DISPERSBABLE WET WIPES MADE USING SHORT CELLULOSE FIBERS FOR ENHANCED DISPERSIBILITY

Inventors: Nathan John Vogel, Neenah, WI (US); Kenneth John Zwick, Neenah, WI (US); David James Sealy Powlung, Combined Locks, WI (US); Kroy Donald Johnson, Neenah, WI (US); Peter Shawn Lortscher, Neenah, WI (US)

Abstract

The present disclosure generally relates to dispersible wet wipes. More particularly, the disclosure relates to a dispersible wet wipe constructed of a wipe substrate containing a tissue web consisting of cellulose fibers and a binder composition for binding said binder composition to said tissue web. The tissue web contains cellulose fibers that have a fiber length of 3 mm or less. The construction of the dispersible wipes may allow for a pass through percentage value calculated via a dispersibility shake flask test of at least about 70 percent for increased dispersibility. More desirably, the single-ply dispersible wet wipes may have a pass through percentage value of at least about 95 percent.
DISPEROSIBLE WET WIPES MADE USING SHORT CELLULOSE FIBERS FOR ENHANCED DISPERSIBILITY

BACKGROUND

[0001] Dispersible flushable moist products must exhibit satisfactory in-use strength, but quickly break down in sewer or septic systems. Current flushable moist wipes do this by using a triggering salt sensitive binder on a substrate comprising cellulose based fibers. The binder attaches to cellulose fibers which form a network of in-use strength in a 2 percent salt solution (used as the moist wipe formulation), but swells and falls apart in the fresh water of the toilet and sewer system.

[0002] Additionally, flushable moist wipes need to easily pass through current municipal sewer systems. For many years, the problem of disposability has plagued industries that provide disposable items, such as diapers, wet wipes, incontinence garments and feminine care products. Ideally, when a flushable disposable product is discarded in either sewer or septic systems, the product, or designated portions of the product, should “disperse” and thus sufficiently dissolve or disintegrate in water so as not to present problems under conditions typically found in household and municipal sanitation systems. Some products have failed to properly disperse. Many current wipe manufacturers achieve acceptable strength in flushable moist wipes by using long fibers (>10 mm) which entangle with other fibers to develop a wet strength network. However, these long fibers are not desirable because they tend to collect on screens in waste water systems and cause obstructions and blockages.

[0003] As a result, there has been a movement by municipalities to define “flushable” through various regulations. Flushable moist wipes must meet these regulations to allow for compatibility with home plumbing fixtures and drain lines, as well as the disposal of the product on site and municipal wastewater treatment systems. By following these regulations, manufacturers can ensure that in normal conditions products best disposed of via the waste water systems for public health and hygiene reasons will not block toilets, drainage pipes, water conveyance and treatments systems or become an aesthetic nuisance in surface waters or soil environments.

[0004] One challenge for flushable moist wipes is that it takes much longer to break down when compared to dry toilet tissue potentially creating issues in sewer or septic systems. Currently dry toilet tissue quickly exhibits lower post-use strength when exposed to tap water whereas current flushable moist wipes take time and/or agitation.

[0005] To achieve faster dispersion times with current binder technologies requires lower in-use strength that is deemed unacceptable by current consumers. Dispersibility could also be improved by curing/drying the binder less, but again provides unacceptable in-use strength.

[0006] Unfortunately, these approaches to addressing the dispersibility problems provide unacceptable strength or products that do not disperse quickly enough. Thus, there is a need to provide a wet wipe that provides proper in-use strength for consumers, but disperses more like toilet paper to pass various municipal regulations and be defined as a flushable product.

SUMMARY

[0007] The present disclosure generally relates to dispersible wet wipes. More particularly, the disclosure relates to a dispersible wet wipe constructed of a wipe substrate containing a tissue web consisting of cellulose fibers and a binder composition for binding said binder composition to said tissue web. The tissue web contains cellulose fibers that have a fiber length of 3 mm or less.

[0008] The construction of the dispersible wipes may allow for a pass through percentage value based on the INDA/EDANA dispersibility shake flask test of at least about 70 percent for increased dispersibility. More desirably, the single-ply dispersible wet wipes may have a pass through percentage value of at least about 95 percent. For purposes herein, the “pass through percentage value” is equal to the amount of the substrate that passes through the 3.18 mm perforated plate using the Dispersibility Shake Flask Test described herein.

[0009] The amount of binder composition present in the single-ply wipe substrates may desirably range from about 1 to about 15 percent by weight based on the total weight of the single-ply wipe substrates. More desirably, the binder composition may range from about 1 to about 8 percent by weight based on the total weight of the single-ply wipe substrate.

[0010] The amount of solids in the binder composition may desirably be less than about 18 percent by weight based on the total weight of the binder composition. More desirably, the amount of solids binder composition may be less than about 16 percent by weight based on the total weight of the binder composition.

[0011] In exemplary embodiments, the wipes substrate is constructed from a tissue web that may be an uncreped through-air dried tissue web. Additionally, the wipe substrate may be a single layer.

[0012] The dispersible wet wipes must have the desired in-use strength. As disclosed herein, the dispersible wipes may possess an in-use wet tensile strength of at least about 300 grams per linear inch. The sections of the dispersible wet wipe that have broken apart when agitated in a slosh box for approximately ten minutes soaked in tap water after about 50 minutes or less have a post-use machine tensile strength of less than about 200 grams per linear inch.

[0013] Desirably, the dispersible wet wipes have a ratio of machine direction tensile strength to cross-direction tensile strength that is less than 2.2. The dispersible wet wipe may also have a geometric mean tensile strength of at least 300 grams per linear inch. The dispersible wet wipe may also have a formation value of greater than 18.

DETAILED DESCRIPTION

[0014] The present disclosure generally relates to dispersible wet wipes. More particularly, the disclosure relates to a dispersible wet wipe constructed of a wipe substrate containing a tissue web consisting of cellulose fibers and a binder composition for binding said binder composition to said tissue web. The tissue web contains cellulose fibers that have a fiber length of 3 mm or less to enhance the dispersibility of the wipes.

[0015] Desirably, the dispersible wipes are constructed from tissue webs. Basesheets suitable for this purpose can be made using any process that produces a high density, resilient tissue structure. Such processes include uncreped through-dried, creped throughdried and modified wet press processes. Exemplary processes to prepare uncreped throughdried tissue is described in U.S. Pat. No. 5,607,551, U.S. Pat. No. 5,672,248, and U.S. Pat. No. 5,593,545. U.S. Pat. No. 6,083,346 and U.S. Pat. No. 7,056,572, all herein incorporated by reference.
Typically, the tissue webs of the present disclosure define a basis weight of from about 60 to about 120 grams per square meter (gsm) and desirably from about 60 gsm to about 90 gsm. Most desirably, the wipes of the present disclosure define a basis weight from about 65 to about 80 gsm.

[0016] For example, the tissue web may be made using an uncreped through-air-dried tissue making process in which a single-layer headbox deposits an aqueous suspension of papermaking fibers between forming wires. The newly-formed web is transferred from the forming wire to a slower moving transfer fabric with the aid of a vacuum box. The web is then transferred to a through-drying fabric and passed over throughdryers to dry the web. After drying, the web is transferred from the throughdrying fabric to a reel fabric and thereafter briefly sandwiched between fabrics. The dried web remains with fabric until it is wound up into a parent roll.

[0017] Desirably, the tissue web consists of fibers that have fiber lengths that are less than 3 mm. By having fiber lengths of the less than 3 mm and providing the proper cure to the dispersible binder, it will bring the fibers closer together so the dispersible binder can build an acceptable in-use network, but still break up effectively to individual fibers. Therefore, the broken-down product will be able to effectively pass through the smallest wastewater treatment screens, or sieves, just like toilet paper. Optimizing basemat properties and process conditions allows above average in-use strength generation while improving flushability of the product, with less risk to wastewater treatment facilities.

[0018] To provide a wipe substrate with the requisite strength, good formation of high basis weight tissue is beneficial. To prepare a tissue web with better formation, a wide slice opening on the headbox may be used to allow a lot of water through and operate at a higher tensile ratio. Providing good formation of the substrate provides the ability to deliver strength with significantly less binder and without the need of longer fibers.

[0019] Desirably, the wipe substrate of the present disclosure has a formation value of greater than 18. Providing a wipe substrate with a formation value of greater than 18, provides the necessary strength for in-use, but also allows a wipe substrate that disperses in water.

[0020] The wipe substrate 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 material may also be formed from a plurality of separate fibrous materials wherein each of the separate fibrous materials may be formed from a different type of fiber. In those instances where the fibrous material includes multiple layers, the binder composition may be applied to the entire thickness of the fibrous material, or each individual layer may be separately treated and then combined with other layers in a juxtaposed relationship to form the finished fibrous material. Desirably, the wipe may be formed from a single layer or ply.

[0021] As described above, the wipe substrate includes a binder composition. In one embodiment the binder composition may include a triggerable polymer. In another embodiment, the binder composition may comprise a triggerable polymer and a cobinder polymer.

[0022] The amount of binder composition present in the single-ply wipe substrate may desirably range from about 1 to about 15 percent by weight based on the total weight of the single-ply wipe substrate. More desirably, the binder composition may comprise from about 1 to about 10 percent by weight based on the total weight of the single-ply wipe substrate. Even more desirably, the binder composition may comprise from about 1 to about 8 percent by weight based on the total weight of the single-ply wipe substrate. Most desirably, the binder composition may comprise from about 1 to about 8 percent by weight based on the total weight of the single-ply wipe substrate. The amount of the binder composition results in a single-ply wipe substrate that has in-use integrity, but quickly disperses when soaked in tap water.

[0023] The composition of tap water can vary greatly depending on the water source. In the case of a dispersible wipe, the binder composition may preferably be capable of losing sufficient strength to allow the wet wipe to disperse in tap water covering the preponderance of the tap water composition range found throughout the United States (and throughout the world). Thus, it is important to evaluate the dispersibility of the binder composition in aqueous solutions which contain the major components in tap water and in a representative concentration range encompassing the majority of the tap water sources in the United States. The predominant inorganic ions typically found in drinking water are sodium, calcium, magnesium, bicarbonate, sulfate and chloride. Based on a recent study conducted by the American Water Works Association (AWWA) in 1996, the predominance of the U.S. municipal water systems (both ground water and surface water sources) surveyed have a total dissolved solids of inorganic components of about 500 ppm or less. This level of 500 ppm total dissolved solids also represents the secondary drinking water standard set by the U.S. Environmental Protection Agency. The average water hardness, which represents the calcium and magnesium concentrations in the tap water source, at this total dissolved solids level was approximately 250 ppm (CaCO₃ equivalent), which also encompasses the water hardness for the predominance of the municipal water systems surveyed by the AWWA. As defined by the United States Geological Survey (USGS), a water hardness of 250 ppm CaCO₃ equivalent would be considered “very hard” water. Similarly, the average bicarbonate concentration at 500 ppm total dissolved solids reported in the study was 12 ppm, which also encompasses the bicarbonate, or alkalinity, of the predominance of the municipal water systems surveyed. A past study by the USGS of the finished water supplies of 100 of the largest cities in the United States suggests that a sulfate level of about 100 ppm is sufficient to cover the majority of finished water supplies. Similarly, sodium and chloride levels of at least 50 ppm each should be sufficient to cover the majority of U.S. finished water supplies. Thus, binder compositions which are capable of losing strength in tap water compositions meeting these minimum requirements should also lose strength in water compositions of lower total dissolved solids with varied compositions of calcium, magnesium, bicarbonate, sulfate, sodium, and chloride. To ensure the dispersibility of the binder composition across the country (and throughout the whole world), the binder composition may desirably be soluble in water containing up to about 100 ppm total dissolved solids and a CaCO₃ equivalent hardness up to about 55 ppm. More desirably, the binder composition may be soluble in water containing up to about 300 ppm of total dissolved solids and a CaCO₃ equivalent hardness up to about 150 ppm. Even more desirably, the binder composition may be soluble in water containing up to about 500 ppm total dissolved solids and a CaCO₃ equivalent hardness up to about 250 ppm.
[0024] To provide a wipe substrate with the necessary strength, good distribution of the binder across the sheet is needed. Earlier examples using a similar basis sheet had coverage with a single nozzle that gave poor distribution of binder. Improving distribution is critical to generate optimum strength and for proper sheet handling.

[0025] To measure the proper distribution of binder across the sheet, a ratio of the machine direction tensile strength to cross direction tensile strength can be measured. Having more similar values between the machine direction tensile strength to cross direction tensile strength indicates that there is better binder distribution across the sheet.

[0026] Desirably, the wipe substrate of the present disclosure has a ratio value of machine direction tensile strength to cross direction tensile strength of less than 2.25. Providing a wipe substrate with a formation value of less than 2.25, provides the necessary strength for in-use, but also allows it to disperse in water.

[0027] As previously disclosed, the binder composition may comprise the triggerable polymer and a cobinder. A variety of triggerable polymers may be used. One type of triggerable polymer is a dilution triggerable polymer. Examples of dilution triggerable polymers include ion-sensitive polymers, which may be employed in combination with a wetting composition in which the insolubilizing agent is a salt. Other dilution triggerable polymers may also be employed, wherein these dilution triggerable polymers are used in combination with wetting agents using a variety of insolubilizing agents, such as organic or polymeric compounds.

[0028] Although the triggerable polymer may be selected from a variety of polymers, including temperature sensitive polymers and pH-sensitive polymers, the triggerable polymer may preferably be the dilution triggerable polymer, comprising the ion-sensitive polymer. If the ion-sensitive polymer is derived from one or more monomers, where at least one contains an anionic functionality, the ion-sensitive polymer is referred to as an anionic ion-sensitive polymer. If the ion-sensitive polymer is derived from one or more monomers, where at least one contains a cationic functionality, the ion-sensitive polymer is referred to as a cationic ion-sensitive polymer. An exemplary anionic ion-sensitive polymer is described in U.S. Pat. No. 6,423,804, which is incorporated herein in its entirety by reference.


[0030] Desirably, the ion-sensitive polymer may be insoluble in the wetting composition, wherein the wetting composition comprises at least about 0.3 weight percent of an insolubilizing agent which may be comprised of one or more inorganic and/or organic salts containing monovalent and/or divalent ions. More desirably, the ion-sensitive polymer may be insoluble in the wetting composition, wherein the wetting composition comprises from about 0.3 to about 3.5 percent by weight of an insolubilizing agent which may be comprised of one or more inorganic and/or organic salts containing monovalent and/or divalent ions. Even more desirably, the ion-sensitive polymer may be insoluble in the wetting composition, wherein the wetting composition comprises from about 0.5 to about 3.5 percent by weight of an insolubilizing agent which comprises one or more inorganic and/or organic salts containing monovalent and/or divalent ions. Especially desirable, the ion-sensitive polymer may be insoluble in the wetting composition, wherein the wetting composition comprises from about 1 to about 3 percent by weight of an insolubilizing agent which comprises one or more inorganic and/or organic salts containing monovalent and/or divalent ions. Suitable monovalent ions include, but are not limited to, Na⁺ ions, K⁺ ions, Li⁺ ions, NH₄⁺ ions, low molecular weight quaternary ammonium compounds (e.g., those having fewer than 5 carbons on any side group), and a combination thereof.

Suitable divalent ions include, but are not limited to, Ca⁡⁺⁺, Sr⁡⁺⁺, and Mg⁡⁺⁺. These monovalent and divalent ions may be derived from organic and inorganic salts including, but not limited to, NaCl, NaBr, KCl, NH₄Cl, Na₂SO₄, ZnCl₂, CaCl₂, MgCl₂, MgSO₄, and combinations thereof. Typically, alkali metal halides are the most desirable monovalent or divalent ions because of cost, purity, low toxicity and availability. A desirable salt is NaCl.

[0031] In a preferred embodiment, the ion-sensitive polymer may desirably provide the wipe substrate with sufficient in-use strength (typically >300 grams per linear inch) in combination with the wetting composition containing sodium chloride. These wipe substrates may be dispersible in tap water, desirably losing most of their wet strength (<200 grams per linear inch) in one hour or less.

[0032] In another preferred embodiment, the ion-sensitive polymer may comprise the cationic sensitive polymer, wherein the cationic sensitive polymer is a cationic polyacrylate that is the polymerization product of 96 mol % methyl acrylate and 4 mol % [2-(acylloyloxyethyl)]trimethyl ammonium chloride.

[0033] As previously discussed, the binder composition may comprise the triggerable polymer and/or the cobinder. When the binder composition comprises the triggerable polymer and the cobinder, the triggerable polymer and the cobinder may preferably be compatible with each other in aqueous solutions to: 1) allow for facile application of the binder composition to the fibrous substrate in a continuous process and 2) prevent interference with the dispersibility of the binder composition. Therefore, if the triggerable polymer is the anionic ion-sensitive polymer, cobinders which are anionic, nonionic, or very weakly cationic may be preferred. If the triggerable polymer is the cationic ion-sensitive polymer, cobinders which are cationic, nonionic, or very weakly anionic may be added. Additionally, the cobinder desirably does not provide substantial cohesion to the wipe substrate by way of covalent bonds, such that it interferes with the dispersibility of the wipe substrate.

[0034] The presence of the cobinder may provide a number of desirable qualities. For example, the cobinder may serve to reduce the shear viscosity of the triggerable polymer, such that the binder composition has improved sprayability over the triggerable binder alone. By use of the term "sprayable" it is meant that these polymers may be applied to the fibrous material or substrate by spraying, allowing the uniform distribution of these polymers across the surface of the substrate and penetration of these polymers into the substrate. The cobinder may also reduce the stiffness of the wipe substrate compared to the stiffness of a wipe substrate to which only the
triggerable polymer has been applied. Reduced stiffness may be achieved if the cobinder has a glass transition temperature, Tg, which is lower than the Tg of the triggerable polymer. In addition, the cobinder may be less expensive than the triggerable polymer and by reducing the amount of triggerable polymer needed, may serve to reduce the cost of the binder composition. Thus, it may be desirable to use the highest amount of cobinder possible in the binder composition such that it does not jeopardize the dispersibility and in-use strength properties of the wet wipe. In a preferred embodiment, the cobinder replaces a portion of the triggerable polymer in the binder composition and permits a given strength level to be achieved, relative to a wet wipe having approximately the same tensile strength but containing only the triggerable polymer in the binder composition, to provide at least one of the following attributes: lower stiffness, better tactile properties (e.g., lubricity or smoothness) or reduced cost.

In one embodiment, the cobinder present in the binder composition, relative to the mass of the binder composition, may be about 10 percent or less, more desirably about 15 percent or less, more desirably about 20 percent or less, more desirably about 30 percent or less, or more desirably about 45 percent or less. Exemplary ranges of cobinder relative to the solid mass of the binder composition may include from about 1 to about 45 percent, from about 25 to about 35 percent, from about 1 to about 20 percent and from about 5 to about 25 percent.

The cobinder may be selected from a wide variety of polymers, as are known in the art. For example, the cobinder may be selected from the group consisting of poly(ethylene-vinyl acetate), poly(styrene-butadiene), poly(styrene-acrylic), a vinyl acryl terpolymer, a polyester latex, an acrylic emulsion latex, poly(vinyl chloride), ethylene-vinyl chloride copolymer, a carboxylated vinyl acetate latex, and the like. A variety of additional exemplary cobinder polymers are described in U.S. Pat. No. 6,653,406 and U.S. Patent Application Publication No. 2003/00326063, which are both incorporated herein by reference in their entirety. Particularly preferred cobinders include Airflex® EZ125 and Airflex® 110.

To prepare the wipe substrates described herein, the binder composition may be applied to the fibrous material by any known process. Suitable processes for applying the binder composition include, but are not limited to printing, spraying, electrostatic spraying, the use of metered press rolls or impregnating. The amount of binder composition may be metered and distributed uniformly onto the fibrous material or may be non-uniformly distributed onto the fibrous material.

Once the binder composition is applied to the fibrous material, drying, if necessary, may be achieved by any conventional means. Once dry, the wipe substrate may exhibit improved tensile strength when compared to the tensile strength of the untreated wet-laid or dry-laid fibrous material, and yet should have the ability to rapidly “fall apart” or disintegrate when placed in tap water.

For ease of application to the fibrous substrate, the binder composition may be dissolved in water, or in a non-aqueous solvent, such as methanol, ethanol, acetone, or the like, with water being the preferred solvent. The amount of binder dissolved in the solvent may vary depending on the polymer used and the fabric application. Desirably, the binder solution contains less than about 18 percent by weight of binder composition solids. More desirably, the binder solution contains less than 16 percent by weight of binder composition solids.

Unexpectedly, it was discovered that the a percentage binder composition solids of less than about 18 percent, and preferably less than about 16 percent ensure spray coverage is optimized with acrylate-based binder. Unexpectedly, low solids spraying of the binder on uncured through air-dried tissue provided beneficial strength benefits despite significantly high attachment points per fiber volume (36,000 contacts/mm³) that, in theory, should not require droplet size optimization. In addition, one skilled in the art would prefer not to lower the percentage of solids in the binder since the lower binder add-on made spraying at lower solids difficult due to dispersible binder nozzle tip requirements.

Effective spray coverage will provide better strength to the wipe. The “geometric mean tensile strength” (GMT) may be used to define effective spray coverage by illustrating the strength across the wipe. Desirably, the dispersible wet wipes have a geometric mean tensile strength of at least 300 grams per linear inch.

A number of techniques may be employed to manufacture the wet wipes. In one embodiment, these techniques may include the following steps:

1. Providing the fibrous material (e.g., an unbonded airlaid, a tissue web, a carded web, fluff pulp, etc.).
2. Applying the binder composition to the fibrous material, typically in the form of a liquid, suspension, or foam to provide the wipe substrate.
3. The wipe substrate may be dried.
4. Applying a wetting composition to the wipe substrate to generate the wet wipe.
5. Placing the wet wipe in roll form or in a stack and packaging the product.

In one embodiment, the binder composition as applied in step 2 may comprise the triggerable polymer. In a further embodiment, the binder composition as applied in step 2 may comprise the triggerable polymer and the cobinder.

The finished wet wipes may be individually packaged, desirably in a folded condition, in a moisture proof envelope or packaged in containers holding any desired number of sheets in a water-tight package with a wetting composition applied to the wipe. Some example processes which can be used to manufacture folded wet wipes are described in U.S. Pat. Nos. 5,540,332 and 6,905,748, which are incorporated by reference herein. The finished wipes may also be packaged as a roll of separable sheets in a moisture-proof container holding any desired number of sheets on the roll with a wetting composition applied to the wipes. The roll can be coreless and either hollow or solid. Coreless rolls, including rolls with a hollow center or without a solid center, can be produced with known coreless roll winders, including those of SRP Industry, Inc. of San Jose, Calif.; Shimizu Manufacturing of Japan, and the devices disclosed in U.S. Pat. No. 4,667,890. U.S. Pat. No. 6,651,924 also provides examples of a process for producing coreless rolls of wet wipes.

In addition to the wipe substrate, wet wipes also contain a wetting composition described herein. The liquid wetting composition can be any liquid, which can be absorbed into the wet wipe basessheet and may include any suitable components, which provide the desired wiping properties. For example, the components may include water,
emollients, surfactants, fragrances, preservatives, organic or inorganic acids, chelating agents, pH buffers, or combinations thereof, as are well known to those skilled in the art. Further, the liquid may also contain lotions, medicaments, and/or antibacterials.

[0051] The wetting composition may desirably be incorporated into the wipe in an add-on amount of from about 10 to about 600 percent by weight of the substrate, more desirably from about 20 to about 500 percent by weight of the substrate, even more desirably from about 100 to about 500 percent by weight of the substrate, and especially more desirably from about 200 to about 300 percent by weight of the substrate.

[0052] In the case of a dispersible wipe, the wetting composition for use in combination with the wipe substrate may desirably comprise an aqueous composition containing the insolubilizing agent that maintains the coherency of the binder composition and thus the in-use strength of the wet wipe until the insolubilizing agent is diluted with tap water. Thus the wetting composition may contribute to the triggerable property of the triggerable polymer and concomitantly the binder composition.

[0053] The insolubilizing agent in the wetting composition can be a salt, such as those previously disclosed for use with the ion-sensitive polymer, a blend of salts having both monovalent and multivalent ions, or any other compound, which provides in-use and storage strength to the binder composition and may be diluted in water to permit dispersion of the wet wipe as the binder composition transitions to a weaker state. The wetting composition may desirably contain more than about 0.3 weight percent of an insolubilizing agent based on the total weight of the wetting composition. The wetting composition may desirably contain from about 0.3 to about 10 weight percent of an insolubilizing agent based on the total weight of the wetting composition. More desirably, the wetting composition may contain from about 0.5 to about 5 weight percent of an insolubilizing agent based on the total weight of the wetting composition. More desirably, the wetting composition may contain in a range of from about 1 to about 4 weight percent of an insolubilizing agent based on the total weight of the wetting composition. Even more desirably, the wetting composition may contain from about 1 to about 2 weight percent of an insolubilizing agent based on the total weight of the wetting composition.

[0054] The wetting composition may desirably be compatible with the triggerable polymer, the co-binder polymer, and any other components of the binder composition. In addition, the wetting composition desirably contributes to the ability of the wet wipes to maintain coherency during use, storage and/or dispensing, while still providing dispersibility in tap water.

[0055] In one example, the wetting compositions may contain water. The wetting compositions can suitably contain water in an amount of from about 0.1 to about 99.9 percent by weight of the composition, more typically from about 40 to about 99 percent by weight of the composition, and more preferably from about 60 to about 99.9 percent by weight of the composition. For instance, where the composition is used in connection with a wet wipe, the composition can suitably contain water in an amount of from about 75 to about 99.9 percent by weight of the composition.

[0056] The wetting compositions may further contain additional agents that impart a beneficial effect on skin or hair and/or further act to improve the aesthetic feel of the compositions and wipes described herein. Examples of suitable skin benefit agents include emollients, sterols or sterol derivatives, natural and synthetic fats or oils, viscosity enhancers, rheology modifiers, polyols, surfactants, alcohols, esters, silicones, clays, starch, cellulose, particulates, moisturizers, film formers, slip modifiers, surface modifiers, skin protectants, humectants, sunscreens, and the like.

[0057] Thus, in one example, the wetting compositions may further optionally include one or more emollients, which typically act to soften, soothe, and otherwise lubricate and/or moisturize the skin. Suitable emollients that can be incorporated into the compositions include oils such as petroleum-based oils, petrolatum, mineral oils, alkyl dimethicones, alkyl methicones, alkyldimethicone copolymers, phenyl silicones, alkyl trimethylysilanes, dimethicone, dimethicone crosspolymers, cyclomethicone, lanolin and its derivatives, glycerol esters and derivatives, propylene glycol esters and derivatives, alkoxypropoxy carboxylic acids, alkoxyalkyl alcohols, and combinations thereof.

[0058] Others such as eucalyptol, cetaryl glucoside, dimethyl isosorbide polyglyceryl-3 cetyl ether, polyglyceryl-3 decylenetraecanol, propylene glycol myristyl ether, and combinations thereof, can also suitably be used as emollients.

[0059] In addition, the wetting composition may include an emollient in an amount of from about 0.01 to about 20 percent by weight of the composition, more desirably from about 0.05 to about 10 percent by weight of the composition, and more typically from about 0.1 to about 5 percent by weight of the composition.

[0060] One or more viscosity enhancers may also be added to the wetting composition to increase the viscosity, to help stabilize the composition thereby reducing migration of the composition and improving transfer to the skin. Suitable viscosity enhancers include polyolefin resins, lipophile oil thickeners, polyethylene, silica, silica silylate, silica methyl silylate, colloidal silicone dioxide, cetyl hydroxy ethyl cellulose, other organically modified celluloses, PVP/decane copolymer, PVM/MA decadiene crosspolymer, PVP/VP/crospovidone, PVP/hexadecane copolymer, clays, starches, gums, water-soluble acrylates, caromers, acrylate based thickeners, surfactant thickeners, and combinations thereof.

[0061] The wetting composition may desirably include one or more viscosity enhancers in an amount of from about 0.01 to about 25 percent by weight of the composition, more desirably from about 0.05 to about 10 percent by weight of the composition, and even more desirably from about 0.1 to about 5 percent by weight of the composition.

[0062] The compositions of the disclosure may optionally further contain humectants. Examples of suitable humectants include glycerin, glycerin derivatives, sodium hyaluronate, betaine, amino acids, glycosaminoglycans, honey, sorbitol, glycols, polyols, sugars, hydrogenated starch hydrolysates, salts of PCA, lactic acid, lactates, and urea. A particularly preferred humectant is glycerin. The composition of the present disclosure may suitably include one or more humectants in an amount of from about 0.05 to about 25 percent by weight of the composition.

[0063] The compositions of the disclosure may optionally further contain film formers. Examples of suitable film formers include lanolin derivatives (e.g., acetylated lanolins), superfatted oils, cyclomethicone, cyclopentasiloxane, dimethicone, synthetic and biological polymers, proteins, quaternary ammonium materials, starches, gums, celluloses, polysaccharides, albumen, acrylates derivatives, IPDI derivatio-
tives, and the like. The composition of the present disclosure may suitably include one or more film formers in an amount of from about 0.01 to about 20 percent by weight of the composition.

[0064] The wetting compositions may also further contain skin protectants. Examples of suitable skin protectants include ingredients referenced in SP monograph (21 CFR §347). Suitable skin protectants and amounts include those set forth in SP monograph, Subpart B—Active Ingredients §347.10: (a) Allantoin, 0.5 to 2%, (b) Aluminum hydroxide gel, 0.15 to 5%, (c) Calamine, 1 to 25%, (d) Cocoa butter, 50 to 100%, (e) Cod liver oil, 5 to 13.56%, in accordance with §347.20(a)(1) or (a)(2), provided the product is labeled so that the quantity used in a 24-hour period does not exceed 10,000 U.S.P. Units vitamin A and 400 U.S.P. Units cholecalciferol, (f) Colloidal oatmeal, 0.007% minimum; 0.003% minimum in combination with mineral oil in accordance with §347.20 (a)(4), (g) Dimethicone, 1 to 30%, (h) Glycerin, 20 to 45%, (i) Hard fat, 50 to 100%, (j) Kaolin, 4 to 20%, (k) Lanolin, 12.5 to 50%, (l) Mineral oil, 50 to 100%; 30 to 35% in combination with colloidal oatmeal in accordance with §347.20(a)(4), (m) Petrolatum, 30 to 100%, (n) Sodium bicarbonate, (q) Topical starch, 10 to 98%, (r) White petrolatum, 30 to 100%, (s) Zinc acetate, 0.1 to 2%, (t) Zinc carbonate, 0.2 to 2%, (u) Zinc oxide, 1 to 25%.

[0065] The wetting compositions may also further contain quaternary ammonium materials. Examples of suitable quaternary ammonium materials include polyquaternium-7, polyquaternium-10, benzalkonium chloride, behentrimonium methosulfate, cetrimonium chloride, cocamidopropyl pg-dimmonium chloride, guar hydroxypropyltrimonium chloride, isoamidopropyl morpholine lactate, polyquaternium-33, polyquaternium-60, polyquaternium-79, quaternium-18 hectorite, quaternium-79 hydrolyzed silk, quaternium-79 hydrolyzed soy protein, rapeseed amidopropyl ethylhydroximethosulfate, silicone quaternium-7, stearamonium chloride, palmamidopropyltrimonium chloride, butylglycosides, hydroxypropyltrimonium chloride, laurdimoniumhydroxypropyl decylglucosides chloride, and the like. The composition of the present disclosure may suitably include one or more quaternary materials in an amount of from about 0.01 to about 20 percent by weight of the composition.

[0066] The wetting compositions may optionally further contain surfactants. Examples of suitable additional surfactants include, for example, anionic surfactants, cationic surfactants, amphoteric surfactants, zwitterionic surfactants, non-ionic surfactants, and combinations thereof. Specific examples of suitable surfactants are known in the art and include those suitable for incorporation into wetting compositions and wipes. The composition of the present disclosure may suitably include one or more surfactants in an amount of from about 0.01 to about 20 percent by weight of the composition.

[0067] In addition to nonionic surfactants, the cleanser may also contain other types of surfactants. For instance, in some embodiments, amphoteric surfactants, such as zwitterionic surfactants, may also be used. For instance, one class of amphoteric surfactants that may be used in the present disclosure are derivatives of secondary and tertiary amines having aliphatic radicals that are straight chain or branched, wherein one of the aliphatic substituents contains from about 8 to 18 carbon atoms and at least one of the aliphatic substituents contains an anionic water-solubilizing group, such as a carboxy, sulfonate, or sulfate group. Some examples of amphoteric surfactants include, but are not limited to, sodium 3-(dodecylamino)propanoate, sodium 3-(dodecylamino)propane-1-sulfonate, sodium 2-(dodecylamino)ethyl sulfate, sodium 2-(dimethylamino)octadecanoate, disodium 3-(N-carboxymethyl-dodecylamino)propane-1-sulfonate, disodium octaethylaminodiacetate, sodium 1-carboxymethyl-2-undecylidazol, and sodium N,N-bis(2-hydroxyethyl)-2-sulfato-3-dodec oxypropylamine.

[0068] Additional classes of suitable amphoteric surfactants include phosphobetaines and the phosphinaïtes. For instance, some examples of such amphoteric surfactants include, but are not limited to, sodium cocamidopropyl betaine, sodium oleyl N-methyl taurate, sodium tall oil acid N-methyl taurate, sodium palmitoyl N-methyl taurate, cocodimethycarballylxybetaine, lauryldimethycarballylxybetaine, cetyl dimethycarballylxybetaine, lauryl-bis-(2-hydroxyethyl) carbomethybetaine, oleoyldimethyl gammampropylbetaine, lauryl-bis-(2-hydroxypropyl)-carboxybetaine, cocoamidomethylpropylsultaine, stearylamidomethylpropylsultaine, laurylamido-bis-(2-hydroxyethyl)propylsultaine, di-sodium oleamide PEG-2 sulfo succinate, TEA oleamido PEG-2 sulfo succinate, disodium oleamide MEA sulfo succinate, disodium oleamide MIPA sulfo succinate, disodium ricinoleamide MEA sulfo succinate, disodium undecylenamide MEA sulfo succinate, disodium laurel sulfo succinate, disodium wheat germamido MEA sulfo succinate, disodium wheat germ amido PEG-2 sulfo succinate, disodium isostearami do MEA sulfo succinate, cocoamphoglycinate, cocoamphocarboxyglucinate, lauroamphoglycinate, lauroamphocarboxylycinate, capryloamphocarboxylglycin, cocomphopropionate, cocoamphocarboxypropionate, lauroamphocarboxypropionate, capryloamphocarboxypropionate, dihydroxyethyl tall glycinolate, cocoamido disodium 3-hydroxypropyl phosphobetaine, lauric myristic amido disodium 3-hydroxypropyl phosphobetaine, lauric myristic amido glycercyl phosphobetaine, lauric myristic amido carboxy disodium 3-hydroxypropyl phosphobetaine, cocoamido propyl monosodium phoshinate, cocoamidopropyl betaine, lauric myristic amido propyl monosodium phosinhate, and mixtures thereof.

[0069] In certain instances, it may also be desired to utilize one or more anionic surfactants with the cleanser. Suitable anionic surfactants may include, but are not limited to, alkyl sulfates, alkyl ether sulfates, alkyl ether sulfonates, sulfate esters of an alkybenzene polyoxyethylene alcohol, alpha-olefin sulfonates, beta-alcohol alkane sulfonates, alkylaryl sulfonates, alkyl monoglyceride sulfates, alkyl monoglyceride sulfonates, alkyl carbonates, alkyl ether carboxylates, fatty acid salts, sulfo succinates, sarcosinates, octoxynol or nonoxynol phosphates, taurates, fatty amines, fatty acid amide polyoxyethylene sulfates, isethionates, or mixtures thereof.

[0070] Particular examples of some suitable anionic surfactants include, but are not limited to, C₈₋₁₈ alkyl sulfates, C₉₋₁₈ fatty acid salts, C₉₋₁₈ alkyl ether sulfates having one or two moles of ethoxylat, C₉₋₁₈ alkyl sarcosinates, C₈₋₁₈ sulfo succinates, C₉₋₁₈ alkyl sulfo succinates, C₁₀₋₁₂ alkyl diphenyl oxide disulfonates, C₁₂₋₁₈ alkyl carbonates, C₁₀₋₁₂ alpha-olefin sulfonates, methyl ester sulfonates, and blends thereof. The C₉₋₁₈ alkyl group can be straight chain (e.g., lauryl) or branched (e.g., 2-ethylhexyl). The cation of the anionic surfactant can be an alkali metal (e.g., sodium or potassium),...
ammonium, C$_{1-4}$ alkylammonium (e.g., mono-, di-, tri-), or C$_{3-13}$ alkanolammonium (e.g., mono-, di-, tri-).

[0071] Specific examples of such anionic surfactants include, but are not limited to, laurel sulfates, octyl sulfates, 2-ethylhexyl sulfates, decyl sulfates, tridecyl sulfates, cocoylates, lauryl sarcosinates, lauryl sulfosuccinates, linear C$_{10}$-diphenyl oxide disulfonates, lauryl sulfosuccinates, lauryl ether sulfates (1 and 2 moles ethylene oxide), myristyl sulfates, oleates, stearates, tallates, ricinoleates, cetyl sulfates, and similar surfactants.

[0072] Cationic surfactants, such as cetylpyridinium chloride and methylbenzethonium chloride, may also be utilized.

[0073] The wetting compositions may also further contain additional emulsifiers. As mentioned above, the natural fatty acids, esters and alcohols and their derivatives, and combinations thereof, may act as emulsifiers in the composition. Optionally, the composition may contain an additional emulsifier other than the natural fatty acids, esters and alcohols and their derivatives, and combinations thereof. Examples of suitable emulsifiers include nonionic emulsifiers such as polysorbate 80, anionic emulsifiers such as DEA phosphate, cationic emulsifiers such as behentrimonium methosulfate, and the like. The composition of the present disclosure may suitably include one or more additional emulsifier in an amount of from about 0.01 to about 10 percent by weight of the composition.

[0074] For example, nonionic surfactants may be used as an emulsifier. Nonionic surfactants typically have a hydrophobic base, such as a long chain alkyyl group or an alkylated aryl group, and a hydrophilic chain comprising a certain number (e.g., 1 to about 30) of ethoxy and/or propoxy moieties. Examples of some classes of nonionic surfactants that can be used include, but are not limited to, ethoxylated alkylphenols, ethoxylated and propoxylated fatty alcohols, polyethylene glycol ethers of methyl glucose, polyethylene glycol ethers of sorbitol, ethylene oxide-propylene oxide block copolymers, ethoxylated esters of fatty (C$_{8-18}$) acids, condensation products of ethylene oxide with long chain amines or amides, condensation products of ethylene oxide with alcohols, and mixtures thereof.

[0075] Various specific examples of suitable nonionic surfactants include, but are not limited to, methyl glucose-10, PEG-20 methyl glucose distearate, PEG-20 methyl glucose sesquisteareate, C$_{11-15}$ pareth-20, ceteth-8, ceteth-12, dodoxynol-12, laurhex-15, PEG-20 castor oil, polysorbate 20, steareth-20, polyoxethylene-10 cetly ether, polyoxethylene-10 stearyl ether, polyoxethylene-20 cetly ether, polyoxylene-10 oleyl ether, polyoxethylene-20 oleyl ether, an ethoxylated nonylphenol, ethoxylated cetylphenol, ethoxylated dodecylphenol, ethoxylated fatty (C$_{22}$) alcohol, including 3 to 20 ethylene oxide moieties, polyoxylene-20 isohexadecyl ether, polyoxylene-23 glycerol inurate, PEG 80 sorbitan inurate, polyoxyethylene-20 glyceryl stearate, PEG-10 methyl glucose ether, PEG-20 methyl glucose ether, polyoxylene-20 sorbitan monoesters, polyoxethylene-80 castor oil, polyoxylene-15 tridecyl ether, polyoxyethylene-6 tridecyl ether, laurhex-2, laurhex-3, laurhex-4, PEG-3 castor oil, PEG 600 dioleate, PEG 400 dioleate, and mixtures thereof.

[0076] The wetting compositions may also further contain preservatives. Suitable preservatives for use in the present compositions may include, for instance, Kathon CG, which is a mixture of methylchloroisothiazolinone and methylisothiazolinone available from Rohm & Haas of Philadelphia, Pa.; Neolone 950®, which is methylisothiazolinone available from Rohm & Haas of Philadelphia, Pa.; DMDM hydantoin (e.g., Glydant Plus available from Lonza, Inc. of Fair Lawn, N.J.); iodopropynyl butylcarbamate; benzoic esters (parabens), such as methylparaben, propylparaben, butylparaben, ethylparaben, isopropylparaben, isobutylparaben, benzylparaben, sodium methylparaben, and sodium propylyparaben; 2-bromo-2-nitropropane-1,3-diol; benzoyl acid; imidazolidinyl urea; diazolidinyl urea; and the like. Still other preservatives may include ethylhexyglycerin, phenoxyethanol caprylyl glycol, a blend of 1,2-hexanediol, caprylyl glycol and tropolone, and a blend of phenoxyethanol and tropolone.

[0077] The wetting compositions may additionally include adjunct components conventionally found in pharmaceutical compositions in their art-established fashion and at the art-established levels. For example, the compositions may contain additional compatible pharmaceutically active materials for combination therapy, such as antimicrobials, antioxidants, anti-parasitics, antipruritics, antifungals, anti-septic actives, biological actives, astringents, keratolytic actives, local anesthetics, anti-stinging agents, anti-reddening agents, skin soothing agents, and combinations thereof. Other suitable additives that may be included in the compositions of the present disclosure include colorants, deodorants, fragrances, perfumes, emulsifiers, anti-foaming agents, lubricants, natural moisturizing agents, skin conditioning agents, skin protectants and other skin benefit agents (e.g., extracts such as aloe vera and anti-aging agents such as peptides), solvents, solubilizing agents, suspending agents, wetting agents, humectants, pH adjusters, buffering agents, dyes and/or pigments, and combinations thereof.

[0078] The wet wipes, as disclosed herein, do not require organic solvents to maintain in-use strength, and the wetting composition may be substantially free of organic solvents. Organic solvents may produce a greasy after-feel and cause irritation in higher amounts. However, small amounts of organic solvents may be included in the wetting composition for different purposes other than maintaining in-use wet strength. In one embodiment, small amounts of organic solvents (less than about 1 percent) may be utilized as fragrance or preservative solubilizers to improve process and shelf stability of the wetting composition. The wetting composition may desirably contain less than about 5 weight percent of organic solvents, such as propylene glycol and other glycols, polyhydroxy alcohols, and the like, based on the total weight of the wetting composition. More desirably, the wetting composition may contain less than about 3 weight percent of organic solvents. Even more desirably, the wetting composition may contain less than about 1 weight percent of organic solvents.

[0079] The wet wipes, as disclosed herein, desirably may be made to have sufficient tensile strength, sheet-to-sheet adhesion, calculated per layer stack thickness and flexibility.

[0080] The wet wipes may be prepared using a wipe substrate with a fibrous material and a binder composition forming a nonwoven air-laid web. These wet wipes made with wipe substrate may also be made to be usable without breaking or tearing, to be consumer acceptable, and to provide problem-free disposal once disposed in a household sanitation system. The wet wipes may also be prepared using a confrom substrate as described above.

[0081] The wet wipe formed with a wipe substrate desirably may have a machine direction tensile strength ranging from at least about 300 to about 1000 grams per linear inch.
More desirably, the wet wipe may have a machine direction tensile strength ranging from at least about 300 to about 800 grams per linear inch. Even more desirably, the wet wipe may have a machine direction tensile strength ranging from at least about 300 to about 600 grams per linear inch. Most desirably, the wet wipe may have a machine direction tensile strength ranging from at least about 350 to about 550 grams per linear inch.

The wet wipe may be configured to provide all desired physical properties by use of a single or multi-ply wet wipe product, in which two or more plies of wipe substrate are joined together by methods known in the art to form a multiply wipe.

The total basis weight of the wipe substrate, consisting of a single or multiple layers of wipe substrate in the final wet wipe product, may be in the range of at least about 25 to about 120 gsm. More desirably, the basis weight of the wipe substrate may be between about 40 and 90 gsm. Even more desirably, the basis weight of the wipe substrate may be between about 60 and 80 gsm. Especially more desirably, the basis weight of the wipe substrate may be between about 70 and 75 gsm.

As mentioned previously, the wet wipes formed from the wipe substrate, may be sufficiently dispersible so that they lose enough strength to break apart in tap water under conditions typically experienced in household or municipal sanitation systems. Also mentioned previously, the tap water used for measuring dispersibility should encompass the concentration range of the majority of the components typically found in tap water compositions that the wet wipe would encounter upon disposal. Previous methods for measuring dispersibility of the wipe substrates, whether dry or pre-moistened, have commonly relied on systems in which the material was exposed to shear while in water, such as measuring the time for a material to break up while being agitated by a mechanical mixer. Constant exposure to such relatively high, uncontrolled shear gradients offers an unrealistic and overly optimistic test for products designed to be flushed in a toilet, where the level of shear is extremely weak or brief. Shear rates may be negligible, for example once the material enters a septic tank. Thus, for a realistic appraisal of wet wipe dispersibility, the test methods should simulate the relatively low shear rates the products will experience once they have been flushed in the toilet.

A static soak test, for example, should illustrate the dispersibility of the wet wipe after it is fully submerged with water from the toilet and where it experiences negligible shear, such as in a septic tank. Desirably, the wet wipe may have less than about 200 grams per linear inch of tensile strength after one hour when soaked in tap water.

As mentioned previously, the wet wipes formed from the singly-ply wipe substrate, may be sufficiently dispersible so that they lose enough strength to break apart in tap water under conditions typically experienced in household or municipal sanitation systems. Also mentioned previously, the tap water used for measuring dispersibility should encompass the concentration range of the majority of the components typically found in the tap water compositions that the wet wipe would encounter upon disposal. The Dispersibility Shake Flask Test is the first of two options to assess the dispersibility or physical break-up of a test product during its transport through building drain lines, sewage pumps, and sewer pipes in the INDA/EDANA Guidance Document for Assessing the Flushability of Nonwoven Consumer Products. It simulates the physical forces acting to disintegrate the product during passage through sewage pumps or through sewer pipes. The whole product is placed in a flask containing tap water or raw wastewater and is mechanically shaken under specified conditions. The contents of the flask are passed through a series of screens with sizes of 12, 6, 3 and 1.5 mm and the various size fractions retained on the screens are weighed so that the extent of disintegration can be determined. Under this test, if greater than 95 percent of the product mass passes through a 3.18-mm sieve (perforated plate) after agitation for one hour, then it is deemed that the product will adequately disperse during sewer conveyance. For purposes herein, the pass through percentage value is equal to the amount of the wipe that passes though the 3 mm perforated plate after one-hour of agitation. Thus, wipes will be the necessary size or smaller to allow the pieces to pass through the bar screens typically found in municipal sanitary sewer treatment facilities and not cause problems or blockages in households.

The Dispersibility Shake Flask Test should illustrate the dispersibility of the wet wipe after it is fully wetted with water from the toilet and where it experiences typical forces during its transport through sewage pumps and municipal wastewater conveyance systems.

In one embodiment, the dispersible wet wipe has a pass through percentage value of at least 70 percent. More desirably, the dispersible wet wipe has a pass through percentage value of at least 90 percent. Even more desirably, the dispersible wet wipe has a pass through percentage value of at least 95 percent.

Desirably, the wet wipes, as disclosed herein, may possess an in-use wet tensile strength of at least about 300 grams per linear inch, and a tensile strength of less than about 200 grams per linear inch when soaked in tap water after about one hour.

Most desirably, the wet wipes, as disclosed herein, may possess an in-use wet tensile strength greater than about 300 grams per linear inch when wetted, and a post-use tensile strength of less than about 150 grams per linear inch when soaked in tap water desirably after about one hour.

The wet wipe preferably maintains its desired characteristics over the time periods involved in warehousing, transportation, retail display and storage by the consumer. In one embodiment, shelf life may range from two months to two years.

The wet wipes, as disclosed herein, are 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 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 and/or the scope of the appended claims.

Test Methods

Wet Wipe Tensile Strength Measurements

For purposes herein, tensile strength may be measured using a Constant Rate of Elongation (CRE) tensile tester using a 1-inch jaw width (sample width), at test span of 3 inches (gauge length), and a rate of jaw separation of 25.4 centimeters per minute after maintaining the sample at the ambient conditions of 23±2°C. and 50±5% relative humidity for four hours before testing the sample at the same ambient
conditions. The wet wipes are cut with 1-inch wide strips cut from the center of the wipes in the specified machine direction (MD) or cross-machine direction (CD) orientation using a JDC Precision Sample Cutter (Thwing-Albert Instrument Company, Philadelphia, Pa., Model No. JDC3-10, Serial No. 37333). The “MD tensile strength” is the peak load in grams-force per inch of sample width when a sample is pulled to rupture in the machine direction. The “CD tensile strength” is the peak load in grams-force per inch of sample width when a sample is pulled to rupture in the cross direction.

The instrument used for measuring tensile strength is an MTS Systems Sinergie 200 model. The data acquisition software is MTS TestWorks® for Windows Ver. 4.0 commercially available from MTS Systems Corp., Eden Prairie, Minn. The load cell is an MTS 50 Newton maximum load cell. The gauge length between jaws is 3±0.04 inches. The top and bottom jaws are operated using pneumatic-action with maximum 60 PS.I. The break sensitivity is set at 40 percent. The data acquisition rate is set at 100 Hz (i.e. 100 samples per second). The sample is placed in the jaws of the instrument, centered both vertically and horizontally. The test is then started and ends when the force drops by 40 percent of peak. The peak load expressed in grams-force is recorded as the “MD tensile strength” of the specimen. At least twelve representative specimens are tested for each product and its average peak load is determined. As used herein, the “geometric mean tensile strength” (GMT) is the square root of the product of the dry machine direction tensile strength multiplied by the dry cross-machine direction tensile strength and is expressed as grams per inch of sample width. All of these values are for in-use tensile strength measurements.

To provide post-use tensile strength measurements, the samples are submerged in tap water for a time period of one hour and then measured for tensile strength.

Basis Weight

The dry basis weight of the basesheet material forming the wet wipes can be obtained using the ASTM active standard D646-01 (2001), Standard Test Method for Grammage of Paper and Paperboard (Mass per Unit Area), or an equivalent method.

Dispersibility Shake Flask Test

The Percentage Mass Loss of the wet wipes can be obtained using the INDA/EDANA Guidance Document for Assessing the Flushability of Nonwoven Consumer Products, Dispersibility Shake Flask Test. For purposes herein, samples were placed into tap water and tested after shaking on the flask shaker for one hour.

As used herein, the Pass Through Percentage Value is equal to Percentage Mass Loss, or the amount of the substrate that passes through the 3 mm perforated plate.

This test is used to assess the dispersibility or physical breakup of a flushable product during its transport through sewage pumps (e.g., ejector or grinder pumps) and municipal wastewater conveyance systems (e.g., sewer pipes and lift stations). This test assesses the rate and extent of disintegration of a test material in the presence of tap water or raw wastewater. Results from this test are used to predict the compatibility of a flushable product with household sewage pumps and municipal collection systems.

Materials and Apparatus:

1. Fernbach triple-baffled, glass, culture flasks (2500 mL).
2. Orbital floor shaker with 2-in (5-cm) orbit capable of 150 rpm. The platform for the shaker needs clamps to be able to accommodate a bottom flask diameter of 205 mm.
3. USA Standard Testing Sieve #18 (1 mm opening); 8 in (20 cm) diameter.
4. Perforated Plate Screens details

<table>
<thead>
<tr>
<th>Hole Size (mm)</th>
<th>Hole Size (in)</th>
<th>Hole Center (in)</th>
<th>Pattern</th>
<th>Gauge</th>
<th>% open area</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.75 mm</td>
<td>½&quot;</td>
<td>1/16&quot;</td>
<td>Staggered</td>
<td>16SWG</td>
<td>48%</td>
</tr>
<tr>
<td>6.35 mm</td>
<td>¼&quot;</td>
<td>½&quot;</td>
<td>Staggered</td>
<td>16SWG</td>
<td>58%</td>
</tr>
<tr>
<td>3.18 mm</td>
<td>⅛&quot;</td>
<td>⅛&quot;</td>
<td>Staggered</td>
<td>20SWG</td>
<td>40%</td>
</tr>
<tr>
<td>1.59 mm</td>
<td>⅛&quot;</td>
<td>⅜&quot;</td>
<td>Staggered</td>
<td>20SWG</td>
<td>41%</td>
</tr>
</tbody>
</table>

5. Drying oven capable of maintaining a temperature of 40±3°C. For thermoplastic test materials and capable of maintaining a temperature of 103±3°C for non-plastic test materials.

Test Initiation:

Each test product is run in triplicate so there are three flasks prepared for each of the two predetermined destructive sampling time points. Each flask contains one liter of prescreened wastewater or room temperature tap water and the test product (see section 6.1 Summary of Test Methods for guidance in choosing a medium for test). Each test product should be pre-weighted in triplicate (dry weight basis) on an analytical balance that measures at least 2-decimal places and then these weights recorded in a laboratory notebook for later use in the final percent disintegration calculations. Control flasks with the reference material are also run to accommodate two destructive sampling time points. Each flask also contains one liter of prescreened wastewater or tap water and an appropriate reference material. Whatman #41 ashless filter paper if used should be folded into quarters and reopened before placing in flask. For products that are pre-moistened (e.g., wet wipes) sample preconditioning to simulate product delivery to the sewer can be performed by flushing the product through the toilet and drain line apparatus. This should be documented in the study record. Measure one liter of wastewater or tap water into each of the Fernbach flasks and place them on the rotary shaker table. Add test product to the flasks (either one article or for toilet tissue typically 1 to 3 grams on dry weight basis). A minimum of one gram of test product should be used to ensure accurate measurement of the disintegration loss. The flasks are shaken at 150 rpm. For the sewage pump assessment test and control products are observed after 30 and 60 minutes, and then destructively sampled at three hours. For the sewer conveyance assessment, visual observations of the test and control products are made at one hour, and then destructively sampled at six hours. These tests are incubated at room temperature (22±5°C).

Test Termination:

At the designated destructive sampling points a flask from each set of products being tested and the control set is removed and the contents poured through a nest of screens arranged from top to bottom in the following order: 12 mm, 3 mm and 1.5 mm (diameter opening). Additional screens can be added to better understand the dispersibility characteristics.
of the sample. With a hand held showerhead spray nozzle held approximately 10 to 15 cm above the sieve, the material is gently rinsed through the nested screens for two minutes at a flow rate of 4 L/min being careful not to force passage of the retained material through the next smaller screen. After the two minutes of rinsing the top screen is removed and rinsing of the next smaller screen, still nested, continues for two additional minutes using the same procedure as above. The rinsing process is continued until all of the screens have been rinsed. After rinsing is complete, the retained material is removed from each of the screens using forceps or by backwashing into a smaller sized sieve. The content from each screen is transferred to a separate, labeled tared aluminum weigh pan and dried overnight at 103±3°C. Dried samples are cooled in a desiccator. After cooling the materials are weighed and percentage of disintegration based on the initial starting weight of the test material is calculated.

Test Initiation:
- The test is terminated when the product reaches a dispersion point of no piece larger than 1 in (25 mm) square in size or at the designated destructive sampling points. At the designated destructive sampling points, remove the clear plastic tank from the oscillating platform. Pour the entire contents of the plastic tank through a nest of screens arranged from top to bottom in the following order: 25.40 mm, 12.70 mm, 6.35 mm, 3.18 mm, 1.59 mm (diameter opening). Make sure that the perforated plate screens are set with the smooth side up. With a showerhead spray nozzle held approximately 10 to 15 cm above the sieve, gently rinse the material through the nested screens for two minutes at a flow rate of 4 L/min (1 gal/min) being careful not to force passage of the retained material through the next smaller screen. The flow rate can be assessed by measuring the time it takes to fill a 4 L beaker. The average of three flow rates should be 60±2 seconds. The procedure is similar to that used in the INDA/ES dams spray impact test method (WSP 80.3). After the two minutes of rinsing, remove the top screen and continue to rinse the next smaller screen, still nested, for two additional minutes. Again, be careful not to force passage of retained material to the next smaller screen. After rinsing is complete, remove the retained material from each of the screens using forceps and/or commercial paintbrushes. Transfer the content from each screen to a separate, labeled aluminum weigh pan. Place the pan in a drying oven overnight at 103±3°C. (or some other appropriate temperature depending on the thermostability of the test material). Continue this procedure at each designated sampling time until all the test products are sampled. Allow dried samples to cool down in a desiccator. After all the samples are dry, weigh the materials from each of the retained fractions and calculate the percentage of disintegration based on the initial starting weight of the test material.

Fiber Length
- Fiber length may be tested by TAPPI test method T 271 om-02 entitled Fiber Length of Pulp and Paper by Automated Optical Analyzer Using Polarized Light. The test method is an automated method by which the fiber length distributions of pulp and paper in the range of 0.1 to 7.2 mm can be measured using light polarizing optics. Fiber length is measured and calculated as a length weighted mean fiber length according to the test method.

Formation Value
- The formation value is tested using the Paper Per-Fect Formation Analyzer Code LPA07 from OPTEST Equipment Inc. (Optest Equipment Inc. 900 Tupper St., Hawkesbury, ON, Canada). The samples are tested using the procedure outlined in Section 10.0 of the Paper Per-Fect Code LPA07 Operation Manual (LPA07_PPXF_Operation Manual_004.wpd 2009-05-20). The formation analyzer gives PPF formation values calculated for ten size ranges from C1 for 0.5 to 0.7 mm to C10 for 31 to 60 mm. The smaller sizes are important for printing clarity and the larger sizes are important for strength properties. For purposes herein, the C9 PPF value for the formation size range from 18.5 to 31 mm is used to generate a measurement for the strength of the basisheet. The PPF values are based on a 1000 point scale with 1000 being completely uniform. The C9 PPF values reported for each sample are based on the average of ten tests on five samples (two tests per sample).
EXAMPLES

Example 1

[0120] The basesheet is made using an uncreped through-air-dried tissue making process in which a headbox deposits an aqueous suspension of papermaking fibers between forming wires. The newly-formed web is transferred from the forming wire to a slower moving transfer fabric with the aid of a vacuum box. The web is then transferred to a throughdrying fabric and passed over throughdriers to dry the web. After drying, the web is transferred from the throughdrying fabric to a reel fabric and thereafter briefly sandwiched between fabrics. The dried web remains on the fabric until it is wound up into a parent roll.

[0121] To form the tissue, a headbox was employed, through which the 100 percent softwood fibers and broke are pumped in a single layer. The fiber was diluted to between 0.19 and 0.29 percent consistency in the headbox to ensure uniform formation. The resulting single-layered sheet structure was formed on a twin-wire, suction form roll. The speed of the forming fabric was 1304 feet per minute (fpm). The newly-formed web was then rewetted to a consistency of about 20 to 27 percent using vacuum suction from below the forming fabric before being transferred to the transfer fabric, which was traveling at 2800 fpm (18 percent rush transfer). A vacuum shoe pulling about 9 to 10 inches of mercury vacuum was used to transfer the web to the transfer fabric. A second vacuum shoe pulling about 5 to 6 inches of vacuum was used to transfer the web to a twin-roller to throughdrying fabric manufactured by Voith Fabrics Inc. The web was carried over a pair of honeycomb throughdriers operating at temperatures of about 400 to 430°F and dried to a final dryness of about 97 to 99 percent consistency. The dried cellulose web was rolled onto a core to form a parent roll of tissue.

[0122] A series of Unijet® nozzles, Nozzle type800050, manufactured by Spraying Systems Co., Wheaton, Ill., operating at approximately 70 to 120 psi were used to spray the binder composition onto both sides of the fibrous material. Each binder composition was sprayed at approximately 15 percent binder solids with water as the carrier. The wet partially formed single-ply wipe substrate was carried through a dryer operating at 350 to 400°F. A speed of 350 fpm to dry the single-ply wipe substrate. The partially dry wipe substrate was then wound on a core and then unwound and run through the 350 to 400°F dryer a second time at a speed between 300 and 650 fpm to raise the temperature of the web to a temperature of 250 to 350°F. The total dry weight percent of binder addition was 5 percent relative to the dry mass of the single-ply wipe substrate. The basisheet was machine-converted into sections of continuous web 5.5 inches wide by 56 inches long with perforations every 7 inches which were adhesively joined, fan-folded and applied with the wetting composition at 235 percent add-on to yield a fan-folded stack of wet wipes. A wetting composition that is used on commercially available wet wipes under the trade designation KLEENEX® COTTONELLE FRESH® Folded Wipes (Kimberly-Clark Corporation of Neenah, Wis.) with the addition of 2 weight percent sodium chloride in the converting process for Example A. A wetting composition that is used on commercially available wet wipes under the trade designation KLEENEX® COTTONELLE FRESH® Folded Wipes (Kimberly-Clark Corporation of Neenah, Wis.) with the addition of 2 weight percent sodium chloride and 2 percent organopolysiloxane in the converting process for Example B.

[0123] The exemplary dispersible wipes were tested under the Shake Flask Test with each sample tested at screen sizes of 12.70 mm, 6.35 mm, 3.18 mm, 1.59 mm and mass measured after the wipes and tensile strength test and compared to KLEENEX® COTTONELLE FRESH® Flushable Moist Wipes and Natural Choice® Flushable Moist Wipes. Illustrative results are set forth below in Table 1.

<table>
<thead>
<tr>
<th>Example</th>
<th>Tissue</th>
<th>In-Use Tensile Strength (MD)</th>
<th>In-Use Tensile Strength (CD)</th>
<th>Shake Flask (% Pass Through)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>UCTAD</td>
<td>568</td>
<td>272</td>
<td>100</td>
</tr>
<tr>
<td>B</td>
<td>UCTAD</td>
<td>513</td>
<td>264</td>
<td>100</td>
</tr>
<tr>
<td>Comparative A</td>
<td>KLEENEX® COTTONELLE FRESH®</td>
<td>374</td>
<td>271</td>
<td>100</td>
</tr>
<tr>
<td>Comparative B</td>
<td>Natural Choice®</td>
<td>560</td>
<td>205</td>
<td>20</td>
</tr>
</tbody>
</table>

[0124] As can be seen from these results, use of a basesheet made with cellulose fibers of length less than 3.18 mm have the necessary strength for use by consumers, but also more easily pass through smaller sieves. The exemplary wipes had percentage mass loss values of greater than 95 percent at 3.18 mm, while the comparative examples do not. Thus, using smaller fibers makes a big improvement in percent pass through of the shake flask test versus current wipes on the market. The results show clear advantages in flushability.

Example 2

[0125] For example 2, a wipe substrate was prepared as described in Example A. Example C was prepared as a basesheet that was produced without converting and subsequently adding the wetting composition. For comparative purposes, a basesheet of airlaid nonwoven web was formed continuously on a commercial scale airlaid machine similar to the pilot-scale machine. Weyerhaeuser CF405 bleached softwood kraft fiber in pulp sheet form was used as the fibrous material. This airlaid fibrous material was densified to the desired level by heated compaction rolls and transferred to an oven wire, where it was sprayed on the top side with the a binder composition of a cationic polyacrylate that is the polymerization product of 96 mol % methyl acrylate and 4 mol %
[2-(acryloyloxy)ethyl]trimethyl ammonium chloride and Airflex® EZ123 in a 70:30 ratio was used to bond the substrate binder composition, applying approximately half of the desired binder solids onto the dry fibrous material to prepare Comparative Example C. The airfilled basesheet is commonly used with KLEENEX® COTTONELLE FRESH® Flushable Moist Wipes.

Example 3 and Comparative Example C were tested to find the formation value as described above. Example C has a formation value of about 20.36 and Comparative Example C has a formation value of about 16.90. Example C has better formation, and provides the necessary strength while still being able to provide a wipe that disperses in the sewer system.

Example 3 illustrates the affect of the amount of binder solids present in the binder composition used for the wipe substrate. The basesheet was produced as described above for Example A, but with varying the percentage of solids within the binder to prepare Example D, Comparative Example D and Comparative Example E. To illustrate the affect of the amount of binder solids present in the binder composition, Example D, Comparative Example D and Comparative Example E were tested for in-use tensile strength and are illustrated in Table 2.

<table>
<thead>
<tr>
<th>Example</th>
<th>Tissue</th>
<th>% Solids in Binder (g/linear inch)</th>
<th>In-Use Tensile Strength (MD) (g/linear inch)</th>
<th>In-Use Tensile Strength (CD) (g/linear inch)</th>
<th>In-Use GMT (g/linear inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>UCTAD</td>
<td>15</td>
<td>716.7</td>
<td>179.7</td>
<td>358.8</td>
</tr>
<tr>
<td>Comparative D</td>
<td>UCTAD</td>
<td>18</td>
<td>432.4</td>
<td>115.8</td>
<td>223.8</td>
</tr>
<tr>
<td>Comparative E</td>
<td>UCTAD</td>
<td>21</td>
<td>404.8</td>
<td>132.8</td>
<td>231.8</td>
</tr>
</tbody>
</table>

As can be seen by the results illustrated in Table 2, low solids spraying of the binder significantly improved in-use strength by creating better coverage of the binder on the sheet. It was discovered that the percentage binder composition solids of less than about 18 percent, and preferably less than about 16 percent ensure spray coverage is optimized with acrylate-based binder. Unexpectedly, low solids spraying of the binder on UCTAD provided beneficial strength benefits despite significantly high attachment points per fiber volume (36,000 contacts/mm³) that, in theory, should not require droplet size optimization. In addition, one skilled in the art would prefer to lower the percentage of solids in the binder since the lower binder add-on made spraying at lower solids difficult due to dispersible binder nozzle tip requirements. Better coverage of the binder provides better in-use GMT. As seen in Table 2, a lower amount of binder solids increased the in-use GMT to about 300 grams/linear inch.

Example 4

Use of a better binder application on the wipe substrate also led to better strength formation. A wipe substrate was prepared as described for Example A to create Example E. For comparative purposes, wipe substrates was prepared as described for Example A but varying the method of binder application, the amount of plies, the binder add-on and the percentage of binder solids to prepare Comparative Example F, Comparative Example G, and Comparative Example H. Comparative Example F is a two-ply tissue with a printed binder. Comparative Example G is a single-ply tissue with a printed binder. Comparative Example H is a single-ply tissue with a sprayed binder but with only a single nozzle. To illustrate the affect of these changes, Example D, Comparative Example D and Comparative Example E were tested for in-use tensile strength, the tensile strength ratio, and post-use and are illustrated in Table 3.

<table>
<thead>
<tr>
<th>Example</th>
<th>Tissue</th>
<th>% Add-On of Binder</th>
<th>% Solids in Binder (g/linear inch)</th>
<th>In-Use Tensile Strength (MD) (g/linear inch)</th>
<th>In-Use Tensile Strength (CD) (g/linear inch)</th>
<th>Tensile Strength Ratio (MD/CD)</th>
<th>Post-use Tensile Strength (MD) (g/linear inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>UCTAD</td>
<td>5</td>
<td>15</td>
<td>568</td>
<td>272</td>
<td>2.08</td>
<td>108.2</td>
</tr>
<tr>
<td>Comparative F</td>
<td>UCTAD</td>
<td>10</td>
<td>22</td>
<td>397.5</td>
<td>156.2</td>
<td>2.54</td>
<td>344</td>
</tr>
<tr>
<td>Comparative G</td>
<td>UCTAD</td>
<td>9</td>
<td>21</td>
<td>467</td>
<td>283</td>
<td>2.54</td>
<td>285</td>
</tr>
<tr>
<td>Comparative H</td>
<td>UCTAD</td>
<td>5</td>
<td>20</td>
<td>567</td>
<td>247</td>
<td>2.30</td>
<td>315</td>
</tr>
</tbody>
</table>
[0130] As illustrated in Table 3, applying the binder composition to the wipe substrate by printing or with a single nozzle provides poor distribution of binder. Improving distribution is critical to generate optimum strength and for proper sheet handling. This is shown by the above data regarding MD/CD tensile ratio. The lower tensile strength ratio which is less 2.25 for Example E illustrates improvements to the binder application, the binder add-on, the percentage solids in the binder composition have allowed the invention to reduce binder content and curing so that they are more fully dispersible.

[0131] Additionally, as can be seen by the post-use strength in Table 3, the proper binder application, the percent add-on and the percent solids in the binder provide a wipe substrate that is strong enough in-use, but quickly lowers in strength in water to provide a dispersible product. Example E provides a sheet that can pass 95 percent of its weight or greater through the 3.18 mm sieve in the shake flak test with an in-use MD tensile strength greater than 300 grams per linear inch. Comparative Examples F, G and H do not pass through a 3.18 mm sieve.

[0132] Other modifications and variations to the appended claims may be practiced by those of ordinary skill in the art, without departing from the spirit and scope as set forth in the appended claims. It is understood that features of the various examples may be interchanged in whole or part. The preceding description, given by way of example in order to enable one of ordinary skill in the art to practice the claimed invention, is not to be construed as limiting the scope of the invention, which is defined by the claims and all equivalents thereto.

What is claimed is:

1. A dispersible wet wipe comprising:
   a wipe substrate containing a tissue web consisting of cellulose fibers, wherein said cellulose fibers have a fiber length of 3 mm or less, and a binder composition for binding said binder composition to said tissue web, wherein said binder composition is present at an add-on rate of between about 1 percent and about 15 percent based on total weight of the wipe substrate, the binder composition comprising less than about 18 percent by weight of binder composition solids; and a wetting composition containing between about 0.4 and 3.5 percent salt.

2. The dispersible wet wipe of claim 1 wherein said binder composition is present at an add-on rate of between about 1 and about 8 percent based on total weight of the wipe substrate.

3. The dispersible wet wipe of claim 1 wherein the binder composition comprising less than about 16 percent by weight of binder composition solids.

4. The dispersible wet wipe of claim 1 wherein the fibrous substrate comprises an uncreped through-air dried tissue web.

5. The dispersible wet wipe of claim 1 wherein the wet wipe has an in-use machine direction tensile strength of greater than 300 grams per linear inch.

6. The dispersible wet wipe of claim 1 wherein the wet wipe has an post-use machine direction tensile strength of less than 200 grams per linear inch.

7. The dispersible wet wipe of claim 1 wherein the wet wipe has a ratio of machine direction tensile strength to cross-direction tensile strength of less than 2.25.

8. The dispersible wet wipe of claim 1 wherein the wet wipe has a geometric mean tensile strength of at least 300 grams per linear inch.

9. The dispersible wet wipe of claim 1 wherein the wipe substrate comprises a single layer.

10. The dispersible wet wipe of claim 1 wherein said wipe substrate has a formation value of greater than 20.

11. A dispersible wet wipe comprising:
    a wipe substrate containing a tissue web consisting of cellulose fibers, wherein said cellulose fibers have a fiber length of 3 mm or less, and a binder composition for binding said binder composition to said tissue web, said binder composition is present at an add-on rate of between about 1 and about 15 percent; and a wetting composition containing between about 0.4 and about 3.5 percent salt;
    wherein said dispersible wet wipe has a pass through percentage value of at least about 70 percent.

12. The dispersible wet wipe of claim 11 wherein said dispersible wet wipe has a pass through percentage value of at least about 95 percent.

13. The dispersible wet wipe of claim 11 wherein said binder composition is present at an add-on rate of between about 1 and about 8 percent based on total weight of the wipe substrate.

14. The dispersible wet wipe of claim 11 wherein the binder composition comprising less than about 18 percent by weight of binder composition solids.

15. The dispersible wet wipe of claim 11 wherein the fibrous substrate comprises an uncreped through-air dried tissue web.

16. The dispersible wet wipe of claim 11 wherein the wet wipe has an in-use machine direction tensile strength of greater than 300 grams per linear inch.

17. The dispersible wet wipe of claim 11 wherein the wet wipe has a post-use machine direction tensile strength of less than 200 grams per linear inch.

18. The dispersible wet wipe of claim 11 a pass through percentage value of at least about 70 percent.

19. The dispersible wet wipe of claim 11 wherein said wipe substrate has a formation value of greater than 18.

20. The dispersible wet wipe of claim 11 wherein the wet wipe has a ratio of machine direction tensile strength to cross-direction tensile strength of less than 2.25.

21. The dispersible wet wipe of claim 11 wherein the wet wipe has a geometric mean tensile strength of at least 300 grams per linear inch.

* * * * *