United States Patent

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[54] **FLUSHABLE WRAPPER FOR ABSORBENT PADS AND PAD COVERED THEREWITH**
18 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** ..... **128/290,** 117/76 P, 117/155, 162/175
[51] **Int. Cl.** **A61f 13/16**
[50] **Field of Search** ..... 128/284, 287, 290, 296; 162/164–165, 168, 175; 117/76, 155, 161, 76 P, 76 T, 84, 140 A, 143 A

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ABSTRACT: An improved wrapper for sanitary napkins and other absorbent pads, adapted for easy disposal by flushing down conventional sewerage systems. The wrapper comprises a nonwoven fiber web bonded by dialdehyde starch alone or in combination with cold-water-soluble binders. A web of such structure retains significant strength during use in the presence of moisture given off by body fluids, but is readily disintegrated after short exposure to excess water, as in the sewerage system, for easy disposal.

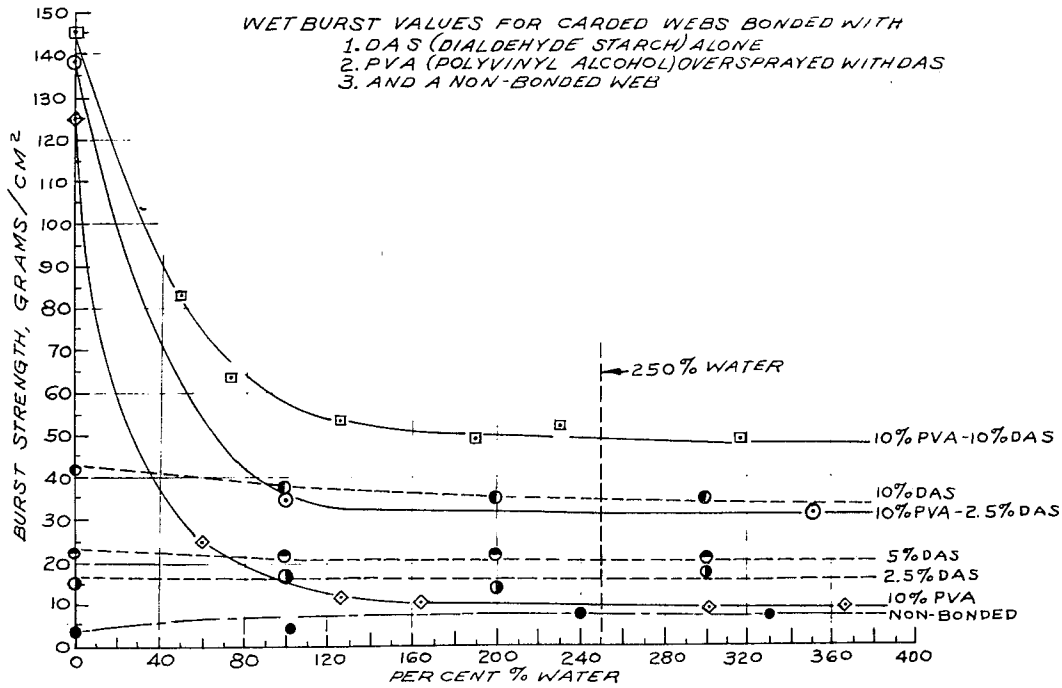


Fig. 1

WET BURST VALUES FOR CARDED WEBS BONDED WITH
1. DAS (DIALDEHYDE STARCH) ALONE
2. PVA (POLYVINYL ALCOHOL) OVERSPRAYED WITH DAS
3. AND A NON-BONDED WEB

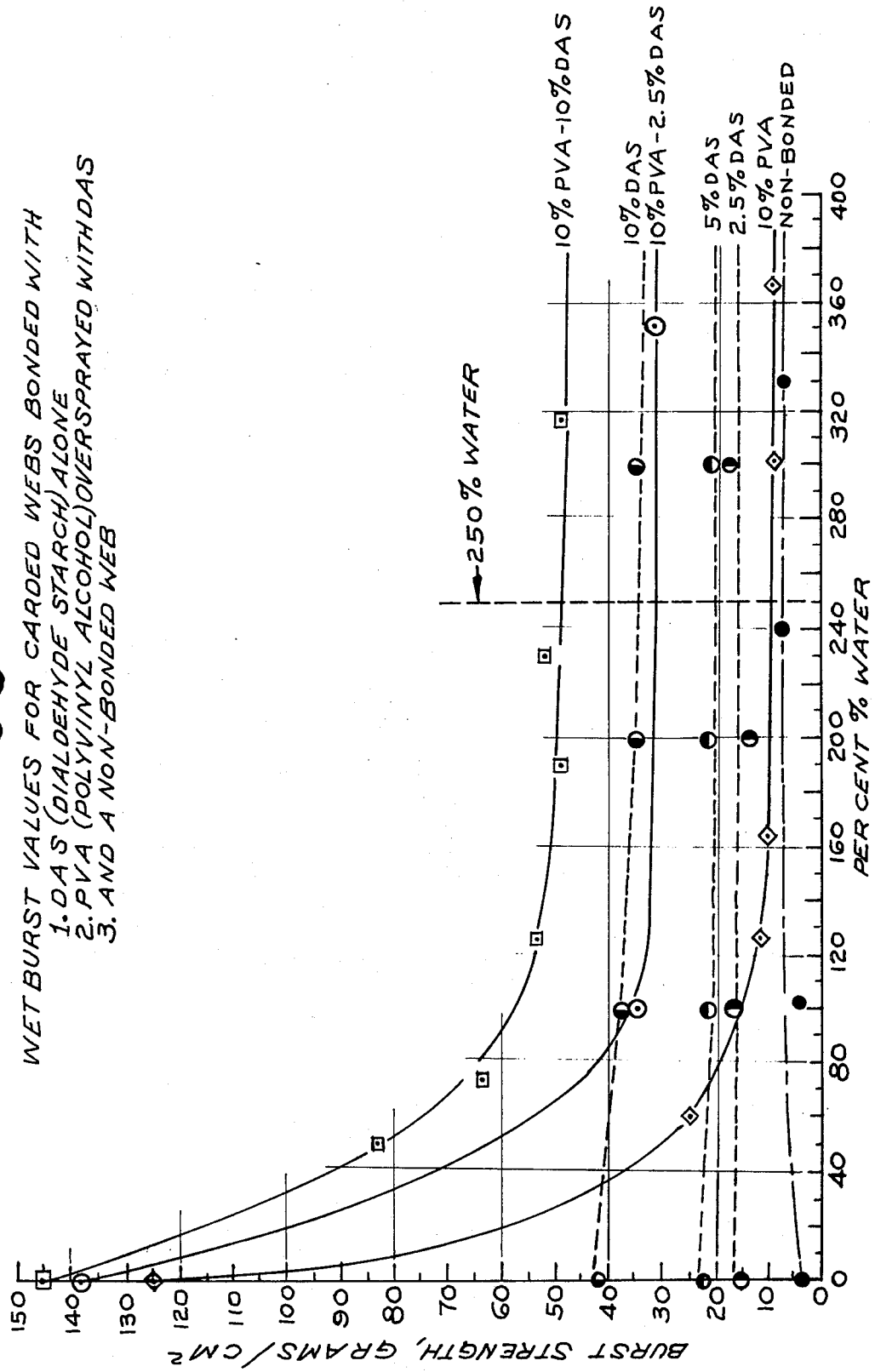


Fig. 2

DECAY OF WET STRENGTH OF CARDED WEBS BONDED WITH DAS AS A TIME FUNCTION IN EXCESS WATER

- ⊡ 5% DAS
- ⊙ 2.5% DAS
- ◇ 1% DAS

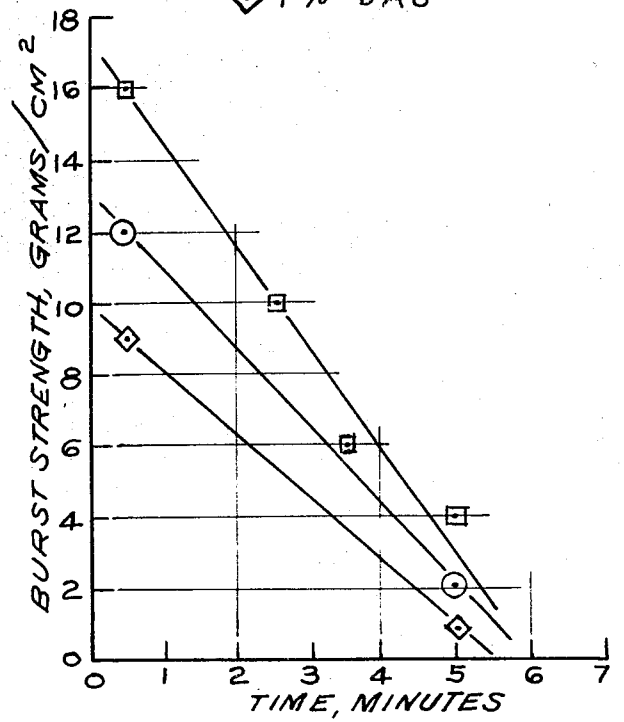
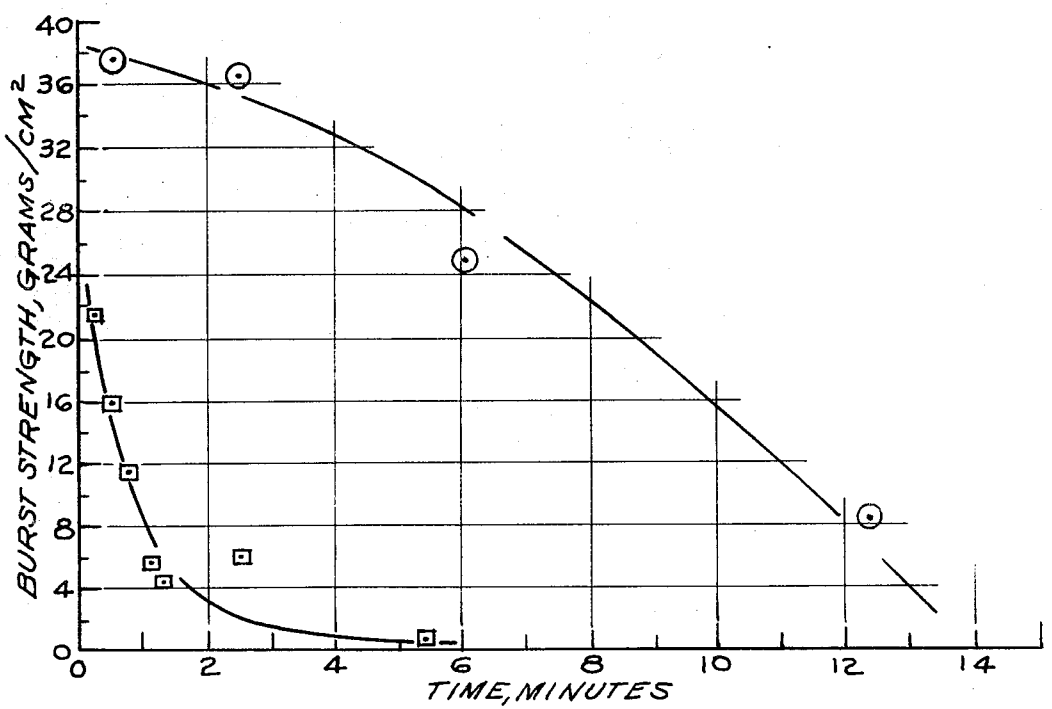


Fig. 3

DECAY OF WET STRENGTH OF CARDED WEBS BONDED WITH DAS AND PVA

- ⊙ 2.5% DAS SPRAYED OVER 10% BONDED WEB
- ⊡ 2.0% DAS SPRAYED TOGETHER WITH 8% PVA ON CARDED WEB



FLUSHABLE WRAPPER FOR ABSORBENT PADS AND PAD COVERED THEREWITH

BACKGROUND OF THE INVENTION

Many attempts have been made to produce a sanitary napkin which may be safely flushed away in conventional toilets. While the absorbent components of a sanitary napkin, i.e. wood fluff, absorbent cotton batts, cellulose wadding and the like, are of such construction that they easily disintegrate when agitated in water, they are necessarily enclosed in a fluid-pervious wrapper of a strength sufficient to hold the absorbent components together and to retain the napkin in place when worn. If this wrapper element is not removed when an attempt is made to dispose of the napkin in a toilet, as sometimes happens, the absorbent component will not disintegrate because it cannot escape the confines of the wrapper. Such napkins, therefore, retain most of their bulk form when encased in a wrapper and frequently will cause stoppages in the disposal system when such attempts at disposal are practiced without removing the wrapper. The wrapper, of course, can be stripped off, but this procedure is extremely inconvenient and unsanitary, and for that reason the user usually prefers not to go to that trouble, and instead, will dispose of the used napkin in a disposal bag or container for solid wastes.

Accordingly, there is a need to provide sanitary napkins and similar absorbent pads with a wrapper which is strong enough to perform its support function and yet which will disintegrate readily after a short time in flowing water. Attempts have been made to bond nonwoven fiber webs by the application thereto of a cold-water-soluble adhesive such as polyvinyl alcohol, polyvinyl methylether, glycol cellulose, cellulose glycolate, methyl cellulose, sodium alginate acrylic ester and the like, to provide a sanitary pad wrapper which is readily disintegratable in excesses of water. While the latter characteristic is easily achieved, it was found that these water-soluble adhesives also tend to soften and dissolve when in the presence of body moisture generated by discharged body fluids so that the wrapper becomes weakened to an extent where it ruptures prematurely during use.

It would be highly desirable to provide a napkin wrapper with a binder which retains the capability of being disintegratable in excess water after a short period but which has sufficient strength to retain its integrity in use when exposed to the moist environment of the body.

The present invention is based on the discovery that when dialdehyde starch is used alone or in combination with one of the water-soluble binders listed above, this desirable goal is achieved.

SUMMARY OF THE INVENTION

Dialdehyde starch is well known as a wet-strength agent for paper, where it has been suggested for use in amounts up to about 3.5 percent by weight, and is termed in that segment of the art as a temporary wet-strength agent. Even though the latter term is used, it has been found that when paper treated with dialdehyde starch is immersed in water at pH 4.5 for 24 hours it retains about 30 percent of the wet strength it had after 30 minutes immersion. (See TAPPI Monograph Ser. No. 29, "Wet Strength in Paper and Paperboard" Technical Association of the Pulp and Paper Industry 1965, pp. 65–73.) Thus, even after extended immersion, the fibers in the paper sheet are not free to separate to permit the sheet to disintegrate, and dialdehyde starch is, to that extent, a permanent wet-strength agent.

Prior to this time, dialdehyde starch has never been suggested as a bonding agent for nonwoven fiber webs. It has now been found that dialdehyde starch when so used imparts sufficient strength to nonwoven webs to permit their use as a sanitary pad wrapper in the presence of body moisture, while the web will disintegrate readily in excess water. Wet strength of dialdehyde starch bonded nonwoven webs falls off to substantially zero after about 5 minutes immersion in water. When the starch is augmented with a cold-water-soluble resin such as polyvinyl alcohol, dry strength is improved without interfering with the ability of the web to disintegrate when fully wetted. For such webs, wet strength in excess water still falls to less than one-fourth of its original wet strength in about 12 minutes. In view of the experience noted for paper these results are totally unexpected and make dialdehyde starch alone, as well as its combination with cold-water-soluble adhesives, excellent binders for the described use. It is theorized that the difference in wet strength between paper and dry-formed nonwovens may be attributed to the fact that when dialdehyde starch is used as a wet-strength agent in paper, it reinforces fiber-to-fiber hydrogen bonds which occur in paper sheet structures, while no such bonds exist in typical dry-formed nonwovens like carded or airlaid webs. In the latter cases, dialdehyde starch, or a mixture of dialdehyde starch and cold-water-soluble resins, acts as an adhesive and supplies the only interfiber bonds which exist.

In accordance with this invention, sanitary pad wrappers are fabricated by binding a web of carded, staple-length textile fibers such as rayon with dialdehyde starch alone or in combination with cold-water-soluble resins. Sanitary napkins made by enclosing an absorbent pad in such wrappers perform during use in substantially the same manner as more conventionally wrapped napkins. When soiled napkins of such construction are dropped in toilets for disposal, the binder swells and begins to soften immediately and the wrappers start to disintegrate soon after contact with the water in the bowl, so that after a short time the entire napkin structure, including the wrapper, completely disperses when flushed and agitated in its conventional movement through a sewer line. When cold-water-soluble adhesives are used in combination with dialdehyde starch, the cold-water-soluble adhesives enhance the dry strength, as well as the temporary wet strength, provided by the dialdehyde starch but do not hinder water dispersibility of the binder.

Accordingly, it is an object of the present invention to provide an improved fluid-pervious wrapper for sanitary napkins and other absorbent pads, which wrapper retains significant strength during normal use in the presence of body moisture, but disintegrates readily after a short time when deposited in water, such as in a toilet bowl, and when agitated in its course through a sewer line.

Another object is to provide a sanitary napkin or the like in which all the structural components, including the wrapper, revert to their fibrous form after a relatively short time when flushed in conventional toilet systems.

These and other objects will become apparent by reference to the following specification and drawings wherein there are described various selected embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a chart showing wet strength as wet burst values at various moisture contents for nonwoven carded webs bonded by various amounts of dialdehyde starch alone, by dialdehyde starch and polyvinyl alcohol, and of a web with no binder.

FIG. 2 is a chart showing the decay of wet strength, as a function of time in excess water, for carded webs bonded with dialdehyde starch alone.

FIG. 3 is a chart showing the decay of wet strength, as a function of time in excess water, for a carded web bonded with polyvinyl alcohol oversprayed with dialdehyde starch, and a web bonded with a dialdehyde starch-polyvinyl alcohol mixture.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In making up a suitable wrapper in accordance with this invention, rayon fibers of 1.5 denier and 1 9/16 inch staple length were carded to form a nonwoven fiber web weighing approximately 14 grams per square yard. The carded web was sprayed with a 3 percent solution of the dialdehyde starch in an amount to provide a solids pick up of about 10 percent by weight. Since dialdehyde starch alone is difficult to disperse in

water, complete dispersion and low viscosity is obtained by dissolving sodium bisulfite or borax in water before adding the dialdehyde starch and heating. Approximately 1.8 percent borax based on the dry weight of the dialdehyde starch, or about 15 percent sodium bisulfite based on the dry weight is adequate to yield complete dispersion and low viscosity. For this embodiment, sodium bisulfite was used as the dispersing aid.

The impregnated web was then pressed to distribute the dialdehyde starch therethrough and oven-dried at about 220° F. for approximately 10 minutes. Air-drying at room temperature gives about the same results as drying at elevated temperature for several minutes, so that an extensive curing period is not required. The heating step is, of course, more efficient.

These wrappers were used to construct sanitary napkins by enwrapping conventional absorbent cores, including layers of cellulose wadding and wood fluff, with the material and sealing the overlap. The finished napkins were then use tested. The wrappers were found to have sufficient strength to retain their integrity during use, and the napkins on a whole performed their absorptive function in a manner comparable to napkins having conventional wrappers.

The used napkins were then dropped into toilets and flushed. The binder on the wrappers immediately swelled and softened upon contact with the water in the bowl, and the entire napkin, including the wrapper, completely disintegrated after about 5 minutes when subjected to the flushing action of the water. No trace of stoppage or clogged pipelines could be found in the sewerage system after these tests.

In another embodiment rayon fibers of similar length and weight as those described above were carded into lighter weight webs and two of these crosslaid to form a laminated web of about 14 grams per square yard. These were also treated with dialdehyde starch in the amounts specified above and tested in the same manner. As expected, these wrappers had better cross-direction strength but less long-direction strength than the material first described. However, they performed just as well during use and disintegrated completely upon flushing.

While the dry-formed nonwoven webs bonded by dialdehyde starch alone as described above were satisfactory for uses involving moderate stress, resistance to scuffing over extended or extreme conditions of use was not as good as desired. This weakness was overcome by using a cold-water-soluble adhesive to augment the dialdehyde starch and provide additional dry strength.

In a specific example of this latter embodiment, a nonwoven web of rayon fibers of 1.5 denier, 1 9/16 inch staple length and about 14 grams per square yards in weight, was sprayed with a 3 percent solution comprising a mixture of 4 parts polyvinyl alcohol and 1 part dialdehyde starch to give 10 percent pickup in the same manner as previously described. These webs had a much higher dry strength than webs bonded by dialdehyde starch alone, yet disintegrated readily after about 5 minutes exposure to an excess of water. Sanitary napkins using these webs as a wrapper performed well, showed improved scuff resistance and were readily disposed of by flushing.

In additional examples, similar webs were treated with 10 percent by weight of polyvinyl alcohol and then oversprayed with dialdehyde starch. In one run the amount of dialdehyde starch retained was 2.5 percent and in another run the amount retained was about 10 percent by weight.

In each of the latter runs, the dry strength was considerably improved over dialdehyde starch alone as well as over the polyvinyl alcohol-dialdehyde starch mixture. The wet burst values at various moisture contents also increased considerably over dialdehyde starch alone, but the decay of wet strength was unexpectedly slower than the decay of wet strength for webs oversprayed with the polyvinyl alcohol-dialdehyde starch mixture. With the increase in dry strength, scuff resistance improved. Surprisingly, the increased wet strength still permitted disposal by flushing.

Since bisulfite treated, or borax treated, dialdehyde starch readily dissolves in excess water, the retention of its binding power in the presence of body moisture and menstrual fluids is somewhat unexpected. It is theorized that the proteins in menstrual fluid may stabilize the polyaldehydes so that they are made temporarily insoluble whereby the web maintains its integrity while in contact with the body. This temporary insolubility is apparently destroyed in excess water since the binder loses its binding power completely therein. Another contributing factor may be that the absorbent core tends to draw most of the moisture to the interior of the napkin so that its debilitating effect on the binder in the wrapper is minimized. It is also theorized that the dialdehyde starch may interact with cellulose, forming acetal and hemiacetal cross-links with the cellulose to make the web more resistant to disintegration when merely moistened with water, but which resistance disappears rapidly in excess water. (Reference: Whistler, Roy L., Starch: Chemistry and Technology, Vol. 2 Industrial Aspects, 1967, pp. 441–442.) The following data are also of interest in explaining the phenomenon.

Reference is made to the chart shown in FIG. 1 where wet burst values for wrappers bonded by various amounts of dialdehyde starch (DAS), and also in combination with water-soluble polyvinyl alcohol (PVA) is plotted against percent moisture present in the web. The wet strength of a carded web without binder is also shown.

Percent moisture is calculated by spraying a web of known weight with a predetermined amount of water. Wet burst is measured by a simplified penetration tester. The moistened web is placed over a clear plastic plate containing a 5-inch diameter circular aperture. A matching plate is placed on top of the web with the apertures in alignment and the sandwich clamped together. A 3-inch diameter aluminum beaker is placed on the hole and weighted with lead shot until the web bursts.

The base web used in these determinations comprised 1 9/16 inch rayon fibers, of 1.5 denier, weighing approximately 14 grams per square yard.

Burst strength is given in grams per square centimeter.

In FIG. 1, particular reference is made to the readings at the 250 percent moisture line, which is a rough approximation of average environmental body moisture conditions surrounding a sanitary napkin when worn.

The chart indicates that at the indicated moisture level, the carded web without binder has a wet burst value of about 7.5 gram/cm^2. This amount may therefore be attributable to the effects of the surface tension of water alone.

The carded web bonded by 10 percent polyvinyl alcohol has a wet burst value of about 9 g./cm.^{2}. Thus the polyvinyl alcohol contributes 9 minus 7.5 g./cm.^{2} (the latter amount attributable to water alone) or about 1.5 g./cm.^{2} wet strength.

The web bonded by 2.5 percent dialdehyde starch alone has a wet burst of about 16 g./cm.^{2}. Subtract the 7.5 g./cm.^{2} from this and the amount attributable to dialdehyde starch is about 8.5 g./cm/^{2}.

The web bonded by 10 percent polyvinyl alcohol oversprayed with 2.5 percent dialdehyde starch has a wet burst of about 31 g./cm/^{2}. Subtract the 7.5 g./cm.^{2} from this value and the amount attributable to the combination is about 23.5 g./cm/^{2}, or about 13.5 g./cm.^{2} more than if the wet burst values for 2.5 percent dialdehyde starch alone and 10 percent polyvinyl starch alone are simply added, i.e. 1.5 plus 8.5 or 10 g./cm/^{2}. Thus the wet burst value of the combination is more than twice the simple added figure, indicating the synergism of the combined binder system.

It is also noted that burst values for various percentages of dialdehyde starch when the web is substantially dry and at increasing moisture content remain approximately the same.

Note further that when 10 percent polyvinyl alcohol is used alone as the binder, the web has high burst values when substantially dry and that these values fall sharply even when only 100 percent moisture by weight is present, to a point where the web has less strength than a web bonded with only 2.5 percent dialdehyde starch.

A suitable strength for satisfactory performance is about 20 grams/cm² in the range of 200 percent to 300 percent moisture content, which range of moisture content is estimated to be exemplary of the normal conditions which exist in a sanitary napkin wrapper during use. When dialdehyde starch is used in amounts of 5 percent this requirement is met.

The chart shows further that while 10 percent polyvinyl alcohol has little wet strength in the presence of 100 percent or more of moisture, the addition of as little as 2.5 percent dialdehyde starch in combination with the polyvinyl alcohol increases the dry strength slightly but raises the burst minimum strength substantially above the desired level.

In FIG. 2 there is charted the decay of wet strength exhibited when a carded web bonded with 1 percent, 2.5 percent and 5 percent respectively of dialdehyde starch is subjected to an excess of water by dropping the web into a container of water. Note that the decay is very rapid, dropping to a minimum after only 5 minutes exposure.

In FIG. 3 the decay of wet strength for webs bonded respectively with, (1) a mixture of 2 percent dialdehyde starch and 8 percent polyvinyl alcohol and (2) 10 percent polyvinyl alcohol oversprayed with 2.5 percent dialdehyde starch is shown. Each of these webs starts at a higher dry strength, but the web bonded with the mixture acts almost the same as dialdehyde starch alone, dropping to a minimum after 5 minutes, whereas when the polyvinyl alcohol bonded web is oversprayed with the dialdehyde starch, decay to the minimum strength takes about 12 minutes.

Thus, it will be seen that when the dialdehyde starch-polyvinyl alcohol combination is used, the oversprayed application provides better performance in use, while the strength still decays in a satisfactory time period for disposal.

In addition to rayon fibers, other synthetic fibers such as other types of regenerated cellulose may be suitably used in the wrapper as well as natural cellulose fibers. Small amounts of noncellulosic fibers may also be added without deleterious effect. The dialdehyde starch may be applied by impregnation, printing, or other suitable means. Any suitable absorbent core which is disintegratable in water may be used as the napkin filler. Soluble or insoluble baffle members, as found in certain napkin constructions, may also be used. While insoluble baffles such as thin polyethylene will not disintegrate in water, such baffles are usually so thin and flexible that they will not cause stoppages in disposal systems having standard diameter pipelines.

While the above described preferred embodiments of the invention relate particularly to sanitary napkins, it will readily be seen that the wrapper is equally applicable to other absorbent pads such as diapers, hospital pads, absorbent bandages and the like.

What is claimed is:

1. An improved wrapper for sanitary napkins and pads for absorbing body fluids comprising a dry-formed nonwoven web of cellulosic fibers bonded at least in part by an adhesive material which provides said web with a wet burst value sufficient to maintain said web intact when subjected to the moist environment produced by body-generated fluids and which wet burst value decays rapidly after exposure of said web to an excess of water permitting said web to disintegrate in said water said adhesive comprising dialdehyde starch and a cold-water-soluble binder.

2. The improved wrapper of claim 1 in which said wet burst value is at least about 20 grams/cm².

3. The improved wrapper of claim 1 in which said dialdehyde starch is oversprayed on a web previously treated with said binder.

4. The improved wrapper of claim 3 in which said cold-water-soluble binder is polyvinyl alcohol.

5. The improved wrapper of claim 4 in which said dialdehyde starch is present in the amount of at least 2.5 percent by weight and the polyvinyl alcohol is present in the amount of about 10 percent by weight.

6. The improved wrapper of claim 1 in which said dialdehyde starch is present in the amount of at least 2.5 percent by weight and the cold-water-soluble binder is present in the amount of about 10 percent by weight.

7. The improved wrapper of claim 1 in which said nonwoven web comprises a carded web of rayon fibers.

8. The improved wrapper of claim 1 in which said nonwoven web comprises a laminate of at least two crosslaid carded webs.

9. The improved wrapper of claim 1 in which said dialdehyde starch is present in the amount of at least 5 percent by weight.

10. A sanitary napkin comprising an absorbent core enwrapped with a fluid pervious wrapper capable of being readily dispersed in excess water, said wrapper comprising a dry-formed nonwoven web of staple length cellulosic fibers bonded at least in part by an adhesive material which provides said web with a wet burst value sufficient to maintain said web intact when subjected to the moist environment produced by body-generated fluids and which wet burst value decays rapidly after disposal of said web in an excess of water, whereby the fibers in said web and said napkin are free to disperse in said water said adhesive material being dialdehyde starch.

11. The sanitary napkin of claim 10 in which said wet burst value is at least about 20 grams/cm².

12. The sanitary napkin of claim 10 in which the fibers in said web are rayon.

13. The sanitary napkin of claim 10 in which said adhesive material is augmented by a cold-water-soluble binder.

14. The sanitary napkin of claim 13 in which said dialdehyde starch is oversprayed on a web previously bonded with said binder.

15. The sanitary napkin of claim 14 in which said cold-water-soluble binder is polyvinyl alcohol.

16. The sanitary napkin of claim 12 in which said dialdehyde starch is present in the amount of at least 5 percent by weight.

17. The sanitary napkin of claim 13 in which said dialdehyde starch is present in the amount of at least 2.5 percent and the cold-water-soluble binder is present in the amount of about 10 percent by weight.

18. The sanitary napkin of claim 17 in which said water-soluble binder is polyvinyl alcohol.