SELECTIVELY DISPERSABLE SANITARY STRUCTURES

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8 Claims

ABSTRACT OF THE DISCLOSURE

Toilet-flushable sanitary products capable of absorbing body-discharge such as diapers and sanitary napkins are disclosed which have excellent dry and wet strength and which comprise a scrim or paper of biodegradable fibers such as cellulosic fibers, and padding of water-dispersable absorbent material. The structures have a series of channels containing a selectively soluble resin which bonds the staple fibers to each other and to the absorbent material and possesses certain critical characteristics including the fact that it is stable to body-discharge but capable of being degraded in a toilet system upon the addition of a suitable substance.

This application is a continuation-in-part of application Ser. No. 699,711 filed Jan. 22, 1968, now abandoned.

A potentially huge market exists for such sanitary products as sanitary napkins and diapers which can be disposed of in a more acceptable manner than can the conventional products. Treating a soiled sanitary product as ordinary garbage involves obvious unpleasantnesses associated with its handling and storage.

Several workers in the art have proposed diapers and the like which reportedly can be disposed of in a family septic tank or toilet. While this approach would solve the above-mentioned problem, it presupposes that the sanitary structures readily disintegrates or disperses in the toilet in order to avoid plugging of the plumbing system. Dispersibility in water has generally been predicated upon structural disintegration through the weakening of interfiber friction. These suggested dispersible sanitary products have been seriously lacking in one or more aspects. Some must be torn or shredded before disposal thus requiring unpleasant handling. Others do not break up easily or quickly in the toilet. Still others are not efficiently absorbent or have a low rate of absorbency or do not have enough strength to hold up under use. Still other proposed structures are not sufficiently flexible and/or require the removal of a non-disintegrable plastic film bucking.

It is an object of this invention to provide diapers and other sanitary products which are inexpensive enough to dispose of after a single use. It is a further object that these products possess sufficient wet strength to maintain their structural integrity under the conditions of use without the need for a textile fabric reinforcement. The products should, of course, have sufficient dry strength so that handling, folding, and packaging will not tear or puncture them. It is still further an object to provide a process so that these products are readily, easily, and safely disposed of in a toilet bowl or septic tank without the need for tearing. As a still further object, the product should be aesthetically pleasing in hand and appearance, i.e., whiteness, and non-irritating to the human skin.

It is now been found that sanitary products can be prepared which meet all of the above objectives by providing a laminar, non-woven structure which comprises:

(a) A water-dispersible, absorbent inner-layer composed of biodegradable, e.g., cellulosic, fibers;

(b) A moisture-permeable layer comprising aligned staple fibers on at least one side of the inner-layer;

(c) A moisture-impermeable film attached to and covering another side of the inner-layer; and

(d) A series of channels interlaid intermittently across and through the surface of said layer (b) such that substantially all of said aligned staple fibers are crossed by at least one of said channels, and extending depth-wise through at least said inner-layer, said channels containing a resin which is non-irritating to the human body and characterized by being stable to body-discharge but capable of being degraded in a toilet system upon the addition of a suitable degrading agent.

The term degraded is used in its generic sense and is not necessarily limited to chemical degradation, i.e., the reduction of the number of carbon atoms in a chain. Thus, it refers to the swollen, solubilized, partially solubilized, oxidized, or reduced state of the resin binder subsequent to interaction with a suitable degrading agent.

In addition to diapers, other sanitary products within the scope of this invention are catamenial devices such as sanitary napkins or vaginal tampons, pads for protecting the bed against wetting and similar hygienic products. It is to be immediately noted that the broad concept of non-woven products comprising biodegradable fibers and a binder with or without padding is notoriously old in the art and the products of the instant invention are to be distinguished therefrom.

In the first place the vast majority of the binders heretofore employed in the prior art products were water-soluble and, in fact, common practice has been to apply the binder to the cellulosic fibers by means of an aqueous solution. The products were subsequently dried so as to remove the water and leave the binder.

The binders contemplated in the finished products of the instant invention must be stable in body-discharge during use and obviously this excludes all water-soluble binders. As a matter of fact, body-discharge broadly ranges in pH from extremes of about 4.6 to about 8.4 so that the binders of the instant invention must be stable in the slightly alkaline and slightly acidic discharge encountered during use. Quite obviously, the exact pH encountered within the broad range set forth varies depending upon many factors including the specific end use. Thus, diapers and sanitary napkins are not necessarily subjected to the same pH ranges during use. Therefore, the binders employed must be stable only in the particular body-discharge encountered during use.

It is to be noted, however, that water-soluble binders can be initially used for application to the biodegradable fibers from aqueous solution thereof providing such binders are subsequently treated to make them water-insoluble. Thus, the binder in the finished product must be water-insoluble.

Another characteristic of the binders employed in the instant invention is the fact that they must be substantially free from irreversible cross-linking, either in the manufacture of sanitary products or in the use thereof. Some of the resins in prior art products were subjected to chemical treatment of significantly high temperatures during manufacture so that they became irreversibly cross-linked. Although this technique does improve the bond between biodegradable fibers such as cellulosic fibers and the resin, it does not result in the production of toilet flushable articles. As has heretofore been stated, it is an object of this invention to use a binder which is stable in body-discharge but which can be degraded in an ordinary toilet upon the addition of a suitable substance. If the binder is irreversibly cross-linked, it becomes impractical to use substances, i.e., acids, bases, etc. and thus cannot be readily degraded. Accordingly, one very necessary char-
acteristic of the binders employed is that they be substantially free from irreversible cross-linking both during manufacture and use. It is to be immediately understood, however, that this invention encompasses a reaction of binders which is only temporarily or reversibly cross-linked. Thus, for example, a polymer can be reacted with a metal salt so that it cross- 

inks, i.e., ionic cross-linking, yet when treated with a suita-

able degrading agent such as a base, the cross-linking will reverse itself and the polymer will degrade.

Another important characteristics of the binders em-

ployed is that the instant reaction is that they be nonirritating 
to the human body and when combined with a cellulosic fiber the resulting product should possess a pleasing hand or feel. It should become immediately apparent that if a binder is employed which is irritating to the human body, it is completely unsuitable irrespective of the fact that it might be stable in body-discharge and capable of being degraded in a toilet. In this connection, a test method has been devised to determine whether or not a candidate binder is nonirritating to the human skin. In this test a sample one-inch square is applied to the skin and held in place with adhe-

sive tape. After 48 hours the sample was removed and 10-14 days were allowed to elapse. The test was then repeated for an additional 48 hours. If any redness, scal-

liness, accumulation of fluid in the skin, etc., occurred, the polymer was considered unsuitable. This test is more fully described in the Public Health Report, volume 59, 1944, under Prophetic Patch Test at p. 551.

Thus, the expression "non-irritating to the human skin" as used in the specification and claims is intended to define a polymer which satisfies the above test procedure.

As has heretofore been noted, the disposable sanitary products of this invention should have sufficient dry strength so that handling, folding or packaging will not tear or puncture them. In this connection, it has been found that the products of this invention can be charac-

terized as possessing a scrim or paper which has a dry, break strength of at least 2.0 pounds. Additionally, in view of the fact that the disposable sanitary products must possess sufficient wet strength to maintain their structural integrity under conditions of use, the scrim or paper must possess a wet strength of at least 0.25 and preferably at least 0.5 pound.

It is also noted that wet and dry strength are not suffi-
cient to characterize a product which is useful as a sanitary product in view of the fact that the degree of elongation or stretch must also be taken into consideration if these products are to function properly. In this connection, it has been found that the products of this invention must possess a dry elongation of from about 3 to about 50 per-

cent and wet elongation of from about 3 to 50 percent.

The above figures were obtained by the use of a con-

ventional Instron Testing Machine wherein a sample strip one inch by six inches is preconditioned by maintaining it at 73.4°F. and 50% relative humidity for 48 hours. The test strip is then inserted into the rubber-faced jaws of said Instron Testing Machine to a gauge length of two inches and tested at an elongation rate of four inches per minute.

In those situations where the wet strength and wet 
elongation are desired the sample strip was soaked in 
water having a pH of about 7 for about 10 minutes after 
the 48-hour treatment previously referred to and there-

after tested.

The biodegradable fibers incorporated with the binder are not narrowly critical and typical examples include protein fibers, e.g., silk, wool, etc., although cellulosic fibers are preferred. The types of cellulosic fibers em-

ployed are also not critical and cellulose is the preferred fiber. Thus, regeneration wood pulps of moderate alpha cellulose content and cot-

ton linters represent conventional sources thereof. Addi-

tionally, the average fiber length is not narrowly critical

and any convenient length can be employed, although it is advantageous to use less than ½ inch and even more desirably, less than ¼ inch.

Numerous polymer substances are known in the art 

which are stable in body-discharge yet are capable of being degraded upon the addition of a suitable degrading agent. Typical examples of these types of polymers would include those polymers which are stable in neutral or acidic media but which dissolve or degrade in alkaline media. In like manner, polymers are known which are stable in alkaline or acidic media but which are soluble or degradable in acid media. Additionally, polymers are known which are stable in the pH range of body-discharge but are capable of being dissolved or de-
graded by organic solvents such as propylene glycol, phenol, etc. Still other polymers are stable in body dis-
charge but can be degraded by oxidizing agents such as 
alumina hypochlorite solutions commonly known as 

household bleach as well as by perborates and by reducing agents such as 
alumina hydrosulfites.

Representative of polymers which are stable in neutral 
or acid media but which degrade in alkaline media are 
copolymer of ethylenically unsaturated mono- and poly-
carboxylic acid derivatives generally used as adhesives 
or nitriles such as copolymers of acrylic or methacrylic acid 
and an alkyl acrylate or methacrylate, e.g., ethyl acrylate, 
methyl methacrylate, etc., or with acrylonitrile; carboxy 
er ester lactones; copolymers of alpha, beta, ethylene dicar-

boxylic acids such as maleic acid and vinyl compounds 
such as styrene; polyacrylic acid-polyether additives, sty-
rene-monoethyl maleate heteropolymers, itaconic acid 
polymers, and the like.

The above polymer substances are extremely well 

known in the art and are described in the literature as 
well as in U.S. and foreign patents such as U.S. 3,017,291; 
3,260,760; German Pat. 1,046,884; 1,113,090; 1,125,916; 
1,164,095; Belgium Pat. 639,010; 621,179; 670,986; 632; 629; 
634,666; 636,162; as well as British Pat. 941,312 and 879,930.

In like manner, polymer substances are known which 
are stable in neutral or alkaline media but which are 
degraded or dissolved in acid media. Polymers of this 
type would include copolymers of aminocrylates such as 
dimethylaminomethacrylate and an alkyl acrylate such as 
etyl acrylate, polyvinylpyrrolidines, etc. Polymers of this 
type are also described in various patents including U.S. 
3,099,636.

The nature of the fibers in the non-woven covering is 
not critical. The average fiber length should be between 
about ½ and 3 inches, and preferably between 1 and 2 

inches. It is too difficult with shorter lengths to intermit-
tently bond substantially all the fibers. If the average fiber 
length is too long, the filaments will tend to entangle and 
result in significant integrity even in neutralizing solution. Suitable fibrous materials include celluloses such as 
rayon, cotton, cellulose acetate, and mixtures thereof.

This non-woven covering can be prepared from a web 
of substantially aligned staple fibers. Suitable webs of 
substantially aligned staple fibers can be formed in any 
of several various methods well known to those skilled in 
the art, as for example by carding and drafting. More 
highly aligned webs are preferred. In one embodiment of 
this invention, these webs are treated before printing with 
a slight amount of a selected resin to maintain fiber align-
ment during processing. The aforesaid resin should be one 
which is soluble either in neutral water or under the 

pH conditions required for solubility of the resin used in the 
channels.

The nature of the cellulose fibers in the inner layer is 
not critical. Wood pulp of moderate alpha cellulose con-
tent and cotton linters represent inexpensive sources of 
such cellulose fibers. These fibrous webs or pads may be 
formed in any suitable manner such as carding, garnet-
ting or by dry deposition from an air suspension of the 
fibers. The fibers in the web can be oriented or non-

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oriented. Suitable non-oriented webs can be conveniently produced, for example, by a Rando-Webber Machine (Curulator Company, Rochester, N.Y.). Such webs have equal strength in all directions without resorting to cross-lamination. The production of such webs are well known in the art and form no part of the instant invention. The desired strength of the web depends merely on the intended end use, i.e., the necessary absorbency.

The structures of this invention can be prepared by passing the layer of staple aligned fibers together with a backing of the cellulose web through cameo or intaglio printing rolls wetted with the adhesive solution and then dried. (In the context of this specification, "adhesive solution" includes an emulsion.) Cameo and intaglio printing are well known to those skilled in the art and involve passing the web through the nip between a pressure roll and a printing roll which has projecting or recessed binder-applying portions, respectively, which are spaced according to the desired design. When employing cameo printing in producing the structures of this invention, the projecting ridges should be cupped or recessed so as to pinch or locally compact the web in order to diminish the tendency for the binder to spread or diffuse beyond the pinched or locally compacted web portions. The printing roll can be wetted by the adhesive solution in any of various conventional ways, such as by a doctor blade. In a preferred embodiment, the adhesive solution is sufficiently diluted with any of numerous suitable volatile organic solvents (such as methyl ethyl ketone) to reduce the viscosity and thereby increase penetration of the adhesive. After printing, part of the solution is evaporated, e.g., in an oven, to render the adhesive solution tacky. The structure can then be compacted. The printed portion remains indented below the surface of the unprinted portions. The compression of the web along the printed lines also provides added reinforcement for the web.

In a simple embodiment, the lines can be parallel to each other and perpendicular to the direction of the aligned fibers to provide lateral strength. Also a crisscrossing pattern can be employed to give reinforcement in both directions. The adhesive lines should be so regularly spaced, of course, as to cross each fiber. In other words, the distance between the lines of the adhesive pattern should be less than the average fiber length of the fibers composing the web. The optimum total surface area which the adhesive pattern should cover can be determined by simple experimentation as a function of the nature of the fiber and the intended end use. If the area which the adhesive covers is too low, the structure will not have the requisite dry and/or wet strength.

The backing film must be impermeable to the body fluids that the structure is required to absorb. In a preferred embodiment this film exhibits selective solubility properties similar to that of the adhesive resin. That is, it is water-insoluble in the pH range of the body fluids that it will be in contact with the water-soluble under at least some pH conditions outside this range. For this purpose, the film can be cast from the same resinous material employed as the binder for the covering web. Also this backing sheet can be adhered to the inner cellulose layer by the same resin employed in the covering web. The backing layer can be laminated to the rest of the structure by numerous means apparent to those skilled in the art. This can be conveniently conducted by passing the inner layer or film through nip rolls which are wet with the backing adhesive and then compacted. The same adhesive channels employed in binding the covering layer and inner layer can in some instances also serve to bind the backing layer to the inner layer. For this purpose the adhesive should be deeply printed. The depth of printing can be controlled by the roll design, the viscosity of the adhesive solution, the pressure and the web i.e., pad construction.

This tactical compression of the web and moisture-permeable layer and the application of the adhesive from the top to form deeply imprinted channels provides inter alia:

1. A highly strengthened, moisture-permeable layer or cover;

2. A bonding not only of the aligned staple fibers in the top layer but also an anchoring of the layer to the cellulose web, thus preventing any tendency during handling and use for the cellulose fibers in the web to break up and shift in position (such shifts cause lumps in one area and relatively empty areas of reduced absorptive capacity);

3. Channels to conduct the liquid discharge away from its area of deposition, increasing both the total effective absorbency of the structure and rate of absorption;

4. Relief from tactual irritation for the adhesive pattern is depressed below the covering;

5. A quick neutralization and thereby solubilization since the neutralizing solution immediately comes in contact with the adhesive without having to permeate any covering material;

6. Increased flexibility of the product;

7. Increased effective surface area; and

8. A possibility of imposing a pleasing design i.e., increasing the aesthetic appeal of the product.

Preferred embodiments of the invention are further illustrated by the following drawings, in which:

FIG. 1 is a schematic view of apparatus for the production of a preferred structural embodiment;

FIG. 2 is a fragmentary perspective view of the cameo printing roller shown in FIG. 1;

FIG. 3 is a fragmentary top plan view of the product;

FIG. 4 is a fragmentary sectional view taken along line 4–4 of FIG. 3.

In the exemplary operation shown in FIG. 1, an upper layer of aligned staple fibers 1 is joined with a lower layer of a cellulose web 2 which is fed around guide roll 3 in the nip between rollers 4 and 6. Roll 4 can best be understood by referring to FIG. 4 having projections 5 putting out therefrom in a regularly spaced pattern. These projections before engaging the layers in the nip intermesh with the rubbery exterior 8 of the furnish roller 7. This rubbery exterior is inked by conventional means (e.g., reservoir 21) with a solution 9 of the selectively soluble resin. Thus, the projections 5 after leaving 8 contain adhesive solution 9 thereon. As the rotating projections compress layers 1 and 2 against backing roll 6, the adhesive solution is deposited on layer 1 and proceeds to some depth into layer 2. The printed layers 1 and 2 then proceed by conveyor belt or other suitable means through a heating zone such as oven 16 to remove some of the solvent from the adhesive solution and thus render it tacky. After exiting from the heated zone the printed layers are then passed through the nip between rollers 11 and 12 which compress these layers. At the same time a film layer 15 coming from supply roll 13 and around guide roll 14 and pressure roll 12 is laminated to the underside of layer 2. Layer 15 is sprayed with a fine mist of adhesive solution 19 by conventional means 17 at a point between rolls 14 and 12. The resulting product 16 after drying is permanently channelled in the desired manner.

The surface of the printing roll 4 can be more clearly seen in FIG. 2. The roller containing ridges 5 in the form of a diamond pattern illustrates one form of applicator that may be used. As noted above, these ridges contain recesses 20 to minimize lateral migration of the adhesive. The final product 16 has a channelled surface as shown in FIG. 3. This pattern corresponds to the pattern in FIG. 2. The channels 18 are more clearly visible in cross-section in FIG. 4: two layers of the same adhesive channels employed in binding the covering layer and inner layer can in some instances also serve to bind the backing layer to the inner layer. For this purpose the adhesive should be deeply printed. The depth of printing can be controlled by the roll design, the viscosity of the adhesive solution, the pressure and the web i.e., pad construction.

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from FIG. 4, the channels 18 also increase the effective surface area of the web through which the liquid can be absorbed.

The sanitary products of this invention, after use, are merely placed in a regular toilet to which is added suitable degrading agents such as alkalis, acids, oxidizing or reducing agents or organic solvents. Typical examples of alkaline materials would include ammonia, sodium carbonates, ammonium borate and the like. Preferred alkaline materials would include alkali metal borates, phosphates and silicates, e.g., sodium borate, potassium phosphate, potassium silicate, sodium hypochlorite, etc. Typical acidic substances are citric acid, boric acid and acid salts such as calcium and ammonium chloride. Preferred acidic materials include acetic acid, citric acid and dilute hydrochloric acid. Quite obviously, any acid or base can be employed such as dilute hydrochloric acid, dilute potassium hydroxide, but these materials may not be generally found about the home.

Typical oxidizing and reducing agents which can be used are sodium hypochlorite, sodium perborate, sodium hydrosulfitte, sodium sulfcoxylate and the like. Typical solvents include propylene glycol, alcohol, phenol and the like.

As has heretofore been stated, the degrading agent interacts with the binder causing it to degrade and the sanitary products are thereafter dispersed in the toilet system by the act of flushing. It is specifically noted that the degrading agent, as per se, does not disperse the sanitary products since it substantially only interacts with the binder. The biodegradable fibers are dispersed only upon agitation as is accomplished either by stirring or more simply, by the act of flushing.

It is within the scope of this invention, however, to add the required acidic or alkaline materials in premeasured amounts as tablets, packaged powder or as liquid designed for this specific purpose so as to minimize the inconvenience of storing, handling and measuring the compounds necessary to degrade the sanitary products.

It is also within the scope of this invention to add perfumes or deodorants in the premeasured degrading agents in order to minimize the unpleasant odors usually encountered in the disposal of sanitary products. It is also noted that perfumes or deodorants can be incorporated into the sanitary structure per se—either in the scrim or in the absorbent padding or in both. Additionally, it is also within the scope of this invention to incorporate into the sanitary products bacteriostatic and dye additives if such is desired.

What is claimed is:

1. A toilet-flushable laminar structure capable of absorbing a body-discharge, comprising:
   (a) a cellulose web;
   (b) a moisture-permeable layer comprising aligned biodegradable, staple fibers attached to and covering one side of said cellulose web;
   (c) a moisture-impermeable film attached to and covering the other side of said cellulose web; and
   (d) a series of channels spaced intermittently across the surface of said layer (b) such that substantially all of said aligned staple fibers are crossed by at least one of said channels, and extending depthwise into said cellulose web, said channels containing a thermoplastic resin binder which is non-irritating to the human body, insoluble in water in the pH range of said body-discharge and soluble in water at selected pH values outside of said range; said binder being substantially free from irreversible cross-linking and capable of being degraded and releasing said biodegradable fibers and web upon the addition thereto of a substance which is capable of interacting with said binder and degrading the same.

2. A structure according to claim 1 wherein said staple fibers have an average fiber length of about ½ to 3 inches.

3. A structure according to claim 1 wherein said aligned fibers comprise rayon.

4. A structure according to claim 1 wherein said cellulose web (a) is composed of randomly oriented wood pulp fibers.

5. A structure according to claim 1 wherein said resin is soluble in water only in the alkaline pH range.

6. A structure according to claim 1 wherein said staple fibers have an average fiber length of about 1 to 2 inches.

7. A structure according to claim 1 wherein said channels (d) cross-cut at regularly spaced intervals.

8. A structure according to claim 1 wherein said film (c) is composed of a material having substantially the same water-solubility characteristics as said resin.

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