FLUID MANAGEMENT BY ACQUISITION LAYERS IN ABSORBENT ARTICLES

An Intellectual Property Report

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Scope of Report

The scope of this report is the patent art in the field of liquid management by topsheet structures in disposable absorbent articles. Patents that appeared until the end of May 2003 have been included. The emphasis in the report is on describing the technologies that appear in the patents for regulating the flow that is seen by the core in an absorbent article.

As will be discussed in more detail below, in order for the absorbent core material in a diaper or sanitary napkin to be most effectively utilized, it needs to see fluid over a wide surface area. However, the topsheet structure needs to move fluid as quickly as possible away from the wearer's body for maximum comfort. How these two opposing needs are accomplished in articles that are claimed in the patent art is of major interest here.

The technologies found in these patents fall into one of two categories:

- Those technologies that control the z direction, or vertical, flow rate (defined below) of fluid into the pad and away from the wearer's skin, and

- Those technologies that control the x-y plane, or horizontal, flow of the fluid (also defined below) once it has been moved clear of the wearer's skin.

In addition, we can consider technologies in two further sub categories. One in which a non woven faces the wearer's skin, and secondly, those that use a formed film in such a position. The formed film is found, for example, in the "Always®" sanitary napkin, by Procter and Gamble, and is often perceived to have the advantage of generally more effective fluid transfer compared to non wovens. Non wovens are often perceived to be softer than formed films, and are commonly used, for example, in diapers.

The search string that was used on the USPTO database was:

Aclm/(topsheet or "top sheet" or "body side liner") and "absorbent article". There were around 900 hits. A total of 47 patents were reviewed and summarized for this report.

Note that I often quote, or quote from, only the first claim in a patent. This is because the first claim is by definition independent, and sets the foundation of much of what follows. However, in reading the scope of the claims of a patent to complete a non infringement or prior art search, all claims must be considered.

Introduction to the Technology

Absorbent articles have been known for a long time as hygiene products. They find use, for example, as diapers and women's sanitary pads. These absorbent articles are constructed in such a way that they can absorb and store liquid bodily excretions such as urine, menstrual fluid, or blood. External absorbent articles are worn on the outside of the body and, in this regard, they differ from tampons, which are introduced into the female body and can thus be termed "internal" products.

The most basic design of all such externally worn articles typically includes a body side liner that faces the body of the wearer and hence receives the exudate from the wearer’s body. The liner is also referred to as a “topsheet”. The design also includes an outer cover (also referred to as a “backsheet”) that faces the wearer’s garments and therefore has to block fluid flow into the garment to avoid staining, and an absorbent core disposed between the body side liner and the outer cover.

Typical absorbent articles may be bent or twisted easily to fit the contours of a wearer’s body and gross curvature results to the overall structure, but locally, mutually orthogonal spatial basis vectors can be defined as follows:

- The “z direction”, as commonly referred to, is a direction which, when the article is laid out flat, is locally parallel to an axis through the absorbent article that passes from the point of entry of fluid into the article and perpendicular to the surface on the article that contacts the wearer’s body. When the article is bent or twisted away from a planar configuration, the z direction is a normal to the surface of the article and is also the direction of initial flow of fluid from the wearer’s body.

- The “y direction” is generally defined as line on the surface of the article that connects the front of the wearer to his or her rear. It represents the long axis of most absorbent articles that are worn in the crotch of the wearer.

- The “x direction” is the direction of the width of the article that is mutually perpendicular to the y and z directions.

The x-y plane represents the plane in which it is desirable to have fluid move in order to render the absorbent core maximally efficient (i.e. use most of its surface area). However, excessive flow in the x-y plane can occur, and be defined as flow that results in leakage out of the edges of the article.

In the event of inadequate z direction flow of fluid into the article following impingement of fluid onto the topsheet, then the topsheet, which is turned toward the body, exhibits wet areas; this effect is frequently found to be disadvantageous when using known absorbent articles and leads to an unpleasant feeling for the wearer. In addition, the excreted bodily liquids frequently leave visible residues behind on the surface of the absorbent article used, so the user of the article is tempted to change the absorbent article more frequently than would be necessary if liquid were being absorbed to the maximum extent of the capacity of the absorbent core.

However, if fluid flow into the article in the z direction is too fast, the absorbent material inside the article can become locally saturated, and is inefficiently utilized as a result. Therefore some distribution of fluid in the x-y plane is necessary to assure efficient use of the absorbent material. It is better if such a distribution in the x-y plane occurs inside the pad, where the stain from the fluid is masked and fluid cannot contact the wearer's skin, rather than on the surface of the pad.

The ability to direct or control the flow of fluid in the z direction of the pad, and balance it with x-y plane flow has become the object of several inventions in the field. The control of liquid dispersion in articles by means of topsheets and associated structures is the subject of this report.

"z" Direction Fluid Control.

Fluid transport in the z direction across a topsheet is generally modified by either using the capiliarity of the topsheet structure or surface energy of the structure or its components. As an example of the first method, using suitably shaped cones can direct and move fluid through a topsheet. As an example of the second method, using surface energy levels or gradients across the topsheet can move fluid thorugh the topsheet.

Issues with top sheet design in this regard have been focused on two areas.

1. Resolving the compromise that exists between fluid handling ability on the one hand, and softness on the other hand, as for example, when a non woven is used as a topsheet. A non woven may be preferred for softness, and therefore efforts are seen in the patent literature to improve the fluid handling of topsheets in which a non woven contactes the wearer's body.

2. Optimizing topsheet performance for the wide variety of fluid properties, in particular viscosity, that are seen in practice. Diapers, for example, have to be able

to handle fecal matter as well as urine.

Non Woven Topsheets

The first class of inventions we list are focused on z direction functionality in the article, which is measured by fluid uptake rates and the amount of fluid that rewets the surface when compressive pressure is applied to the article in the z direction.

There have been several patents directed towards reducing the surface wetness in disposable diaper structures that use a non woven material as a wearer facing surface. U.S. Pat. No. 3,945,386 to Anczurowski claims diaper structures having a perforated thermoplastic film interposed between the topsheet and the absorbent core. U.S. Pat. Nos. 3,965,906 and 3,994,299 to Karami (hereinafter ‘906 and ‘299 respectively) claim a part of the surface of a topsheet being a performated film. The ‘906 patent teaches that the film be bonded to the absorbent core, thereby increasing the structural integrity of the article.

U.S. Pat. No. 4,324,247 to Aziz describes an effort directed to both reducing run-off and reducing the surface wetness of absorbent articles, also by using a film with tapered capillaries between the topsheet and the absorbent core.
The z direction performance of a non woven topsheet can be improved by perforating the topsheet. This technique is claimed in U.S. 6383441 to Uni Charm. The claims are to a method. The method is high pressure water jets that are used to entangle fibers, and simultaneously produce set of oval apertures with a major axis in a particular direction. The web is then mechanically apertured to form ovals with major axes in the orthogonal direction to the first.

The design of the composite topsheet can also be used to selectively transport or absorb different components of the wearer’s fluid discharge. For example, U.S. 5,342,338 to P&G discloses a double topsheet structure that handles low viscosity fecal material by transporting it through the first topsheet, and then dewatering it over the second.

In a further example of an invention that purports to offer z direction control over fluid, U.S. 5,500,270 to P&G describes the use of a laminate material to provide a capillary zone intermediate between two fluid permeable topsheet layers. The two layers are separated by discrete spacers that provide a capillary zone in between the two topsheets.

The fiber cross section can be changed to change the fluid transfer properties of the fiber. Although it is strictly not for a topsheet, in U.S. 6,436,518 to Clemson University, improvement in fluid transfer rates takes place in a bundle of synthetic fibers that comprises at least two fibers that seem to have a synergistic effect on each other. The fiber cross section of at least one fiber is shaped (i.e. non circular). The one claim is for an absorbent article that contains a core with the subject fiber bundles.

The capiliarity of the absorbent region can be zoned in order to provide improved z direction wicking, and this technique is the subject of U.S. 6,437,214 to Kimberly Clark. The absorbent core has two layer regions, and at least one of these regions is "zoned". The first claim contains references to properties of the core that are defined in the disclosure and must be read in that context. An article is claimed.

Similarly, U.S. 6,274,218 to Uni Charm claims a topsheet with apertured fibrous layers and an increasing density moving in the z direction away from the wearer.

Low viscosity fecal material is the subject of U.S. 6,545,197 to P&G which claims an absorbent article that comprises a topsheet that itself comprises a backing, and a sheet of fibers that is anchored in a particular way to the backing. The fibers have to be less hydrophilic than the backing. U.S. 6,440,114 has a fecal management layer inbetween the topsheet and the core. The fecal management layer looks very similar to the sheet of fibers in '197 (note the use of the word "arcuate" to describe the fiber arrangement).

Surface energy gradients as drivers of fluid transfer will be discussed in more detail in the section on formed films, although note in passing U.S. 6,232,521 to P&G that utilizes a contact angle gradient across the core and backsheet.

Formed Film Topsheets

Formed film topsheets are generally acknowledged in the art to have superior fluid handling characteristics but are inferior in terms of softness. Their use has generally been restricted to feminine sanitary products, as they are not perceived as having suitable properties for use in baby diapers. The formed film advantage seems to come basically from z direction movement of fluid. Cones or similar structures move fluid quickly through away from the wearer's body, and can inhibit rewet.

It is worthwhile to consider briefly how the problem of softness has been addressed, as the solution to that problem may have an effect on fluid management properties. Three general methods can be identified from the existing art for providing a soft surface feel to a formed film.

The first method is to lay a non woven web onto a formed film. The web and the film can be left unbonded, or they can be intimately bonded by some bonding means. For example, U.S. Pat. No. 3,945,386 to Anczurowski and U.S. 4,324,247 to Aziz attempt to combine the softness of a non woven topsheet with the z direction fluid handling characteristics of a formed film sub layer. The presence of the formed film sublayer is seen to significantly reduce the rewet value of diaper constructions that include it.

Similarly WO 93/09741 and H1,670 to Aziz et al describe a topsheet that comprises a non woven web combined with a formed film in a face to face relationship. The web and the film can be bonded, and said bonding would be expected to improve the fluid uptake rate of the combination as the web and the film come into intimate contact.

The second method of imparting softness to the surface of a formed film is to coat the film surface with loose fibers. This art is exemplified in U.S. 6,242,074 to Tredegar. The problem with this method is that loose fibers are limited in the degree of softness that they can impart to the film surface.

The third method of imparting softness to the surface of a formed film is to form the film in such a way that softness becomes one of the intrinsic characteristics of the film. This approach is exemplified in Curro (U.S. 4,609,518) in which water jets are used to impart a microstructure to the film surface. The microstructure has a soft feel against human skin. Although this method has the advantage that a lamination step is not required in the manufacture of the film, the need to provide liquid handling facilities adds cost to the process.

Despite the general effectiveness of formed films as fluid transporters, there is a need to ensure that the surface of the film that faces the wearer can be wetted by the fluid. U.S. 4,456,570 to Ethyl (now expired) describes the use of a surfactant, and corona discharge, to reduce the run off from a formed film topsheet. Claim 1 reads:

> "*1. A method of preparing a perforated sheet comprising polymeric material utilizing non-welded screens comprising the steps of:*
>
> *(a) shaping into the form of a sheet, a resin selected from the group consisting of polyethylene and copolymers of ethylene and propylene, and blended therewith an effective small amount of a polarizable migrating surfactant up to about 10 percent by weight of the resin;*
>
> *(b) perforating said sheet utilizing a non-welded screen;*
>
> *(c) subjecting at least one surface of the perforated sheet to corona discharge treatment; and,*

> *(d) recovering a perforated plastic sheet having a percent run off from zero to less than about ten percent*."

The use of surface energy gradients to direct fluid using what is in fact (though not mentioned explicitly) the "Marangoni" effect is exemplified by U.S. 6,231,948 to P&G. It is worth quoting the first claim verbatim also:

> "*1. A web having first and second surfaces, said web comprising:*
>
> *(a) a plurality of fluid passageways placing said first and second surfaces in fluid communication with one another; and*
>
> *(b) a plurality of microscopic, spaced regions disposed on said first surface, said regions having a first surface energy which is lower than a second surface energy of the remainder of said web, a difference between said first and second surface energies defines a surface energy gradient which is adapted to exert a force on fluid contacting said first surface, such that said fluid will be directed toward said fluid passageways for transportation away from said first surface and in the direction of said second surface*."

Note the use of regions defined on the first surface to describe the situation of lower surface energy on the first surface.

U.S. 6,024,049 has a very similar claim to the above. Coatings that yield lower surface energy are also claimed in dependent claims.

> *"1. An apertured, three-dimensional, macroscopically-expanded, formed film web having first and second surfaces, said web comprising:*
>
> *(a) a plurality of fluid passageways placing said first and second surfaces in fluid communication with one another, each of said fluid passageways having an entrance in said first surface, said first surface including land areas between said fluid passageways, said land areas including a plurality of microscopic surface aberrations thereon; and*
>
> *(b) a plurality of microscopic, discontinuous, spaced regions of said web, said spaced regions comprising depositions of a low surface energy material, at least a portion of which are located on said land areas between said microscopic surface aberrations, said spaced regions having a first surface energy that is less*

than a second surface energy of the remainder of said land areas, a difference between said second surface energy and said first surface energy defines a first surface energy gradient between said spaced regions and the remainder of said land areas which exerts a force on fluid contacting said first surface to direct said fluid toward and into said fluid passageways for transportation away from said first surface and in the direction of said second surface."

Other P&G patents that build on the surface energy concept are:

- U.S. 6,180,052 discloses a method for making a web of the type described above. A ductility difference between the first and second layers exposes the difference between surface energies after forming of the film.

- U.S. 6,353,149 to P&G discloses and claims the use of a fast blooming surfactant to generate a surface energy gradient to drive the transport of fluid.

- U.S. 6,461,716 to P&G uses a two layer system in which one layer is of a hydrophilic polymer and one a hydrophobic polymer. This makes the hydrophilicity gradient permanent.

- U.S. 6,291,050 to P&G describes the use of a hydrophobic additive to achieve improved fluid handling characteristics. An article is claimed that uses the topsheet with said additive.

- U.S. 6,025,535 claims a fluid pervious web that comprises fibers, and a low surface energy masking composition.

Note that a hydrophilicity gradient is claimed in the context of a second transport layer by KC in U.S. 4,798,603. KC did not, however, put the surface energy gradient into the one material. The first claim to '603 reads:

1. An absorbent article, comprising:

an absorbent body composed of a substantially hydrophilic material which is capable of absorbing liquid;

a liquid permeable topsheet layer superposed in facing relation with said absorbent body and having an effective average pore size therein;

a liquid permeable transport layer located between said topsheet layer and said absorbent body, and composed of a material which is less hydrophilic than said absorbent body, said transport layer having an effective average pore size therein which is smaller than said topsheet layer pore size.

McNeil has a recent patent, U.S. 6,570,055 that claims a topsheet with a combination of a hydrophilic and a lyophilic additive. Claim 1 reads:

1. A polymeric film material useful as a body-side liner of an absorbent article, the film material comprising an apertured polymeric film web having disposed thereon an additive combination comprising:

a) about 10 to about 90 wt-% of a hydrophilic agent; and

b) about 90 to about 10 wt-% of a lyophilic agent;

wherein the film material exhibits a sinking basket test time of less than about 25 seconds.

Note that later claims in this patent are directed towards use of the film in tampons, where the lubricity of the lyophilic additive is an advantage.

Uni Charm addresses the problem of the need to hide menstrual fluid in U.S. 6,517,925 By claiming a three layer structure that is a fibrous layer in between two film layers. (The first claim is very long and needs careful study in the context of the disclosure to understand what is really being claimed.)

The problem of viscous fluid with formed film topsheets tends to be limited to the field of sanitary napkins, in which case the fluid viscosity being handled is that seen in menses during a typical menstrual cycle. P&G addresses the issue of multiple viscosities by claiming a range of hole sizes in U.S. 5,998,696. The claim 1 reads:

*"1. An **absorbent article** comprising a **topsheet,** a backsheet, and an absorbent structure placed between said **topsheet** and said backsheet, said **topsheet** having a wearer facing surface and a garment facing surface and said **topsheet** comprising a film passage layer having small, medium, large and extra-large apertures for liquid transport,*

said small apertures have an individual area in the range from more than 0 mm.sup.2 to 0.1 mm^2,

> *said medium apertures have an individual area in the range from more than 0.1 mm.sup.2 to 0.5 mm^2,*
>
> *said large apertures have an individual area in the range from more than 0.5 mm.sup.2 to 1.4 mm^2,*
>
> *said extra-large apertures have an individual area in the range from more than 1.4 mm.sup.2 to 3 mm^2,*
>
> *said small apertures have a total open area in the range from 0.1% to 5% of the total area of said film passage layer,*
>
> *said medium apertures have a total open area in the range from 1% to 35% of the total area of said film passage layer,*
>
> *said large apertures have a total open area in the range from 1% to 30% of the total area of said film passage layer,*
>
> *said extra-large apertures have a total open area in the range from 1% to 25% of the total area of said film passage layer,*
>
> *said liquid transport apertures have a largest inner diagonal length and a smallest inner diagonal length, the ratio of said largest to said smallest inner diagonal length is in the range from 1 to 6."*

"x-y" Direction Fluid Control

Basic x-y direction flow control can come simply from putting holes in the topsheet only where the fluid is to flow through. U.S. 4,908,026 to Kimberly Clark claims an absorbent article. The article comprises a topsheet that has perforations arranged in a central area. This is not the entire claim for the article, though, and a "flow zone control means" is also claimed, to control flow before fluid reached the core.

A body side cover with two materials is claimed in U.S. 5,533,991 to KC. One material is perforated, and goes in the fluid strike zone of the article, the other is a non woven with a rewet that is higher than that of the first material.

Sometimes the use of the word “means” is all that is needed to define how an invention should work. For example in U.S. 4,973,325 to KC, an article in claimed in which a two piece core is fed by a fluid transfer means that distributes the fluid in the x-y plane.

Basic x-y direction fluid control is also provided by the pattern of bonding of the topsheet to the core. Such a pattern is claimed in U.S. 6,231,555 to P&G. An unbonded region “more readily acquires fluids” than the surrounding unbonded region.

U.S. 6,117,523 also uses the overall lateral structure of the topsheet to direct fluid. This time by claiming an article that comprises a topsheet that has segments. One segment is an apertured film. If we consider just the part of the claim that concerns the structure of the topsheet we read:

> *a) a nonapertured nonwoven outer layer which is able to acquire liquids deposited thereon, said nonwoven outer layer having a pair of longitudinally oriented inner edges in a predetermined spaced apart relationship wherein the lateral separation between said inner edges defines the lateral width of said central zone,*
>
> *b) an apertured thermoplastic film layer having longitudinal edges, said apertured thermoplastic film layer being positioned beneath said nonwoven outer layer so that said nonwoven outer layer overlies said apertured thermoplastic film layer in said side zones and said apertured thermoplastic film layer is exposed in at least a portion of said central zone, at least a portion of said thermoplastic film layer being treated with surfactant, wherein*
>
> *c) said nonwoven outer layer and said apertured thermoplastic film layer are joined by a pattern of intermittent fusion bonds;*

Note the specific bonding pattern, and the surfactant treatment that is specific to the central zone.

A composite fabric structure with a liquid strikethrough region and a barrier region also appears in U.S. 6,049,024 to BBA.

> *“1. Coverstock for a disposable* ***absorbent article,*** *said coverstock comprising a nonwoven composite bonded fabric structure having a liquid transport region for strikethrough of liquid through the surface thereof bounded on at least one side*

thereof by a liquid barrier region, said liquid barrier region of said nonwoven composite bonded fabric structure comprising at least one discrete layer of fibers sufficient to provide liquid barrier, said at least one layer being bounded on each side thereof by at least one discrete layer of coarse synthetic polymeric continuous filaments."

This patent ('024) evidently had regions that are pervious and regions that are ipervious to fluid, both comprising fibers.

In the field of feminine sanitary products, U.S. 5,846,230 to P&G describes a sanitary napkin in which strips positioned under the topsheet and between the topsheet and the absorbent core are used to direct into the x-y direction of the pad any fluid that impinges on the pad from the wearer. In another example, U.S. 4,973,325 describes an absorbent article that controls fluid distribution in the article by means of the relative positioning of the absorbents in the article, and other objects such as baffles. U.S. 6,241,714 describes the use of an undulating strip of material that directs fluid that has passed through the topsheet towards the front and back of the napkin. U.S. 4,908,026 teaches the use of a flow zone control layer between the topsheet and absorbent core that directs fluid in the y direction before it impinges on the core.

U.S. 5,674,211 to Ekdahl (hereinafter '211) discloses a method that results in a laminate topsheet in which perforations are made by applying pressure across a laminate of a film and a non woven. Residue from the perforation step remains embedded in the non woven and prevents fluid from rewetting the surface of the film. The problem with reducing the invention of '211 to practice is that very high pressure differentials across the web would be required to simultaneously perforate a film and compress a non woven, compared to conventional polymer melt vacuum forming techniques that are known to those skilled in the art.

Recent art describes fluid management topsheets that utilize topsheets with more than one material distributed in the x-y plane of the topsheet. For example U.S. 5,533,991 to Kirby et al. describes a topsheet assembly that comprises two webs of differing structures and hence rewet values arranged in the x-y plane to provide some control over x-y plane fluid distribution. U.S. 5,961,505 to Coe et al. describes a similar type of structure.

The problem of side leakage in a narrow structure like a thong pantiliner is addressed in U.S. 6,526,239 to Tyco. The bonding pattern is in generally parallel lines along the length of the pantiliner.

The fluid acquisition system or layer can also be distinct from, but in fluid contact with the topsheet. Indeed, there appears to be a trend in that direction in recent patents to Tyco. For example, a fluid acquisition system for delivering fluid from the topsheet to the absorbent core is described in U.S. 6,509,513 to Glaug et. al., and assigned to Tyco. This system comprises two layers, the layer below the topsheet is an apertured film, and the layer that delivers fluid to the absorbent core is a fibrous material. An article with a similar fluid acquisition system is described in U.S. 6,455,753 also to Tyco. U.S. 6,566,578 also claims an article with a fluid acquisition system. The fluid acquisition system itself comprises two layers – one an apertured film and one fibrous. Claim 1 is worth seeing in its entirety:

> *1. A disposable absorbent article arranged to be worn by a wearer to trap and collect fluid waste products of the wearer, said article being suitable accommodating multiple insults of said fluid waste products, said article comprising a top-sheet, a fluid acquisition system, and a fluid absorbent core, said top sheet having a portion forming a fluid intake zone, said top sheet portion being formed of a fluid pervious material, said fluid acquisition system comprising a first fluid acquisition layer and a second fluid acquisition layer, said first fluid acquisition layer comprising an apertured film, said second fluid acquisition layer comprising a fibrous, fluid pervious material, said absorbent core comprising a fluid absorbing material suitable for accommodating multiple insults of the fluid waste product, said first acquisition layer being coextensive in size and substantially coextensive in area with said second acquisition layer and located over said second acquisition layer and under said fluid intake zone of top-sheet, said second acquisition layer being located under said first acquisition layer and over said absorbent core and being secured to said first acquisition layer by one of the group consisting of adhesives, ultrasonic bonding, heat sealing, hot knife slitting, hydroentanglement and physical stitching, said first acquisition layer having a plurality of small apertures tapering in a direction toward said core.*

If we parse through this claim a little (or at least just rewrite part of it in more than one sentence). The fluid acquisition system has two layers. One is an apertured film, and one is a fibrous fluid pervious material. The second layer is attached to the core. The core being suitable for multiple insults, the shape of the apertures must be tapered towards the core, but nothing is said about the material of construction of any of the materials, or their degree of hydrophilicity. Expect to see the word “small” as a qualifier of apertures defined in the disclosure somewhere.

In another example of a fluid management system that is distinct from the topsheet in what is essentially a diaper, U.S. 6,186,992 to P&G describes an article that manages viscous bodily waste by using an acquisition element and a storage element. The best way to explain this concept is to quote from claim 1.

> *"1. An absorbent article having a first waist region, a second waist region opposed to the first waist region and a crotch region disposed between the first waist region and the second waist region, the absorbent article comprising:*
>
> *a liquid pervious topsheet;*
>
> *a liquid impervious backsheet joined to at least a portion of the topsheet;*
>
> *an absorbent core disposed between at least a portion of the topsheet and*
>
> *the backsheet, and*
>
> *a waste management element disposed in at least a portion of the crotch region, the waste management element including:*
>
> *an acceptance element having an Acceptance Under Pressure value of greater than about 0.50 grams of a viscous fluid bodily waste per square inch of the acceptance element per millijoule of energy input an wherein said acceptance element comprises a netting, and*
>
> *a storage element having a Storage Under Pressure value of at least about 0.70 grams of the viscous fluid bodily waste per square inch of the storage element, wherein said storage element comprises a three-dimensional web having arcuate portions intermittent with bondable locations."*

Note that the terms whose meanings are not immediately obvious in this claim should be defined in the disclosure. The netting seems to be an important element of the invention.

All inventions that use distribution layers or strips of some kind to direct fluid after it has passed through the topsheet suffer from the disadvantage that they have to accept fluid at whatever x-y coordinates it happens to have passed through the topsheet. Their fluid management performance is also limited to the rate at which the topsheet passes fluid in the z direction. So, for example, if the fluid has been able to spread on the topsheet before passing through, the stain left by the fluid on the topsheet will be larger than it would if the fluid has been directed through the topsheet in the z direction only. The appearance of such a stain can be unacceptable to users of the napkin, and also residual fluid on the topsheet makes the napkin uncomfortable to wear. The latter problem can be particularly acute for wearers of napkins with non woven topsheets which do not have the same z direction fluid transmittability as formed film topsheets.

A structure that enhances x-y distribution of fluid is described in U.S. 6,348,253 to Daley et al., and assigned to Kimberley Clark. A pad is claimed that comprises a “rapid intake cover” that is adjacent a coapertured intake / distribution and transfer delay layer. The whole assembly is adjacent to an absorbent core.

In some cases inhibition of x-y flow may be more important than promotion of such flow. U.S. 6,492,574 to Kimberly Clark provides for a wicking barrier. The claim is for an absorbent article that contains an absorbent core, with the core comprising the wicking barrier.

U.S. 6,572,599 to SCA uses barriers in the form of pockets to limit x-y flow from the core.

Viscous Flow

Problems with fluid flow are particularly acute with discharge that is viscous or semisolid, and may not be able to be passed quickly into the pores that exist for fluid transport in existing non woven or formed film topsheets. Such discharge will sit on the surface of the topsheet for several seconds before being taken up and passed into the absorbent zone. This problem is the subject of WO 99/55273, mentioned *supra*, to Busam, in which low viscosity fecal material is handled by a double topsheet structure, in which both layers are apertured. The apertures in the two layers must also be aligned in this invention, and this requirement makes implementation of the invention difficult.

Other examples of art that are specifically directed to the problem of handling viscous flow include U.S. 4,397,644 to KC, which provides a “transfer portion” positioned between the absorbent core and the topsheet to enhance transport of viscous fluids in menses, such as mucous. In another example, U.S. 4,798,603 to Meyer et al. discloses an absorbent article that includes a transport layer between the topsheet and absorbent core. The transport layer facilitates z direction fluid transport, and in being less hydrophilic than the core, inhibits fluid from returning from the core to the topsheet.

Other patents that may mention handling viscous flow are mentioned in the text.

List of Patents Cited

Number	Assignee	Technology
3,945,386	Domtar	Perforated sheet between topsheet and core.
3,965,906	Colgate Palmolive	Perforated sheet on topsheet surface.
3,994,299	ditto	Ditto
4,324,247	P&G	Capillaries between topsheet and core.
4,397,644	KC	Transfer “portion” for viscous fluid.
4,456,570	Ethyl	Surface energy with surfactant and corona discharge.
4,798,603	KC	Liquid transport layer / surface energy gradient.
4,908,026	KC	Localized perforations.
4,973,325	KC	x-y fluid transfer means.
5,342,338	P&G	Secondary topsheet traps fecal material.
5,500,270	P&G	Laminate with capillary zone.
5,533,991	KC	Bodyside cover with x-y structure.
5,674,211	Mölnlycke	Method for vacuum forming a laminate.
5,846,230	P&G	x-y direction control using strips.
5,961,505	P&G	x-y control.
5,998,696	P&G	Multi sized holes in formed film.
6,024,049	P&G	Surface energy gradient.
6,025,049	P&G	Surface energy gradient.
6,025,535	P&G	Surface energy gradient in fibrous structure.
6,049,024	BBA	x-y regions in fabric topsheet.
6,117,523	P&G	Segmented topsheet.
6,180,052	P&G	Surface energy gradient.
6,186,992	P&G	Waste storage region for fecal material.
6,231,555	P&G	Bonded and unbonded regions.
6,231,948	P&G	Surface energy gradient.

6,232,521	P&G	Surface energy gradient in multiplayer structure.
6,241,714	KC	Undulating distribution strip.
6,242,074	Tredegar	Fibers attached to formed film.
6,274,218	Uni Charm	Apertured fibrous layers of different densities.
6,291,050	P&G	Hydrophobic additive.
6,348,253	KC	Coapertured inake and distribution layer.
6,353,149	P&G	Surface energy gradient by fast blooming surfactant.
6,369,292	KC	
6,383,441	Uni Charm	Perforating topsheet with water.
6,436,518	Clemson	Bundle of fibers of different types.
6,437,214	KC	Core with two layer regions.
6,440,114	P&G	Fecal management layer.
6,455,753	Tyco	Fluid acquisition system.
6,461,716	P&G	Surface energy gradient by multiplayer structure.
6,492,574	KC	x-y control using wicking barrier.
6,509,513	Tyco	Fluid acquisition system.
6,517,925	Uni Charm	Three layer structure.
6,526,239	Tyco	Thong pantiliner with strips.
6,545,197	P&G	Topsheet with backing and anchored fibers.
6,566,578	Tyco	Fluid acquisition system.
6,570,055	McNeil	Hydophilic + lyophilic additives.
6,572,599	SCA	x-y control with pockets.