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Multi-ply/single ply embossed absorbent paper products
Ein- oder mehrlagiges, saugfähiges geprägtes Papierprodukt
Produit papetier absorbant gaufré mono- ou multi-couche

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Proprietor: GEORGIA-PACIFIC CORPORATION
Atlanta
Georgia 30303 (US)

Inventors:
- Kershaw, Thomas N.
  Neenah, WI 54956 (US)
- Gracyalny, Dale T.
  Appleton, WI 54914 (US)

Representative: Weber, Thomas et al
Patentanwälte
von Kreisler-Selting-Werner,
Postfach 10 22 41
50462 Köln (DE)

References cited:
EP-A- 0 806 520
US-A- 5 328 565

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Description

TECHNICAL FIELD

[0001] The invention relates to embossed absorbent paper products, for example, paper towels, tissue and napkins, in which an improved embossing arrangement is used which is particularly suitable for embossing paper products which have been processed so as to include undulations in the sheet.

BACKGROUND OF THE INVENTION

[0002] Absorbent paper products, such as paper towels, napkins and toilet tissue are widely used on a daily basis for a variety of household needs. These products are commonly produced by depositing cellulosic fibers suspended in water on a moving foraminous support to form a nascent web, removing water from the nascent web, adhering the dewetted web to a heated cylindrical Yankee dryer, and then removing the web from the Yankee with a creping blade which, in conventional processes, imparts crepe bars, ridges or undulations whose axes extend generally transversely across the sheet (the cross-direction). Products produced in this conventional fashion may often be considered lacking in bulk, appearance and softness and so require additional processing after creping, particularly when produced using conventional wet pressing-technology. Absorbent sheet produced using the through air drying techniques normally have sufficient bulk but may have an unattractive appearance or undesirable stiffness.

[0003] To overcome these deficiencies, an overall pattern is imparted to the web during the forming and drying process by use of a patterned fabric having designs to enhance appearance. Further, through air dried tissues can be deficient in surface smoothness and softness unless strategies such as calendering, embossing, chemical softeners and stratification of low coarseness fibers on the tissue’s outer layers are employed in addition to creping.

[0004] Conventional absorbent paper products produced by wet pressing are almost universally subjected to various post-processing treatments after creping to impart softness and bulk. Commonly such tissues are subjected to various combinations of both calendering and embossing to bring the softness and bulk parameters into acceptable ranges for premium quality products. Calendering adversely affects bulk and may raise tensile modulus, which is inversely related to tissue softness. Embossing increases product caliper (bulk) and can reduce modulus, but lowers strength and can have a deleterious effect on surface softness. Accordingly, it can be appreciated that these processes can have adverse effects on strength, appearance, surface smoothness and particularly thickness perception since there is a fundamental conflict between bulk and calendering.

[0005] In U.S. Patent Nos. 5,656,134; 5,685,954; and 5,885,415 to Marinack et al. (hereinafter the Marinack et al. patents), the disclosure of which is incorporated by reference as if fully set forth herein) it was shown that paper products having highly desirable bulk, appearance (including reflectivity) and softness characteristics, can be produced by a process similar to conventional processes, particularly conventional wet pressing, by replacing the conventional creping blade with an undulatory creping blade having a multiplicity of serrated creping sections presenting differentiated creping and rake angles to the sheet. Further, in addition to imparting desirable initial characteristics directly to the sheet, the process of the Marinack et al. patents produces a sheet which is more capable of withstanding calendering without excessive degradation than a conventional wet pressed tissue web.

[0006] Accordingly, using a creping technique it is possible to achieve overall processes which are more forgiving and flexible than conventional existing processes. In particular, the processes of Marinack et al. can be used to provide not only desirable premium products including high softness tissues and towels having surprisingly high strength accompanied by high bulk and absorbency, but also to provide surprising combinations of bulk, strength and absorbency which are desirable for lower grade commercial products. For example, in commercial (away-from-home) toweling, it is usually considered important to put quite a long length of toweling on a relatively small diameter roll. In the past, this has severely restricted the absorbency of these commercial toweling products as absorbency suffered severely from the processing used to produce toweling having limited bulk, or more precisely, the processing used to increase absorbency also increased bulk to a degree which was detrimental to the intended application.

[0007] The process and apparatus of the Marinack et al. patents makes it possible to achieve surprisingly high absorbency in a relatively non-bulky towel thus providing an important new benefit to this market segment. Similarly, many webs of the present invention can be calendered more heavily than many conventional webs while still retaining bulk and absorbency, making it possible to provide smoother, and thereby softer feeling, surfaces without unduly increasing tensile modulus or unduly degrading bulk. On the other hand, if the primary goal is to save on the cost of raw materials, the tissue of the present invention can have surprising bulk at a low basis weight without an excessive sacrifice in strength or at low percent crepe while maintaining high caliper. Accordingly, it can be appreciated that the advantages of the present invention can be manipulated to produce novel products having many combinations of properties which previously were impractical.

[0008] The objective of the undulatory creping blade of Marinack et al. is to work the web more effectively than previous creping arrangements. That is, the serrations of the creping blade operate to contact the web rotating off of the dryer in such a way that a part of the web con-
tacts the tops of the serrulations while other parts of the base sheet contact the valleys, thereby forming undulations in the base sheet. This creping operation effectively breaks up the hydrogen and mechanical bonds which link the cellulosic fibers together, thereby producing a smoother, bulkier and more absorbent sheet, which is well suited for consumer use. Creping in accordance with the Marinack et al. patents creates a machine direction oriented shaped sheet which has higher than normal stretch in directions other than the machine direction, that is, particularly high cross-direction stretch.


[0010] While the paper products produced with an undulatory creping blade have commercially desirable properties, additional processing in the form of embossing can further add to the properties and appeal of the products. Such embossing can enhance the bulk, softness and appearance of the products. It has been found that the proper selection of emboss element spacing, distribution and orientation can positively impact on the retention or enhancement of the beneficial properties caused by the creping of the web with an undulatory blade. Conversely, improper selection of the emboss element spacing, distribution and orientation can negatively impact, or cause a complete loss of, the beneficial properties caused by the creping of the web with an undulatory blade.

[0011] Undulatory blade creping creates a machine direction oriented shaped sheet which has higher than normal stretch in the directions other than the machine direction. The present invention recognizes and takes this three dimensional sheet shape and stretch into consideration. The application of embossing to the biaxially undulatory sheet is done in a way that the emboss process provides the desired modifications to the sheet with controlled extension and disruption of the localized bonds and fiber shapes imparted by the undulatory blade creping. In order to determine the parameters for embossing for sheets processed with an undulatory creping blade certain test embossings were made: when a relatively large size Quilt emboss was applied to undulatory blade creped base sheets made with a number of different blades (tooth spacings being different) unsatisfactory interference patterns are seen. This is a direct result of the relative spacing of the local shape and cross-direction stretch in the sheet to the spacing of the points of application of the force due to the embossing process. At the other extreme, when a very busy and tight spacing of emboss patterns are applied to undulatory blade creped base sheets, most if not all of, the benefits of the undulatory creping is lost.

[0012] In accordance with the present invention there were established parameters for embossing webs that have undulations extending longitudinally along a principal undulatory axis and optionally include secondary undulations which extend in the cross (transverse direction) of the web. The parameters must accommodate: the distance at which the undulations are spaced, the total surface area of the design (embossing) elements, the width and length of the embossing elements and the aspect ratio of the elements, and the angular orientation of the embossing elements with respect to the undulations.

[0013] It is an object of the present invention to provide processing to provide multi-ply paper products that have improved appearance, bulk and strength.

[0014] It is another object of the present invention to provide embossing parameters which are compatible with paper webs that have been produced with an undulatory structure.

[0015] The embossing parameters of the present invention are applicable to paper webs having undulations running in either the machine or cross-directions regardless of the means used to apply the undulations to the web.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] For a better understanding of the invention reference is made to the following drawings which are to be taken in conjunction with the detailed description to follow:

Figure 1 illustrates schematically the creping, calendering and embossing of a paper web which may be utilized in accordance with the present invention;

Figures 2 and 3 illustrate the front and back of an undulatory creping blade used to crepe a web to be embossed in accordance with the embossing parameters of present invention;

Figure 4 illustrates the appearance of a biaxially undulatory web that is to be embossed in accordance with the embossing parameters of present invention;

Figures 5(a) and 5(b) are photographs of the surface of a conventional absorbent sheet with an emboss pattern, Figure 5(a) is a photograph at 4X magnification, while Figure 5(b) is a photograph at 6X magnification;

Figures 6(a) and 6(b) are photographs of the surface of an embossed absorbent sheet with a pattern in accordance with the present invention, Figure 6(a) is a photograph at 4X magnification, while Figure 6(b) is a photograph at 6X magnification;

Figures 7(a) and 7(b) are photographs at 6X magnification of the surface of an embossed absorbent sheet with a pattern in accordance with the present invention, the embossments of Figure 7(a) were produced by steel to steel embossing rollers, while the embossments of Figure 7(b) were produced by steel to rubber embossing rollers;
Fibers for use according to the present invention can be obtained from recycling of pre-and post-consumer paper products. Fiber may be obtained, for example, from the recycling of printers trims and cuttings, including book and clay coated paper, post consumer paper including office and curbside paper recycling and old newspaper. The various collected papers can be recycled using means common to recycled paper industry. The papers may be sorted and graded prior to pulping in conventional low-, mid-, and high-consistency pulpers. In the pulpers the papers are mixed with water and agitated to break the fibers free from the sheet. Chemicals common to the industry may be added in this process to improve the dispersion of the fibers in the slurry and to improve the reduction of contaminants that may be present. Following pulping, the slurry is usually passed through various sizes and types of screens and cleaners to remove the larger solid contaminants while retaining the fibers. It is during this process that such waste contaminants as paper clips and plastic residuals are removed.

The pulp is then generally washed to remove smaller sized contaminants consisting primarily of inks, dyes, fines and ash. This process is generally referred to as deinking. Deinking, in the modern sense, refers to the process of making useful pulp from wastepaper while removing an ever-increasing variety of objectionable, noncellulosic materials. One example of a deinking process by which fiber for use in the present invention can be obtained is called floatation. In this process small air bubbles are introduced into a column of the furnish. As the bubbles rise they tend to attract small particles of dye and ash. Once upon the surface of the column of stock they are skimmed off. At this point the pulp may be rel-
To increase the brightness the furnish (pulp) is often bleached. Bleaching can be accomplished by a number of means including, but not limited to, bleaching with chlorine, hypochlorite, chlorine dioxide, oxygen, peroxide, hydrosulfite, or any other commonly used bleaching agents. The types and amounts of bleaching agents depend on the nature of the wastepaper being processed and upon the desired level of brightness. Generally speaking, unbleached waste papers can have brightness levels between 60 to 80 on the G.E. brightness scale, depending upon the quality of the paper being recycled. Bleached waste papers can range between the same levels and may extend up to about 90, however, this brightness level is dependent upon the nature of the waste papers used. The particular brightness level selected will likewise depend on the product desired.

The creping process is illustrated in Figure 1. In the process, a web of single-ply paper tissue sheet 20 is creped from the surface of a Yankee dryer 22 using an undulatory creping blade 24. Creping blade 24 imparts to the sheet undulations which extend in the longitudinal direction (machine direction) in addition to transverse crepe bars as is discussed and illustrated in detail to follow. Optionally, creped sheet 20 may be calendered by passing it through the nip of a pair of calender rolls 26a and 26b which impart smoothness to the sheet while reducing its thickness. After calendering, the sheet is wound on reel 28. To emboss sheet 20 it is unwound from reel 28 in a converting operation and passed through the nip of a pair of embossing rollers 30a, 30b. Thereafter sheet 20 proceeds to further process steps such as perforating, cutting the sheet into the widths suitable for end users and winding of same unto tubes.

As long as embossing rollers 30 are capable of carrying out embossing according to the parameters of the present invention, rollers 30 may be of either the matched or unmatched type and can be of either steel or rubber. Matched embossing rollers means that the male embossing elements, carried by one roller, are engraved first and the female elements carried by the other rollers are subsequently made from the male elements, or vice versa, so that both elements are virtually inverse or reciprocal images of each other within the practicabilities of manufacturing tolerances. This is in contrast to unmatched embossing rollers in which the male and female embossing elements are not identical in shape, but still are positioned relative to each other in registry such that they engage.

The present invention is applicable to uncreped as well as to both dry and wet creping processes. In a dry creping process, the moisture content of the web when it contacts undulatory creping blade 24 is usually in the range of 2 to 8 percent which permits the web to be calendered and wound on reel 28. In a wet creping process the consistency of the web contacting undulatory creping blade 24 is usually in the range of 40 to 75 percent (solids content). After the creping operation, the drying process is completed by use of one or more heated dryers through which the web is wound. These dryers are used to reduce the water content to its desired final level, usually from 2 to 8 percent. The dried sheet is then optionally calendered and wound on reel 28.

Figures 2 and 3 illustrate a portion of undulatory creping blade 24 which extends indefinitely in length, typically exceeding 100 inches in length and often reaching over 26 feet in length to correspond to the thickness of the Yankee dryer on the larger modern paper machines. In contrast, the thickness of blade 24 indicated at 25 is usually on the order of fractions of an inch. As illustrated in Figures 2 and 3, an undulatory cutting edge 34 is defined by serrulations 36 disposed along, and formed in, one edge of blade 24 so that an undulatory engagement surface 38, engages Yankee dryer 22 during use. The shape of undulatory cutting edge 34 strongly influences the configuration of the creped web, in that the peaks and valleys of serrulations 36 form undulations in web 20 whose longitudinal axes lies along the machine direction. The number of serrulations 36 can range from 10 to 50 per inch depending upon the desired number of undulations per inch in the finished web.

Figure 4 is a close up illustration of the configuration of web 20 after it has been creped by the action of an undulatory creping blade such as that shown in Figures 2 and 3, but before being embossed. Web 20 is characterized by a recticulum of intersecting crepe bars 39 extending transversely in the cross-direction which are formed during the creping of web 20 from Yankee dryer 22. As is seen at right edge shown in Figure 4, crepe bars 39 form a series of relatively small undulations 40 whose longitudinal axes extend in the cross-direction. The action of serrations 36 of crepe blade 24 form a series of larger undulations 42 whose longitudinal axes extend in the machine direction, each undulation 42 includes an upwardly disposed portion (peak) 44 and a downwardly disposed portion (valley) 46. As is seen at lower edge 48 shown in Figure 4, undulations 42 extend in the machine direction and are larger than undulations 40 formed by creped bars 39 extending in the cross-direction. Thus, web 20 has undulations running in both the machine and cross-direction forming a biaxially undulatory web. The present invention provides embossing parameters which enhance the desirable properties of the web shown in Figure 4. It will be appreciated by one of skill in the art that the absorbent sheet in accordance with the invention may be provided with an undulatory structure or a biaxially undulatory structure such as is shown in Figure 4 by any suitable technique for making absorbent sheet. One technique, used in both creped and uncreped through-air drying processes involves wet-shaping the web or sheet on a fabric. There is disclosed, for example, a method of forming tissue in United States Patent No. 5,607,551 to Farington, Jr. et al. wherein the
functions of providing machine direction stretch and cross machine direction stretch are accomplished by providing a wet end rush transfer and a particular through air drying fabric design respectively. The process according to the ’551 patent does not include a Yankee dryer or creping; however, this process may be used to provide undulatory structures useful in connection with the present invention. The disclosure of United States Patent No. 5,607,551 is hereby incorporated by reference. Absorbent sheet with undulatory structures may also be prepared in the absence of wet-end pressing or undulatory creping. There is disclosed, for example, in United States Patent No. 3,994,771 to Morgan, Jr. et al. a sheet provided with an undulatory pattern by knuckling a thermally pre-dried web onto a Yankee dryer followed by creping the sheet off the Yankee dryer. This process may likewise be employed to prepare an undulatory substrate for embossing in accordance with the present invention. The disclosure of United States Patent No. 3,994,771 is here-in incorporated by reference in its entirety into this application.

[0027] There is shown in Figures 5(a) and 5(b) a conventional absorbent sheet with an emboss pattern. The sheet has a generally smooth finish and does not include undulations extending longitudinally in the machine direction. Figure 5(a) is a photograph at 4X magnification of the surface, while Figure 5(b) is a photograph at 6X magnification of the surface of the sheet. The embossments cover more than about 50 percent of the surface area. In Figures 5(a) and 5(b), the machine direction is the shorter (vertical) direction, while the longer dimension (horizontal) is in the cross-direction of the sheet. Figures 6(a) through 8(b) are similarly oriented as discussed in more detail hereinafter.

[0028] There is shown in Figures 6(a) and 6(b) an embossed absorbent sheet with an emboss pattern useful in connection with the present invention. Figure 6(a) is a photograph of a portion of the sheet at 4X magnification, while Figure 6(b) is a photograph of the sheet at 6X magnification. In both cases, the machine direction of the sheet is in the vertical (shorter) direction of the photograph, while the cross-direction of the sheet is in the larger (horizontal) direction. It will be appreciated from the photographs that the sheet has an undulatory structure in the machine direction, crepe bars in the cross-direction, as well as a floral emboss pattern made up of a plurality of design elements.

[0029] The design elements of Figures 6(a) and 6(b) can be characterized as follows: there is an upper circular portion having an aspect ratio of approximately 0, thus having an angle with the machine direction of 0; a central stem portion having an aspect ratio of roughly 3, also having an angular relation to the machine direction of 0° and a leaf portion having an aspect ratio of about 1.5, having a characteristic angle with the machine direction of about 25° to about 35°. As will be appreciated from the discussion which follows, the sheet may also be described as having primary undulations extending along a principal undulatory axis of the sheet (in this case the machine direction), as well as having secondary undulations substantially perpendicular to the primary undulations (in this case the cross-direction of the sheet) such that the sheet is biaxially undulatory. This structure is conveniently provided by way of an undulatory creping blade as noted above, but may also be accomplished in connection with wet shaping or fabric molding.

[0030] There is shown in Figure 7(a) a photograph of another sheet provided with an emboss pattern useful in connection with the invention, wherein the photograph is at 6X magnification and there is provided a plurality of repeating hexagonal embossments in accordance with the invention. Here again, the machine direction of the sheet is the vertical (shorter) side of the photograph, while the cross-direction of the sheet is the longer (horizontal) side of the photograph. The sheet of Figure 7(a) was produced with matched steel embossing rolls. Two features to note in connection with the sheet of Figure 7(a) are: (1) the embossments have relatively “soft” edges due to local elongation and the longitudinal undulations are offset laterally by the embossments.

[0031] Yet another sheet having a pattern useful in connection with the present invention is shown in Figure 7(b) which is also a photograph at 6X magnification of a sheet in accordance with the present invention. The machine direction is, here again, in the shorter (vertical) direction of the photograph and the cross-direction is along the longer (horizontal) side of the photograph, as mounted. The sheet of Figure 7(b) is, in most aspects, similar to the sheet of Figure 7(a); however, the edges of the embossments are sharp. The sheet of Figure 7(b) was made by way of rubber to steel embossing. Here again, the embossments are operative to laterally displace the vertical or machine direction undulations due to movement allowed by cross-direction stretch.

[0032] Still yet another absorbent sheet with an emboss pattern which may be used in accordance with the present invention appears in the photographs of Figures 8(a) and 8(b). Figure 8(a) is a photograph at 6X magnification, while Figure 8(b) is a photograph of the sheet of Figure 8(a) at 4X magnification. In both cases, the machine direction is along the shorter edge of the photograph, with the cross-direction being perpendicular thereto. The embossments are arranged in a plurality of diamond-like arrays, repeating over the surface of the sheet. The 0 individual embossments have an aspect ratio of about 1.5 and one spaced at a distance of about 1.5 times the separation distance between longitudinal undulations as further described below.

[0033] Figure 9 depicts schematically a portion of a floral design element 50 such as a petal shown on Figures 6(a) and 6(b) including a first elongate embossment 52 opposing a second elongate embossment 54. The embossments are provided on a base sheet indicated generally at 56 provided with a plurality of undulations 58, 60, 62 which repeat over the surface of sheet 56. The undulations extend in the machine direction 64 of the
Design element 50 has a characteristic maximum width, 66, also labeled W in the figure and a characteristic maximum length, L, indicated at 68. The aspect ratio, L:W, is characteristically from about 1 to about 4. Length, L, is disposed about a direction, L'; indicated at 70 which is at an angle, θ, shown at 72, with the machine direction (MD) 64.

Longitudinal undulations such as undulations 58-62 cover the base sheet in a repeating pattern typically with a frequency of from about 1 to about 50 undulations per inch, thus spaced at a plurality of crest to crest distances, S1, S2, S3, indicated at 74, 76, 78 typically in some embodiments at slightly more than a millimeter; 1.5 millimeters or so also being typical. S1, S2 and S3 may be the same in the case of uniform spacing, or may differ if so desired. In the case of non-uniform spacing, the respective distances may be averaged when compared with emboss distances and design element widths.

While embossments 52, 54 may define a design element of an embossing pattern applied in accordance with the present invention, the design elements may also be in the form of embossed shapes, such as hexagons, diamonds, square, ovals, rectangular structures and the like which are uniformly repeating over the surface of the sheet or are provided in clusters. Most preferably, the emboss design elements have an aspect ratio, L:W, greater than 1 and are aligned in the machine direction such that θ is 0.

The invention is further exemplified and described with reference to Figures 10 through 12.

Figure 10 depicts the embossed sheet of Figures 6(a) and 6(b). The sheet 80 has a plurality of longitudinal undulations 82, 84, 86 and so forth extending in the machine direction 88. A flower design element 90 is essentially circular, having an aspect ratio of 1 and making an angle θ with the machine direction 88 of 0. The central stem design element 92 also extends along the machine direction (θ=0°) and has an aspect ratio of roughly 3. A leaf design element, 94, has an aspect ratio of roughly 1.5 and makes an angle θ with the machine direction of between about 25° and 35°. It should also be noted that sheet 80 is a creped sheet having repeating crepe bars 96, 98, 100 and so forth in the cross-direction. The longitudinal undulations have a frequency of about 20 undulations per inch, while the frequency of the crepe bars is much higher.

There is shown in Figure 11 embossed sheet of Figures 7(a) and 7(b) indicated at 102. Sheet 102 has a plurality of design elements in the form of embossed hexagons 104, 106, 108 and so forth which repeat over the surface of the sheet as shown. Longitudinal undulations are provided at a frequency of about 20 undulations per inch. Interestingly, some of the undulations, such as longitudinal undulations 110 conform to a serpentine shape in the machine direction due to the embossments. This is believed due to the property of relative high cross-direction stretch of the inventive embossed sheets. Thus, the design elements may be continuously embossed shapes such as hexagons.

Figure 12 shows the sheet of Figures 8(a) and 8(b) at 112. Hence, the emboss pattern of the invention is embodied in diamond-like clusters 114 of elongate embossments 116 having a collective aspect ratio of about 1. Individual embossments 116 have an aspect ratio of 1.5 and a width, W, of about 1 mm. The longitudinal undulations are spaced at 20 per inch, thus having a spacing, S, of about 1.3 mm. The individual embossments are spaced at a distance, D, of about 1.4 mm. Thus, the ratio of D:S is about 1 or more.

Figure 13 is an illustration schematically depicting one means for carrying out embossing in accordance with the present invention in connection with a multiple ply web. In this embodiment first and second plies are prepared and creped so as to include the machine direction undulations described in detail above. In Figure 13 a first paper ply 120 is conveyed past a series of idler rollers 122 towards a nip 123 located between a steel engraved roll 124 and a rubber roll 126 where ply 120 will be embossed as set forth in detail above. Engraved roll 124 rotates in a clockwise direction while rubber roll 126 rotates in a counterclockwise direction. A second tissue ply 128 is conveyed around idler rollers 132 and is then passed to a nip 133 located between a rubber roll 134 and an engraved roll 124 where ply 128 will be embossed. Thereafter second ply 128 winds around engraved roll 124 where it passes through nip 123 located between steel engraved roll 124 and rubber roll 126 wherein plies 120, 128 will be joined together into a two ply product 136 which is conveyed by idler rollers 138 to take-up reel 140. The use of an arrangement with two separate nips, whose pressure can be independently adjusted, permits the embossing depth of each ply to be different from that of the other.

Figure 14 illustrates machinery for simultaneously carrying out the embossing and bonding of the plies. However, the bonding and embossing operations need not be carried out simultaneously. Figure 14 illustrates apparatus in which the bonding of the plies and the embossing is carried out in separate operations. In Figure 14 a first supply reel 150 provides a first ply 152 of paper processed so as to include machine direction...
undulations and a second supply reel 154 provides a second ply 156 of paper including machine direction undulations. Plies 152, 156 pass to a nip 158 formed between a pair of bonding rolls 160, 162 which are constructed in the known manner so as to bind plies 152, 156 together. If required a glue applying roll 163 will apply a film of glue to ply 152 to positively bind the plies together. After passing through nip 158 the now two ply web 164 proceeds to a nip 166 formed between embossing rolls 168, 170 for embossing of two ply web 164 in accordance with the principles of the present invention. Embossing rolls 168, 170 may again be constructed from steel or resilient materials and may be matched or unmatched. After embossing, two ply web 164 may proceed to further processing steps such as perforating, cutting into consumer widths and winding onto rolls.

[0044] Figure 15 illustrates an arrangement in which the embossing of the plies is carried out prior to the bonding of the plies together. In Figure 15 a first supply reel 180 provides a first ply 182 of paper which is processed so as to impart undulations as described in detail above. First ply 182 then passes through a nip formed between a first pair 184, 186 of embossing rolls for embossing in accordance with the principles of the present invention. A second supply reel 188 provides a second ply 190 of paper which includes the machine direction undulations as described above. Second ply 190 then passes through a nip formed between a second pair 192, 194 of embossing rolls for embossing in accordance with the present invention. Thereafter ply 182 and ply 190 pass to the nip formed by a pair of confronting binding rolls 196, 198 for binding into a two ply web 200. If required a glue roller 202 can be utilized to apply a film of glue between plies 182, 190 before binding. Embossing rolls 184, 186, 192, 194 may also be constructed from steel or resilient materials and may be matched or unmatched. After embossing, two ply web 200 may proceed to further processing steps such as perforating, cutting into consumer widths and winding onto rolls.

[0045] During the binding of two or more paper plies together each ply may be displaced in the cross direction so that the "peaks" of the undulations of one ply are either bound with the peaks or the "valleys" of the undulations of the other ply. In this manner the peaks of one ply are arranged to nest in the valleys of the other ply a relatively dense two ply web will be formed. If, on the other hand, the peaks and valleys of one ply are opposed to the peaks and valleys of the other ply a very thick, soft two ply web will be formed. In this manner the density of the two ply web can be readily controlled, depending on the application for which the paper product is intended. While the foregoing examples have been directed to two ply arrangements it is to be understood that the principles of the present development are equally applicable to three or more ply webs. It should also be noted that each of the plies of the webs need not be processed to include machine direction undulations such as those produced by an undulatory creping blade as one or more plies of a multiple ply web can be free of undulations and free of embossments.

[0046] There is thus provided in accordance with the present invention a multi-ply absorbent sheet provided with primary undulations extending along a principal undulatory axis of the sheet, the primary undulations being laterally spaced apart a distance, S, while the single-ply absorbent sheet is provided with an emboss pattern comprising a plurality of design elements wherein up to about 50 percent of the surface area of said absorbent sheet is embossed. The sheet is characterized in that each design element of the emboss pattern has a characteristic emboss element lateral width, W, and a characteristic emboss element, length, L, along a direction L' and wherein the ratio of W:S for each design element is from about 1 to about 4. More typically, the ratio of W:S for each design element is from about 1.5 to about 3, and usually the aspect ratio, L:W for each design element is at least about 1.1. An aspect ratio, L:W for each design element is at least about 1.2 is preferred in some cases, but may be from about 1.1 to about 4, or from about 1.2 to about 2.5.

[0047] The direction, L', makes an angle θ of less than about 45 degrees with the principle undulatory axis of the sheet in preferred cases while instances wherein L', makes an angle θ of less than about 30 degrees with the principal undulatory axis of the sheet are preferred. An aspect ratio, L:W for each design element of about 1 is preferred in some embodiments.

[0048] In biaxially undulatory embodiments the sheet is provided with secondary undulations substantially perpendicular to the primary undulations such that the secondary undulations extend along a secondary undulatory axis of the sheet. In such cases, the sheet may have from about 10 to about 50 primary undulations per inch extending along the principal undulatory axis and from about 10 to about 150 secondary undulations per inch extending along the secondary undulatory axis of said sheet. In particularly preferred embodiments, the sheet has from about 12 to about 25 primary undulations extending along the principal undulatory axis of the sheet.

[0049] In some embodiments, the secondary undulations have a frequency greater than that of said primary undulations and the sheet includes a creped ply wherein the primary undulations extend in the machine direction of the ply and are longitudinally extending undulations. The ply may have from about 10 to about 150 crepe bars per inch extending in the cross-direction of the ply, and may be prepared with an undulatory creping blade operative to form the longitudinally extending undulations. Here, also, the creped ply has from about 10 to about 50 longitudinally extending undulations per inch, and more typically, from about 12 to about 25 longitudinally extending undulations per inch. The crepe bars likewise have a frequency greater than that of the longitudinally extending undulations; generally with a frequency of the crepe bars from about 2 to about 6 times the frequency of the longitudinally extending undulations. More typically, the
frequency of the crepe bars is from about 2 to about 4 times the frequency of the longitudinally extending undulations.

[0050] Preferably, the emboss pattern does not substantially alter the cross-direction stretch of the absorbent sheet from which the embossed absorbent sheet was prepared. Preferably, the cross-direction stretch of the sheet is from about 0.2 to about 0.8 times the machine direction stretch of the sheet, whereas a cross-direction stretch of the sheet from about 0.35 to about 0.8 times the machine direction stretch of said sheet is more preferred.

[0051] The distance between design elements, D, is greater generally than S, typically from about 1.5 to about 3 times S. The design elements have an emboss depth of from about 15 to about 30 mils in many cases and from about 10 to about 25 percent of the surface area of the sheet is embossed.

[0052] The absorbent sheet may be a tissue product having a basis weight of from about 5 to about 40 pounds per 3,000 square foot ream, or a towel product having a basis weight of from about 15 to about 45 pounds per 3,000 square foot ream. In any case, the sheet may be prepared utilizing recycle furnish.

[0053] In another aspect of the present invention there is provided a multi-ply sheet provided with primary undulations extending along a principal axis of the sheet, the primary undulations are laterally spaced apart a distance, S, and the single-ply absorbent sheet being further provided with an emboss pattern comprising a plurality of embossments of width, W, and length, L, wherein the lengths are along a direction, L', and wherein the embossments cover no more than about fifty percent of the area of said absorbent sheet. The embossments are spaced apart from each other at a distance, D, with the proviso that at least one of the ratios of W:S and D:S is from about 1 to about 4. More typically, at least one of the ratios of W:S and D:S is from about 1.5 to about 3.5, and the embossments cover no more than about 25 percent of the surface area of the sheet. The ratio of cross-direction stretch to machine direction stretch is from about 0.2 to about 0.5, whereas from about 0.35 to about 0.5 is more typical. In preferred embodiments, the principal undulatory axis is along the machine direction of said sheet, and the primary undulations are non-compacted relative to the other portions of the sheet.

[0054] In another aspect of the invention, there is provided a method of making a multi-ply absorbent sheet comprising: preparing a plurality of absorbent plies, and bonding the plies, where the sheet includes a plurality of primary undulations extending along a principal undulatory axis of the sheet, said undulations being spaced apart a distance, S; and providing an emboss to said sheet, wherein said emboss pattern comprises a plurality of design elements wherein up to about 50 percent of the surface area is embossed, characterised in that said design elements have a characteristic design element width, W, and a characteristic emboss length, L, along a direction, L', and wherein the ratio of W:S for each design element is from about 1 to about 4. The sheet may include at least one unembossed ply if so desired and at least one of the plies may be embossed prior to bonding the plies. In other embodiments, the multi-ply absorbent sheet is embossed simultaneously with the bonding of said plies or the sheet is embossed subsequent to the bonding of the plies. Furthermore, the sheet may be a biaxially undulatory sheet with secondary undulations extending in a direction substantially perpendicular to the principal undulatory axis. In preferred embodiments, the process includes at least one creped ply.

[0055] In accordance with the invention, there is provided a method of providing an absorbent ply in a multi-ply absorbent product comprising: preparing a web comprising cellulosic furnish; applying the web to a Yankee dryer; creping the web from the Yankee dryer with an undulatory creping blade at a consistency of between about 40 and about 98 percent, such that the creped ply is provided with crepe bars extending laterally in the cross-direction and undulations extending longitudinally in the machine direction, said undulations being spaced apart a distance, S; embossing the ply with an emboss pattern comprising a plurality of design elements wherein up to about 25 percent of the area of the absorbent ply is embossed, characterized in that each design element of said emboss pattern has a characteristic emboss element lateral width, W, and wherein the ratio of W:S for each design element is from about 1 to about 4; and incorporating said ply into said multi-ply absorbent product.

[0057] The ply may be embossed prior to being incorporated into the multi-ply absorbent product or the ply may be embossed subsequent to being incorporated into said multi-ply absorbent product. Most preferably, the ply is embossed simultaneously with being incorporated into the multi-ply absorbent product.

Claims

1. A single-ply or multi-ply absorbent sheet provided with primary undulations (40) extending along a principal undulatory axis of said sheet, said primary undulations (40) being laterally spaced apart a distance, S (58, 60, 62), said single-ply or multi-ply absorbent sheet being provided with an emboss pattern comprising a plurality of design elements (90, 92, 94) wherein up to 50 percent of the surface area of
said absorbent sheet is embossed, characterised in that each design element of said emboss pattern (52, 54) has a characteristic emboss element lateral width, W (66), and a characteristic emboss element length, L (68), along a direction L' and wherein the emboss elements are spaced apart from each other at a distance, D, and wherein at least one of the ratios of W:S and D:S is from 1 to 4.

2. A single-ply or multi-ply sheet provided according to claim 1 wherein W:S is from 1 to 4.

3. A single-ply or multi-ply absorbent sheet according to any preceding claim, wherein said sheet is provided with secondary undulations (42) substantially perpendicular to said primary undulations (40) such that said sheet is a biaxially undulatory sheet with secondary undulations (42) extending along a secondary undulatory axis of said sheet.

4. A method of making a multi-ply absorbent sheet comprising:

preparing a plurality of absorbent plies (152, 156, 182, 190) comprising at least one biaxially undulatory ply, and

bonding said plies (152, 156, 182, 190) to each other,

wherein said biaxially undulatory ply includes a plurality of primary undulations (40) extending along a principal undulatory axis of this sheet, said undulations being spaced apart a distance, S (74, 76, 78); and

providing an emboss pattern (52, 54) to said sheet, wherein said emboss pattern comprises a plurality of design elements (50, 90, 92, 94) wherein up to 50 percent of said surface area is embossed, characterised in that said design elements (50, 90, 92, 94) have a characteristic design element width, W (66), and a characteristic emboss element length, L (68), along a direction, L' (70), and wherein the ratio of W:S for each design element is from 1 to 4.

5. A method of making a single-ply absorbent sheet comprising:

preparing a web (20) comprising cellulosic furnish;

drying the web (20) to form said absorbent sheet (20);

providing said sheet (20) with primary undulations extending along a principal undulatory axis of the absorbent sheet, said undulations being spaced apart a distance, S (58, 60, 62); and

embossing the sheet with an emboss pattern comprising a plurality of design elements (50, 90, 92, 94) wherein up to 50 percent of the surface area of said sheet is embossed, characterised in that each design element (50, 90, 92, 94) of said emboss pattern has a characteristic emboss element width, W (66), and a characteristic emboss element length, L (68), along a direction, L' (70), and wherein the ratio of W:S for each design element is from 1 to 4.

6. A method of making a single-ply embossed absorbent sheet according to claim 5 or of providing an absorbent ply in a multi-ply absorbent product according to claim 4, which method comprises:

preparing a web (20) comprising cellulosic furnish;

applying said web (20) to a Yankee dryer (22); creping said web (20) from said Yankee dryer with an undulatory creping blade (24) at a consistency of between 40 and 98 percent, such that said creped sheet (20) or ply is provided with crepe bars (39) extending laterally in the cross-direction (96, 98, 100) and undulations (40, 82, 84, 86) extending longitudinally in the machine direction, said undulations (40) being spaced apart a distance, S (58, 60, 62);

embossing said sheet or ply with an emboss pattern comprising a plurality of design elements (90, 92, 94, 50) wherein up to 50 percent of the area of said absorbent sheet or ply is embossed, characterised in that each design element of said emboss pattern has a characteristic emboss element lateral width, W (66), and wherein the ratio of W:S for each design element (50, 90, 92, 94) is from 1 to 4; and

if desired, incorporating said ply into said multi-ply (152, 154, 182, 190) absorbent product.

7. A method according to any of claims 4 to 6, wherein said cellulosic furnish comprises synthetic fiber.

8. A method according to any of claims 4 to 7, wherein said cellulosic furnish comprises non-cellulosic material.

Patentansprüche

1. Einlagige oder mehrlagige absorbierende Bahn, die mit primären Wellungen (40) versehen ist, die sich entlang einer Hauptwellungsachse der Bahn erstrecken, wobei die primären Wellungen (40) lateral mit einem Abstand S (58, 60, 62) voneinander be- abstandet sind, wobei die einlagige oder mehrlagige absorbierende Bahn mit einem Prägemuster versehen ist, das eine Mehrzahl von Designelementen (90, 92, 94) umfasst, wobei bis zu 50 % der Oberflächen der absorbierenden Folie geprägt sind, durch gekennzeichnet, dass jedes Designele-
des Prägemusters (52, 54) eine charakteristische Prägelleichtelement-Lateralbreite W (66) und eine charakteristische Prägelleichtelement-Länge L (68) entlang einer Richtung L' aufweist und wobei die Prägeelemente mit einem Abstand D voneinander beabstandet sind und wobei wenigstens eines der Verhältnisse W:S und D:S von 1 bis 4 beträgt.

2. Einlagige oder mehrlagige Bahn nach Anspruch 1, wobei W:S von 1 bis 4 beträgt.

3. Einlagige oder mehrlagige absorbierende Bahn nach einem der vorhergehenden Ansprüche, wobei die Bahn mit sekundären Wellungen (42) versehen ist, die im Wesentlichen senkrecht zu den primären Wellungen (40) sind, so dass die Bahn eine biaxial gewellte Bahn mit sekundären Wellungen (42) ist, die sich entlang einer zweiten Wellungsschase der Bahn erstrecken.

4. Verfahren zur Herstellung einer mehrlagigen absorbierenden Bahn, umfassend:

   das Herstellen einer Mehrzahl von absorbierenden Lagen (152, 156, 182, 190), umfassend wenigstens eine biaxial gewellte Lage, und das Verbinden der Lagen (152, 156, 182, 190) miteinander, wobei die biaxial gewellte Lage eine Mehrzahl von primären Wellungen (40) einschließt, die sich entlang einer primären Wellungsschase dieser Bahn erstrecken, wobei die Wellungen um einen Abstand S (74, 76, 78) voneinander beabstandet sind, und das Bereitstellen eines Prägemusters (52, 54) auf der Bahn, wobei das Prägemuster eine Mehrzahl von Designelementen (50, 90, 92, 94) einschließt, wobei bis zu 50 % der Oberfläche geprägt sind, dadurch gekennzeichnet, dass jedes Designelement (50, 90, 92, 94) eine charakteristische Prägeelement-Lateralbreite W (66) und eine charakteristische Prägeelement-Länge L (68) entlang einer Richtung L' (70) aufweisen und wobei das Verhältnis W:S für jedes Designelement von 1 bis 4 beträgt.

5. Verfahren zur Herstellung einer einlagigen absorbierenden Bahn, umfassend:

   das Herstellen einer Cellulose-Eintrag umfassenden Bahn (20), das Trocknen der Bahn (20) unter Bildung der absorbierenden Bahn (20), das Versehen der Bahn (20) mit primären Wellungen, die sich entlang einer Haupt-Wellungssache der absorbierenden Bahn erstrecken, wobei die Wellungen um einen Abstand S (58, 60, 62) voneinander beabstandet sind, und das Prägen der Bahn mit einem Prägemuster, das eine Mehrzahl von Designelementen (50, 90, 92, 94) umfasst, wobei bis zu 50 % der Oberfläche der Bahn geprägt sind, dadurch gekennzeichnet, dass jedes Designelement (50, 90, 92, 94) des Prägemusters eine charakteristische Prägeelement-Lateralbreite W (66) und eine charakteristische Prägeelement-Länge L (68) entlang einer Richtung L' (70) aufweist und wobei das Verhältnis W:S für jedes Designelement von 1 bis 4 beträgt.

6. Verfahren zur Herstellung einer einlagigen, geprägten, absorbierenden Bahn nach Anspruch 5 oder zur Bereitstellung einer absorbierenden Lage in einem mehrlagigen absorbierenden Produkt nach Anspruch 4, wobei das Verfahren Folgendes umfasst: die Herstellung einer Cellulose-Eintrag umfassenden Bahn (20), das Aufbringen der Bahn (20) auf einen Yankee-Trockner (22), das Kreppen der Bahn (20) vom Yankee-Trockner mit einer gewellten Kreppschaber Klinge (24) bei einer Konsistenz zwischen 40 und 98 %, so dass die gekreppte Bahn (20) oder Lage mit Kreppfalten (39), die sich lateral in der Querrichtung (96, 98, 100) erstrecken, und Wellungen (40, 82, 84, 86), die sich longitudinal in Maschinenrichtung erstrecken, versehen wird, wobei die Wellungen (40) mit einem Abstand S (58, 60, 62) voneinander beabstandet sind, das Prägen der Bahn oder Lage mit einem Prägemuster, das eine Mehrzahl von Designelementen (90, 92, 94, 50) umfasst, wobei bis zu 50 % der Oberfläche der absorbierenden Bahn oder Lage geprägt werden, dadurch gekennzeichnet, dass jedes Designelement des Prägemusters eine charakteristische Prägeelement-Lateralbreite W (66) und eine charakteristische Prägeelement-Länge L (68) entlang einer Richtung L' (70) aufweisen und wobei das Verhältnis W:S für jedes Designelement von 1 bis 4 beträgt.

7. Verfahren nach einem der Ansprüche 4 bis 6, wobei der Cellulose-Eintrag synthetische Faser umfasst.


Revendications

1. Feuille absorbante monocouche ou multicouches dotée d’ondulations primitives (40) s’étendant le long
d’un axe d’ondulation principal de ladite feuille, les dites ondułations primaires (40) étant latéralement espacées d’une distance S (58, 60, 62), ladite feuille absorbante monocouche ou multicouches étant dotée d’un motif gaufré comprenant une pluralité d’éléments de design (90, 92, 94), de telle sorte que jusqu’à 50 % de la superficie de ladite feuille absorbante est gaufrée, caractérisée en ce que chaque élément de design dudit motif gaufré (52, 54) présente une largeur latérale caractéristique d’élément gaufré W (66), et une longueur caractéristique d’élément gaufré L (68), le long d’une direction L’ et dans laquelle les éléments gaufrés sont espacés les uns des autres d’une distance D, et dans laquelle l’un au moins des rapports W:S et D:S est de 1 à 4.

2. Feuille absorbante monocouche ou multicouches selon la revendication 1, dans laquelle W:S est de 1 à 4.

3. Feuille absorbante monocouche ou multicouches selon l’une quelconque des revendications précédentes, dans laquelle ladite feuille est dotée d’ondulations secondaires (42) sensiblement perpendiculaires auxdites ondulations primitives (40), de telle sorte que ladite feuille est une feuille à ondulations biaxiales avec des ondulations secondaires (42) s’étendant le long d’un axe d’ondulation secondaire de ladite feuille.

4. Procédé pour produire une feuille absorbante multicouches, comprenant :

la préparation d’une pluralité de couches absorbantes (152, 156, 182, 190) comprenant au moins une couche à ondulations biaxiales, et le collage desdites couches (152, 156, 182, 190) les unes aux autres,

dans lequel ladite couche à ondulations biaxiales inclut une pluralité d’ondulations primitives (40) s’étendant le long d’un axe d’ondulation principal de la feuille, lesdites ondulations étant espacées d’une distance S (74, 76, 78) ; et

la réalisation d’un motif gaufré (52, 54) sur ladite feuille, dans lequel ledit motif gaufré comprend une pluralité d’éléments de design (50, 90, 92, 94) tels que jusqu’à 50 % de ladite superficie est gaufrée, caractérisé en ce que lesdits éléments de design (50, 90, 92, 94) ont une largeur caractéristique d’éléments de design W (66) et une longueur caractéristique de gaufrage L (68), le long d’une direction L’ (70), et dans lequel le rapport W:S pour chaque élément de design est de 1 à 4.

5. Procédé de fabrication d’une feuille absorbante monocouche, comprenant :

la préparation d’une nappe (20) comprenant une pâte cellulosique ;

le séchage de la nappe (20) pour former ladite feuille absorbante (20) ;

la réalisation sur ladite feuille (20) d’ondulations primitives s’étendant le long d’un axe d’ondulation principal de la feuille absorbante, lesdites ondulations étant espacées d’une distance S (58, 60, 62) ; et

le gaufrage de la feuille avec un motif gaufré comprenant une pluralité d’éléments de design (50, 90, 92, 94) tels que jusqu’à 50 % de la superficie de ladite feuille est gaufrée, caractérisé en ce que chaque élément de design (50, 90, 92, 94) dudit motif gaufré a une largeur caractéristique d’élément gaufré W (66) et une longueur caractéristique de gaufrage L (68), le long d’une direction L’ (70), et dans lequel le rapport W:S pour chaque élément de design est de 1 à 4.

6. Procédé de fabrication d’une feuille absorbante gaufrée monocouche selon la revendication 5, ou de fourniture d’une couche absorbante dans un produit absorbant multicouches selon la revendication 4, le dit procédé comprenant :

la préparation d’une nappe (20) comprenant une pâte cellulosique, l’application de ladite nappe (20) dans un séchoir de type yankee (22) ;

le crépage de ladite nappe (20) sortant dudit séchoir de type yankee avec une lame de crêpage ondulatoire (24) à une consistance entre 40 et 98 %, de telle sorte que ladite feuille (20) ou ladite couche crépée est dotée de nervures de crêpage (39) s’étendant latéralement dans la direction transversale (96, 98, 100) et d’ondulations (40, 82, 84, 86) s’étendant longitudinalement dans la direction de la machine, lesdites ondulations (40) étant espacées d’une distance S (58, 60, 62) ;

le gaufrage de ladite feuille ou de ladite couche avec un motif gaufré comprenant une pluralité d’éléments de design (90, 92, 94, 50) tels que jusqu’à 50 % de la superficie de ladite feuille ou de ladite couche absorbante est gaufrée, caractérisé en ce que chaque élément de design dudit motif gaufré a une largeur latérale caractéristique d’élément gaufré W (66), et dans lequel le rapport W:S pour chaque élément de design (50, 90, 92, 94) est de 1 à 4 ; et

si désiré, l’incorporation de ladite couche dans ledit produit absorbant multicouches (152, 154, 182, 190).

7. Procédé selon l’une quelconque des revendications 4 à 6, dans lequel ladite pâte cellulosique comprend des fibres synthétiques.
8. Procédé selon l'une quelconque des revendications 4 à 7, dans lequel ladite pâte cellulosique comprend un matériau non cellulosique.