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(54) **DISPERSIBLE ALCOHOL/CLEANING WIPES
VIA TOPICAL OR WET-END APPLICATION
OF ACRYLAMIDE OR VINYLAMIDE/AMINE
POLYMERS**

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(57) **ABSTRACT**

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The present invention is directed to a wet wipe product. The wet wipe product comprises a fibrous substrate and a triggerable binder formulation. The triggerable binder formulation is capable of binding the fibers in the fibrous substrate. The triggerable binder formulation may include acrylamide polymers, vinylamide/amine polymers, and mixtures. The triggerable binder formulation is insoluble in a wetting composition comprising an insolubilizing agent but is dispersible in disposal water.

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DISPERSIBLE ALCOHOL/CLEANING WIPES VIA TOPICAL OR WET-END APPLICATION OF ACRYLAMIDE OR VINYLAMIDE/AMINE POLYMERS

BACKGROUND OF THE INVENTION

[0001] For many years, the problem of disposability has plagued industries that provide disposable products such as diapers, wet wipes, adult incontinent garments and feminine care products. While much headway has been made in addressing this problem, one of the weak links has been the inability to create an economical coherent fibrous web which will readily dissolve or disintegrate in water but still have sufficient in-use tensile strength.

[0002] Binder compositions have been developed which can be more dispersible and are more environmentally responsible than past binder compositions. One class of binder compositions includes polymeric materials having inverse solubility in water. These binder compositions are insoluble in warm water, but are soluble in cold water, such as found in a toilet. It is well known that a number of polymers exhibit cloud points or inverse solubility properties in aqueous media. These polymers include: (1) evaporation retarders; (2) temperature sensitive compositions, which are useful as temperature indicators due to a sharp color change associated with a corresponding temperature change; (3) heat sensitive materials that are opaque at a specific temperature and become transparent when cooled to below the specific temperature; (4) wound dressings with good absorbing characteristics and easy removal; and, (5) materials in flushable personal care products.

[0003] Other binders include a class of binders which are ion-sensitive. In some cases, terpolymers are used as binders for flushable nonwoven webs. The acrylic acid-based terpolymers, which comprise partially neutralized acrylic acid, butyl acrylate and 2-ethylhexyl acrylate, may be used as binders for use in flushable nonwoven webs in some parts of the world. However, because of the presence of a small amount of sodium acrylate in the partially neutralized terpolymer, such binders fail to disperse in water containing more than about 15 ppm Ca^{2+} and/or Mg^{2+} . When placed in water containing more than about 15 ppm Ca^{2+} and/or Mg^{2+} ions, nonwoven webs using the above-described binders maintain a tensile strength greater than 30 g/in, which negatively affects the "dispersibility" of the nonwoven web. The proposed mechanism for the failure is that each calcium ion binds with two carboxylate groups either intramolecularly or intermolecularly. Intramolecular association causes the terpolymer chain to coil up, which eventually leads to polymer precipitation. Intermolecular association yields crosslinking. Whether intramolecular or intermolecular associations are taking place, the terpolymer is not soluble in water containing more than about 15 ppm Ca^{2+} and/or Mg^{2+} . Due to the strong interaction between calcium ions and the carboxylate groups of the terpolymer, dissociation of the complex is highly unlikely because this association is irreversible. Therefore, the terpolymer that has been exposed to a high Ca^{2+} and/or Mg^{2+} concentration solution will not disperse in water even if the calcium concentration decreases. This limits the application of the terpolymer as a flushable binder material because most areas across the U.S. have hard water, which contains more than 15 ppm Ca^{2+} and/or Mg^{2+} .

[0004] Other binders, while being in contact with an organic solvent, usually as a cleaning agent or a preservative, still require the presence of ions, such as monovalent or divalent metal ions, to establish sufficient stability during use and dispersibility at disposal. As discussed above, the issue of hard water may again apply to such binders.

[0005] In some dispersible cleaning or personal care products, such as a water-disintegratable cleansing sheet; i.e., wet wipe, comprising water-dispersible fibers treated with a water-soluble binder having a carboxyl group. The cleansing sheet is treated with a cleansing agent containing 5%-95% of a water-compatible organic solvent and 95%-5% water. The organic solvent is typically propylene glycol. The cleansing sheet retains wet strength and does not disperse in the organic solvent-based cleansing agent, but disperses in water. The cleansing sheets must have higher concentrations of organic solvents as these solvents ensure the in-use wet strength for the cleansing sheets. Without the solvents, the cleansing sheets would have little in-use wet strength and would not be effective as a wet wipe. However, the use of such high amounts of organic solvent results in a greasy after-feel when the cleansing sheet is used, and these organic solvents may cause discomfort and irritation to skin in higher amounts.

[0006] There exists a need for dispersible cleaning or personal care products possessing softness, flexibility, three dimensionality, and resiliency; wicking and structural integrity in the presence of aqueous or bodily fluids; and, true fiber dispersion after toilet flushing so that the cleaning or personal care product does not become entangled at obstructions, such as with tree roots or at bends, in sewer pipes. Moreover, there is a need in the art for flushable cleaning or personal care products having water-dispersibility in all areas of the world, including soft and hard water areas. Furthermore, there is a need for water-dispersible binders that do not reduce wettability of the cleaning or personal care product with which they are used and are sprayable for relatively easy and uniform application to and penetration into the cleaning or personal care products. Finally, there is a need for water-dispersible, flushable wet wipes that are stable during storage and retain a desired level of wet strength during use when wetted with the appropriate cleaning, disinfection, or sanitizing wetting composition. Such a cleaning or personal care product is needed at a reasonable cost without compromising product safety and environmental concerns, something that past products have failed to do.

SUMMARY OF THE INVENTION

[0007] The present invention is directed to triggerable binder formulations of acrylamide and vinylamide/amine polymers and polymer formulations, which have been developed to address the above-described problems. As used herein, the term "polymer" is understood to include polymers, copolymers, terpolymers, and higher order polymers. The triggerable binder formulations of the present invention may provide strength in the dry state, but more importantly, may help maintain a desired level of strength of the fibrous substrate in the wet state by solvent triggerability. A controlled concentration of an insolubilizing agent, such as a lower level alcohol, glycol, ketone, or mixtures thereof, in the wetting composition insolubilizes the triggerable binder formulation and allows it to function as an adhesive for the fibers to form or further enhance a fibrous substrate. When

the wet wipe is discarded into the wastewater stream, the insolubilizing agent concentration is diluted, the triggerable binder formulation becomes soluble, and the strength of the fibrous substrate drops below a critical level. The triggerable binder formulations of the present invention have a "trigger property," such that the triggerable binder formulations are insoluble in a wetting composition comprising an insolubilizing agent of a particular type and concentration, such as alcohol, glycol, ketone, or mixtures thereof at concentrations above about 50% by weight, but are soluble when diluted with water, including hard water having 500 ppm (parts per million) or greater of calcium and magnesium ions. This allows the fibrous substrate to break apart into small pieces and, ultimately, disperse.

[0008] Unlike some ion-sensitive polymer formulations, which lose dispersibility in hard water because of ion cross-linking by calcium ions, the triggerable binder formulations of acrylamide and vinylamide/amine polymers and polymer formulations of the present invention are insensitive to calcium and/or magnesium ions at concentrations of a few hundred ppm and are insensitive to pH variations. Consequently, flushable cleaning or personal care products containing the triggerable binder formulations of the present invention maintain dispersibility of the fibrous substrates in hard water or soft water.

[0009] The polymers and polymer formulations of the present invention are useful as triggerable binder formulations and structural components for air-laid and wet-laid fibrous substrates, such as nonwoven fabrics, for applications, such as cleaning, hard surface cleaning, disinfecting, sanitizing, and personal care products. The polymers and polymer formulations of the present invention are particularly useful as triggerable binder formulations for flushable cleaning and personal care products, particularly wet wipes for personal use, such as cleaning or treating skin, make-up removal, nail polish removal, medical care, and also wipes for use in hard surface cleaning, automotive care, including wipes comprising cleaning agents, disinfectants, and the like. The flushable cleaning or personal care products maintain integrity or wet strength during storage and use, and break apart or disperse after disposal in the toilet when the alcohol concentration falls below a critical level. Suitable fibrous substrates for treatment with the triggerable binder formulations of the present invention include, but are not limited to tissue, such as creped or uncreped tissue, coform products, hydroentangled webs, airlaid mats, fluff pulp, nonwoven webs, and composites thereof. Methods for producing uncreped tissues and molded three-dimensional tissue webs of use in the present invention may be found in commonly owned U.S. Pat. No. 6,436,234, issued to Chen et al. on Aug. 20, 2002; U.S. Pat. No. 5,429,686, issued to Chiu et al. on Jul. 4, 1995; U.S. Pat. No. 5,399,412, issued to S. J. Sudall et al. on Mar. 21, 1995; U.S. Pat. No. 5,672,248, issued to Wendt et al. on Sep. 30, 1997; and U.S. Pat. No. 5,607,551, issued to Farrington et al. on Mar. 4, 1997; the disclosures of which are incorporated by reference to the extent they are non-contradictory herewith. The molded tissue structures of the above patents may be especially helpful in providing good cleaning in a wet wipe. Good cleaning may also be promoted by providing a degree of texture in the fibrous substrates as well by embossing,

molding, wetting and through-air drying on a textured fabric, and the like. The acrylamide and vinylamide/amine polymers and polymer formulations of the present invention are particularly useful as triggerable binder formulations for fibrous substrates because the acrylamide and vinylamide/amine polymers and polymer formulations are substantive to the fibers.

[0010] Air-laid material may be formed by metering an airflow containing the fibers and other optional materials, in substantially dry condition, onto a typically horizontally moving wire forming screen. Suitable systems and apparatus for air-laying mixtures of fibers and thermoplastic material are disclosed in, for example, U.S. Pat. No. 4,157,724, issued to Persson on Jun. 12, 1979 and reissued on Dec. 25, 1984 as Re. U.S. Pat. No. 31,775; U.S. Pat. No. 4,278,113, issued to Persson on Jul. 14, 1981; U.S. Pat. No. 4,264,289, issued to Day on Apr. 28, 1981; U.S. Pat. No. 4,352,649, issued to Jacobsen et al. on Oct. 5, 1982; U.S. Pat. No. 4,353,687, issued to Hosler, et al. on Oct. 12, 1982; U.S. Pat. No. 4,494,278, issued to Kroyer, et al. on Jan. 22, 1985; U.S. Pat. No. 4,627,806, issued to Johnson 4 on Dec. 9, 1986; U.S. Pat. No. 4,650,409, issued to Nistri, et al. on Mar. 17, 1987; and, U.S. Pat. No. 4,724,980, issued to Farley on Feb. 16, 1988; and, U.S. Pat. No. 4,640,810, issued to Laursen et al. on Feb. 3, 1987, the disclosures of which are incorporated by reference to the extent that they are non-contradictory herewith.

[0011] The present invention also discloses how to make water-dispersible fibrous substrates, including wet wipes, which are stable in wetting compositions having an insolubilizing content, such as alcohol, glycol, ketone, or mixtures thereof, using the above-described unique polymers and polymer formulations as triggerable binder compositions. The resultant treated fibrous substrates are flushable and water-dispersible due to the tailored sensitivity for insolubilizing agents, which can be triggered regardless of the hardness of water found in toilets throughout the United States and the world.

[0012] The present invention further discloses a suitable wetting composition for wet wipes. Wet wipes employing the polymers and polymer formulations as triggerable binder formulations of the present invention are stable during storage and retain a desired level of in-use tensile strength during use and are wetted with a wetting composition or cleaning agent comprising an insolubilizing agent, such as a lower level alcohol, glycol, ketone, or mixtures thereof.

[0013] These and other objects, features and advantages of the present invention will become apparent after a review of the following detailed description of the disclosed embodiments and the appended claims.

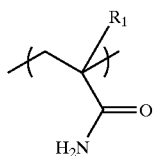
DETAILED DESCRIPTION OF THE DISCLOSED EMBODIMENTS

[0014] The present invention is practiced using triggerable binder formulations comprising acrylamide and vinylamide/amine polymers or polymer formulations. The triggerable binder formulations are an insolubilizing agent-sensitive acrylamide and vinylamide/amine polymer and polymer formulations. In order to be an effective insolubilizing

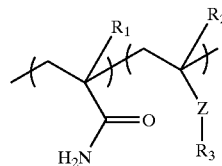
agent-sensitive or triggerable polymer or polymer formulation for use in flushable or water-dispersible cleaning or personal care products, the triggerable binder formulations may be: (1) functional, i.e., maintain wet strength of the fibrous substrate under controlled conditions and dissolve or disperse in a reasonable period of time in soft or hard water, such as found in toilets and sinks around the world, thereby allowing the fibrous substrate dissolve or disperse; (2) safe (not toxic); and, (3) relatively economical. In addition to the foregoing factors, the insolubilizing agent-sensitive or triggerable binder formulations when used as a binder material for a fibrous substrate, such as a nonwoven fabric for use in a pre-moistened wipe or wet wipe (hereinafter referred to as wet wipe), may be: (4) processable on a commercial basis; i.e., may be applied relatively quickly on a large scale basis, such as by spraying, coating, printing, and the like; (5) provide acceptable levels of sheet or fibrous substrate wet-tability; (6) provide acceptable levels of sheet or fibrous substrate stiffness; and, (7) reduced tackiness of the fibrous substrate or the product that the fibrous substrate is incorporated into. The wetting composition with which the wet wipes of the present invention are treated may provide some of the foregoing advantages, and, in addition, may provide: (8) improved tactile properties; and, (9) cleaning, disinfecting, sanitizing properties. The insolubilizing agent-sensitive or triggerable binder formulations of the present invention and products made therewith, especially wet wipes comprising particular wetting compositions set forth below, may meet many or all of the above criteria. Of course, it is not necessary for all of the advantages of the embodiments of the present invention to be met to fall within the scope of the present invention.

Alcohol Triggerable Acrylamide and Vinylamide/amine Polymers and Polymer Formulations

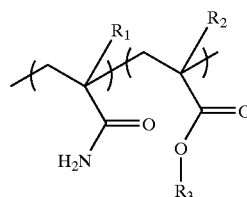
[0015] The insolubilizing agent-sensitive or triggerable binder formulations of the present invention comprise acrylamide and vinylamide/amine polymers and polymer formulations. The insolubilizing agent-sensitive or triggerable binder polymers may function as adhesives for tissue, airlaid pulp, wetlaid pulp, and other fibrous substrates and provide sufficient in-use tensile strength (typically about 300 g/in. or greater; about 500 g/in. or greater; or, about 1,000 g/in. or greater) when wetted with a wetting composition. The fibrous substrates may also be dispersible in tap water (including hard water up to 500 ppm or greater as metal ion), typically losing most of their in-use tensile strength between about 30 to about 75 g/in. in about 24 hours or less. Such insolubilizing agent-sensitive or triggerable binder formulations generally have the following structures:



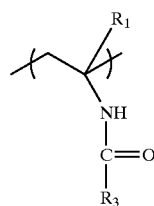
The R₁ moiety may be hydrogen or methyl.



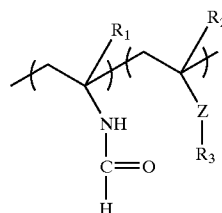
The R₁ and R₂ moieties may be independently hydrogen, methyl, or mixtures thereof. The Z moiety may be —O—, —COO—, —CONH—, —NHCO—, —NH₂, —NHR, and —NR₂. The R₃ moiety may be hydrogen, or any C₁ or higher alkyl group or aryl group, including methyl, ethyl, n-propyl, isopropyl, n-butyl, sec-butyl, tert-butyl, pentyl, hexyl, ethylhexyl, and the like.



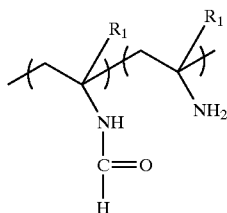
The R₁ and R₂ moieties may be independently hydrogen, methyl, or mixtures thereof. The R₃ moiety may be hydrogen, or any C₁ or higher alkyl group or aryl group, including methyl, ethyl, n-propyl, isopropyl, n-butyl, sec-butyl, tert-butyl, pentyl, hexyl, ethylhexyl, and the like.



The R₁ moiety may be hydrogen or methyl. The R₃ moiety may be hydrogen, or any C₁ or higher alkyl group or aryl group, including methyl, ethyl, n-propyl, isopropyl, n-butyl, sec-butyl, tert-butyl, pentyl, hexyl, ethylhexyl, and the like.



The R_1 and R_2 moieties may be independently hydrogen, methyl, or mixtures thereof. The Z moiety may be $-\text{O}-$, $-\text{COO}-$, $-\text{CONH}-$, $-\text{NHCO}-$, $-\text{NH}_2$, $-\text{NHR}$, and $-\text{NR}_2$. The R_3 moiety may be hydrogen, or any C_1 or higher alkyl group or aryl group, including methyl, ethyl, n-propyl, isopropyl, n-butyl, sec-butyl, tert-butyl, pentyl, hexyl, ethylhexyl, and the like.



The R_1 moieties may be independently hydrogen, methyl, or mixtures thereof.

Polyacrylamide Polymers and Polymer Formulations

[0016] Polyacrylamide polymers and polymer formulations may be anionic, neutral, amphoteric, or positive in charge. Polymethacrylamide and other analogs may also be utilized. The presence of additional hydrophilic or charged groups may enhance solubility, dispersibility, and other properties of the polymers and polymer formulations.

[0017] Examples of anionic or acidic monomers that may copolymerized into the backbone of the polymers and polymer formulations may include acrylic acid, methacrylic acid and their salts, 2-acrylamido-2-methyl-1 propanesulfonic acid (AMPS) and its salts, vinyl sulfonic acid and their salts, other sulfonate monomers such as potassium (3-sulfopropyl) acrylate, sodium styrene sulfonate, and phosphonate/phosphonic acids monomers. Useful neutral monomers include ones such as N-isopropyl acrylamide and other acrylamide derivatives, 2-hydroxyethyl methacrylate, vinyl pyrrolidone, methylvinyl ether, and polyethylene glycol (PEG) acrylate or methacrylates. Useful amphoteric or zwitterionic monomers include N,N-Dimethyl-N-(2-methacryloyloxyethyl)-N-(3-sulfopropyl) ammonium betaine, N,N-dimethyl-N-(2-methacrylamidopropyl)-N-(3-sulfopropyl) ammonium betaine, 1-(3-Sulfopropyl)-2-vinylpyridinium betaine, N-(3-carboxypropyl)-N-methacrylamido-ethyl-N, N-dimethyl ammonium betaine, and 4-vinylpiperidinium ethanecarboxy betaine. Useful cationic monomers include [2-(acryloxy)ethyl] trimethyl ammonium chloride (ADAM-QUAT), [2-(methacryloxy)ethyl] trimethyl ammonium chloride (MADQUAT), (3-acrylamidopropyl) trimethyl ammonium chloride, N,N-diallyldimethyl ammonium chloride, [2-(acryloxy)ethyl] dimethylbenzyl ammonium chloride, (2-(methacryloxy)ethyl) dimethylbenzyl ammonium chloride, [2-(acryloxy)ethyl] dimethyl ammonium chloride, and [2-(methacryloxy)ethyl] dimethyl ammonium chloride. Precursor monomers such as vinylpyridine, dimethylaminoethyl acrylate, and dimethylaminoethyl methacrylate, which may be polymerized and quaternized through post-polymerization reactions may be used in the present invention. Monomers or quaternization reagents which provide different counter-ions such as bromide, iodide, or methyl sulfate are further alternatives applicable to the present invention. In some embodiments of the present invention, certain water-

insoluble monomers may be used to lower the T_g of the polyacrylamide polymers or polymer formulations or to provide other useful properties, wherein the insolubility in the presence of an insolubilizing agent is not compromised or solubility in water is not compromised. Such water-insoluble monomers may include lower level acrylates, such as methyl, ethyl or butyl acrylates, substituted acrylamides, alkyl vinyl ethers, or other vinyl monomers.

Preparation of Polyvinylamide/amines Polymers and Polymer Formulations

[0018] Polyvinylamide/amine polymers or polymer formulations are typically produced by free radical polymerization of N-vinylamide monomers with degree of cationicity controlled by post-polymerization hydrolysis and pH. Such N-vinylamide monomers may include N-vinylformamide, N-vinylacetamide, and other N-vinyl alkylamides. Co-polymerization products of the N-vinylamide monomers with other monomers such as those described above may be useful in the present invention. One embodiment of the present invention may be the co-polymerization product of the N-vinylamide monomer with a vinyl ester monomer, such as vinyl acetate. Hydrolysis may yield co-polymers of vinylamine/amide monomers with vinyl alcohol monomers. The hydrolyzed polymer or polymer formulation may be highly reactive with a host of functional chemistries, resulting in the potential for unique combinations of properties in a water soluble polymer. Examples of said functional chemistries may include cyclic esters, epoxides, isocyanates, carboxylates, organic (i.e. alkyl) halides, aldehydes, etc., wherein the insolubility in the presence of an insolubilizing agent is not compromised or solubility in water is not compromised.

[0019] Cyclic amide polymers or polymer formulations, such as polyvinylpyrrolidone and polyvinylcaprolactam, may also be useful in the present invention.

[0020] The acrylamide and vinylamide/amine polymers and polymer formulations of the triggerable binder formulations of the present invention may have an average molecular weight that varies depending on the ultimate use of the triggerable binder formulation. The triggerable binder formulation of the present invention may have a weight average molecular weight ranging from about 10,000 to about 1,000,000 grams per mol. More specifically, the triggerable binder formulations of the present invention may have a weight average molecular weight ranging from about 25,000 to about 500,000 grams per mol., or, more specifically still, from about 200,000 to about 400,000 grams per mol.

[0021] In one embodiment of the present invention, the above-described triggerable binder formulations may be used as binder materials for flushable and/or non-flushable cleaning or personal care products. In order to be effective as a binder material in flushable cleaning or personal care products throughout the United States, the triggerable binder formulations of the present invention may remain stable and maintain their integrity (in-use tensile strength) while dry or in relatively high concentrations of an insolubilizing agent, such as lower level alcohols, lower level glycols, lower level ketones, and mixtures thereof, but become soluble in water when the concentration of the insolubilizing agent drops below about 50%. The triggerable binder formulations of the present invention may be insoluble in a solution containing

at least about 50 weight percent of an insolubilizing agent, such as a lower level alcohol, lower level glycol, lower level ketone, and mixtures thereof. More specifically, the triggerable binder formulations of the present invention may be insoluble in a solution containing from about 50% to about 100% by weight of an insolubilizing agent, such as a lower level alcohol, a lower level glycol, a lower level ketone, and mixtures thereof. Even more specifically, the triggerable binder formulations of the present invention may be insoluble in a solution containing from about 65% to about 90% by weight of an insolubilizing agent, such as lower level alcohol, lower level glycol, ketone, and mixtures thereof. More specifically, the triggerable binder formulations of the present invention may be insoluble in a solution containing from about 70% to about 90% by weight of an insolubilizing agent, such as lower level alcohol, lower level glycol, lower level ketone, and mixtures thereof.

[0022] Suitable lower level alcohols, lower level glycols, lower level ketones, and mixtures thereof that may be utilized as insolubilizing agents, may include, but are not limited to: methyl alcohol; ethyl alcohol; n-propyl alcohol; isopropyl alcohol; n-butyl alcohol; sec-butyl alcohol; tert-butyl alcohol; ethylene glycol; 1,2 propandiol (propylene glycol); 1,3 propane diol; acetone; methylethyl ketone; and, mixtures thereof.

[0023] In some embodiments of the present invention where the objective of the cleaning or personal care product is to provide disinfecting, sanitizing, or sterilizing properties, it may be undesirable to use a neat solvent wetting solution. It is known that the inclusion of water may enhance the disinfecting, sanitizing, or sterilizing properties of the wetting solution. Alcohols disinfect, sanitize, or sterilize primarily through denaturation (precipitation) of proteins that make up the cell wall of bacteria and other microorganisms. This denaturing effect may be less effective in the absence of water.

[0024] Additional insolubilizing agents useful in the present invention may include water-immiscible solvents. Hydrocarbons, such as C_6 and higher alkanes, including hexanes and octanes, toluenes, xylene, methylene chloride, and chloroform may be useful as insolubilizing agents in wetting compositions.

Triggerable Binder Formulations and Fibrous Substrates Containing the Same

[0025] The triggerable binder formulations of acrylamide and vinylamide/amine polymers and polymer formulations of the present invention may be used as binders. The triggerable binder formulations of the present invention may be applied to any fibrous substrate. The triggerable binder formulations are particularly suitable for use in water-dispersible cleaning or personal care products. Suitable fibrous substrates include, but are not limited to, nonwoven and woven fabrics. In many embodiments, particularly cleaning or personal care products, fibrous substrates may be nonwoven fabrics. As used herein, the term "nonwoven fabric" refers to a fibrous substrate that has a structure of individual fibers or filaments randomly arranged in a mat-like fashion (including papers). Nonwoven fabrics may be made from a variety of processes including, but not limited to, air-laid processes, wet-laid processes, hydroentangling processes, staple fiber carding and bonding, solution spinning, and any other method known to one skilled in the art.

[0026] The triggerable binder formulation may be applied to the fibrous substrate by any known process of application. Suitable processes for applying the triggerable binder formulation include, but are not limited to, printing, spraying, electrostatic spraying, coating, flooded nips, metered press rolls, impregnating or by any other technique. The amount of the triggerable binder formulation may be metered and distributed uniformly within the fibrous substrate or may be non-uniformly distributed within the fibrous substrate. The triggerable binder formulation may be distributed throughout the entire fibrous substrate or it may be distributed within a multiplicity of small closely spaced areas. The triggerable binder formulation may be applied to the fibers prior to incorporation of the fibers into a fibrous substrate.

[0027] The solution of the triggerable binder formulation may contain up to about 50 percent by weight of triggerable binder formulation solids. More specifically, the solution of the triggerable binder formulation may contain from about 2 to about 20 percent by weight of triggerable binder formulation solids, more specifically about 5 to about 10 percent by weight of triggerable binder formulation solids. Plasticizers, perfumes, coloring agents, antifoams, bactericides, preservatives, surface active agents, thickening agents, fillers, opacifiers, tackifiers, detackifiers, co-binder polymers, and similar additives may be incorporated into the solution of the triggerable binder formulation, if so desired.

[0028] Once the triggerable binder formulation is applied to the fibrous substrate, the fibrous substrate may be dried by any conventional means. Once dry, the coherent fibrous substrate exhibits improved in-use tensile strength when compared to the in-use tensile strength of the untreated wet-laid or air-laid fibrous substrates, and yet has the ability to rapidly "fall apart", or disintegrate when placed in soft or hard water having a divalent ion concentration of about 500 ppm or greater of Ca^{2+} and/or Mg^{2+} and agitated. For example, the dry tensile strength of the triggerable binder formulation treated fibrous substrate may be increased by at least about 25 percent as compared to the dry tensile strength of the untreated fibrous substrate. More particularly, the dry tensile strength of the triggerable binder formulation treated fibrous substrate may be increased by at least about 100 percent as compared to the dry tensile strength of the untreated fibrous substrate. Even more particularly, the dry tensile strength of the fibrous substrate treated with the triggerable binder formulation may be increased by at least about 500 percent as compared to the dry tensile strength of the untreated fibrous substrate.

[0029] One feature of the present invention is that the improvement in the in-use tensile strength is effected where the amount of triggerable binder formulation present, "add-on", in the resultant fibrous substrate may represent only a small portion by weight of the entire fibrous substrate. The add-on level of the triggerable binder formulation may depend upon the in-use tensile strength that is desired in the fibrous substrate and the product into which the fibrous substrate is incorporated. Typically, dense, low caliper fibrous substrates may require a lower add-on level of the triggerable binder formulation to obtain targeted properties while lofty, higher caliper fibrous substrates may require a higher add-on level of the triggerable binder formulation to obtain targeted properties. In addition, wet-laid fibrous substrates may require a lower add-on level of the triggerable binder formulation in the presence of an inherent dry

strength resulting from fiber-fiber hydrogen bonding. Air-laid fibrous substrates may require a higher add-on level of the triggerable binder formulation because such fibrous substrates typically lack an inherent dry strength because hydrogen bonding is less likely to be present within the fibrous substrate.

[0030] The amount of “add-on” may vary for a particular application; however, the optimum amount of “add-on” results in a fibrous substrate which has integrity (desired in-use tensile strength) while in use and also quickly disperses, referred to herein as disposal strength, (typically about 75 g/in. or less; about 50 g/in. or less; or, about 20 g/in. or less) when soaked in water. Typically a lower add-on level is required for wet-end application than for a topical application. For example, the topical add-on level of the triggerable binder formulations may range from about 0.5% to about 25%, by weight, of the total dry fiber weight of the fibrous substrate. More particularly, the topical add-on level of the triggerable binder formulation may range from about 2% to about 15%, by weight, of the total dry fiber weight of the fibrous substrate. Even more particularly, the topical add-on level of the triggerable binder formulations may be from about 5% to about 12% by weight of the total dry fiber weight, of the fibrous substrate. For wet-end application, the wet-end add-on level of the triggerable binder formulations may range from about 0.1% to about 2%, by weight, of the total dry fiber weight of the fibrous substrate. More particularly, the wet-end add-on level of the triggerable binder formulation may range from about 0.3% to about 1%, by weight, of the total dry fiber weight of the fibrous substrate. Even more particularly, the wet-end add-on level of the triggerable binder formulations may be from about 0.5% to about 1% by weight of the total dry fiber weight of the fibrous substrate.

[0031] The treated fibrous substrates of the present invention may have good in-use tensile strength, as well as, triggerability based on the presence of an insolubilizing agent. The fibrous substrates treated with the triggerable binder formulation of the present invention may be abrasion resistant and retain significant tensile strength in aqueous wetting compositions containing the specific amount and type of the insolubilizing agent, such as lower level alcohols, glycols, ketones, and mixtures thereof, disclosed herein.

[0032] The fibers forming the fibrous substrates may be made from a variety of materials including natural fibers, synthetic fibers, and combinations thereof. The choice of fibers depends upon, for example, the intended end use of the finished fibrous substrate, such as a nonwoven fabric, and fiber cost. For instance, the fibrous substrates may include, but are not limited to, natural fibers such as cotton, linen, jute, hemp, wool, wood pulp, etc. Similarly, regenerated cellulosic fibers, such as viscose rayon and cuprammonium rayon, modified cellulosic fibers, such as cellulose acetate, or synthetic fibers, such as those derived from polypropylenes, polyethylenes, polyolefins, polyesters, polyamides, polyacrylics, etc., alone or in combination with one another, may likewise be used. Blends of one or more of the above fibers may also be used, if so desired. Among the wood pulp fibers, any known papermaking pulp fibers may be used, including softwood and hardwood pulp fibers. Fibers, for example, may be chemically pulped or mechanically pulped, bleached or unbleached, virgin or recycled,

high yield or low yield, and the like. Mercerized, chemically stiffened or crosslinked fibers may also be used.

[0033] Synthetic cellulose fiber types include rayon in all its varieties and other fibers derived from viscose or chemically modified cellulose, including regenerated cellulose and solvent-spun cellulose, such as Lyocell. C hemically treated natural cellulosic fibers may be used, such as mercerized pulps, chemically stiffened or crosslinked fibers, or sulfonated fibers. Recycled fibers, as well as virgin fibers, may be used. Cellulose produced by microbes and other cellulosic derivatives may be used. As used herein, the term “cellulosic” is meant to include any material having cellulose as a major constituent, and, specifically, comprising at least 50 percent by weight cellulose or a cellulose derivative. Thus, the term includes cotton, typical wood pulps, nonwoody cellulosic fibers, cellulose acetate, cellulose triacetate, rayon, thermomechanical wood pulp, chemical wood pulp, debonded chemical wood pulp, milkweed, and bacterial cellulose.

[0034] The triggerable binder formulation of the present invention may also be applied to other fibers or particles. Other fibers that may be treated with the triggerable binder formulation of the present invention may include fibers such as those made fibers made from carboxymethyl cellulose, chitin, and chitosan. The triggerable binder formulation of the present invention may also be applied to particles, such as sodium polyacrylate superabsorbent particles. Superabsorbent particles are frequently incorporated on or into fibrous substrates used for cleaning or personal care products, especially nonwoven fabrics.

[0035] The fiber length is important in producing the fibrous substrates, such as nonwoven fabrics, of the present invention. The minimum length of the fibers depends on the method selected for forming the fibrous substrate. For example, where the fibrous substrate is formed by carding, the length of the fiber should usually be at least about 42 mm in order to insure uniformity.

[0036] Where the fibrous substrate is formed by air-laid or wet-laid processes, the fiber length may desirably be about 0.2 to about 6 mm. Although fibers having a length of greater than 50 mm may be used, it has been determined that when a substantial quantity of fibers having a length greater than about 15 mm is placed in a flushable fabric, though the fibers will disperse and separate in water, their length tends to form “ropes” of fibers, which are undesirable when flushing in home toilets. Therefore, for these products, it is desired that the fiber length be about 15 mm or less so that the fibers will not have a tendency to “rope” when they are flushed through a toilet. Although fibers of various lengths are applicable in the present invention, desirably fibers are of a length less than about 15 mm so that the fibers disperse easily from one another when in contact with water. The fibers, particularly synthetic fibers, may also be crimped.

[0037] The fibrous substrates, such as woven and nonwoven fabrics, may be formed from a single layer or multiple layers. In the case of multiple layers, the layers are generally positioned in a juxtaposed or surface-to-surface relationship and all or a portion of the layers may be bound to adjacent layers. The fibrous substrates may also be formed from a plurality of separate webs wherein the separate webs may be formed from single or multiple layers. In embodiments of the present invention where the fibrous substrate

includes multiple layers, the entire thickness of the fibrous substrate may be subjected to an application of the triggerable binder formulation or each individual layer may be separately subjected to an application of the triggerable binder formulation and then combined with other layers in a juxtaposed relationship to form the finished fibrous substrate, such as woven or nonwoven fabrics.

[0038] In one embodiment of the present invention, the fibrous substrates may be incorporated into cleaning products, such as wet wipes, cleaning wipes for cleansing hard surfaces, and the like. These products may comprise one or more layers of a fluid-pervious element, such as fibrous tissue, gauze, plastic netting, etc.

[0039] The triggerable binder formulations of the present invention may be useful for binding fibers of air-laid or wet-laid fibrous substrates, such as nonwoven fabrics. The basis weights for air-laid or wet-laid fibrous substrates may range from about 10 grams per square meter ("gsm") to about 200 gsm. More specifically, the basis weights for the fibrous substrates may range from about 20 gsm to about 70 gsm and more specifically, from about 30 gsm to about 70 gsm. The basis weight, caliper, and other properties may be chosen to deliver desired attributes such as bulk, stretch, resiliency, toughness, and the like. The air-laid fibrous substrates may be especially useful for a wet wipe. The basis weights for such air-laid fibrous substrates may range from about 20 gsm to about 200 gsm with staple fibers having a denier of about 0.5 to about 10 and a length of about 6 to about 15 millimeters.

[0040] The fibrous substrates may also be incorporated into such body fluid absorbing products as pads, surgical dressings, tissues and the like. The triggerable binder formulation is such that it will not dissolve when contacted by body fluids. The fibrous substrate retains its structure, softness and exhibits a toughness satisfactory for practical use. However, when the fibrous substrate is brought into contact with water having a concentration of an insolubilizing agent, such as a lower level alcohol, lower level glycol, lower level ketone, or mixtures thereof, up to about 300 ppm or less, the triggerable binder formulation disperses. The fibrous substrate is then easily broken and dispersed or dissolved in the water.

[0041] In one embodiment of the present invention, the in-use tensile strength of a fibrous substrate may be enhanced by forming the fibrous substrate with a binder material comprising the triggerable binder formulation of the present invention and subsequently applying an insolubilizing agent, such as a lower level alcohol, glycol, ketone, or mixtures thereof, to the fibrous substrate. The insolubilizing agent may be applied to the fibrous substrate by any method known to those of ordinary skill in the art including spraying a solution onto the fibrous substrate. The amount of the insolubilizing agent may vary depending on a particular application. However, the amount of the insolubilizing agent may be applied to the fibrous substrate may be from about 50 weight percent to about 700 weight percent of the insolubilizing agent based on the total weight of the fibrous substrate. The insolubilizing agent-containing fibrous substrates of the present invention may be used in a variety of fibrous substrates applications including, but not limited to, wipe products, such as wet wipes, cleaning wipes for hard surfaces, and the like.

[0042] Those skilled in the art will readily understand that the triggerable binder formulations and fibrous substrates of the present invention may be advantageously employed in the preparation of a wide variety of products, including but not limited to, cleaning or personal care products designed to be contacted with body fluids. Such cleaning or personal care products may only comprise a single layer of the fibrous substrate, or may comprise a combination of elements, as described above. Although the triggerable binder formulations and fibrous substrates of the present invention are particularly suited for cleaning or personal care products, the triggerable binder formulations and fibrous substrates may be advantageously employed in a wide variety of consumer products.

[0043] The triggerable binder formulations of the present invention may be activated as binders without the need for elevated temperature. While drying or water removal may be useful in achieving a good distribution of the triggerable binder formulation in a fibrous substrate, elevated temperature, per se, is not essential because the triggerable binder formulation does not require crosslinking or other chemical reactions with high activation energy to serve as a within the fibrous substrate. Rather, the interaction with a soluble insolubilizing agent, typically a lower level alcohol, glycol, ketone, or mixtures thereof, is sufficient to cause the triggerable binder formulation to become insoluble; i.e., activated by interaction between the insolubilizing agent and the triggerable binder formulation. Thus, a drying step may be avoided, if desired, or replaced with low-temperature water removal operations such as room-temperature drying or freeze drying. Elevated temperature is generally helpful for drying, but the drying may be done at temperatures below what is normally needed to drive crosslinking reactions. Thus, the peak temperature to which the fibrous substrate is exposed or to which the fibrous substrate is brought may be below any of the following: 200° C., 180° C., 160° C., 140° C., 120° C., 110° C., 105° C., 100° C., 90° C., 75° C., and 60° C.

Wet Wipe Wetting Composition and Wet Wipes Containing the Same

[0044] One embodiment of the present invention is the production of wet wipes comprising the triggerable binder formulations and fibrous substrates. For wet wipes, the fibrous substrate may be in the form of a woven or nonwoven fabric; however, nonwoven fabrics may be more typical. The fibrous substrate may be formed from relatively short fibers, such as wood pulp fibers. The minimum length of the fibers may depend on the method selected for forming the fibrous substrate, such as a nonwoven fabric. Where the fibrous substrate is formed by a wet or dry method, the fiber length may range from about 0.1 millimeters to 15 millimeters. The fibrous substrate for use in the present invention may have a relatively low wet cohesive strength when it is not bonded together by an adhesive or binder material. When such fibrous substrates are bonded together by a triggerable binder formulation, which loses its bonding strength in tap water and in sewer water, the fibrous substrate may break up readily by the agitation provided by flushing and moving through the sewer pipes.

[0045] The finished wet wipes may be individually packaged, desirably in a folded condition, in a moisture and/or solvent proof envelope or packaged in containers holding

any desired number of sheets of wet wipes in a moisture/solvent-tight package with a wetting composition applied to the wet wipe. The finished wet wipes may also be packaged as a roll of separable sheets of wet wipes in a moisture/solvent-proof container holding any desired number of sheets of wet wipes on the roll with a wetting composition applied to the wet wipes. The roll may be coreless and either hollow or solid. Coreless rolls, including rolls with a hollow center or without a solid center, may be produced with known coreless roll winders, including those of SRP Industry, Inc. located in San Jose, Calif.; Shimizu Manufacturing located in Japan; and, the devices discussed in U.S. Pat. No. 4,667,890, issued to Gietman on May 26, 1987. Solid-wound coreless rolls may offer more product for a given volume and may be adapted for a wide variety of dispensers.

[0046] Relative to the weight of the dry fibrous substrate, the wet wipe may contain from about 10 percent to about 500 percent of the wetting composition, more specifically from about 100 percent to about 400 percent of the wetting composition, and even more specifically from about 200 percent to about 300 percent of the wetting composition. The wet wipe may maintain its desired characteristics over the time periods involved in warehousing, transportation, retail display and storage by the consumer.

[0047] Various forms of impermeable envelopes and storage means for containing wet-packaged materials, such as wipes and towelettes and the like, are well known in the art. Any of these may be employed in packaging the wet wipes of the present invention.

[0048] The wet wipes of the present invention are wetted with an solvent-based wetting composition, which has one or more of the following properties:

[0049] (1) is compatible with the above-described triggerable binder formulations of the present invention;

[0050] (2) enables the pre-moistened wipe to maintain its wet strength during converting, storage and usage (including dispensing), as well as, dispersibility in a toilet bowl;

[0051] (3) reduces tackiness of the wipe, and provides tactile properties, such as skin glide and a "lotion-like feel";

[0052] (4) acts as a vehicle to deliver cleansing, sanitizing, or disinfecting benefits;

[0053] (5) acts as a vehicle to deliver "moist cleansing" and other skin health benefits; and,

[0054] (6) provides for rapid evaporation and/or drying.

[0055] In one aspect of the present invention, the wetting composition may contain an insolubilizing agent that maintains the strength of a water-dispersible triggerable binder formulation until the insolubilizing agent is diluted with water, whereupon the strength of the water-dispersible triggerable binder formulation begins to decay. The water-dispersible triggerable binder formulation may be any of the triggerable binder formulations of the present invention. The insolubilizing agent in the wetting composition may be a lower level alcohol, glycol, ketone, or mixtures thereof which provides in-use and storage strength to the water-dispersible triggerable binder formulation, and may be diluted in water to permit dispersion of the fibrous substrate

as the triggerable binder formulation triggers to a weaker state. Examples of lower level alcohols, glycols, and ketones may include, but are not limited to: methyl alcohol; ethyl alcohol; n-propyl alcohol; isopropyl alcohol; n-butyl alcohol; sec-butyl alcohol; tert-butyl alcohol; ethylene glycol; 1,2 propandiol (propylene glycol); 1,3 propane diol; acetone; methylethyl ketone; and, mixtures thereof.

[0056] Determination of a suitable lower level alcohol, glycol, ketone, or mixtures thereof may be conducted using the solubility. The solubility of an amorphous polymer in a given solvent is governed by the Gibbs free energy of mixing given by Equation (1):

$$\Delta G_m = \Delta H_m - T\Delta S_m \quad (1)$$

ΔG_m is the free energy change of the system upon mixing. ΔH_m and ΔS_m are the enthalpy and entropy change upon mixing, respectively, and T is the absolute temperature. When the free energy of mixing is less than zero ($\Delta G_m < 0$) for a given polymer and solvent (or solvent mixture thereof), a single-phase system is obtained and mixing occurs spontaneously. Since dissolution of a high molecular weight polymer is almost always accompanied by an increase in entropy of the system ($\Delta S_m > 0$), the sign and magnitude of ΔH_m is generally the deciding factor for solubility.

[0057] Solubility parameters, originally developed to describe enthalpy of mixing with simple nonpolar solvents, have been extended to describe the interactions of polymers and polar solvent. The enthalpy of mixing of such systems is expressed in a form like Equation (2):

$$\Delta H_m = V \left[\left(\frac{\Delta E_1^v}{V_1} \right)^{\frac{1}{2}} - \left(\frac{\Delta E_2^v}{V_2} \right)^{\frac{1}{2}} \right]^2 \phi_1 \phi_2 \quad (2)$$

V is the volume of the mixture, ΔE_1^v is the ideal energy of vaporization of the solvent, and ΔE_2^v is the ideal or theoretical energy of vaporization of the polymer. V_1 and V_2 are the partial molar volumes of the solvent and polymer, respectively. ϕ_1 and ϕ_2 are the respective volume fractions. The $(\Delta E_i^v/V_i)$ terms represent "cohesive energy density" values and correspond to the energy of vaporization per unit volume of a component under ideal conditions. The solubility parameter or Hildebrand parameter, δ , is defined as the square root of the cohesive energy density, given by Equation (3):

$$\delta_i = \left(\frac{\Delta E_i^v}{V_i} \right)^{\frac{1}{2}} \quad (3)$$

The solubility parameter describes the attractive strength between the molecules of a material and is sometimes referred to as an "internal cohesion parameter". For the mixing of two substances to take place, the breaking of these internal cohesive forces must occur.

[0058] Substituting the results from Equation (3) and Equation (2) into Equation (1) and canceling the bulk volume term (V) yields the following result, where v_1 and v_2

are the relative volumes of the solvent and polymer, respectively, as depicted in Equation (4):

$$\Delta G_m = ((\delta_1 - \delta_2)^2 v_1 v_2) - T \Delta S_m \quad (4)$$

Equation (4) represents the thermodynamic basis for the old chemical rule-of-thumb, “like dissolves like”. When $\delta_1 = \delta_2$, the enthalpic term goes to zero and the free energy of mixing is always negative. If the difference is small, the entropic term may out weight the enthalpy and spontaneous mixing will still occur. If the difference in δ values is large, then the magnitude of the enthalpic term will out-weigh the entropy gain and mixing will not occur. In such cases where the difference in solubility parameters for a polymer-solvent combination is large, the solvent is considered to be a “non-solvent” for the polymer.

[0059] The units of δ may be difficult to rationalize. They are generally expressed as units of $\text{MPa}^{1/2}$ or $(\text{cal}/\text{cm}^3)^{1/2}$. One simple way to understand these units is to note that Equation (4) calls for a solution in terms of a quantity of energy. It can be readily seen that substitution of δ values in terms of $(\text{cal}/\text{cm}^3)^{1/2}$ or $\text{MPa}^{1/2}$ into Equation (4) results in a quantity of energy in terms of calories or joules, respectively, after unit cancellation ($1 \text{ MPa} = 1 \text{ kJ}/\text{m}^3$). For purposes of the present work, $(\text{cal}/\text{cm}^3)^{1/2}$ units for δ will be used.

[0060] Finally, in the extension of solubility parameters to polar systems, one should recognize the presence and activity of hydrogen bonding. Hydrogen bonding forces may be much stronger than van der Waals and dipole forces and may dominate the enthalpy of mixing. In general, complete miscibility may be only expected when the solubility parameter and hydrogen bonding character are similar. The contribution of hydrogen bonding applies to the solubility of polar vinyl polymers, such as polyacrylamide and polyvinyl pyrrolidone. In this study, numerical hydrogen bonding indices are assigned. Often, however, solvents are assigned to a hydrogen-bonding group: strong (s); moderate (m); and, poor (p). Direct comparison of physical properties of polymer-solvent pairs based on δ values will usually be done within the same hydrogen bonding group.

[0061] A vast number of solvent solubility parameter values are available in the Polymer Handbook, 4th Edition, John Wiley & Sons, New York, (1999), the disclosure of which is incorporated by reference to the extent it is non-contradictory herewith. Table A shows the solubility parameters and hydrogen bonding groups for selected solvents. Note that all the solvents selected are strong hydrogen bonders except for acetone, which has moderate hydrogen bonding ability. Typically, miscibility with water is desirable for disposal in common waste-water streams, but other solvents may also be suitable. δ values for these solvents range from 14.5 to 9.9. Water, on the other hand, has a much higher value of 23.4, is a strong hydrogen bonder, and is known to be a very good solvent for many polymers with polar groups, hence the term “water-soluble polymers”.

[0062] A δ value for polyacrylamide homopolymer (PAM) of 21 $(\text{cal}/\text{cm}^3)^{1/2}$ has been assigned for comparison. This also allows calculation of the cohesive energy difference parameter, $(\delta_1 - \delta_2)^2$, for each solvent with PAM. These data are also presented in Table A. A solubility parameter is not readily available for polyvinylamine/vinylamide resins. However, polyvinylformamide is a structural isomer and should be expected to have similar values through functional

group contributions. Therefore, copolymers derived from this material should have similar solubility behavior as acrylamide copolymers and some license may be taken in discussing their behavior generically as “polyacrylamide”, unless specific differences are being highlighted.

[0063] With decreasing δ value or increasing cohesive energy difference, the solvents in Table A should become better non-solvents for polyacrylamide. Therefore, fibrous substrates treated with polyacrylamide and wetted with non-solvent should show high in-use strength. Strength should somehow correlate with the non-solvency of the wetting fluid or δ value. In certain cases, it may be desirable to use a mixture of one or more of the solvents with water. In these cases, solvency (or non-solvency) of the solvent mixture may be evaluated by calculating a weighted average or “apparent” solubility parameter ($\delta_{1(\text{app})}$) and properties of the fibrous substrate should governed by the relative amounts of solvent and non-solvent in the solvent mixture.

TABLE A

Solubility parameter values and hydrogen bonding groups for selected solvents.

Solvent	ID	Solubility Parameter, δ (cal/cm^3) ^{1/2}	$(\delta_1 - \delta_2)^2$ PAM	H-Bonding Group
Water	H ₂ O	23.4	5.8	s
Methyl alcohol	MeOH	14.5	42.3	s
Ethyl alcohol	EtOH	12.7	68.9	s
Propylene glycol	PPG	12.6	70.6	s
n-Propyl alcohol	NPA	11.9	82.8	s
Isopropyl alcohol	IPA	11.5	90.3	s
n-Butyl alcohol	NBA	11.4	92.6	s
t-Butyl alcohol	TBA	10.6	108.2	s
Acetone	ACE	9.9	123.2	m

[0064] The wetting composition may contain more than about 0.3 weight percent of the insolubilizing agent based on the total weight of the wetting composition for triggerable binder polymers or polymer formulations. Specifically, the wetting composition may contain from about 50 weight percent to about 100 weight percent of the insolubilizing agent. Even more specifically, the wetting composition may contain from about 65 weight percent to about 90 weight percent of an insolubilizing agent. More precisely, the wetting composition may contain from about 70 weight percent to about 90 weight percent of the insolubilizing agent.

[0065] The wetting composition of the present invention may further comprise a variety of additives compatible with the insolubilizing agent and the water-dispersible triggerable binder formulation, such that the strength and dispersibility functions of the wet wipe are not jeopardized. Suitable additives in the wetting composition include, but are not limited to, the following additives: chelators; odor control agents; detackifying agents to reduce the tackiness of the triggerable binder formulation; particulates; antimicrobial agents; preservatives; wetting agents and cleaning agents, such as detergents, surfactants, and some silicones; emollients; humectants; surface feel modifiers for improved tactile sensation (e.g., lubricity) on the skin; fragrance; fragrance solubilizers; opacifiers; fluorescent whitening

agents; stabilizers; oxidizers; UV absorbers; pharmaceuticals; and, pH control agents, such as malic acid and potassium hydroxide.

[0066] Examples of wetting compositions are described in U.S. Pat. No. 5,145,663, issued to Simmons on Sep. 8, 1992 and U.S. Pat. No. 5,441,723, issued, to Simmons on Aug. 15, 1995, the disclosures of which are incorporated by reference to the extent that they are non-contradictory herewith.

Additional Additives

Odor Control Additives

[0067] Suitable odor control additives for use in the wetting composition and wet wipes of the present invention may include, but are not limited to: zinc salts; talc powder; encapsulated perfumes (including microcapsules, macrocapsules, and perfume encapsulated in liposomes, vesicles, or microemulsions); chelants, such as ethylenediamine tetraacetic acid; zeolites; activated silica, activated carbon granules or fibers; activated silica particulates; polycarboxylic acids, such as citric acid; cyclodextrins and cyclodextrin derivatives; chitosan or chitin and derivatives thereof; oxidizing agents; antimicrobial agents, including silver-loaded zeolites (e.g., those of BF Technologies, located in Beverly, Mass., sold under the trademark HEALTHSHIELD™); triclosan; kieselguhr; and, mixtures thereof. In addition to controlling odor from the body or body wastes, odor control strategies may also be employed to mask or control any odor of the treated fibrous substrate. The wetting composition may contain less than about 5 weight percent of odor control additives based on the total weight of the wetting composition. More specifically, the wetting composition may contain from about 0.01 weight percent to about 2 weight percent of odor control additives. Even more specifically, the wetting composition may contain from about 0.03 weight percent to about 1 weight percent of odor control additives.

[0068] In one embodiment of the present invention, the wetting composition and/or wet wipes may comprise derivatized cyclodextrins, such as hydroxypropyl beta-cyclodextrin in solution, which remain on the skin after wiping and provide an odor-absorbing layer. In other embodiments of the present invention, the odor source may be removed or neutralized by application of an odor-control additive, exemplified by the action of a chelant that binds metal groups necessary for the function of many proteases and other enzymes that commonly produce an odor. Chelating the metal group interferes with the enzyme's action and decreases the risk of malodor in the wet wipe product.

[0069] Principles for the application of chitosan or chitin derivatives to nonwoven webs and cellulosic fibers are described by S. Lee et al. in "Antimicrobial and Blood Repellent Finishes for Cotton and Nonwoven Fabrics Based on Chitosan and Fluoropolymers," *Textile Research Journal*, 69(2); 104-112, February 1999.

Microparticulates

[0070] The wetting composition of the present invention may be further modified by the addition of solid particulates or microparticulates. Suitable particulates may include, but are not limited to: mica, silica, alumina, calcium carbonate, kaolin, talc, and zeolites. The particulates may be treated with stearic acid or other additives to enhance the attraction or bridging of the particulates to the triggerable binder

formulation, if desired. Also, two-component microparticulate systems, commonly used as retention aids in the paper-making industry, may also be used. Such two-component microparticulate systems generally comprise a colloidal particle phase, such as silica particles, and a water-soluble cationic polymer for bridging the particles to the fibers of the fibrous substrate to be formed. The presence of particulates in the wetting composition may serve one or more useful functions, such as: (1) increasing the opacity of the wet wipes; (2) modifying the rheology or reducing the tackiness of the wet wipe; (3) improving the tactile properties of the wet wipe; or, (4) delivering desired agents to the skin via a particulate carrier, such as a porous carrier or a microcapsule. The wetting composition may contain less than about 25 weight percent of particulate based on the total weight of the wetting composition. More specifically, the wetting composition may contain from about 0.05 weight percent to about 10 weight percent of microparticulate. Even more specifically, the wetting composition may contain from about 0.1 weight percent to about 5 weight percent of microparticulate.

Microcapsules and Other Delivery Vehicles

[0071] Microcapsules and other delivery vehicles may also be used in the wetting composition of the present invention to provide skin-care agents; medications; comfort promoting agents, such as eucalyptus; perfumes; skin care agents; odor control additives; vitamins; powders; and, other additives to the skin of the user. Specifically, the wetting composition may contain up to about 25 weight percent of microcapsules or other delivery vehicles based on the total weight of the wetting composition. More specifically, the wetting composition may contain from about 0.05 weight percent to about 10 weight percent of microcapsules or other delivery vehicles. Even more specifically, the wetting composition may contain from about 0.2 weight percent to about 5.0 weight percent of microcapsules or other delivery vehicles.

[0072] Microcapsules and other delivery vehicles are well known in the art. For example, POLY-PORE® E200, commercially available from Chemdal Corporation located in Arlington Heights, Ill., may be a delivery agent comprising soft, hollow spheres that can contain an additive at over 10 times the weight of the delivery vehicle. Additives that may be used with POLY-PORE® E200 include, but are not limited to: benzyl peroxide, salicylic acid, retinol, retinyl palmitate, octyl methoxycinnamate, tocopherol, silicone compounds (DC 435), and mineral oil. Another delivery vehicle that may be used in the present invention is a sponge-like material commercially available under the trade designation of POLY-PORE® L200 from Chemdal Corporation, with silicone (DC 435) and mineral oil. Other delivery systems may include cyclodextrins and their derivatives, liposomes, polymeric sponges, and spray-dried starch.

[0073] Additives present in microcapsules may be isolated from the environment and the other agents in the wetting composition until the wet wipe is applied to the skin, whereupon the microcapsules break and deliver their load to the skin or other surfaces.

Preservatives and Anti-Microbial Agents

[0074] The wetting composition of the present invention may also contain preservatives and/or anti-microbial agents

for cleaning and/or sanitizing uses. Several preservatives and/or anti-microbial agents, such as Mackstat H 66 commercially available from McIntyre Group located in Chicago, Ill., may prevent bacteria and mold growth. Other preservatives and anti-microbial agents may include, but are not limited to: DMDM hydantoin, e.g., commercially available under the trade designation of Glydant Plus™ from Lonza, Inc. located in Fair Lawn, N.J.; iodopropynyl butylcarbamate; Kathon commercially available from Rohm and Hass located in Philadelphia, Pa.; methylparaben; propylparaben; 2-bromo-2-nitropropane-1,3-diol; benzoic acid; benzalkonium chloride; benzethonium chloride; and, the like. The wetting composition may contain less than about 2 weight percent on an active basis of preservatives and/or anti-microbial agents based on the total weight of the wetting composition. More specifically, the wetting composition may contain from about 0.01 weight percent to about 1 weight percent of preservatives and/or anti-microbial agents. Even more specifically, the wetting composition may contain from about 0.01 weight percent to about 0.5 weight percent of preservatives and/or anti-microbial agents. Further discussion regarding preservatives and/or anti-microbial agents may be found in *Disinfection, Sterilization, and Preservation*, 4th Edition, Lea & Frebiger, (1991), the disclosure of which is incorporated by reference to the extent it is non-contradictory herewith.

Wetting Agents and Cleaning Agents

[0075] A variety of wetting agents and/or cleaning agents may be used in the wetting composition of the present invention. Suitable wetting agents and/or cleaning agents may include, but are not limited to; detergents and nonionic, amphoteric, cationic, and anionic surfactants. The wetting composition may contain less than about 3 weight percent of wetting agents and/or cleaning agents based on the total weight of the wetting composition. More specifically, the wetting composition may contain from about 0.01 weight percent to about 2 weight percent of wetting agents and/or cleaning agents. Even more specifically, the wetting composition may contain from about 0.1 weight percent to about 0.5 weight percent of wetting agents and/or cleaning agents. Suitable cationic surfactants may include, but are not limited to, quaternary ammonium alkyl halides like cetyl trimethyl ammonium chloride and cetyl trimethyl ammonium bromide.

[0076] Amino acid-based surfactant systems, such as those derived from amino acids L-glutamic acid and other natural fatty acids, may offer pH compatibility to human skin and good cleansing power, while being relatively safe and providing improved tactile and moisturization properties compared to other anionic surfactants. One function of the surfactant may be to improve wetting of the dry fibrous substrate with the wetting composition. Another function of the surfactant may be to disperse bathroom soils when the wet wipe contacts a soiled area and to enhance their absorption into the fibrous substrate. The surfactant may assist in make-up removal, general personal cleansing, hard surface cleansing, odor control, and the like. One commercially available example of an amino-acid based surfactant is acylglutamate, marketed under the trade designation of Amisoft from Ajinomoto Corporation located in Tokyo, Japan.

[0077] Suitable non-ionic surfactants may include, but are not limited to, the condensation products of ethylene oxide

with a hydrophobic (oleophilic) polyoxyalkylene base formed by the condensation of propylene oxide with propylene glycol. The hydrophobic portion of these compounds may have a molecular weight sufficiently high so as to render it water-insoluble. The addition of polyoxyethylene moieties to this hydrophobic portion increases the water-solubility of the molecule as a whole, and the liquid character of the product may be retained up to the point where the polyoxyethylene content is about 50% of the total weight of the condensation product. Examples of compounds of this type include commercially available Pluronic surfactants from BASF Wyandotte Corporation located in Wyandotte, Mich., especially those in which the polyoxypropylene ether has a molecular weight of about 1500 to about 3000 and the polyoxyethylene content is about 35% to about 55% of the molecule by weight, i.e. Pluronic L-62.

[0078] Other useful nonionic surfactants may include, but are not limited to, the condensation products of C_8 to C_{22} alkyl alcohols with 2 to 50 moles of ethylene oxide per mole of alcohol. Examples of compounds of this type may include the condensation products of C_{11} to C_{15} secondary alkyl alcohols with 3 to 50 moles of ethylene oxide per mole of alcohol, which are commercially available under the trade designation of the Poly-Tergent SLF series from Olin Chemicals located in Baltimore City, Md. or the TERGITOL® series from Union Carbide located in Danbury, Conn.; i.e., TERGITOL® 25-L-7, which is formed by condensing about 7 moles of ethylene oxide with a C_{12} to C_{15} alkanol.

[0079] Other nonionic surfactants, which may be employed in the wetting composition of the present invention, may include the ethylene oxide esters of C_6 to C_{12} alkyl phenols such as (nonylphenoxy)polyoxyethylene ether. Esters prepared by condensing about 8 to 12 moles of ethylene oxide with nonylphenol, i.e. the IGEPAL® CO series commercially available from GAF Corporation located in Wayne, N.J. may be used in the wetting composition of the present invention.

[0080] Further non-ionic surface active agents may include, but are not limited to, alkyl polyglycosides (APG) derived as a condensation product of dextrose (D-glucose) and a straight or branched chain alcohol. The glycoside portion of the surfactant may provide a hydrophilic having high hydroxyl density, which enhances water solubility. Additionally, the inherent stability of the acetal linkage of the glycoside provides chemical stability in alkaline systems. Furthermore, unlike some non-ionic surface active agents, alkyl polyglycosides have no cloud point, allowing one to formulate without a hydrotrope, and these are very mild, as well as readily biodegradable non-ionic surfactants. This class of surfactants is commercially available from Henkel Corporation located in Ambler, Pa. under the trade designations of Glucopon 220, Glucopon 225 and Glucopon 425.

[0081] Silicones are another class of wetting agents that may be available in pure form, or as microemulsions, macroemulsions, and the like. One non-ionic surfactant group is the silicone-glycol copolymers. These surfactants may be prepared by adding poly(lower)alkylenoxy chains to the free hydroxyl groups of dimethylpolysiloxanols and are commercially available from the Dow Corning Corporation located in Midland, Mich. under the trade designations of

Dow Corning 190 and Dow Corning 193 surfactants (CTFA name: dimethicone copolyol). These surfactants may function, with or without any volatile silicones used as solvents, to control foaming produced by the other surfactants, and also may impart a shine to metallic, ceramic, and glass surfaces.

[0082] Anionic surfactants may also be used in the wetting compositions of the present invention. Anionic surfactants may be useful due to their high detergency include anionic detergent salts having alkyl substituents of 8 to 22 carbon atoms such as the water-soluble higher fatty acid alkali metal soaps, e.g., sodium myristate and sodium palmitate. One class of anionic surfactants encompasses the water-soluble sulfated and sulfonated anionic alkali metal and alkaline earth metal detergent salts containing a hydrophobic higher alkyl moiety (typically containing from about 8 to 22 carbon atoms) such as salts of higher alkyl mono or polynuclear aryl sulfonates having from about 1 to 16 carbon atoms in the alkyl group, with examples commercially available under the trade designation of the Bio-Soft series, i.e. Bio-Soft D-40 from Stepan Chemical Co. located in Northfield, Ill.

[0083] Other useful classes of anionic surfactants may include, but are not limited to: sulfated higher fatty acid monoglycerides such as the sodium salt of the sulfated monoglyceride of cocoa oil fatty acids and the potassium salt of the sulfated monoglyceride of tallow fatty acids; alkali metal salts of sulfated fatty alcohols containing from about 10 to 18 carbon atoms (e.g., sodium lauryl sulfate and sodium stearyl sulfate); sodium C_{14} to C_{16} -alphaolefin sulfonates such as the Bio-Terge series commercially available from Stepan Chemical Co.; alkali metal salts of sulfated ethyleneoxy fatty alcohols (the sodium or ammonium sulfates of the condensation products of about 3 moles of ethylene oxide with a C_{12} to C_{15} n-alkanol, i.e., the Neodol ethoxysulfates commercially available from Shell Chemical Co. located in Houston, Tex.; alkali metal salts of higher fatty esters of low molecular weight alkylol sulfonic acids, e.g. fatty acid esters of the sodium salt of isothionic acid and the fatty ethanolamide sulfates; the fatty acid amides of amino alkyl sulfonic acids, e.g., lauric acid amide of taurine; as well as numerous other anionic organic surface active agents such as sodium xylene sulfonate, sodium naphthalene sulfonate, sodium toluene sulfonate; and, mixtures thereof.

[0084] A further useful class of anionic surfactants may include the 8-(4-n-alkyl-2-cyclohexenyl)-octanoic acids, wherein the cyclohexenyl ring is substituted with an additional carboxylic acid group. These compounds or their potassium salts, are commercially available from Westvaco Corporation located in Meriden, Conn. under the trade designations of Diacid 1550 or H-240. In general, these anionic surface active agents may be employed in the form of their alkali metal salts, ammonium or alkaline earth metal salts.

Surface Feel Modifiers

[0085] Surface feel modifiers may be used to improve the tactile sensation (e.g., lubricity) of the skin during use of the cleaning or personal care product. Suitable surface feel modifiers include, but are not limited to, commercial debonders and softeners, such as the softeners used in the art of tissue making including quaternary ammonium compounds with fatty acid side groups, silicones, waxes, and the like. Quaternary ammonium compounds that may have utility as

softeners are disclosed in U.S. Pat. No. 3,554,862, issued to Hervey et al. on Jan. 12, 1971; U.S. Pat. No. 4,144,122, issued to Emanuelsson et al. on Mar. 13, 1979; U.S. Pat. No. 5,573,637, issued to Ampulski et al. on Nov. 12, 1996; and, U.S. Pat. No. 4,476,323, issued to Hellsten et al. on Oct. 9, 1984, the disclosures of which are incorporated by reference to the extent that they are non-contradictory herewith. The wetting composition may contain less than about 2 weight percent of surface feel modifiers based on the total weight of the wetting composition. More specifically, the wetting composition may contain from about 0.01 weight percent to about 1 weight percent of surface feel modifiers. Even more specifically, the wetting composition may contain from about 0.01 weight percent to about 0.05 weight percent of surface feel modifiers.

Fragrances

[0086] A variety of fragrances may be used in the wetting composition of the present invention. The wetting composition may contain less than about 2 weight percent of fragrances based on the total weight of the wetting composition. More specifically, the wetting composition may contain from about 0.01 weight percent to about 1 weight percent of fragrances. Even more specifically, the wetting composition may contain from about 0.01 weight percent to about 0.05 weight percent of fragrances.

[0087] Fragrance Solubilizers Further, a variety of fragrance solubilizers may be used in the wetting composition of the present invention. Suitable fragrance solubilizers may include, but are not limited to: polysorbate 20; propylene glycol; ethanol; isopropanol; diethylene glycol monoethyl ether; dipropylene glycol; diethyl phthalate; triethyl citrate; Ameroxol OE-2 commercially available from Amerchol Corporation located in Midland, Mich.; Brij 78 and Brij 98 commercially available from ICI Surfactants located in Wilmington, Del.; Arlasolve 200 commercially available from ICI Surfactants; Calfax 16L-35 commercially available from Pilot Chemical Co. located in Santa Fe Springs, Calif.; Capmul POE-S commercially available from Abitec Corporation located in Columbus, Ohio; Finsolv SUBSTANTIAL commercially available from Finetex located in Elmwood Park, N.J.; and, the like. The wetting composition may contain less than about 2 weight percent of fragrance solubilizers based on the total weight of the wetting composition. More specifically, the wetting composition may contain from about 0.01 weight percent to about 1 weight percent of fragrance solubilizers. Even more specifically, the wetting composition may contain from about 0.01 weight percent to about 0.05 weight percent of fragrance solubilizers.

Opacifiers

[0088] Suitable opacifiers may include, but are not limited to, titanium dioxide or other minerals or pigments, and synthetic opacifiers, such as REACTOPAQUE® particles commercially available from Sequa Chemicals, Inc. located at Chester, S. C. The wetting composition may contain less than about 2 weight percent of opacifiers based on the total weight of the wetting composition. More specifically, the wetting composition may contain from about 0.01 weight percent to about 1 weight percent of opacifiers. Even more specifically, the wetting composition may contain from about 0.01 weight percent to about 0.05 weight percent of opacifiers.

pH Control Agents

[0089] pH control agents for use in the wetting composition of the present invention may include, but are not limited to; malic acid; citric acid; hydrochloric acid; acetic acid; sodium hydroxide; potassium hydroxide; and, the like. An appropriate pH range minimizes the amount of skin irritation resulting from the wetting composition on the skin. The pH range of the wetting composition may range from about 3.5 to about 6.5. More specifically, the pH range of the wetting composition may range from about 4 to about 6. The overall pH of the wet wipe product; i.e., the complete wet wipe product including the fibrous substrate portion and the wetting composition portion, may range from about 4.5 to about 5.5; more specifically, about 5.0. The wetting composition may contain less than about 2 weight percent of a pH adjuster based on the total weight of the wetting composition. More specifically, the wetting composition may contain from about 0.01 weight percent to about 1 weight percent of a pH adjuster. Even more specifically, the wetting composition may contain from about 0.01 weight percent to about 0.05 weight percent of a pH adjuster.

[0090] It should be noted that the above-described wetting compositions of the present invention may be used with any one of the above-described triggerable binder compositions of the present invention. Further, the above-described wetting compositions of the present invention may be used with any other binder composition, including conventional binder compositions, or with any known fibrous or absorbent substrate, whether dispersible or not.

Method of Making Wet Wipes

[0091] The wet wipes of the present invention may be made in several ways. In one embodiment of the present invention, the triggerable binder formulation may be applied to a fibrous substrate as part of an aqueous solution or suspension, wherein subsequent drying is needed to remove the water and promote binding of the fibers within the fibrous substrate. In particular, during drying, the triggerable binder formulation migrates to the crossover points of the fibers and becomes activated as a triggerable binder formulation in those regions, thus providing acceptable strength to the fibrous substrate. By way of example, the following steps are provided and may be applied:

- [0092] 1. Providing an absorbent fibrous substrate that is not highly bonded (e.g., an unbonded airlaid, a tissue web, a carded web, fluff pulp, etc.);
- [0093] 2. Applying a triggerable binder formulation to the fibrous substrate, typically in the form of a liquid, suspension, or foam;
- [0094] 3. Drying the fibrous substrate to promote bonding of the fibers within the fibrous substrate;
- [0095] 4. Applying a wetting composition to the fibrous substrate thereby providing a wetted product; and,
- [0096] 5. Placing the wetted product in roll form or in a stack and packaging the wetted product.

[0097] Application of the triggerable binder formulation to the fibrous substrate may be accomplished by means of spray application; foam application; immersion in a bath; curtain coating; coating and metering with a wire-wound rod; passage of the fibrous substrate through a flooded nip;

contact with a pre-metered wetted roll coated with the triggerable binder formulation; by pressing the fibrous substrate against a deformable carrier containing the triggerable binder formulation such as a sponge or felt to effect transfer into the fibrous substrate; printing such as gravure, inkjet, or flexographic printing; and, any other means known to one skilled in the art. In the alternative, wet-end application is acceptable.

[0098] Without wishing to be bound by theory, it is believed that a drying step after application of the triggerable binder formulation and before application of the wetting composition may enhance bonding of the fibers within a fibrous substrate by driving the triggerable binder formulation to fiber crossover points as moisture is driven off, thus promoting efficient use of the triggerable binder formulation. However, in an alternative method, the drying step discussed above may be skipped, and the triggerable binder formulation may be applied to the fibrous substrate followed by application of the wetting composition without significant intermediate drying. In one embodiment of this method, the triggerable binder formulation may selectively adhere to the fibers, permitting excess water to be removed in an optional pressing step without a significant loss of the triggerable binder formulation from the fibrous substrate. In another embodiment of this method, no significant water removal need occur prior to application of the wetting composition. In yet another alternative embodiment of this method, the triggerable binder formulation and the wetting composition may be applied simultaneously to the fibrous substrate, optionally with subsequent addition of additives or insolubilizing agents to further render the triggerable binder formulation insoluble.

[0099] The present invention may be further illustrated by the following examples, which are not to be construed in any way as imposing limitations upon the scope thereof. On the contrary, it is to be clearly understood that resort may be had to various other embodiments, modifications, and equivalents thereof which, after reading the description herein, may suggest themselves to those skilled in the art without departing from the spirit of the present invention and/or the scope of the appended claims.

EXAMPLE 1

Wetting Composition Preparation

[0100] ACS reagent grade or better of isopropanol (IPA), acetone(ACE), t-butyl alcohol (TBA), n-butyl alcohol (NBA), n-propanol (NPA), ethanol (EtOH) or methanol (MeOH) were used in formulating the wetting solutions used in the following examples. The concentrations of these insolubilizing agents in the wetting compositions ranged between 60% and 100% (neat). Where the concentration of the insolubilizing agents in the wetting compositions was below 100%, insolubilizing agent was combined with deionized water.

Fibrous Substrate Sample Preparation

[0101] Two different fibrous substrates were used to evaluate the performance of the triggerable binder formulation: UCTAD tissue and thermally-bonded air-laid nonwoven.

UCTAD Tissue

[0102] An uncreped through-air dried(UCTAD) tissue fibrous substrate with a basis weight of about 50 gsm and a

caliper of about 1.3 mm was used to evaluate samples of the triggerable binder formulations. Eucalyptus wood pulp fibers are commercially available from Aracruz located in the Brazilian states of Espirito Santo, Rio Grande do Sul and Eunapolis. LL-19 wood pulp fibers are commercially available from Kimberly-Clark Corporation located in Neenah, Wis. These fibers were used to form the fibrous substrates. The eucalyptus and LL-19 wood pulp fibers were dispersed into water to form an eucalyptus pulp fiber slurry and a LL-19 pulp fiber slurry. A 3-layer headbox was utilized to deposit the pulp fiber slurries in a 30/40/30 split of eucalyptus/LL-19/eucalyptus wood pulp fibers into a fibrous substrate. The substrate was rush-transferred to a transfer fabric (T807-1 from Voith Fabrics of Appleton, Wis.). The transfer fabric was traveling 28-30 percent slower than the forming fabric using a vacuum shoe to assist the transfer. At a second vacuum shoe-assisted transfer, the substrate was transferred and wet-molded onto the throughdrying fabric (T1203-8 from Voith Fabrics of Appleton, Wis.). The sheet was dried with a throughdryer operating at a temperature of approximately 290° F. Targeted ranges of geometric mean tensile (GMT) and tensile ratio were 1500-2000 and 1.2-1.5, respectively. The UCTAD fibrous substrate had no residual wet strength in water.

Thermally-bonded Air-laid Nonwoven

[0103] A weak, thermally-bonded air-laid (TBAL) nonwoven fibrous substrate was fabricated using Weyerhaeuser NF405 wood pulp fibers and KoSA T-255 binder fibers. The T-255 binder fibers had a polyester core and a polyethylene sheath that melts at about 130° C. The air-laid fibrous substrate was formed using about 4% T-255 binder fibers and thermally bonded above the melting temperature of the polyethylene sheath. The TBAL fibrous substrate samples have an average basis weight of about 51 gsm and an average caliper of about 1.0 mm. The TBAL fibrous substrate samples have a residual CD wet tensile strength of about 30 g/inch in water. Unless otherwise noted, the data for the TBAL fibrous substrate samples have been corrected for this residual wet strength. The application and drying methods used for the treatments of the triggerable binder formulation are those described above for the UCTAD fibrous substrate samples.

Topical Application Method for Triggerable Binder Formulation

[0104] A uniform and consistent amount of each sample of triggerable binder formulation was applied to the fibrous substrate via a pressurized handsheet spray unit. This handsheet spray unit is designed to closely resemble the operation of a commercial air-laid machine using liquid or emulsion binders, but on a smaller pilot scale. The handsheet spray unit is enclosed in a small-framed housing, which may be placed, under a laboratory hood. The handsheet spray unit has a stationary sample holder section (10"×13") in the center of the unit and a moveable spray header directly over the sample holder section. A vacuum box is installed under the sample holder section to help draw the triggerable binder formulation into the fibrous substrate during the application process. The fibrous substrate sample is placed on the vacuum box and the spray head is moved across the fibrous substrate sample as the triggerable binder formulation is sprayed in a flat V-shaped pattern. The triggerable binder formulation is contained in a pressurized storage vessel

located outside of the spray cabinet and is delivered to the spray nozzles via high pressure flexible tubing. The spray header with its spray nozzle assembly (commercially available from Spraying Systems Company located at Wheaton, Ill.) is moved over the sample by means of a belt driven slide assembly, providing the desired application uniformity and speed. The spray header may be operated at speeds close to 180 fpm and the spray atomization pressure could be set as high as 200 psig. Approximately one half of the desired weight of the triggerable binder formulation is applied to the first side of each fibrous substrate sample. Each fibrous substrate sample is then manually turned over and the remaining desired weight of the triggerable binder formulation is applied to the second side. The fibrous substrate sample is manually removed and dried in a Werner Mathis, Model LTV Through-Air Dryer (TAD) at 193° C. for about 20 seconds to about 40 seconds.

In-use Tensile Strength and Disposal Strength Testing

[0105] A SinTech 1/D tensile tester with Testworks 3.03 version software is used for all sample testing. A 100 Newton load cell with pneumatic grips is utilized. A gauge length of 2 inch and a crosshead speed of 12 inch/minute are employed. The peak load values (in g/in.) of sample replicates are recorded and averaged and reported as machine-direction wet tensile strength (MDWT) or cross-deckle wet tensile strength (CDWT), depending on how the measurement was made.

[0106] The in-use strength of each fibrous substrate sample is simulated by soaking 1 inch by 4.5 inch strip fibrous substrate samples in an excess of wetting composition containing the desired insolubilizing agent. The fibrous substrate samples are allowed to equilibrate for at least 12 hours before measurements of the tensile strength of each fibrous substrate samples are taken. The disposal strength or dispersibility is assessed by transferring the fibrous substrate samples treated as "in-use" into an excess (typically 500 mL for 4 to 8 strips of fibrous substrate samples) of deionized water or hard water of specified hardness level (as metal ion) and allowing the fibrous substrate samples to soak for the indicated amount of time before the tensile strength of each fibrous substrate sample is measured. In cases where a soaked fibrous substrate sample is too weak to be handled or to allow measurements of the tensile strength to be taken, a value of zero is recorded for the peak load of the fibrous substrate sample.

Results

[0107] A non-crosslinking cationic polyacrylamide polymer, commercially available under the trade designation of Baystrength® 711 from Bayer Corporation located in Pittsburgh, Pa., was evaluated as a triggerable binder formulation on the UCTAD and TBAL fibrous substrate samples as described above. Unless otherwise stated, the Baystrength® 711 as used herein was a solution of 5% solids. The Baystrength® 711 polymer was applied to the fibrous substrate samples as described above. The triggerable binder formulation add-on level for each fibrous substrate sample was 5 wt %. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in 100% and 65 wt % isopropyl alcohol (IPA) wetting compositions. The tensile strength of the treated fibrous substrate samples is presented in Table 1.

TABLE 1

Performance of Baystrength® 711 polymer at 5 wt % triggerable binder formulation add-on level on TBAL and UCTAD fibrous substrates in IPA wetting compositions.						
Code	% IPA (overnight soak)	Basesheet	CDWT (g/in.)		CDWT (g/in.) 10 min.	
			In-use	Std. Dev.	Hard Water	Std. Dev.
8635-47-1	100	UCTAD	944	35	0	—
8635-47-2	65	UCTAD	232	35	13	4
8635-47-3	100	TBAL	425	138	0	—
8635-47-4	65	TBAL	84	8	0	—

As used herein, the phrase “overnight soak” means a soak of about 16 to about 24 hours.

[0108] As shown in Table 1, the in-use tensile strength of the fibrous substrate samples depends on fibrous substrate type and the composition of the wetting composition. The UCTAD fibrous substrate sample showed significant In-use tensile strength in the 100% IPA wetting composition, possibly due to its inherent hydrogen bonding (about 325 g/in). However, the in-use tensile strength of the UCTAD fibrous substrate sample is lower in the 65% IPA wetting composition, possibly due to the high water content. Higher in-use strength may be achieved in both fibrous substrate types by choosing a wetting composition having a higher alcohol content. Dispersibility or disposal strength, as indicated by 10 minute soaks in 200 ppm hard water (as metal ion), is very good for both fibrous substrate types.

[0109] Two wetting compositions having antiseptic and disinfecting properties were formulated. The Baystrength® 711 polymer was applied to the fibrous substrate samples as described above. The triggerable binder formulation add-on level for each fibrous substrate sample was 5 wt %. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements in the formulated wetting compositions A and B. The in-use tensile strength of the treated fibrous substrate samples are presented in Table 2.

[0110] As shown in Table 2, the in-use tensile strength of the treated fibrous substrate samples depends on the fibrous substrate type and the composition, namely the water content, in the wetting composition. The dispersibility or disposal strength for both fibrous substrate types is good.

EXAMPLE 2

[0111] An anionic polyacrylamide polymer, commercially available under the trade designation of Baystrength® 85 from Bayer Corporation, was evaluated as a triggerable binder formulation on the UCTAD and TBAL fibrous substrate samples as described above. The Baystrength® 85 polymer was applied to the fibrous substrate samples as described above. The triggerable binder formulation add-on level for each fibrous substrate sample ranged from 1.8 wt % to 10 wt %. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in wetting compositions having an IPA content that ranged from 65% to 100%. Dry treated fibrous substrate samples were also tested for in-use tensile strength. The in-use tensile strength of the treated fibrous substrate samples, wet and dry, is presented in Table 3. The dispersibility or disposal strength of the treated fibrous substrate samples for 10 minute and 30 minute soaks in 200 ppm hard water are also presented in Table 3.

TABLE 2

Performance of Baystrength® 711 polymer at 5 wt % triggerable binder formulation add-on level on TBAL and UCTAD fibrous substrates in formulated wetting compositions A and B.						
Code	Solution (overnight soak)	Basesheet	CDWT (g/in.)		CDWT (g/in.) 10 min.	
			In-use	Std. Dev.	Hard Water	Std. Dev.
8635-50-1	A	UCTAD	375	28	19	7
8635-50-2	A	TBAL	175	52	2	5
8635-50-3	B	UCTAD	704	49	9	11
8635-50-4	B	TBAL	463	40	1	5

Solution A:	65% IPA	Solution B:	75% IPA
	8% Propylene glycol		12% Propylene glycol
	27% Water		13% Water

TABLE 3

Performance of Baystrength® 85 polymer at various triggerable binder formulation add-on levels on TBAL and UCTAD fibrous substrates in IPA wetting compositions.									
Code	% Binder	% IPA overnight soak	Basesheet	CDWT (g/in.)		CDWT (g/in.) 10 min.		CDWT (g/in.) 30 min.	
				In-use	Std. Dev.	Hard Water	Std. Dev.	Hard Water	Std. Dev.
1	1.8	Dry	UCTAD	1165	72	—	—	—	—
2	1.8	100	UCTAD	931	45	0	—	0	—
3	1.8	90	UCTAD	572	136	0	—	0	—
4	1.8	80	UCTAD	347	98	0	—	0	—
5	1.8	65	UCTAD	155	43	0	—	0	—
6	5.0	Dry	UCTAD	1741	71	—	—	—	—
7	5.0	100	UCTAD	1109	204	0	—	0	—
8	5.0	90	UCTAD	1090	223	0	—	0	—
9	5.0	80	UCTAD	617	212	0	—	0	—
10	5.0	65	UCTAD	223	83	0	—	0	—
11	6.9	Dry	UCTAD	1546	139	—	—	—	—
12	6.9	90	UCTAD	842	288	0	—	0	—
13	6.9	80	UCTAD	783	222	0	—	0	—
14	6.9	65	UCTAD	324	56	0	—	0	—
15	6.9	50	UCTAD	117	21	0	—	0	—
16	7.6	Dry	TBAL	547	83	—	—	—	—
17	7.6	90	TBAL	291	67	4	14	0	0
18	7.6	80	TBAL	204	94	14	29	29	0
19	7.6	65	TBAL	34	27	—	—	—	—
20	10	Dry	TBAL	936	266	—	—	—	—
21	10	100	TBAL	582	228	28	14	20	6
22	10	90	TBAL	633	43	8	4	6	36
23	10	80	TBAL	316	117	14	9	10	4
24	10	65	TBAL	51	17	22	9	13	5

[0112] As shown in Table 3, a broad range of in-use tensile strength and disposal strength may be achieved by the choice of the fibrous substrate type and the composition of the wetting composition.

EXAMPLE 3

[0113] An UCTAD fibrous substrate sample having a basis weight of about 45 gsm and a caliper of about 1.3 mm commercially available from Kimberly-Clark Corporation, was used for evaluation of the Baystrength® 85 polymer as a triggerable binder formulation. This UCTAD fibrous substrate sample possesses a residual wet strength of about 40 gsm in water. The results presented in Table 4 were not corrected for residual wet strength of the UCTAD fibrous substrate samples in this example. The Baystrength® 85 polymer was applied to the fibrous substrate samples as

described above. The triggerable binder formulation add-on level for each fibrous substrate sample ranged from 2 wt % to 5 wt %. The in-use tensile strength and disposal strength for the treated fibrous substrate samples were evaluated as described in Example 1, with the exception that 100 ppm hard water (as metal ion) was utilized for soak tests. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in wetting compositions having an IPA content ranging from 65% to 100%, an ethanol (EtOH) content ranging from 80% to 100%, or a methanol (MeOH) content of 100%. The treated fibrous substrate samples were soaked in the hard water for disposal strength measurements for 10 minutes and 30 minutes. The in-use tensile strength and disposal strength measurements of the treated fibrous substrate samples are presented in Table 4.

TABLE 4

Performance of Baystrength® 85 polymer at various triggerable binder formulation add-on levels on UCTAD fibrous substrate in various wetting compositions.								
		CDWT (g/in.)						
Binder %	Solvent >	65% IPA	80% IPA	90% IPA	100% IPA	80% EtOH	100% EtOH	100% MeOH
2%	In-use	174	388	739	936	463	543	475
	std. dev.	18	20	38	122	53	102	40
	10 min. soak	39	38	39	41	42	40	38
	std. dev.	1	2	3	1	3	3	3
	30 min. soak	41	41	36	44	43	41	40
	std. dev.	3	3	2	3	4	3	3
3%	In-use	300	921	1009	1266	722	1082	1000
	std. dev.	10	22	77	64	102	3	50

TABLE 4-continued

		Performance of Baystrength® 85 polymer at various triggerable binder formulation add-on levels on UCTAD fibrous substrate in various wetting compositions.						
		CDWT (g/in.)						
Binder %	Solvent >	65% IPA	80% IPA	90% IPA	100% IPA	80% EtOH	100% EtOH	100% MeOH
4%	10 min. soak	39	43	47	41	45	41	45
	std. dev.	7	7	4	4	1	2	1
	30 min. soak	44	42	45	40	45	41	43
	std. dev.	1	1	3	2	5	3	2
	In-use	373	862	1399	1294	845	1438	1283
	std. dev.	5	56	79	192	100	94	70
	10 min. soak	42	42	44	47	45	43	39
	std. dev.	3	4	3	3	5	1	5
	30 min. soak	44	44	43	45	44	45	46
	std. dev.	2	3	1	3	2	1	7
	In-use	442	1073	1569	1296	965	1561	1341
	std. dev.	12	31	78	166	13	62	37
5%	10 min. soak	39	45	40	40	44	39	42
	std. dev.	4	0	6	6	3	4	5
	30 min. soak	37	45	35	46	42	41	40
	std. dev.	3	5	7	4	1	3	5

[0114] As shown in Table 4, the triggerable binder formulation add-on levels, insolubilizing agent, and the composition of the wetting composition may be chosen to provide a targeted in-use tensile strength or disposal strength. The disposal strength of the treated fibrous substrate samples returns to the level of the residual wet strength of the fibrous substrate sample during soaks in the hard water within 10 minutes or less.

EXAMPLE 4

[0115] The TBAL fibrous substrate sample from Example 1 was used to evaluate the Baystrength® 85 polymer as a triggerable binder formulation. The Baystrength® 85 polymer was applied to the fibrous substrate samples as described above. The triggerable binder formulation add-on level for each fibrous substrate was 5 wt %. The in-use tensile strength and disposal strength for the treated fibrous substrate samples were evaluated as described in Example 1. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in wetting compositions of neat insolubilizing agents as provided in Table 5 below. The use of neat insolubilizing agents allowed for the examination of the relationship of the Solubility Parameter theory to the in-use tensile strength of the fibrous substrate samples. Methanol (MeOH), ethanol (EtOH), n-propanol (NPA), isopropanol (IPA), n-butanol (NBA), tert-butanol (TBA), acetone (ACE), and propylene glycol (PPG) were utilized as insolubilizing agents. The Baystrength® 85 polymer has a δ value of about 21 (cal/cm³)^{1/2}. According to Solubility Parameter theory, solvents having similar δ values to that of an acceptable solvent would be acceptable as solvents as well. In addition, solvents having dissimilar δ values to an acceptable solvent would not be an acceptable solvent. Water, having a δ of 23.4 (cal/cm³)^{1/2}, is known to be an excellent solvent for polyacrylamide polymer, leading to good dispersibility of fibrous substrates of the present invention treated with such a triggerable binder formulation. In accordance with the theory, one might predict that solvent having a δ value with the largest difference from the δ value of water would yield

the highest in-use tensile strength. In general, such a trend is seen, within experimental error, for the groups of solvents investigated as insolubilizing agents, with the exception of the tertiary alcohol, TBA. Note that CDWT of the TBAL fibrous substrate samples not treated with the triggerable binder formulation in selected solubilizing agents show only in-use tensile strength values that reflect residual strength levels of the fibrous substrate samples.

TABLE 5

In-use tensile strength of TBAL fibrous substrates is various insolubilizing agents for the Baystrength® 85 polymer as a triggerable binder formulation.			
Solvent	(cal/cm ³) ^{0.5}	CDWT (g/in.)	Std.Dev.
MeOH	14.5	455	21
EtOH	12.7	618	34
PPG	12.6	762	47
NPA	11.9	737	74
IPA	11.5	768	51
NBA	11.4	851	24
TBA	10.6	646	25
ACE	9.9	838	75
Dry TBAL	5% Binder	758	25
MeOH	TBAL no binder	22	2
IPA	TBAL no binder	37	3
ACE	TBAL no binder	32	2
Dry TBAL	no binder	36	8

EXAMPLE 5

[0116] An anionic polyacrylamide polymer, commercially available under the trade designation of Hercobond® 2000 polymer from Hercules Incorporated located in Wilmington, Del., was evaluated as a triggerable binder formulation. The Hercobond® 2000 polymer had a weight-average molecular weight (M_w) of about 400,000 g/mole. The performance of the Hercobond® 2000 polymer as a triggerable binder formulation was compared with Baystrength® 85 polymer on 6041 towel fibrous substrate samples commercially available from the Kimberly-Clark Corporation. The 6041 towel fibrous substrate samples have a basis weight of about 30

gsm and a caliper of about 0.5 mm. The 6041 towel fibrous substrate samples have a residual wet strength of about 60 gsm in water. The results presented in Table 6 were not corrected for residual wet strength of the 6041 towel fibrous substrate samples of this example. The Hercobond® 2000 polymer and the Baystrength® 85 polymer were applied to the 6041 towel fibrous substrate samples as described above. The triggerable binder formulation add-on levels for each 6041 towel fibrous substrate sample of the Hercobond® 2000 polymer range from 2.1 wt % to 4.1 wt % and of the Baystrength® 85 polymer range from 1.9 wt % to 4.0 wt %. The in-use tensile strength and disposal strength for the treated 6041 towel fibrous substrate samples were evaluated as described in Example 1, with one exception. Due to the sheet size of the 6041 towel fibrous substrate samples and the configuration of the handsheet spray unit, the treated 6041 towel fibrous substrate samples were evaluated in Machine direction of the fibrous substrate. The treated 6041 towel fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in a wetting composition having an IPA content of 80%. The treated 6041 towel fibrous substrate samples were soaked in the hard water for disposal strength measurements for 10 minutes and 30 minutes. The in-use tensile strength and disposal strength measurements of the treated 6041 towel fibrous substrate samples are presented in Table 6.

SPP-949, SPP-376, and SPP-377 from Scientific Polymer Products, Incorporated located in Ontario, N.Y., as triggerable binder formulations on the UCTAD fibrous substrate samples as described in Example 1. The SPP-949 polymer is a nonionic polyacrylamide with molecular weight of about 10,000 g/mole. The SPP-376 polymer is a carboxyl modified polyacrylamide (having a low carboxyl content) with a molecular weight of about 200,000 g/mole. The SPP-377 polymer is a carboxyl modified polyacrylamide (having a high carboxyl content) with a molecular weight of about 200,000 g/mole. The Hercobond® 2000 polymer, SPP-949 polymer, SPP-376 polymer, and SPP-377 polymer were applied to the fibrous substrate samples as described above. The triggerable binder formulation add-on levels for each fibrous substrate sample of the Hercobond® 2000 polymer, SPP-949 polymer, SPP-376 polymer, and SPP-377 polymer were at 2.0 wt %, 8.2 wt %, 4.2 wt %, and 4.4 wt %, respectively. The in-use tensile strength and disposal strength for the fibrous substrate samples were evaluated as described in Example 1. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in wetting composition having an IPA content ranging from 80% to 100%. The treated fibrous substrate samples were soaked in the hard water for disposal strength measurements for 10 min-

TABLE 6

Performance of Hercobond® 2000 polymer and Baystrength® 85 polymer on 6041 towel fibrous substrates in 80% IPA wetting composition.								
Code	Binder	In-use (80% IPA)			MDWT		MDWT	
		% Add-on	MDWT	std. dev	10 min. soak	std. dev	30 min. soak	std. dev.
KCP 6041	none	—	329	13	60	13	62	15
8635-154A	Baystrength 85	4.0	1450	80	—	—	—	—
8635-154B	Baystrength 85	2.8	1213	47	—	—	—	—
8635-154C	Baystrength 85	1.9	1048	93	110	8	103	6
8635-155A	Hercobond 2000	4.1	1153	68	—	—	—	—
8635-155B	Hercobond 2000	3.1	1129	89	—	—	—	—
8635-155C	Hercobond 2000	2.1	1056	86	125	12	113	15

[0117] As presented in Table 6, both the Hercobond® 2000 polymer and the Baystrength® 85 polymer show high in-use tensile strength (greater than about 1000 g/in.) of the 6041 towel fibrous substrate samples treated with a triggerable binder formulation add-on level as low as 2 wt %. However the disposal strength of the treated 6041 towel fibrous substrate samples appears to higher—thus the dispersibility of the treated 6041 towel fibrous substrate samples appear to be lower and/or slower. The 6041 towel fibrous substrate samples treated with about 2 wt % add-on level of one of the triggerable binder formulations retained about 100 g/in. Disposal strength measurements were taken of the treated 6041 towel fibrous substrate samples after soaking for 30 minutes in hard water.

EXAMPLE 6

[0118] The performance of the Hercobond® 2000 polymer was compared with three other polyacrylamide polymers commercially available under the trade designations of

utes. The in-use tensile strength and disposal strength measurements of the treated fibrous substrate samples are presented in Table 7.

[0119] As shown in Table 7, the SPP-949 polymer requires slightly higher triggerable binder formulation add-on level to achieve a higher in-use tensile strength. The In-use tensile strength of the fibrous substrate samples treated with the SPP-949 polymer drops significantly when water is utilized in the wetting composition. The SPP-376 polymer and the SPP-377 polymer show good in-use tensile strength of the fibrous substrate samples in the wetting compositions having IPA contents of 100% and 80%. The in-use tensile strength of the fibrous substrate sample treated with the SPP-377 polymer drops significantly when water is utilized in the wetting composition. The fibrous substrate samples treated with the Hercobond® 2000 polymer, SPP-949 polymer, SPP-376 polymer, and SPP-377 polymer show good disposal strength.

TABLE 7

Comparison of Hercobond® 2000 polymer with SPP-949 polymer, SPP-376 polymer, and SPP-377 polymer on UCTAD fibrous substrates in 80% and 100% IPA wetting compositions.							
Code	Binder	% Add-on	% IPA	In-use MDWT	std. dev.	MDWT 10 min. soak	std. dev.
8635-184A	Hercobond 2000	2.0	100	974	40	31	14
8635-184A	Hercobond 2000	2.0	80	497	21	33	2
8635-185A	SPP-949	8.2	100	598	25	31	14
8635-185A	SPP-949	8.2	80	113	9	—	—
8635-186A	SPP-376	4.2	100	1079	132	18	7
8635-186A	SPP-376	4.2	80	783	51	16	8
8635-187A	SPP-377	4.4	100	1131	70	32	3
8635-187A	SPP-377	4.4	80	406	11	12	1

[0120] As shown in Table 7, the molecular weight and triggerable binder formulation may be chosen to provide a targeted in-use tensile strength or disposal strength.

EXAMPLE 7

[0121] Polyvinylamine/vinylformamide co-polymers, commercially available under the trade designation of Catiofast® 8104 co-polymer, Catiofast® 8087 co-polymer, and Catiofast® 8106 co-polymer from BASF located in Holly Springs, N.C., were evaluated as triggerable binder formulations on the TBAL fibrous substrate samples as described in Example 1. The Catiofast® 8104 co-polymer is a 10% hydrolyzed poly-N-vinylformamide. The Catiofast® 8087 co-polymer is a 50% hydrolyzed poly-N-vinylformamide. The Catiofast® 8106 co-polymer is a 90% hydrolyzed poly-N-vinylformamide. The Catiofast® 8104 co-polymer, Catiofast® 8087 co-polymer, and Catiofast® 8106 co-polymer were applied to the fibrous substrate samples as described above. The triggerable binder formulation add-on level of 5 wt % for each fibrous substrate sample of the Catiofast® 8104 co-polymer, Catiofast® 8087 co-polymer, and Catiofast® 8106 co-polymer. The in-use tensile strength and disposal strength for the treated fibrous substrate samples were evaluated as described in Example 1. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in wetting compositions having an ethanol content of 100%, having an acetone content of 100%, and IPA content ranging from 60% to 100% as shown in Table 8 and Table 9. The treated fibrous substrate samples were soaked in the hard water for disposal strength measurements for 60 minutes. The in-use tensile strength and disposal strength measurements of the treated fibrous substrate samples are presented in Table 8 and Table 9.

TABLE 8

In-use tensile strength of TBAL fibrous substrates in various insolubilizing agents for Catiofast® 8104 co-polymer, Catiofast® 8087 co-polymer, and Catiofast® 8106 co-polymer.					
Binder	Solvent	CDWT (g/in.) In-use	Std. Dev.	CDWT (g/in.) 1 hour Hard Water	Std. Dev.
Catiofast 8104	EtOH	297	16	13	18
Catiofast 8104	IPA	431	17	28	10

TABLE 8-continued

In-use tensile strength of TBAL fibrous substrates in various insolubilizing agents for Catiofast® 8104 co-polymer, Catiofast® 8087 co-polymer, and Catiofast® 8106 co-polymer.					
Binder	Solvent	CDWT (g/in.) In-use	Std. Dev.	CDWT (g/in.) 1 hour Hard Water	Std. Dev.
Catiofast 8104	ACE	389	49	20	13
Catiofast 8087	EtOH	230	15	68	10
Catiofast 8087	IPA	444	25	55	10
Catiofast 8087	ACE	405	51	61	10
Catiofast 8106	EtOH	222	20	86	8
Catiofast 8106	IPA	322	11	90	6
Catiofast 8106	ACE	261	49	80	19

[0122] As shown in Table 8, the in-use tensile strength and disposal strength of the treated fibrous substrate samples is a function of triggerable binder formulation type and insolubilizing agent type. Dispersibility appears to be better for lower degrees of hydrolysis of the triggerable binder formulation.

TABLE 9

In-use tensile strength of TBAL fibrous substrates for Catiofast® 8104 co-polymer in wetting compositions having IPA content.		
% IPA	CDWT (g/in.) In-use	Std. Dev.
60	140	1
70	144	8
80	194	27
90	328	13
100	431	17

[0123] As shown in Table 9, the in-use tensile strength of the fibrous substrate samples treated with the Catiofast® 8104 co-polymer decreases with increasing water content of the wetting composition.

EXAMPLE 8

[0124] An un-bonded air-laid fibrous substrate was prepared using CF 405 wood pulp fibers, commercially available from Weyerhaeuser (complete name/location) via a air-forming apparatus used in the art for air-laying pro-

cesses. The fibrous substrate was deposited and sandwiched between two thin tissue carrier sheets to allow the fibrous substrate to be rolled into a stable roll. The width of the fibrous substrate is about 8 inches. The fibrous substrate has a basis weight of 58 gsm (± 2) and caliper of 1.0 mm (± 0.1). The Hercobond® 2000 polymer, as a triggerable binder formulation, was applied to the fibrous substrate as described in Example 1, with the following exceptions: square fibrous substrate samples having 8.25"×8.25" dimensions are cut from the fibrous substrate roll; the fibrous substrate samples are carefully separated from the tissue carrier sheets and placed on a 10.25"×8.25" nylon screen; and, a rubber mask was placed over the fibrous substrate sample exposing a 7.5"×7.5" area. This assembly of the fibrous substrate sample, nylon screen, and rubber mask is placed on the stationary sample holder section of the handsheet spray unit. The triggerable binder formulation add-on level for the exposed first surface of each fibrous substrate sample was 5 wt %. The rubber mask is removed and the fibrous substrate sample, still retained on the nylon screen, is placed in the TAD and dried at 193° C. for 30 seconds. After drying, the fibrous substrate sample is removed from the TAD. The fibrous substrate sample is removed from the nylon screen and replaced onto the nylon screen with the treated first surface in contact with the nylon screen. The rubber mask is placed on the second side of the fibrous substrate sample. The triggerable binder formulation add-on level for the exposed second surface of each fibrous substrate sample was 5 wt %. The rubber mask is removed and the fibrous substrate sample, still retained on the nylon screen, is placed in the TAD and dried at 193° C. for 30 seconds. After drying, the fibrous substrate sample is removed from the TAD. The fibers from the un-bonded edges of the treated fibrous substrate are removed by hand. The treated fibrous substrate samples are trimmed on a laboratory cutter to provide a treated fibrous substrate sample having the dimensions of 6.5" (MD)×5.5" (CD). The total triggerable binder formulation add-on level for the treated fibrous substrate samples was 10 wt %. The treated fibrous substrate sample has a basis weight of 65 gsm and a caliper of 1.6 mm. The dry treated fibrous substrate samples are cut into strips having the dimensions of 1" by 4.5". The strips of the treated fibrous substrate samples are allowed to equilibrate for in-use tensile strength measurements in a wetting composition having an IPA content of 80%. The MD and CD in-use tensile strengths of the treated fibrous substrate samples were 912 g/in. (± 58) and 746 g/in. (± 68), respectively. The strips of the treated fibrous substrate samples are transferred to 100 ppm hard water for a 10 minute soak. Disposal strength measurements are taken after the soaking period. In both cases, the strips were too weak to accurately measure the tensile strength (>20 g/in). In a further experiment, 6.5"×5.5" prototypes were wet with approximately 300-700% add-on level of 80% IPA. The prototype wet wipes gave excellent durability and adequate in-use properties to be used for hard surface cleaning and other applications. When the wipes were placed in a 2L beaker filled with tap water and gently stirred, they broke into small pieces and fibers in a few seconds.

EXAMPLE 9

[0125] The Baystrength® 711 polymer was evaluated as a triggerable binder formulation in a wet-laid handsheet fibrous substrate samples. The wet-laid handsheet fibrous

substrate samples were prepared by dispersing 24 grams of oven-dried eucalyptus wood pulp fibers in approximately 2 liters of water. The fiber slurry was prepared through an application of 5 minutes of British Standard disintegration using equipment commercially available under the trade designation of Noram from Lorentzen and Wettre located in Pointe Claire, Quebec, and further diluted with water to a total volume of approximately 8 liters. The Baystrength® 711 polymer was added to the fiber slurry at a level of 0.3 weight percent based upon final fibrous substrate composition. The treated wet-laid handsheet fibrous substrate samples were created in a forming mold, pressed for one minute at a pressure of 98 psi, and dried for two minutes on a steam dryer at 105° C. using handsheet equipment commercially available from Voith Incorporated located in Appleton, Wis. The treated wet-laid handsheet fibrous substrate samples had a basis weight of 60 gsm. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in aqueous or neat alcohol wetting compositions having an IPA content of between 60 and 100 percent. The in-use tensile strength of the treated fibrous substrate samples are presented in Table 10. The disposal strength of the treated fibrous substrate samples after exposure for 60 minutes soaks in 200 ppm hard water are also shown in Table 10. The wet strength decay was calculated for each of the treated fibrous substrate samples by dividing the difference of the in-use tensile strength and the disposal strength by the in-use tensile strength for a given treated fibrous substrate sample. The wet strength decay values are presented in Table 10.

EXAMPLE 10

[0126] The Baystrength® 711 polymer was evaluated as a triggerable binder formulation in a wet-laid handsheet fibrous substrate samples. The wet-laid handsheet fibrous substrate samples were prepared by dispersing 24 grams of oven-dried eucalyptus wood pulp fibers in approximately 2 liters of water. The fiber slurry was prepared through an application of 5 minutes of British Standard disintegration using the Noram equipment and further diluted with water to a total volume of approximately 8 liters. The Baystrength® 711 polymer was added to the fiber slurry at a level of 0.6 weight percent based upon final fibrous substrate composition. The treated wet-laid handsheet fibrous substrate samples were created in a forming mold, pressed for one minute at a pressure of 98 psi, and dried for two minutes on a steam dryer at 105° C. using handsheet equipment commercially available from Voith Incorporated located in Appleton, Wis. The treated wet-laid handsheet fibrous substrate samples had a basis weight of 60 gsm. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in aqueous or neat alcohol wetting compositions having an IPA content of between 60 and 100 percent. The in-use tensile strength of the treated fibrous substrate samples are presented in Table 10. The disposal strength of the treated fibrous substrate samples after exposure for 60 minutes soaks in 200 ppm hard water are also shown in Table 10. The wet strength decay was calculated for each of the treated fibrous substrate samples by dividing the difference of the in-use tensile strength and the disposal strength by the in-use tensile strength for a given treated fibrous substrate sample. The wet strength decay values are presented in Table 10.

EXAMPLE 11

[0127] The Baystrength® 711 polymer was evaluated as a triggerable binder formulation in a wet-laid handsheet fibrous substrate samples. The wet-laid handsheet fibrous substrate samples were prepared by dispersing 24 grams of oven-dried eucalyptus wood pulp fibers in approximately 2 liters of water. The fiber slurry was prepared through an application of 5 minutes of British Standard disintegration using the Noram equipment, and further diluted with water to a total volume of approximately 8 liters. The Baystrength® 711 polymer was added to the fiber slurry at a level of 1.0 weight percent based upon final fibrous substrate composition. The treated wet-laid handsheet fibrous substrate samples were created in a forming mold, pressed for one minute at a pressure of 98 psi, and dried for two minutes on a steam dryer at 105° C. using handsheet equipment commercially available from Voith Incorporated located in Appleton, Wis. The treated wet-laid handsheet fibrous substrate samples had a basis weight of 60 gsm. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in aqueous or neat alcohol wetting compositions having an IPA content of between 60 and 100 percent. The in-use tensile strength of the treated fibrous substrate samples are presented in Table 10. The disposal strength of the treated fibrous substrate samples after exposure for 60 minutes soaks in 200 ppm hard water are also shown in Table 10. The wet strength decay was calculated for each of the treated fibrous substrate samples by dividing the difference of the in-use tensile strength and the disposal strength by the in-use tensile strength for a given treated fibrous substrate sample. The wet strength decay values are presented in Table 10.

TABLE 10

Fibrous substrate performance for Baystrength® 711 polymer concentration and IPA concentration in wetting compositions.				
Baystrength® 711 Dosage (%)	IPA (%)	In-use Tensile Strength (g/in.)	Disposal Strength (g/in.)	Wet Strength Decay (%)
0.3	60	147 ± 33	39 ± 1	73
0.6	60	260 ± 9	68 ± 9	74
1.0	60	362 ± 11	95 ± 13	74
0.3	80	364 ± 11	42 ± 12	88
0.6	80	500 ± 17	82 ± 2	84
1.0	80	731 ± 18	123 ± 6	83
0.3	100	1277 ± 32	43 ± 2	97
0.6	100	1665 ± 108	65 ± 10	96
1.0	100	1964 ± 128	97 ± 9	95

[0128] As shown in Table 10, the in-use strength and the disposal strength of the treated fibrous substrate samples are a function of concentrations of the triggerable binder formulation and insolubilizing agent.

EXAMPLE 12

[0129] The Baystrength® 711 polymer was evaluated as a triggerable binder formulation in a wet-laid handsheet fibrous substrate samples. The wet-laid handsheet fibrous substrate samples were prepared by dispersing 24 grams of oven-dried LL-19 wood pulp fibers in approximately 2 liters of water. The fiber slurry was prepared through an application of 5 minutes of British Standard disintegration using the Noram equipment and further diluted with water to a total

volume of approximately 8 liters. The Baystrength® 711 polymer was added to the fiber slurry at a level of 0.3 weight percent based upon final fibrous substrate composition. The treated wet-laid handsheet fibrous substrate samples were created in a forming mold, pressed for one minute at a pressure of 98 psi, and dried for two minutes on a steam dryer at 105° C. using handsheet equipment commercially available from Voith Incorporated located in Appleton, Wis. The treated wet-laid handsheet fibrous substrate samples had a basis weight of 60 gsm. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in aqueous alcohol wetting compositions having an IPA content of between 80 and 90 percent. The in-use tensile strength of the treated fibrous substrate samples are presented in Table 11. The disposal strength of the treated fibrous substrate samples after exposure for 60 minutes soaks in 200 ppm hard water are also shown in Table 11. The wet strength decay was calculated for each of the treated fibrous substrate samples by dividing the difference of the in-use tensile strength and the disposal strength by the in-use tensile strength for a given treated fibrous substrate sample. The wet strength decay values are presented in Table 11.

TABLE 11

Effect of wood pulp fiber type upon in-use tensile strength and disposal strength performance of fibrous substrates for Baystrength® 711 polymer.				
Wood Fiber	IPA (%)	In-use Tensile Strength (g/in.)	Disposal Strength (g/in.)	Wet Strength Decay (%)
Eucalyptus	80	731 ± 18	123 ± 6	83
LL-19	80	828 ± 45	80 ± 10	90
Eucalyptus	85	1006 ± 26	27 ± 6	97
LL-19	85	1238 ± 31	106 ± 14	91
Eucalyptus	90	1359 ± 116	18 ± 5	99
LL-19	90	1505 ± 149	122 ± 2	92

[0130] As shown in Table 11, the in-use tensile strength and the disposal strength are a function of the wood pulp fiber type.

EXAMPLE 13

[0131] The performance of Baystrength® 711 (Example 11) was compared with Catiofast® 8104 polymer and a crosslinking, cationic polyacrylamide polymer, commercially available under the trade designation of Parex® 631 polymer from Cytec Industries located in West Paterson, N.J., as triggerable binder formulations in wet-laid handsheet fibrous substrate samples. The wet-laid handsheet fibrous substrate samples were prepared by dispersing 24 grams of oven-dried eucalyptus wood pulp fibers in approximately 2 liters of water. The fiber slurry was prepared through an application of 5 minutes of British Standard disintegration using the Noram equipment, and further diluted with water to a total volume of approximately 8 liters. The Parex® 631 or Catiofast® 8104 polymers were added to the fiber slurry at a level of 1.0 weight percent based upon final fibrous substrate composition. The treated wet-laid handsheet fibrous substrate samples were created in a forming mold, pressed for one minute at a pressure of 98 psi, and dried for two minutes on a steam dryer at 105° C. using handsheet equipment commercially available from

Voith Incorporated located in Appleton, Wis. The treated wet-laid handsheet fibrous substrate samples had a basis weight of 60 gsm. The treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in aqueous or neat alcohol wetting compositions having an IPA content of between 60 and 100 percent. The in-use tensile strength of the treated fibrous substrate samples are presented in Table 12. The disposal strength of the treated fibrous substrate samples after exposure for 60 minutes soaks in 200 ppm hard water are also shown in Table 12. The wet strength decay was calculated for each of the treated fibrous substrate samples by dividing the difference of the in-use tensile strength and the disposal strength by the in-use tensile strength for a given treated fibrous substrate sample. The wet strength decay values are presented in Table 12.

TABLE 12

Comparison of Baystrength® 711 polymer with Parex® 631 polymer and Catiofast® 8104 polymer on wet-laid handsheet fibrous substrates in 60% to 100% IPA wetting compositions.				
Polymer	IPA (%)	In-use Tensile Strength (g/in.)	Disposal Strength (g/in.)	Wet Strength Decay (%)
Parex® 631	60	379 ± 9	244 ± 91	36
Baystrength® 711	60	362 ± 11	95 ± 13	74
Catiofast® 8104	60	165 ± 18	0	100
Parex® 631	80	794 ± 154	194 ± 45	76
Baystrength® 711	80	731 ± 18	123 ± 6	83
Catiofast® 8104	80	367 ± 14	0	100
Parex® 631	100	2562 ± 103	174 ± 42	93
Baystrength® 711	100	1964 ± 128	97 ± 9	95
Catiofast® 8104	100	1301 ± 99	0	100

[0132] As shown in Table 12, the in-use tensile strength and the disposal strength are a function of the triggerable binder formulation type and of the concentrations of the triggerable binder formulation and the insolubilizing agent.

EXAMPLE 14

[0133] The performance of the Baystrength® 711 polymer was evaluated as a triggerable binder formulation on wet-laid, 40 gsm handsheet fibrous substrate samples. One set of wet-laid handsheet fibrous substrate samples were prepared by dispersing 16 grams of oven-dried eucalyptus wood pulp fibers in approximately 2 liters of water. The fiber slurry was prepared through an application of 5 minutes of British Standard disintegration using the Noram equipment, and further diluted with water to a total volume of approximately 8 liters. The Baystrength® 711 polymer was added to the fiber slurry at a level of 2.0 weight percent based upon final fibrous substrate composition. The treated wet-laid handsheet fibrous substrate samples were created in a forming mold, pressed for one minute at a pressure of 98 psi, and dried for two minutes on a steam dryer at 105° C. using handsheet equipment commercially available from Voith Incorporated located in Appleton, Wis.

[0134] Another set of wet-laid handsheet fibrous substrate samples were prepared by dispersing 16 grams of oven-dried LL-19 wood pulp fibers in approximately 2 liters of water. The fiber slurry was prepared through an application of 5 minutes of British Standard disintegration using the Noram equipment, and further diluted with water to a total volume

of approximately 8 liters. The Baystrength® 711 polymer was added to the fiber slurry at a level of 2.0 weight percent based upon final fibrous substrate composition. The treated wet-laid handsheet fibrous substrate samples were created in a forming mold, pressed for one minute at a pressure of 98 psi, and dried for two minutes on a steam dryer at 105° C. using handsheet equipment commercially available from Voith Incorporated located in Appleton, Wis.

[0135] Both sets of treated fibrous substrate samples were allowed to equilibrate for in-use tensile strength measurements, as described above, in aqueous or neat alcohol wetting compositions having an IPA content of between 80 and 100 percent. The in-use tensile strength of the treated fibrous substrate samples are presented in Table 13. The disposal strength of the treated fibrous substrate samples after exposure for 60 minutes soaks in 200 ppm hard water are also shown in Table 13. The wet strength decay was calculated for each of the treated fibrous substrate samples by dividing the difference of the in-use tensile strength and the disposal strength by the in-use tensile strength for a given treated fibrous substrate sample. The wet strength decay values are presented in Table 13.

TABLE 13

Effect of wood pulp fiber type upon in-use tensile strength and disposal strength performance of fibrous substrates for Baystrength® 711 polymer.				
Wood Fiber	IPA (%)	In-use Tensile Strength (g/in.)	Disposal Strength (g/in.)	Wet Strength Decay (%)
Eucalyptus	80	615 ± 40	0	100
LL-19	80	775 ± 66	93 ± 11	88
Eucalyptus	85	806 ± 114	0	100
LL-19	85	928 ± 125	80 ± 5	91
Eucalyptus	90	1054 ± 151	0	100
LL-19	90	1231 ± 121	68 ± 20	94
Eucalyptus	95	1476 ± 111	0	100
LL-19	95	1699 ± 143	75 ± 9	96
Eucalyptus	100	1711 ± 366	0	100
LL-19	100	2398 ± 251	45 ± 13	98

[0136] As shown in Table 13, the in-use tensile strength and the disposal strength are a function of wood pulp fiber type.

[0137] It will be appreciated that details of the foregoing embodiments, given for purposes of illustration, are not to be construed as limiting the scope of this invention. Although only a few exemplary embodiments of this invention have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention, which is defined in the following claims and all equivalents thereto. Further, it is recognized that many embodiments may be conceived that do not achieve all of the advantages of some embodiments, particularly of the preferred embodiments, yet the absence of a particular advantage shall not be construed to necessarily mean that such an embodiment is outside the scope of the present invention.

1. A wet wipe product comprising:
 - a fibrous substrate comprising fibers; and,
 - a triggerable binder formulation for binding the fibers in the fibrous substrate wherein the triggerable binder formulation is selected from the group comprising acrylamide polymers and polymer formulations, vinylamide/amine polymers and polymer formulations, and mixtures thereof,
 wherein the triggerable binder formulation is insoluble in a wetting composition comprising an insolubilizing agent and the triggerable binder formulation is dispersible in disposal water.
2. The wet wipe product of claim 1, wherein the wet wipe product is wetted by the wetting composition.
3. The wet wipe product of claim 2, wherein the wetting composition has an insolubilizing agent content of at least about 50%.
4. The wet wipe product of claim 1, wherein the disposal water comprises less than about 50% of the insolubilizing agent.
5. The wet wipe product of claim 1, wherein the fibrous substrate has a triggerable binder formulation add-on level of about 0.5 wt % to about 25 wt %.
6. The wet wipe product of claim 1, wherein the insolubilizing agent is selected from the group comprising a lower level alcohol, a lower level glycol, a lower level ketone, and mixtures thereof.
7. The wet wipe product of claim 1, wherein the insolubilizing agent is selected from the group comprising methyl alcohol, ethyl alcohol, n-propyl alcohol, isopropyl alcohol, n-butyl alcohol, sec-butyl alcohol, tert-butyl alcohol, ethylene glycol, 1,2 propanediol (propylene glycol), 1,3 propane diol, acetone, methylethyl ketone, and mixtures thereof.
8. The wet wipe product of claim 1, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising acrylic acid, methacrylic acid and their salts, 2-acrylamido-2-methyl-1 propanesulfonic acid and its salts, vinyl sulfonic acid and their salts, other sulfonate monomers such as potassium (3-sulfopropyl) acrylate, sodium styrene sulfonate, and phosphonate/phosphonic acids.
9. The wet wipe product of claim 1, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising N-isopropyl acrylamide and other acrylamide derivatives, 2-hydroxyethyl methacrylate, vinyl pyrrolidone, methylvinyl ether, polyethylene glycol acrylates, and polyethylene glycol methacrylates.
10. The wet wipe product of claim 1, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising N,N-dimethyl-N-(2-methacryloyloxyethyl)-N-(3-sulfopropyl) ammonium betaine, N,N-dimethyl-N-(2-methacrylamidopropyl)-N-(3-sulfopropyl) ammonium betaine, 1-(3-Sulfopropyl)-2-vinylpyridinium betaine, N-(3-carboxypropyl)-N-methacrylamido-ethyl-N,N-dimethyl ammonium betaine, and 4-vinylpiperidinium ethanecarboxy betaine.
11. The wet wipe product of claim 1, wherein the triggerable binder formulation is a polymerization product

comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising [2-(acryloxy)ethyl] trimethyl ammonium chloride, [2-(methacryloxy)ethyl]trimethyl ammonium chloride, (3-acrylamidopropyl) trimethyl ammonium chloride, N,N-diallyldimethyl ammonium chloride, [2-(acryloxy)ethyl] dimethylbenzyl ammonium chloride, [2-(methacryloxy)ethyl] dimethylbenzyl ammonium chloride, [2-(acryloxy)ethyl] dimethyl ammonium chloride, and [2-(methacryloxy)ethyl] dimethyl ammonium chloride.

12. The wet wipe product of claim 1, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising vinylpyridine, dimethylaminoethyl acrylate, and dimethylaminoethyl methacrylate.

13. The wet wipe product of claim 1, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising methyl acrylate, ethyl acrylate, butyl acrylate, substituted acrylamide, and alkyl vinyl ether.

14. The wet wipe product of claim 1, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising N-vinylformamide, N-vinyl alkylamides, polyvinylpyrrolidone, and polyvinylcaprolactam.

15. The wet wipe product of claim 1, wherein the wet wipe product has an in-use tensile strength of about 300 g/in or greater.

16. The wet wipe product of claim 1, wherein the wet wipe product has a disposal strength of about 75 g/in. or less.

17. The wet wipe product of claim 1, wherein the fibrous substrate is air-laid, wet-laid, or coform.

18. A wet wipe product comprising:

- a fibrous substrate comprising fibers;

- a triggerable binder formulation composition for binding the fibers in the fibrous substrate wherein the triggerable binder formulation is selected from the group comprising acrylamide polymers and polymer formulations, vinylamide/amine polymers and polymer formulations, and mixtures thereof; and,

- a wetting composition comprising an insolubilizing agent selected from the group comprising a lower level alcohol, a lower level glycol, a lower level ketone, and mixtures thereof,

wherein the triggerable binder formulation is insoluble in the wetting composition and the triggerable binder formulation is dispersible in disposal water.

19. The wet wipe product of claim 18, wherein the wetting composition has an insolubilizing agent content of at least about 50%.

20. The wet wipe product of claim 18, wherein the disposal water comprises less than about 50% of the insolubilizing agent.

21. The wet wipe product of claim 18, wherein the fibrous substrate has a triggerable binder formulation add-on level of about 0.5 wt % to about 25 wt %.

22. The wet wipe product of claim 18, wherein the insolubilizing agent is selected from the group comprising methyl alcohol, ethyl alcohol, n-propyl alcohol, isopropyl

alcohol, n-butyl alcohol, sec-butyl alcohol, tert-butyl alcohol, ethylene glycol, 1,2 propandiol (propylene glycol), 1,3 propane diol, acetone, methylethyl ketone, and mixtures thereof.

23. The wet wipe product of claim 18, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising acrylic acid, methacrylic acid and their salts, 2-acrylamido-2-methyl-1 propanesulfonic acid and its salts, vinyl sulfonic acid and their salts, other sulfonate monomers such as potassium (3-sulfopropyl) acrylate, sodium styrene sulfonate, and phosphonate/phosphonic acids.

24. The wet wipe product of claim 18, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising N-isopropyl acrylamide and other acrylamide derivatives, 2-hydroxyethyl methacrylate, vinyl pyrrolidone, methylvinyl ether, polyethylene glycol acrylate, and polyethylene glycol methacrylates.

25. The wet wipe product of claim 18, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising N,N-imethyl-N-(2-methacryloyloxyethyl)-N-(3-sulfopropyl) ammonium betaine, N,N-dimethyl-N-(2-methacrylamidopropyl)-N-(3-sulfopropyl) ammonium betaine, 1-(3-Sulfopropyl)-2-vinylpyridinium betaine, N-(3-carboxypropyl)-N-methacrylamido-ethyl-N,N-dimethyl ammonium betaine, and 4-vinylpiperidinium ethanecarboxy betaine.

26. The wet wipe product of claim 18, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising [2-(acryloxy)ethyl] trimethyl ammonium chloride, [2-(methacryloxy)ethyl] trimethyl ammonium chloride, (3-acrylamidopropyl) trimethyl ammonium chloride, N,N-diallyldimethyl ammonium chloride, [2-(acryloxy)ethyl] dimethylbenzyl ammonium chloride, [2-(methacryloxy)ethyl] dimethylbenzyl ammonium chloride, [2-(acryloxy)ethyl] dimethyl ammonium chloride, and (2-(methacryloxy)ethyl) dimethyl ammonium chloride.

27. The wet wipe product of claim 18, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising vinylpyridine, dimethylaminoethyl acrylate, and dimethylaminoethyl methacrylate.

28. The wet wipe product of claim 18, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising methyl acrylate, ethyl acrylate, butyl acrylate, substituted acrylamide, and alkyl vinyl ether.

29. The wet wipe product of claim 18, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising N-vinylformamide, N-vinyl alkylamides, polyvinylpyrrolidone, and polyvinylcaprolactam.

30. The wet wipe product of claim 18, wherein the wet wipe product has an in-use tensile strength of about 300 g/in or greater.

31. The wet wipe product of claim 18, wherein the wet wipe product has a disposal strength of about 75 g/in. or less.

32. The wet wipe product of claim 18, wherein the fibrous substrate is air-laid, wet-laid, or coform.

33. A method of making a wet wipe product comprising:

providing a triggerable binder formulation wherein the triggerable binder formulation selected from the group comprising acrylamide polymers and polymer formulations, vinylamide/amine polymers and polymer formulations, and mixtures thereof; and,

providing a fibrous substrate comprising fibers,

wherein the triggerable binder formulation is insoluble in a wetting composition comprising an insolubilizing agent and the triggerable binder formulation is dispersible in disposal water.

34. The method of claim 33, wherein the wetting composition has an insolubilizing agent content of at least about 50%.

35. The method of claim 33, wherein the disposal water comprises less than about 50% of the insolubilizing agent.

36. The method of claim 33, wherein the fibrous substrate has a triggerable binder formulation add-on level of about 0.5 wt % to about 25 wt %.

37. The method of claim 33, wherein the insolubilizing agent is selected from the group comprising a lower level alcohol, a lower level glycol, a lower level ketone, and mixtures thereof.

38. The method of claim 33, wherein the insolubilizing agent is selected from the group comprising methyl alcohol, ethyl alcohol, n-propyl alcohol, isopropyl alcohol, n-butyl alcohol, sec-butyl alcohol, tert-butyl alcohol, ethylene glycol, 1,2 propandiol (propylene glycol), 1,3 propane diol, acetone, methylethyl ketone, and mixtures thereof.

39. The method of claim 33, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising acrylic acid, methacrylic acid and their salts, 2-acrylamido-2-methyl-1 propanesulfonic acid and its salts, vinyl sulfonic acid and their salts, other sulfonate monomers such as potassium (3-sulfopropyl) acrylate, sodium styrene sulfonate, and phosphonate/phosphonic acids.

40. The method of claim 33, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising N-isopropyl acrylamide and other acrylamide derivatives, 2-hydroxyethyl methacrylate, vinyl pyrrolidone, methylvinyl ether, polyethylene glycol acrylate, and polyethylene glycol methacrylates.

41. The method of claim 33, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising N,N-dimethyl-N-(2-methacryloyloxyethyl)-N-(3-sulfopropyl) ammonium betaine, N,N-dimethyl-N-(2-methacrylamidopropyl)-N-(3-sulfopropyl) ammonium betaine, 1-(3-Sulfopropyl)-2-vinylpyridinium betaine, N-(3-carboxypropyl)-N-methacrylamido-ethyl-N,N-dimethyl ammonium betaine, and 4-vinylpiperidinium ethanecarboxy betaine.

42. The method of claim 33, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising [2-(acryloxy)ethyl] trimethyl ammonium chloride, [2-(methacryloxy)ethyl] trimethyl ammonium chloride, (3-acrylamidopropyl) trimethyl ammonium chloride, N,N-diallyldimethyl ammonium chloride, [2-(acryloxy)ethyl] dimethylbenzyl ammonium chloride, [2-(methacryloxy)ethyl] dimethylbenzyl ammonium chloride, [2-(acryloxy)ethyl] dimethyl ammonium chloride, and [2-(methacryloxy)ethyl] dimethyl ammonium chloride.

43. The method of claim 33, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising vinylpyridine, dimethylaminoethyl acrylate, and dimethylaminoethyl methacrylate.

44. The method of claim 33, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising

methyl acrylate, ethyl acrylate, butyl acrylate, substituted acrylamide, and alkyl vinyl ether.

45. The method of claim 33, wherein the triggerable binder formulation is a polymerization product comprising acrylamide or vinylamide/amine monomers and, optionally, at least one monomer selected from the group comprising N-vinylformamide, N-vinyl alkylamides, polyvinylpyrrolidone, and polyvinylcaprolactam.

46. The method of claim 33, wherein the wet wipe product has an in-use tensile strength of about 300 g/in or greater.

47. The method of claim 33, wherein the wet wipe product has a disposal strength of about 75 g/in. or less.

48. The method of claim 33, wherein the fibrous substrate is air-laid, wet-laid, or coform.

49. The method of claim 33, further comprising treating the fibrous substrate with the triggerable binder formulation.

50. The method of claim 33, wherein the fibers of the fibrous substrate are treated with the triggerable binder formulation prior to the formation of the fibrous substrate.

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