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WATER DISPERSIBLE NONWOVEN FABRIC

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Fig.1.

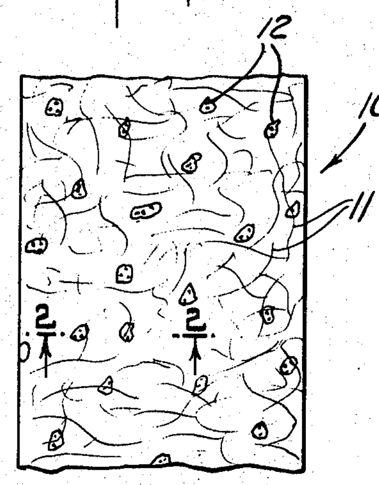


Fig.2.

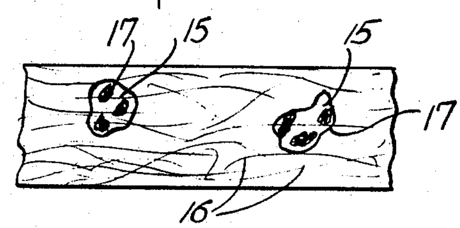
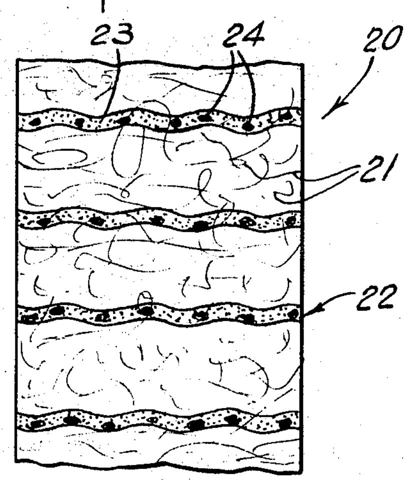


Fig.3.



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WATER DISPERSIBLE NONWOVEN FABRIC

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ABSTRACT OF THE DISCLOSURE

A water dispersible nonwoven fabric comprising a layer of overlapping, intersecting fibers bonded with a water insoluble, substantially water insensitive, film-forming, nonself-crosslinking polymer containing a water soluble material having pseudo-plastic flow properties uniformly distributed throughout the polymer.

This invention relates to a new nonwoven fabric which is readily dispersible in water and is flushable.

Nonwoven fabrics have gained wide acceptance in disposable areas such as sanitary napkins, diapers, bandages, etc. A major problem with these disposable products has been the manner of disposing. One technique for disposing is incineration; however, this cannot always be done and in many instances, depending upon the fibers used and binders used the problems of burning are greatly increased. Furthermore, it is difficult to burn such products in the home and if such products have been used in various medical end uses there are even further problems of burning with regard to contamination. Most of these nonwoven fabrics require wet strength so that they will be functional during many of their end uses and hence, they are not readily flushable down home water closets or industrial sewer systems as they will readily plug sewers and septic systems.

I have now discovered a bonded nonwoven fabric which has good strength when dry, reasonable strength in the presence of most body fluids, such as urine, blood, menstrual fluid, etc., yet is readily dispersible in water and may be flushed in the home water closets and disposed in standard sewer systems or septic systems.

My improved fabric comprises a layer of overlapping, intersecting fibers and from about 4 percent to about 35 percent by weight of fabric of binder distributed in the fiber layer. My binder comprises from about 70 percent to about 90 percent of a water insoluble, substantially water insensitive, film-forming, nonself-crosslinking polymer. Uniformly distributed throughout the polymer is a water soluble material having pseudo-plastic flow properties.

In use, the fabric has good dry strength depending upon the amount of binder applied to the fabric and the manner in which it is applied yet when placed in water the soluble portion of the binder is dissolved and disrupts the globules of binder into very small globules which readily allow the fibers to disperse and the fabric to be flushed. The dissolving out of the water soluble portion of the binder prevents the binder from adhering to itself and to other fibers and greatly reduces the strength of the fabric and allows the fibers to be readily dispersed with little, if any, agitation.

The invention will be more fully described in conjunction with the following drawings wherein:

FIG. 1 is a plan view of a bonded nonwoven fabric in accordance with the present invention;

FIG. 2 is a greatly enlarged cross-sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is another embodiment of a water dispersible nonwoven fabric in accordance with the present invention.

Referring to the drawings in FIGS. 1 and 2 there is shown the water dispersible nonwoven fabric **10**. The

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fabric comprises a layer of overlapping, intersecting, textile length fibers **11** and substantially uniformly distributed throughout this fibrous layer are globules of binder **12**. As is more clearly shown in FIG. 2 these globules of binder comprise for the most part a material **15** which is not water sensitive but adheres readily to the fibers **16**. This material is a water insoluble, film-forming, nonself-crosslinking polymer. Uniformly distributed throughout this material is a water soluble material **17**.

In FIG. 3 there is shown a nonwoven fabric **20** comprising a layer of overlapping, intersecting, textile fibers **21** with a binder distributed in a predetermined pattern **22** over this layer, the pattern being a series of horizontal wavy lines. The binder comprises a nonself-crosslinking polymer **23** which is not water sensitive and uniformly distributed throughout the binder areas is a water soluble material **24**.

The base layers suitable for conversion into the fabric of the present invention may be formed by carding, garnetting, air deposition, water deposition and any of the various techniques known in the art. The fibers in the layer may be oriented predominantly in one direction as in a card web or a card web laminate or they may be substantially isotropic, that is, have equivalent strength in all directions if desired. For napkin covering and similar types of uses such as a facing on disposable diapers where the fabric is to be flushable the web is fairly thin and should weigh between 150 to 400 grains per square yard.

Uniform fiber distribution is an important characteristic particularly in fabrics which must possess a substantial amount of strength, and be free of weak spots due to lack of uniformity. Uniform webs may be produced by carding in which case it is advantageous to use fibers which have good carding characteristics and can be blended into a uniform carded web with facility. Fibers of viscose rayon and cotton are both satisfactory in this respect. However, it should be understood that almost any kind of textile fiber may be employed in forming fabrics of this invention depending upon the intended end use. For instance, the base layer may comprise natural fibers such as cotton, jute, or wool. Artificial fibers of viscose rayon, cuprammonium, cellulose acetate, etc., or synthetic fibers such as polyesters, polyamides, polyolefins, etc., alone or in combination with one another.

The length of the fiber is also important in producing the fabrics of the present invention. The length should usually be a minimum of ¾ inch in order to produce uniform webs in the carding operation and it is preferred that the length be 1½ inches or less so that the fibers will not rope when they are dispersed in water. It has been found that fibers having a length of greater than 2 inches when placed in the fabric, though the fibers will disperse and separate in water, their length tends to form ropes of fibers which is undesirable when flushing in home water closets.

The binder may be deposited on the layer by printing, spraying, impregnating or by other techniques wherein the amount of binder may be metered and the binder can be distributed uniformly throughout the web. The binder may be applied over the entire surface of the layer or it may be distributed in a multiplicity of small closely spaced areas. The binder may be distributed in lines running across the width or at an angle to the width of the web or in separate small shaped areas having circular, angular, square, or triangular configurations. It is preferred that when the binder is applied to the fibrous layer there be left unbonded areas in the layer. These unbonded areas of fibers readily absorb water which attacks the binder areas and makes the fabric dispersible in shorter periods of time.

The amount of binder applied should be from about 4 to 35 percent by weight of the fabric. If less than this amount of binder is applied the fabric does not have sufficient strength; whereas, if more than this amount of binder is applied the fabric will not have suitable water dispersibility and be readily flushable in the home water closet and may lose desirable properties of softness and absorbency. It is preferred that the amount of binder be between about 4 to 12 percent by weight of the fabric in order to produce very quick water dispersibility.

The binder utilized in producing the nonwoven fabric of the present invention comprises two parts; a water soluble part and a water insoluble substantially water insensitive part. The binder should contain from about 10 to 30 percent of the water soluble portion. Minimum amounts of other chemicals such as antifoaming agents, fire retardants, colors, etc., may also be added to the binder.

The water insoluble portion of the binder must be substantially water insensitive. By water insensitivity it is meant that films of the binder do not readily blush and have very little, if any, wettability. A measure of the wettability or water insensitivity of the polymer is the contact angle which is a measure of the surface energy required to disperse a drop of water on the polymer surface. Hence, the higher the contact angle the more wettable or water sensitive the polymer and the lower the contact angle the more water insensitive the polymer.

There are a number of techniques for measuring the contact angle which may be used. One such technique is to clean the surface of the film made from the polymer to be tested with various materials such as deionized water or organic cleaners and then drying the film. Static is removed from the film and the film placed on the platform of an instrument known as a contact angle goniometer. The contact angle goniometer consists of a microscope mounted with its axis horizontal and equipped with a specimen block which can be raised or lowered and moved from side to side. The normal eye piece of the microscope is replaced with a protractor eye piece divided into degrees on a rotating scale with a vernier in minutes on a fixed arm. The cross hairs in the eye piece divide the field view into quadrants. A drop of deionized water is pushed onto the film from a capillary dropper mounted above the specimen block. The dropper is an ordinery eye dropper with the tip drawn into a one inch capillary with a diameter just small enough to prevent water from running out of the tube under gravitational force only. To assist in dispersing the water from the dropper the tip of the capillary is ground at an angle to the perpendicular. The protractor scale is then revolved until its cross hair is parallel to the surface on which the drop is resting. The other cross hair is adjusted until it is tangent to the drop at the point of contact with the surface on which it is resting. The angle between the cross hairs inside the drop is read from the protracting scale. This is the advancing contact angle. Using the dropper, water is subtracted from the drop on the sample and the receding contact angle is recorded. Due to water evaporation these angles may change and, hence, for the purposes herein all references to contact angles are to angles which are taken instantaneously, that is, as soon as the water is placed on the film the angle is measured and then the water removed.

Another technique for measuring contact angles is to place the water on the film and take a cross-sectional picture of the film with the water thereon, enlarge this a suitable number of times, and then measure the contact angle mechanically. The contact angle is the sum of the advancing and receding angles divided by two.

In accordance with the present invention the water insoluble portion of the binder must have a contact angle from about 50° to 70° and preferably from about 55° to 65°. If the contact angle is greater than 70° that portion of the binder will be too water sensitive and, hence, will not provide suitable strength in the final fabric; whereas, if the contact angle is less than 50° the binder is too water insensitive and, hence, will not produce a water dispersible fabric in accordance with the present invention.

In accordance with the present invention the water insoluble portion of the binder must have a degree of wettability such that the contact angle with water on a cast film of such a polymer is between 50° to 70°.

It is believed that the contact angle of the polymer may be greatly controlled by the surfactant used in the polymerization of the polymer. Many of the binder polymers are polymerized in emulsion form, what is termed emulsion polymerization, and in so doing generally various surfactants or soaps are added to aid this polymerization. It is believed that the more surfactant present the more wettable or the less water insensitive the polymer would be. In some instances polymers are polymerized in the presence of a protective colloid such as polyvinyl alcohol rather than surfactants and such polymers make very suitable water insoluble binder portions in the present invention.

The water insoluble binder portion must also be film-forming. By film-forming it is meant that particles of the polymer have the ability to cohere and form a continuous phase at room temperature.

The water insoluble portion of the binder also must be nonself-crosslinking. By nonself-crosslinking it is meant that there are no free radicals or functional groups on the polymer which will crosslink with themselves at elevated temperatures.

Examples of suitable water insoluble, substantially water insensitive, film-forming, nonself-crosslinking polymers are the acrylic resins especially the vinyl acrylic resins, the acetate resins and the butadiene styrene polymers.

The water sensitive or water soluble portion of the binder may be any of the various water sensitive binders such as hydroxyethyl cellulose, carboxymethyl cellulose, the natural gums such as guar and preferably the alginates such as sodium alginate. The important thing is that there be from about 10 to 30 percent of the water soluble material in the binder in the final fabric and that this water soluble material will be substantially uniformly distributed throughout the binder. The preferred amount of water soluble material is from 12 to 26 percent with the most preferable amount being 14 to 18 percent. If too little, that is less than 10 percent water soluble material is used, the fabric will not be water dispersible, whereas if too much water soluble material is used the fabric will not have sufficient dry strength for most end uses. Also, if the water soluble material is not uniformly distributed throughout the resin polymer globule or binder portion when it is dissolved out it will not sufficiently disrupt the fabric and allow separation of fibers to make the fabric dispersible. The uniform distribution of water soluble material through the binder is accomplished by adding the water soluble material to the resin emulsion prior to applying the binder to the fabric. By water soluble material it is meant that the material actually undergoes a physical change when placed in water in that the water gets inbetween the molecules and breaks up material and that substantially all proportions of material are dissolvable in water.

The water soluble materials useful in the present invention have pseudo-plastic flow properties and not Newtonian or thixotropic flow characteristics. By pseudo-plastic it is meant that the flow is characterized in that its rate of shear is not proportional to the shearing force but actually that its rate of shear increases in less proportion to the shearing force applied. Another way of saying this is that viscosity increases in less proportion to the shearing force. Suitable psuedo-plastic water soluble materials have viscosities of from about 500 to 2,000 centipoises and preferably from about 800 to 1,400 centipoises. The most suitable water soluble materials have viscosities of between 1,100 and 1,200 centipoises.

The most preferable water soluble material useful in the present invention is a polymer of mannuronic acid and gluronic acid or derivatives of these materials and specifically sodium alginate.

The following example is illustrative of one fabric according to the present invention:

EXAMPLE

A fibrous layer of 1⅛ inch, 1½ denier extra dull viscose rayon weighing about 252 grains per square yard is formed from standard carding machines. A binder having the following formulation is formed:

	Pounds
Sodium alginate	2.25
Nonself-crosslinking water insensitive vinyl acrylic polymer (contact angle about 58–60°)	12.5
Antifoaming agent	0.2
Water	85.25

The pH of this binder formulation is brought to 7.0 with the addition of ammonia. This binder formulation is printed onto the fibrous layer in a pattern of horizontal wavy lines of six lines per inch. The amount of binder add-on is 12 grains per square yard.

The resultant fabric has a softness of about 72 and has a machine dry tensile of about 4 pounds per inch of width and a cross direction tensile of about .3 pound per inch. A swatch of the fabric six inches by six inches is placed in approximately 600 ml. of water and the water hand stirred being careful not to touch the fabric. The fabric disperses in approximately 15 seconds and cannot be removed in a single piece or in a series of pieces from the water.

Having now described the invention in specific detail and exemplified the manner in which it may be carried into practice it will be readily apparent to those skilled in the art that innumerable variations, modifications, applications, and extensions may be made to the basic principles involved without departing from its spirit and scope. I therefore intend to be limited only in accordance with the appended claims.

I claim:

1. A water dispersible, nonwoven fabric comprising a layer of overlapping, intersecting textile fibers, said fibers being from about ¾ inch to about 2 inches in length, and from about 4 to 35 percent by weight of the fabric of a binder distributed in said fabric, said binder comprising from about 70 to 90 percent of a water insoluble, substantially water insensitive, nonself-crosslinking, film-forming polymer and from about 10 to 30 percent of a water soluble material having pseudo-plastic flow properties uniformly distributed throughout said polymer, said water insoluble polymer having a contact angle of from about 50° to 70°, and said water soluble material having a viscosity of from about 500 to 2,000 centipoises.

2. A water dispersible nonwoven fabric according to claim **1** wherein the water insoluble polymer contains a polyvinyl alcohol protective colloid.

3. A water dispersible nonwoven fabric according to claim **1** wherein the water insoluble polymer is a vinyl acrylic polymer.

4. A water dispersible nonwoven fabric according to claim **1** wherein the water soluble material has viscosity from about 800 to 1,400 centipoises.

5. A water dispersible nonwoven fabric according to claim **1** wherein the water soluble material has a viscosity of from about 1,100 to 1,200 centipoises.

6. A water dispersible nonwoven fabric according to claim **1** wherein the water soluble material is a polymer of mannuronic and gluronic acids or derivatives thereof.

7. A water dispersible nonwoven fabric according to claim **1** wherein the water soluble material is sodium alginate.

8. A water dispersible nonwoven fabric according to claim **1** wherein the fibers are viscose rayon fibers.

9. A water dispersible nonwoven fabric according to claim **1** wherein the fibers are textile fibers having a length of ¾ inch to 1½ inches.

10. A water dispersible nonwoven fabric according to claim **1** wherein the binder is distributed in a predetermined pattern over the surface of the fibrous layer.

11. A water dispersible nonwoven fabric according to claim **1** wherein the water insensitive polymer has a contact angle of from 55° to 65° and the water soluble material has a viscosity of from 800 to 1,400 centipoises.

12. A water dispersible nonwoven fabric according to claim **1** wherein the water insensitive polymer is a vinyl acrylic polymer and the water soluble material is sodium alginate.

13. A water dispersible nonwoven fabric according to claim **1** wherein the fibers are viscose rayon fibers having a length of ¾ inch to 1½ inches, the water insensitive polymer has a contact angle of from 55° to 65° and the water soluble material has a viscosity of from 800 to 1,400 centipoises.

14. A water dispersible nonwoven fabric according to claim **13** wherein the binder is distributed in a predetermined pattern over the surface of the fiber layer.

15. A water dispersible nonwoven fabric according to claim **13** wherein there is about 4 to 12 percent binder by weight of the fabric.

16. A water dispersible nonwoven fabric according to claim **13** wherein from about 14 to 18 percent of the binder is water soluble material.

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