity of the polysiloxanes of the present invention is greater than about 25 centipoise, more typically greater than 50 centipoise and most typically greater than 100 centipoise. Viscosity as referred to herein refers to the viscosity of the neat polysiloxane itself and not to the viscosity of an emulsion if so delivered. It should also be understood that the polysiloxanes of the current invention may be delivered as solutions containing diluents. Such diluents may lower the viscosity of the solution below the limitations set above, however, the efficacious part of the polysiloxane should conform to the viscosity ranges given above. Examples of such diluents include but is not limited to oligomeric and cyclo-oligomeric polysiloxanes such as octamethylcyclotetrasiloxane, octamethyltrisiloxane, decamethylcyclopentasiloxane, decamethyltetrasiloxane and the like including mixtures of said compounds.

A specific class of polysiloxanes suitable for the invention has the general formula:

![Polysiloxane Structure](image)

Wherein the R¹ – R⁶ moieties can be independently any organofunctional group including C₁ or higher alkyl groups, ethers, polyethers, polyesters, amines, imines, amides, or other functional groups including the alkyl and alkenyl analogues of such groups and y is an integer.
integer > 1. Preferably the $R^1 - R^8$ moieties are independently any $C_1$ or higher alkyl group including mixtures of said alkyl groups. Exemplary fluids are the DC-200 fluid series, manufactured and sold by Dow Corning, Inc.

Another exemplary class of functionalized polysiloxanes suitable for the present invention is the polyether polysiloxanes. Such polysiloxanes are widely taught in the art and are usually incorporated wholly or in part with other functional polysiloxanes as a means of improving hydrophilicity of the silicone treated product. Such polysiloxanes will generally have the following structure:

![Polyether polysiloxane structure](image)

Wherein, x and z are integers > 0. y is an integer ≥0. The mole ratio of x to (x + y+z) can be from about 0.05 percent to about 95 percent. The ratio of y to (x+y+z) can be from about 0 percent to about 25 percent. The $R^0 - R^3$ moieties can be independently any organofunctional group including $C_1$ or higher alkyl groups, ethers, polyethers, polyesters, amines, imines, amides, or other functional groups including the alkyl and alkenyl analogues of such groups. The $R^{10}$ moiety is an amino functional moiety including but not limited to primary amine, secondary amine, tertiary amines, quaternary amines, unsubstituted amides and mixtures thereof. An exemplary $R^{10}$ moiety contains one amine group per constituent or two or more amine groups per substituent, separated by a linear or branched alkyl chain of $C^1$ or greater. $R^{11}$ is a polyether functional group having the generic formula: 

$$-R^{12}-(R^{13}-O)_a-(R^{14}O)_b-R^{15}$$

wherein $R^{12}$, $R^{13}$, and $R^{14}$ are independently $C_{1-4}$ alkyl groups, linear or branched; $R^{15}$ can be H or a $C_{1-30}$ alkyl group; and, "a" and "b" are integers of from about 1 to about 100, more specifically from about 5 to about 30. Exemplary fluids are the Wetsoft CTW family manufactured and sold by Wacker, Inc. Other exemplary fluids can be found in U.S. Patent No. 6,432,270 issued to Liu, et.al. and incorporated by reference herein.

Most typically, the polysiloxane is chosen from the group of so called "amino functional" functional polysiloxanes of the general formula:
Wherein, x and y are integers > 0. The mole ratio of x to (x + y) can be from about 0.005 percent to about 25 percent. The R^1 – R^8 moieties can be independently any organofunctional group including C_1 or higher alkyl groups, ethers, polyethers, polyesters, amines, imines, amides, or other functional groups including the alkyl and alkenyl analogues of such groups. The R^{10} moiety is an amino functional moiety including but not limited to primary amine, secondary amine, tertiary amines, quaternary amines, unsubstituted amides and mixtures thereof. An exemplary R^{10} moiety contains one amine group per constituent or two or more amine groups per substituent, separated by a linear or branched alkyl chain of C^1 or greater. An exemplary material includes but is not limited to 2-8220 fluid manufactured and sold by Dow Corning.

It should also be recognized that often it is advantageous to use a blend of various functional polysiloxanes. For example, amino functional polysiloxanes may be blended with polyether functional polysiloxanes and this blend applied to the product. The polyether functional polysiloxane helps mitigate any undesirable hydrophobicity within the product. It should be understood that such blends fall within the scope of the present invention.

At the manufacturing machines 38, one example of such machines 38 is shown in Figure 3, a primary gas stream 66 containing polymeric microfibers, formed by any known method, such as meltblown techniques. The molten polymeric material is extruded through a diehead 68 by converging flows of high velocity heated gas (usually air) supplied from nozzles 70 and 72. The primary gas stream 66 is merged with a secondary gas stream 74 containing individualized chemically treated pulp fibers having the chemical additive 24 so as to integrate the two different fibrous materials into a single integrated stream 76 in a single step. The manufacturing machine 38 typically includes a conventional picker roll 78 having teeth for divellicating pulp sheets 80 into individual chemically treated pulp fibers having the chemical additive 24. The chemically treated pulp sheets 80 having the chemical additive 24 are fed radially by means of rolls 82. The individualized chemically treated pulp fibers having the chemical additive 24 are conveyed downwardly toward the primary air stream 66 through a forming nozzle or duct 84. A housing 86 encloses the picker roll 78 and provides a passage 88 between the housing 86...
and the surface of the picker roll 78. The secondary gas stream 74 supplied through duct 90 passes through the passage 88 while carrying the individualized chemically treated pulp fibers having the chemical additive 24 through the forming nozzle 84. To convert the fibrous blend in the integrated stream 76 into an integral fibrous non-woven material or fibrous non-woven composite material 92, the integrated stream 76 passes through a nip of a pair of vacuum rolls 94 and 96 having foraminous surfaces that rotate continuously over a pair of fixed vacuum nozzles 98 and 100. As the integrated stream 76 is pulled into the vacuum nozzles 98 and 100, the carrying gas is removed while the fibrous blend is supported and slightly compressed by the opposed surfaces of the two rolls 94 and 96. The integral fibrous non-woven material or fibrous non-woven composite material 92 removed from the vacuum roll nip and conveyed to a wind-up roll 102. The integral fibrous non-woven material or fibrous non-woven composite material 92 is passed through an ultrasonic embossing station 108 comprising an ultrasonic calendaring head 104 and a patterned anvil roll 106. The finished product, such as a wet-wipe has enhanced qualities due to the retention of the chemical additive 24 by the chemically treated pulp fibers during the pulp processing. In other embodiments of the present invention, additional chemical additive 24 may be added to the chemically treated pulp fiber stock preparation at the manufacturing machine 38.

Figure 2 depicts an alternative embodiment of the present invention in which sequential addition of the first and second water insoluble chemical additives 24 and 25, respectively, are added to the dewatered fibrous web slurry 33 and/or the dried fibrous web 36. It is understood that the addition of the first water insoluble chemical additive 24 may occur any where that the second water insoluble chemical additive 25 may be applied. It is also understood that the addition of the second water insoluble chemical additive 25 may occur any where that the first water insoluble chemical additive 24 may be applied. A fiber slurry 10 is prepared and thereafter transferred through suitable conduits (not shown) to the headbox 28 where the fiber slurry 10 is injected or deposited into a fourdrinier section 30 thereby forming a wet fibrous web 32. The wet fibrous web 32 may be subjected to mechanical pressure to remove process water. In the illustrated embodiment, the fourdrinier section 30 precedes a press section 44, although alternative dewatering devices such as a nip thickening device, or the like known in the art may be used in the pulp sheet machine. The fiber slurry 10 is deposited onto a foraminous fabric 46 such that the fourdrinier section filtrate 48 is removed from the wet fibrous web 32. The fourdrinier section filtrate 48 comprises a portion of the process water. The press section 44 or other dewatering device suitably increases the fiber consistency of the wet fibrous web 32 to about 30 percent or greater, and particularly about 40 percent or greater thereby forming a
dewatered fibrous web 33. The process water removed as fourdrinier section filtrate 48 during the web forming step may be used as dilution water for dilution stages in the pulp processing or discarded.

The dewatered fibrous web 33 may be further dewatered in additional press sections 44 or other dewatering devices known in the art. The suitably dewatered fibrous web 33 may be transferred to a dryer section 34 where evaporative drying is carried out on the dewatered fibrous web 33 to an airdry consistency, thereby forming a dried fibrous web 36. The dried fibrous web 36 is thereafter wound on a reel 37 or slit, cut into sheets, and baled via a baler (not shown) for delivery to manufacturing machines 38 (shown in Figure 3).

The first water insoluble chemical additive 24 may be added or applied to the dewatered fibrous web 33 or the dried fibrous web 36 at a variety of addition points 35a, 35b, 35c, and 35d as shown in Figure 2. It is understood that while only four addition points 35a, 35b, 35c, and 35d are shown in Figure 2, the application of the first water insoluble chemical additive 24 may occur at any point between the point of initial dewatering of the wet fibrous web 32 to the point the dried fibrous web 36 is wound on the reel 37 or baled for transport to the manufacturing machines 38. The addition point 35a shows the addition of the first water insoluble chemical additive 24 within press section 44. The addition point 35b shows the addition of the first chemical additive 24 between the press section 44 and the dryer section 34. The addition point 35c shows the addition of the first water insoluble chemical additive 24 within the dryer section 34. The addition point 35d shows the addition of the first water insoluble chemical additive 24 between the dryer section 34 and the reel 37 or baler.

The second water insoluble chemical additive 25 may be added or applied to the dewatered fibrous web 33 or the dried fibrous web 36 at a variety of addition points 35a, 35b, 35c, and 35d as shown in Figure 2. It is understood that while only four addition points 35a, 35b, 35c, and 35d are shown in Figure 2, the application of the second water insoluble chemical additive 25 may occur at any point between the point of initial dewatering of the wet fibrous web 32 to the point the dried fibrous web 36 is wound on the reel 37 or baled for transport to the manufacturing machines 38 downstream of at least the initial point of application of the first water insoluble chemical additive 24. The addition point 35a shows the addition of the second water insoluble chemical additive 25 within press section 44. The addition point 35b shows the addition of the second water insoluble chemical additive 25 between the press section 44 and the dryer section 34. The addition point 35c shows the addition of the second chemical additive within the dryer section 34.
The addition point 35d shows the addition of the second water insoluble chemical additive 25 between the dryer section 34 and the reel 37 or baler.

At the manufacturing machines 38, one example of such machines 38 is shown in Figure 3, a primary gas stream 66 containing polymeric microfibers, formed by any known method, such as meltblown techniques. The molten polymeric material is extruded through a diehead 68 by converging flows of high velocity heated gas (usually air) supplied from nozzles 70 and 72. The primary gas stream 66 is merged with a secondary gas stream 74 containing individualized chemically treated pulp fibers having the chemical additives 24 and 25 so as to integrate the two different fibrous materials into a single integrated stream 76 in a single step. The manufacturing machine 38 typically includes a conventional picker roll 78 having teeth for divellicating pulp sheets 80 into individual chemically treated pulp fibers having the chemical additives 24 and 25. The chemically treated pulp sheets 80 having the chemical additives 24 and 25 are fed radially by means of rolls 82. The individualized chemically treated pulp fibers having the chemical additives 24 and 25 are conveyed downwardly toward the primary air stream 66 through a forming nozzle or duct 84. A housing 86 encloses the picker roll 78 and provides a passage 88 between the housing 86 and the surface of the picker roll 78. The secondary gas stream 74 supplied through duct 90 passes through the passage 88 while carrying the individualized chemically treated pulp fibers having the chemical additives 24 and 25 through the forming nozzle 84. To convert the fibrous blend in the integrated stream 76 into an integral fibrous non-woven material or fibrous non-woven composite material 92, the integrated stream 76 passes through a nip of a pair of vacuum rolls 94 and 96 having foraminous surfaces that rotate continuously over a pair of fixed vacuum nozzles 98 and 100. As the integrated stream 76 is pulled into the vacuum nozzles 98 and 100, the carrying gas is removed while the fibrous blend is supported and slightly compressed by the opposed surfaces of the two rolls 94 and 96. The integral fibrous non-woven material or fibrous non-woven composite material 92 removed from the vacuum roll nip and conveyed to a wind-up roll 102. The integral fibrous non-woven material or fibrous non-woven composite material 92 is passed through an ultrasonic embossing station 108 comprising an ultrasonic calendaring head 104 and a patterned anvil roll 106. The finished product, such as a wet-wipe has enhanced qualities due to the retention of the chemical additives 24 and 25 by the chemically treated pulp fibers during the pulp processing. In other embodiments of the present invention, additional chemical additives 24 and 25 may be added to the chemically treated pulp fiber stock preparation at the manufacturing machine 38.
In other embodiments, it is understood that a third, fourth, fifth, so forth, water
insoluble chemical additives may be used to treat the dewatered fibrous web 33 and/or
dried fibrous web 36.

The amount of first water insoluble chemical additive 24 is suitably about 0.1
kg./metric ton of pulp fiber or greater. In particular embodiments, the first water insoluble
chemical additive 24 is a polysiloxane and is added in an amount from about 0.1
kg./metric ton of pulp fiber or greater.

The amount of the second water insoluble chemical additive 25 is suitably about
0.1 kg./metric ton of pulp fiber or greater. In particular embodiments, the second water
insoluble chemical additive 25 is a polysiloxane and is added in an amount from about 0.1
kg./metric ton of pulp fiber or greater.

In other embodiments of the present invention, each of the first and second water
insoluble chemical additives 24 and 25 may be added to the fiber slurry 10 at a variety of
positions in the pulp processing apparatus.

In other embodiments of the present invention, one batch of pulp fibers may be
treated with a first water insoluble chemical additive 24 according to the method of the
present invention as discussed above while a second batch of pulp fibers may be treated
with a second water insoluble chemical additive 25 according to the present invention.
During the manufacturing process, different pulp fibers or pulp fibers having different
treatments may be processed into a layered or plied fibrous non-woven material or a
layered or plied product made therefrom.

In other embodiments of the present invention, a gradient of the first and/or the
second water insoluble chemical additives 24 and 25 along the z-direction of the
dewatered fibrous web 33 and/or the dried fibrous web 36 may be established by a
directed application of the first and/or the second water insoluble chemical additives 24
and 25. In one embodiment, the first and/or the second water insoluble chemical additives
24 and 25 are applied to one side of the dewatered fibrous web 33 and/or the dried fibrous
web 36. In another embodiment, one side of the dewatered fibrous web 33 and/or the
dried fibrous web 36 is saturated with the first and/or the second water insoluble chemical
additives 24 and 25. In another embodiment, a dual gradient may be established in the z-
direction of the dewatered fibrous web 33 and/or the dried fibrous web 36 by applying the
first water insoluble chemical additive 24 to one side of the dewatered fibrous web 33
and/or the dried fibrous web 36 and applying the second water insoluble chemical additive
25 to the other (opposing) side of the dewatered fibrous web 33 and/or the dried fibrous
web 36. The term “z-direction” refers to the direction through the thickness of the web
material.
The first and/or the second water insoluble chemical additives 24 and 25 may be applied so as to establish a gradient wherein about 100 percent of each of the first and/or the second water insoluble chemical additives 24 and 25 is located from the side of the dewatered fibrous web 33 and/or the dried fibrous web 36 treated with the first and/or the second water insoluble chemical additives 24 and 25 to the middle of the dewatered fibrous web 33 and/or the dried fibrous web 36 along the z-direction of the dewatered fibrous web 33 and/or the dried fibrous web 36 and substantially none of each of the first and/or the second water insoluble chemical additives 24 and 25 is located from the middle of the dewatered fibrous web 33 and/or the dried fibrous web 36 to the opposing side of the dewatered fibrous web 33 and/or the dried fibrous web 36 along the z-direction of the dewatered fibrous web 33 and/or the dried fibrous web 36.

The first and/or the second water insoluble chemical additives 24 and 25 may be applied so as to establish a gradient wherein about 66 percent of each of the first and/or the second water insoluble chemical additives 24 and 25 is located from the side of the dewatered fibrous web 33 and/or the dried fibrous web 36 treated with the first and/or the second water insoluble chemical additives 24 and 25 to the middle of the dewatered fibrous web 33 and/or the dried fibrous web 36 along the z-direction of the dewatered fibrous web 33 and/or the dried fibrous web 36 and about 33 percent of each of the first and/or the second water insoluble chemical additives 24 and 25 is located from the middle of the dewatered fibrous web 33 and/or the dried fibrous web 36 to the opposing side of the dewatered fibrous web 33 and/or the dried fibrous web 36 along the z-direction of the dewatered fibrous web 33 and/or the dried fibrous web 36. The gradient may also be established wherein about 100 percent, about 75 percent, about 60 percent, about 50 percent, about 40 percent, about 25 percent, or about 0 percent of each of the first and/or second water insoluble chemical additives 24 and 25 is located from one side of the dewatered fibrous web 33 and/or the dried fibrous web 36 and about 0 percent, about 25 percent, about 40 percent, about 50 percent, about 60 percent, about 75 percent, or about 100 percent of each of the first and/or second water insoluble chemical additives 24 and 25 is located from the opposing side of the dewatered fibrous web 33 and/or the dried fibrous web 36.

It is understood that in any of these embodiments, the first and second water insoluble chemical additives 24 and 25 may be each applied on opposing sides of the dewatered fibrous web 33 and/or the dried fibrous web 36. Alternatively, the first and second water insoluble chemical additives 24 and 25 could be applied to both opposing sides of the dewatered fibrous web 33 and/or the dried fibrous web 36. In still another variation, the first and second water insoluble chemical additives 24 and 25 could be
applied to only one side of the dewatered fibrous web 33 and/or the dried fibrous web 36. Where only a first water insoluble chemical additive 24 is applied to the dewatered fibrous web 33 and/or the dried fibrous web 36, the first water insoluble chemical additive 24 may be applied to one side or both opposing sides of the dewatered fibrous web 33 and/or the dried fibrous web 36.

In another embodiment of the present invention, the amounts of the first and/or second water insoluble chemical additives 24 and 25 may be reduced from typical amounts while still imparting unique product characteristics due to the distribution of the first and/or second water insoluble chemical additives 24 and 25 on or within the dewatered fibrous web 33 and/or the dried fibrous web 36 as opposed to an embodiment of the present invention wherein an equilibrated distribution of the first and/or second water insoluble chemical additives 24 and 25 of the dewatered fibrous web 33 and/or the dried fibrous web 36. The establishment of a gradient of the application of the first and/or the second water insoluble chemical additives 24 and 25 of the dewatered fibrous web 33 and/or the dried fibrous web 36 is one way in which this may be accomplished.

A directed application of a water insoluble chemical additive to treat only a portion of the pulp fibers according to the present invention may result in a product produced having different characteristics than a product having uniformly chemically treated fibers. Additionally, directed applications typically require a lower amount of the water insoluble chemical additive to achieve paper enhancement, thereby minimizing the detrimental effects that result from unretained water insoluble chemical additives in the manufacturing water systems or in the solutions that may be used with finished products.

A wide variety of fluidized bed coating systems can be adapted to coat or treat pulp fibers with a water insoluble chemical additive that enhances the properties of the pulp fibers or the properties of the pulp fibers during the process or methods of making chemically treated fibrous non-woven materials or finished products made therefrom. For example, one can use a Wurster Fluid Bed Coater such as the Ascoat Unit Model 101 of Lasko Co. (Leominster, Mass.), the Magnacoater® by Fluid Air, Inc. (Aurora, Illinois), or the modified Wurster coater described in U.S. Patent No. 5,625,015 issued April 29, 1997 to Brinen et al., herein incorporated by reference. The Wurster fluidized bed coating technology, one of the most popular methods for particle coating, was originally developed for the encapsulation of solid particulate materials such as powders, granules, and crystals, but according to the present invention, can be adapted to deliver a coating of at least one water insoluble chemical additive to the pulp fibers.

The coater is typically configured as a cylindrical or tapered vessel (larger diameter at the top than at the bottom) with air injection at the bottom through air jets or a distributor...
plate having multiple injection holes. The pulp fibers are fluidized in the gaseous flow.
One or more spray nozzles inject the water insoluble chemical additive initially provided as
a liquid, slurry, or foam at a point where good contact with the moving pulp fibers can be
achieved. The pulp fibers move upwards and descend behind a wall or barrier, from
whence the pulp fibers can be guided to again enter the fluidized bed and be coated
(treated) again, treated with a second water insoluble chemical additive, or can be
removed and further processed. The pulp fibers may also be treated simultaneously with
two or more water insoluble chemical additives using one or more nozzles. Ambient dry
air or elevated air temperature or the application of other forms of energy (microwaves,
infrared radiation, electron beams, ultraviolet radiation, steam, and the like) causes drying
or curing of the chemical additive on the pulp fibers. The retention time of the pulp fibers
in the fluidized bed a plurality of times to provides the desired amount of treatment of one
or more water insoluble chemical additives on the pulp fibers.

The original Wurster fluid bed coaters are described in U.S. Patent No. 2,799,241
issued July 16, 1957 to D.E. Wurster; U.S. Patent No. 3,089,824 issued May 14, 1963 to
D.E. Wurster; U.S. Patent No. 3,117,024 issued January 7, 1964 to J.A. Lindlof et al.;
3,253,944 issued May 31, 1966 to D.E. Wurster; all of which are herein incorporated by
reference. More recent examples of the use of Wurster coaters are given in U.S. Patent
No. 4,623,588 issued November 18, 1986 to Nuwayser et al., herein incorporated by
reference. A related device is the coater is disclosed in U.S. Patent No. 5,254,168 issued
October 19, 1993 to Littman et al., herein incorporated by reference.

Other coating methods need not rely on particle fluidization of the pulp fibers in a
gas stream. The pulp fibers may be sprayed or treated with one or more water insoluble
chemical additives while being mechanically agitated by a shaker or other pulsating device
during the manufacturing process, such as while the pulp fibers are dropped from one
container to another, while the pulp fibers are tumbled in a moving vessel or a vessel with
rotating paddles such as a Forberg particle coater (Forberg AS, Larvik, Norway) which can
be operated without applied vacuum to keep the water insoluble chemical additives on the
surface of the pulp fibers, or while the pulp fibers rest in a bed, after which the pulp fibers
may be separated or broken up. In one embodiment, pulp fibers and a water insoluble
chemical additive may be first combined and then the pulp fibers are separated into
individually coated (treated) pulp fibers by centrifugal forces, as disclosed in U.S. Patent
No. 4,675,140 issued June 23, 1987 to Sparks et al., herein incorporated by reference.
Systems for coating dry particles can also be adapted for pulp fibers according to the present invention. Examples of such equipment include:

- Magnetically Assisted Impaction Coating (MAIC) by Aveka Corp. (Woodbury, MN), wherein magnetic particles in a chamber are agitated by varying magnetic fields, causing target particles and coating materials to repeatedly collide, resulting in the coating of the target particles;
- Mechanofusion by Hosokawa Micron Corp. (Hirakata, Osaka, Japan), wherein particles and coating materials in a rotating drum are periodically forced into a gap beneath an arm pad, causing the materials to become heated and joined together to form coated particles, a process that is particularly effective when a thermoplastic material is involved;
- the Theta Composer of Tokuju Corporation (Hiratsuka, Japan), wherein particles and coating material are mechanically brought together by a pair of rotating elliptical heads;
- Henschel mixers from Thyssen Henschel Industritechnik (Kassel, Germany), believed to be useful for combining particles with polymeric materials;
- the Hybridizer of Nara Machinery (Tokyo, Japan), which employs blades rotating at high speed to impact a coating powder onto particles carried by an air stream; and,
- the Rotary Fluidized Bed Coater of the New Jersey Institute of Technology, which comprises a porous rotating cylinder with particles inside. Pressurized air enters the walls of the cylinder and flows toward a central, internal exit port. Air flow through the walls of the chamber can fluidize the particles, acting against centrifugal force. As the particles are fluidized, a coating material injected into the chamber can impinge upon the particles and coat them.

With dry particle coating systems, the pulp fibers may first be treated with a first water insoluble chemical additive by any technique, and then subsequently treated with a second water insoluble chemical additive in powder form. The pulp fibers may also be treated with the first and second water insoluble chemical additives simultaneously. Doing so creates a coating treatment in which the second water insoluble chemical additive is selectively distributed near the exterior surface of the coating treatment, and in which the portion of the coating treatment next to the pulp fibers may be substantially free of the second water insoluble chemical additive.

By way of example, Figures 4 and 5 illustrate two versions of a fluidized bed coating process that can be used to coat pulp fibers 130 according to the present invention. In Figure 4, the depicted apparatus 120 comprises an inner cylindrical partition 122, an outer cylindrical partition 124, and a distributor plate 126 having a central porous or sintered region for injection of gas to entrain pulp fibers 130. The majority of the
fluidizing gas flow is directed through the inner cylindrical partition 122. Thus, the general flow pattern of the pulp fibers 130 is upward inside the inner cylindrical partition 122, and downward outside the inner cylindrical partition 122. Unlike several common versions of the Wurster process, in the apparatus 120 of Figure 4, the spray nozzle 128 is located at the bottom of the apparatus 120, just above the distributor plate 126. The nozzle 128 sprays upward, providing a cocurrent application of a spray 132 of a water insoluble chemical additive to the pulp fibers 130. Any suitable spray nozzle and delivery system known in the art can be used.

Figure 5 is similar to Figure 4 except that the inner cylindrical partition 122 of Figure 4 has been removed, and the porous or sintered region of the distributor plate 126 now substantially extends over the entire distributor plate 126.

Many aspects of the apparatus in Figure 4 can be modified within the scope of the present invention. For example, the inner cylindrical partition 122 may be replaced with one or more baffles or flow guides (not shown). The walls of either the outer cylindrical partition 124 or inner cylindrical partition 122 may be tapered and may be interrupted with ports or openings for removal of the pulp fibers 130 or addition of a water insoluble chemical additive from one or more spray nozzles (not shown). Either the outer cylindrical partition 124 or the inner cylindrical partition 122 or both may rotate, vibrate, or oscillate. The distributor plate 126 may also move during the treatment operation (e.g., vibrate, rotate, or oscillate). A variety of spray nozzles and delivery systems can be applied to deliver the coating material, including the Silicone Dispensing System of GS Manufacturing (Costa Mesa, California). The water insoluble chemical additives can be applied by spraying from any position in the apparatus 120, or by curtain coating or slot coating or other processes applied to a moving stream of pulp fibers 130.

While the invention has been described in conjunction with specific embodiments, it is to be understood that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, this invention is intended to embrace all such alternatives, modifications and variations, which fall within the spirit and scope of the appended claims.
We claim:

1. A method for preparing chemically treated pulp fibers comprising:
   a) creating a fiber slurry comprising process water and virgin pulp fibers;
   b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet
   machine and forming a wet fibrous web;
   c) drying the wet fibrous web to a predetermined consistency thereby forming
   a dried fibrous web;
   d) treating the dried fibrous web with a water insoluble chemical additive
   thereby forming a chemically treated dried fibrous web containing chemically treated pulp
   fibers, wherein the chemically treated pulp fibers have an improved level of chemical
   retention of the water insoluble chemical additive and retain from between about 25 to
   about 100 percent of the applied amount of the water insoluble chemical additive when the
   chemically treated pulp fibers are exposed to a liquid; and,
   e) using the chemically treated pulp fibers having the water insoluble chemical
   additive retained thereon to form a fibrous non-woven material.

2. The method of Claim 1, wherein the fibrous non-woven material is coform.

3. The method of Claim 1, wherein the dried chemically treated fibrous web includes
   a gradient of the water insoluble chemical additive.

4. The method of Claim 1, further comprising dewatering the wet fibrous web thereby
   forming a dewatered fibrous web.

5. The method of Claim 4, further comprising drying the dewatered fibrous web
   thereby forming the dried fibrous web.

6. The method of Claim 5, wherein the fibrous non-woven material comprises
   polypropylene.
7. The method of Claim 2, further comprising producing a finished product having enhanced quality due to the retention of the water insoluble chemical additive by the chemically treated pulp fibers.

5 8. The method of Claim 1, wherein the water insoluble chemical additive is selected from the group comprising softening agents, dry strength agents, wet strength agents, opacifying agents, dyes, debonding agents, absorbency agents, sizing agents, optical brighteners, chemical tracers, and mixtures thereof.

10 9. The method of Claim 1, wherein the water insoluble chemical additive is selected from the group consisting of: mineral oil; petrolatum; olefins; alcohols; fatty alcohols; ethoxylated fatty alcohols; esters; high molecular weight carboxylic and polycarboxylic acids and their salts; polydimethylsiloxane and modified polydimethylsiloxane; and, mixtures thereof.

10 10. The method of Claim 1, wherein the fibrous non-woven material comprises at least 2 plies.

11. The method of Claim 1, wherein the water insoluble chemical additive is applied to the dried fibrous web in an amount of at least about 0.1 kilograms per metric ton or greater.

12. The method of Claim 1, wherein the fibrous non-woven material comprises at least 2 layers.

13. The method of Claim 1, wherein sufficient residence time is provided after the water insoluble chemical additive is applied to the dried fibrous web to allow for retention of the water insoluble chemical additive by the chemically treated pulp fiber of the dried fibrous web.

14. The method of Claim 1, further comprising forming a wet-wipe product from the chemically treated dried fibrous web.

16. The wet-wipe product of Claim 15, wherein the amount of the water insoluble chemical additive applied to the dried fibrous web is about 0.1 kilogram per metric ton or greater.

17. A method for applying a water insoluble chemical additive to a fibrous non-woven material, the method comprising:
   a) mixing pulp fibers with process water to form a pulp fiber slurry;
   b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web;
   c) dewatering the wet fibrous web to a predetermined consistency thereby forming a dewatered fibrous web;
   d) applying a water insoluble chemical additive to the dewatered fibrous web thereby forming a chemically treated dewatered fibrous web containing chemically treated pulp fibers, wherein the chemically treated pulp fibers have an improved level of chemical retention of the water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the water insoluble chemical additive when the chemically treated pulp fibers are exposed to a liquid; and,
   e) using the chemically treated pulp fibers having the water insoluble chemical additive retained thereon to form a fibrous non-woven material.

18. The method of Claim 17, further comprising transporting the chemically treated dewatered fibrous web to a manufacturing machine and mixing the chemically treated pulp fiber having the water insoluble chemical additive retained thereon with a thermoplastic polymeric material.

19. The method of Claim 17, wherein the chemically treated dewatered fibrous web includes a gradient of the non-watered soluble chemical additive.

20. The method of Claim 17, further comprising drying the chemically treated dewatered fibrous web to a predetermined consistency thereby forming a chemically treated dried fibrous web.
21. The method of Claim 20, wherein the chemically treated dried fibrous web includes a gradient of the water insoluble chemical additive.

22. The method of Claim 20, wherein said fibrous non-woven material comprises polypropylene.

23. The method of Claim 22, further comprising forming a finished product having enhanced quality due to the retention of the water insoluble chemical additive by the chemically treated pulp fibers.

24. The method of Claim 22, wherein the amount of the water insoluble chemical additive retained by the chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained the water insoluble chemical additive in the water is between 0 and about 50 percent of the amount of the applied water insoluble chemical additive retained by the chemically treated dried fibrous web.

25. The method of Claim 17, wherein the amount of the water insoluble chemical additive applied to the dewatered fibrous web is about 1 kilograms per metric ton or greater.

26. The method of Claim 17, wherein the amount of the water insoluble chemical additive applied to the dewatered fibrous web is about 3 kilograms per metric ton or greater.

27. The method of Claim 17, wherein the amount of the water insoluble chemical additive applied to the dewatered fibrous web is about 5 kilograms per metric ton or greater.

28. The method of Claim 17, wherein the water insoluble chemical additive is selected from the group comprising softening agents, dry strength agents, wet strength agents,
opacifying agents, dyes, debonding agents, absorbency agents, sizing agents, optical brighteners, chemical tracers, and mixtures thereof.

29. The method of Claim 17, wherein the water insoluble chemical additive is selected from the group consisting of: mineral oil; petroleatum; olefins; alcohols; fatty alcohols; ethoxylated fatty alcohols; esters; high molecular weight carboxylic and polycarboxylic acids and their salts; polydimethylsiloxane and modified polydimethylsiloxane; and, mixtures thereof.

30. A wet-wipe product made from the chemically treated pulp fiber slurry of Claim 17.

31. A method for adding at least a first chemical additive to pulp fiber contained in a fibrous non-woven material, the method comprising:
   a) mixing pulp fibers with process water thereby forming a fiber slurry;
   b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet machine;
   c) dewatering the fiber slurry thereby forming a crumb pulp;
   d) applying a water insoluble chemical additive to the crumb pulp thereby forming a chemically treated crumb pulp containing chemically treated pulp fibers, wherein the chemically treated pulp fibers have an improved level of chemical retention of the water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the water insoluble chemical additive when the chemically treated pulp fibers are exposed to a liquid; and,
   e) using the chemically treated pulp fibers having the water insoluble chemical additive retained thereon to form a fibrous non-woven material.

32. The method of Claim 31, further comprising transporting the chemically treated crumb pulp to a manufacturing machine and mixing the chemically treated pulp fibers having the water insoluble chemical additive retained thereon with a thermoplastic polymeric material.

33. The method of Claim 32, further comprising transporting the chemically treated pulp fiber through the manufacturing machine to form a finished wet-wipe product having
enhanced quality due to the retention of at least a first chemical additive by the chemically treated pulp fibers.

34. The method of Claim 31, further comprising applying a second chemical additive to the chemically treated crumb pulp.

35. A method for applying water insoluble chemical additives to pulp fiber contained in a fibrous non-woven material, the method comprising:
   a) creating a fiber slurry comprising process water and pulp fibers;
   b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web;
   c) dewatering the wet fibrous web to a predetermined consistency thereby forming a dewatered fibrous web;
   d) applying a first water insoluble chemical additive to the dewatered fibrous web thereby forming a chemically treated dewatered fibrous web of chemically treated pulp fibers;
   e) applying a second water insoluble chemical additive to the chemically treated dewatered fibrous web thereby forming a dual chemically treated dewatered fibrous web containing dual chemically treated pulp fibers, wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the first water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid and wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the second water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid; and,
   f) using the dual chemically treated pulp fibers having the first and second water insoluble chemical additives retained thereon to form a fibrous non-woven material.

36. The method of Claim 35, further comprising transporting the dual chemically treated pulp fibers to a manufacturing machine and mixing the dual chemically treated pulp fibers having the first and second water insoluble chemical additives retained thereon with a thermoplastic material.
37. The method of Claim 35, further comprising drying the dual chemically treated dewatered fibrous web to a predetermined consistency thereby forming a dual chemically treated dried fibrous web.

38. The method of Claim 37, further comprising transporting the dual chemically treated dried fibrous web to a manufacturing machine and mixing the dual chemically treated pulp fibers having the first and second water insoluble chemical additives retained thereon with a thermoplastic polymeric material.

39. The method of Claim 35, wherein the dual chemically treated dewatered fibrous web includes a gradient of the first water insoluble chemical additive.

40. The method of Claim 35, wherein the dual chemically treated dried fibrous web includes a gradient of the first water insoluble chemical additive.

41. The method of Claim 35, wherein the dual chemically treated dewatered fibrous web includes a gradient of the second water insoluble chemical additive.

42. The method of Claim 35, wherein the dual chemically treated dried fibrous web includes a gradient of the second water insoluble chemical additive.

43. The method of Claim 38, further comprising producing a wet-wipe product having enhanced quality due to the retention of the first and second water insoluble chemical additives by the dual chemically treated pulp fibers.

44. The method of Claim 35, wherein the first water insoluble chemical additive is selected from the group comprising softening agents, dry strength agents, wet strength agents, opacifying agents, dyes, debonding agents, absorbency agents, sizing agents, optical brighteners, chemical tracers, and mixtures thereof.
45. The method of Claim 44, wherein the first water insoluble chemical additive is
selected from the group consisting of: mineral oil; petrolatum; olefins; alcohols; fatty
alcohols; ethoxylated fatty alcohols; esters; high molecular weight carboxylic and
polycarboxylic acids and their salts; polydimethylsiloxane and modified
polydimethylsiloxane; and, mixtures thereof.

46. The method of Claim 35, wherein the second water insoluble chemical additive is
selected from the group comprising softening agents, dry strength agents, wet strength
agents, opacifying agents, dyes, debonding agents, absorbency agents, sizing agents,
optical brighteners, chemical tracers, and mixtures thereof.

47. The method of Claim 46, wherein the second water insoluble chemical additive is
selected from the group consisting of: mineral oil; petrolatum; olefins; alcohols; fatty
alcohols; ethoxylated fatty alcohols; esters; high molecular weight carboxylic and
polycarboxylic acids and their salts; polydimethylsiloxane and modified
polydimethylsiloxane; and, mixtures thereof.

48. The method of Claim 35, wherein the first and second water insoluble chemical
additives are applied to the dewatered fibrous web simultaneously.

49. The method of Claim 35, wherein the first water insoluble chemical additive is
applied to the dewatered fibrous web in an amount of about 0.1 kilograms per metric ton
or greater.

50. The method of Claim 35, wherein the second water insoluble chemical additive is
applied to the dewatered fibrous web in an amount of about 0.1 kilogram per metric ton or
greater.

51. The method of Claim 35, wherein the dual chemically treated dried fibrous web has
a consistency ranging from about 65 percent to about 100 percent.
52. The method of Claim 35, wherein sufficient residence time is provided after the first water insoluble chemical additive is applied to the dewatered fibrous web to allow the first water insoluble chemical additive to be retained by the dual chemically treated pulp fiber.

53. The method of Claim 35, wherein sufficient residence time is provided after the second water insoluble chemical additive is applied to the dewatered fibrous web to allow the second water insoluble chemical additive to be retained by the dual chemically treated pulp fiber.


55. A method for applying water insoluble chemical additives to pulp fiber contained in a fibrous non-woven material, the method comprising:
   a) mixing pulp fibers with process water to form a fiber slurry;
   b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web;
   c) dewatering the wet fibrous web to a predetermined consistency thereby forming a dewatered fibrous web;
   d) drying the dewatered fibrous web to a predetermined consistency thereby forming a dried fibrous web;
   e) applying a first water insoluble chemical additive to the dried fibrous web and applying a second water insoluble chemical additive to the dried fibrous web thereby forming a dual chemically treated dried fibrous web containing dual chemically treated pulp fibers, wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the first water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid and wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the second water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid; and,
   f) using the dual chemically treated pulp fibers having the first and second water insoluble chemical additives retained thereon to form a fibrous non-woven material.
56. The method of Claim 55, wherein the dual chemically treated dried fibrous web includes a gradient of the first water insoluble chemical additive.

57. The method of Claim 55, wherein the dual chemically treated dried fibrous web includes a gradient of the second water insoluble chemical additive.

58. The method of Claim 55, further comprising transporting the dual chemically treated dried fibrous web to a manufacturing machine and mixing the dual chemically treated pulp fibers having at least the first and second water insoluble chemical additives retained thereon with a thermoplastic material.

59. The method of Claim 55, further comprising transporting the dual chemically treated pulp fiber through the paper machine to form a finished wet-wipe product having enhanced quality due to the retention of at least the first and second water insoluble chemical additives by the dual chemically treated pulp fibers.

60. The method of Claim 58, wherein the amount of the first water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained first water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid.

61. The method of Claim 58, wherein the amount of the second water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained second water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid.

62. The method of Claim 58, wherein the amount of the first water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilograms per metric ton or greater, and the amount of unretained first water insoluble chemical additive
in the water is between 0 and about 75 percent of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are exposed in a liquid and wherein the amount of the second water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained second water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are exposed in a liquid.

63. A paper or tissue product made using the method of Claim 55.

64. A method for applying water insoluble chemical additives to pulp fiber contained in a fibrous non-woven material, the method comprising:
   a) mixing pulp fibers with process water to form a fiber slurry;
   b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web;
   c) dewatering the wet fibrous web to a predetermined consistency thereby forming a dewatered fibrous web;
   d) applying a first water insoluble chemical additive to the dewatered fibrous web to the dewatered fibrous web thereby forming a chemically treated dewatered fibrous web;
   e) drying the chemically treated dewatered fibrous web to a predetermined consistency thereby forming a chemically treated dried fibrous web;
   f) applying a second water insoluble chemical additive to the chemically treated dried fibrous web, thereby forming a dual chemically treated dried fibrous web containing dual chemically treated pulp fibers, wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the first water insoluble chemical additive wherein the level of chemical retention of the first water insoluble chemical additive is between about 25 to about 100 percent retention of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid and the dual chemically treated pulp fibers have an improved level of chemical retention of the second water insoluble chemical additive wherein the level of chemical retention of the second water insoluble chemical additive is between about 25 to about 100 percent retention of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid; and,
g) using the dual chemically treated pulp fibers having the first and second water insoluble chemical additives retained thereon to form a fibrous non-woven material.

65. The method of Claim 64, wherein the chemically treated dewatered fibrous web includes a gradient of the first water insoluble chemical additive.

66. The method of Claim 64, wherein the dual chemically treated dried fibrous web includes a gradient of the first water insoluble chemical additive.

67. The method of Claim 64, wherein the dual chemically treated dried fibrous web includes a gradient of the second water insoluble chemical additive.

68. The method of Claim 64, further comprising transporting the dual chemically treated dried fibrous web to a manufacturing machine and mixing the dual chemically treated pulp fibers having at least the first and second water insoluble chemical additives retained thereon with a thermoplastic polymeric material.

69. The method of Claim 64, further comprising transporting the chemically treated pulp fibers through the manufacturing machine to form a finished wet-wipe product having enhanced quality due to the retention of at least the first and second water insoluble chemical additives by the dual chemically treated pulp fibers.

70. The method of Claim 68, wherein the amount of the first water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained first water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid.

71. The method of Claim 68, wherein the amount of the second water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained second water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the
second water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid.

72. The method of Claim 68, wherein the amount of the first water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilograms per metric ton or greater, and the amount of unretained first water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid and wherein the amount of the second water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained second water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are exposed to a liquid.

73. A wet-wipe product made using the method of Claim 64.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 D21H23/26 D21H23/28

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)

IPC 7 D21H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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- *C* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

**Date of the actual completion of the international search**

11 November 2003

**Date of mailing of the international search report**

25/11/2003

**Patent family members are listed in annex.**

**Further documents are listed in the continuation of box C.**

**Name and mailing address of the ISA**

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Tel. (+31-70) 340-2040, Tx 31 651 epo nl
Fax (+31-70) 340-2018

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