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(71) Applicant: SCOTT PAPER COMPANY
Industrial Highway Tinicum Island Road
Delaware Pennsylvania(US)

(72) Inventor: Anderson, Ralph L
4 Glover Drive Boothwyn
Pennsylvania 19061(US)

(72) Inventor: Grossman, Stephen R.
411 N.Stiles Avenue Maple Shade
New Jersey 08052(US)

(74) Representative: McCall, John Douglas et al,
W.P. THOMPSON & CO. Coopers Building Church Street
Liverpool L1 3AB(GB)

(54) **Absorbent dry-formed fibrous web.**

(57) There is disclosed an absorbent dry-formed fibrous web characterized in that a preponderance, by weight, of the fibres are fine wood pulp fibres of a paper-making length no greater than about 6.35mm. (1/4 in.); these fine wood pulp fibres having experienced a freeness decrement of at least 150 by mechanical working.

EP 0 094 842 A1

DESCRIPTION

ABSORBENT DRY-FORMED FIBROUS WEB.

This invention relates generally to fibrous absorbent webs, and more specifically to a dry-formed fibrous web having improved wipe dry properties.

It is well known in the papermaking art to form paper webs of enhanced strength by mechanically beating the wood pulp fibres prior to web formation. This beating operation reduces the freeness level of the fibres, and in many cases actually fibrillates the fibres to form fibre segments that interconnect with each other to establish a strong web structure. A representative process for fibrillating cellulosic fibres, prior to forming a web therefrom, is disclosed in U.S. Patent No. 3,382,140, issued to Henderson et al.

When wood pulp fibres are beaten to a substantial degree, and their freeness level thereby reduced, the web formed therefrom generally is quite dense. This type of a web has provided an excellent substrate for forming glazed paper, as is disclosed in U.S. Patent No.2,999,786, issued to Downs et al.

In summary, it is well known to fibrillate wood pulp fibres preparatory to forming a strong, dense, wet-laid sheet. While these sheets are known to be desirable for use as printing papers, wrapping papers and for other end uses in which high strength and/or high density is required, forming such a dense, strong sheet for subsequent use as a feed mat to be fiberized in an airlay web forming process has been considered undesirable. Specifically, the high strength construction of such mats is known to interfere with the ability to substantially individualize, or separate the fibres therefrom in the fiberizing operation; a result that needs to be achieved in

order to form a substantial clump-free web. Accordingly, people skilled in the airlay art would not think (or want) to decrease the freeness level of wood pulp fibres employed to form feed mats intended to be utilized in an airlay process. To the best of applicants' knowledge, feed mats formed from highly beaten wood pulp fibres have not been employed in any airlay, or similar dry-forming process to form absorbent fibrous web structures.

According to the present invention there is provided an absorbent dry-formed fibrous web characterized in that a preponderance, by weight, of the fibres are fine wood pulp fibres of a papermaking length no greater than about 6.35 mm (1/4 inch) and having a coarseness of less than 20 milligrams/100 metres, said find wood pulp fibres having experienced a freeness decrement of at least 150 by mechanical working. This magnitude of reduction in the freeness level of the wood pulp fibres is considered necessary in order to achieve the beneficial results of the invention.

Applicants have discovered that, contrary to prior teachings, wood pulp fibres having reduced freeness can be employed with great advantage in dry-formed fibrous webs. In particular, applicants have discovered that mechanically working the fibres to decrease their freeness, most preferably to a level less than 500, provides a significant increase in wipe-dry properties. However, the increase in wipe-dry properties is most pronounced when the mechanically worked wood pulp fibres are "fine" as opposed to being coarse.

For purposes of this invention reference to "fine wood pulp fibres" means fibres of a papermaking length no greater than about 6.35 mm (1/4 inch) and having a

coarseness of less than 20 milligrams/100 metres. These preferably are softwoods.

"Freeness level" or "freeness" in accordance with this invention, is determined by the Canadian standard for pulp freeness, TAPPI method T227 M-58.

The absorbent dry-formed webs of this invention have significant utility in forming household and industrial wipers, and more generally, for other end uses wherein enhanced wipe-dry properties are considered to be important. The basis weight of the dry-formed webs of this invention is preferably less than .1356 kg/m^2 (4oz/yd^2,) and most preferably is in the range of .0678 - .1356 kg/m^2 (2-4 oz/yd^2).

It is extremely important that a preponderance of the fibre composition, by weight, in the dry formed web be the fine, mechanically worked wood pulp fibres, since it is these fibres that are responsible for enhancing the wipe-dry property of the web. However, it is believed that a small percentage of the fibre composition, i.e. up to about 25-30% by weight, can be longer, staple length fibres introduced into the web for purposes of increasing strength. Webs including such longer fibres are known in the prior art, as exemplified by the disclosures in U.S. Patent Nos. 4,145,464 (McConnell et al) and 4,134,948 (Baker,Jr.). These latter patents are incorporated therein by reference.

In the most preferred embodiments of this invention an acrylic binder, or other suitable adhesive can be applied to stabilize the web. Most preferably the binder should constitute less than 5% of the total weight of the final web construction. It is desirable to keep the weight of binder as low as possible, consistent with desired web strength, so that the binder will not interfere unduly with the

absorbent properties of the web. The addition of too much binder to the web can actually mask, or counteract the effect achieved by the mechanical working operation.

In the most preferred embodiment (i.e. "best mode") of the invention, the fibrous web is formed by a conventional airlay web forming operation. Preferably the air-laid web includes a low-binder level, i.e. less than 5% of the total weight of the adhesively bonded construction.

In accordance with this embodiment of the invention one or more wood pulp laps, or mats can be directed into a fiberizing roll for separating individual fibres from the mats and directing them in an airstream onto a foraminous forming surface in the form of an air-laid fibrous web. Such a fiberizing technique is disclosed in U.S.Patent No.4,118,832, issued to Tralance O. Addy and David P. Gutman, and assigned to Scott Paper Company. This patent is incorporated herein by reference.

It also is envisioned that the air-laid web of this invention can include a minor amount, by weight, of longer staple length fibres, such as rayon, polyester and the like. A representative technique for forming such a web is disclosed in U.S.Patent No. 4,134,948, issued to John H. Baker, Jr. and assigned to Scott Paper Company. This patent already has been incorporated herein by reference.

Regardless of the type of air-laid web that is formed, wood pulp lap(s) processed through the fiberizing equipment, in accordance with this invention, is (are) formed of fine wood pulp fibres of a papermaking length no more than about 6.35 mm. Moreover, the fine wood pulp fibres utilized in this invention have experienced a freeness decrement, by

mechanical working, of at least 150; preferably by being treated in a conventional beater as part of the pulp lap forming operation.

As explained earlier, a pulp mat, or lap formed in accordance with the above technique is quite strong and dense, and extremely difficult to fiberize. In order to overcome this problem, a debonder has been added to the furnish prior to forming the lap. This has been found to interfere sufficiently with inter-fibre bonding to permit the desired separation of the individual fibres from the lap in the fiberizing operation. The debonder can be of any suitable type that does not excessively interfere with the absorbent properties of the web. In accordance with a preferred embodiment of the invention a benzyl chromium chloride debonder is employed.

After the individualized fibres are deposited on a forming surface in the form of an air-laid web, the web can be sprayed with adhesive on its opposed surfaces to stabilize the construction. If desired the web can be embossed, prior to adhesive application, in accordance with the process disclosed in the earlier-referenced Baker patent.

Applicants have found, quite surprisingly, that air-laid webs formed in accordance with this invention, whether embossed or not, have a significantly improved wipe-dry level, as compared to similar webs formed from the same type of fine wood pulp fibres, but in an unbeaten state, and also as compared to air-laid webs formed from beaten coarse fibres having a coarseness greater than 20 milli grams/100 metres. This is clearly exemplified by the data presented in Table 1.

The wipe-dry capability for liquid spills referred to in this application was determined by the following

procedure:

first, a sample of the web being tested was mounted on a padded surface of a sled (10 cm x 6.3 cm);

second, the sled was mounted on an arm designed to traverse the sled across a rotating disk;

third, the sled was weighted so that the combined weight of the sled and sample was about 768 grams;

fourth, the sled and traverse arm were positioned on a horizontal rotatable disk with the sample being pressed against the surface of the disk by the weighted sled (the sled and traverse arm being positioned with the leading edge of the sled (6.3 cm side) just off the centre of the disk and with the 10 cm centreline of the sled being positioned along a radial line of the disk so that the trailing 6.3 cm edge was positioned near the perimeter of the disk);

fifth, 0.5 millilitres of water was placed on the centre of the disk in front of the leading edge of the sled (sufficient surfactant was added to the water so that it left a film, rather than discrete droplets, when wiped). For this test a 0.1% Tergitol 15-S-15-solution (a nonionic surfactant available from Union Carbide) was used;

sixth, the disk, having a diameter of about 60 centimetres, was rotated at about 65 rpm while the traverse arm moved the sled across the disk at a speed of about 2 1/2 centimetres per second until the trailing edge of the sled crossed off the outer edge of the disk, at which point the test was stopped (about 15 seconds from start to finish of the test);

seventh, the wiping effect of the test sample upon the water solution was observed during the test as the sled wiped across the disk, (the wetted surface was observed and a wiped dry area appeared at the centre of the disk and enlarged radially on the disk);

eighth, at the moment the test was stopped (when the trailing edge of the sled passed off the edge of the disk) the size of the wiped dry area in square centimetres (if any) was observed.

The test was performed under constant temperature and relative humidity conditions (70°F ± 2° F, 65% relative humidity ± 2%). The test was repeated and the average of the wiped dry area observations (step 8) in square centimetres was defined as the wipe dry index for the sample being tested. To aid in the observation of the size of the area on the disk that was wiped dry by the test sample (steps 7 and 8), concentric circular score lines were provided on the surface of the disk corresponding to the 50, 100, 200, 300, 400, 500, 750 and 1,000 square centimetre circles so that the side of the dry area could be determined quickly by visually comparing the dry area to a reference score line representative of a known area.

The wipe dry index determined by the above-described test is believed to be accurate to a value of ± 50. Despite this range of error, a significant difference in the wipe dry property between webs being compared, from a technical standpoint, is reflected in a difference between their wipe dry indices that is greater than ± 50.

In Table 1 the reported difference between the wipe dry index of beaten and unbeaten Brunswick pine (a coarse fibre having a coarseness of greater than 20 milligrams/100 metres) is within the range of experimental error (± 50). Accordingly, when beating the coarse Brunswick pine to a freeness level of 450, a decrement of approximately 250 from the freeness level of about 700 for the initially purchased, or produced pulp, the change in wipe dry, if any, is regarded as technically insignificant. However, when webs formed

from unbeaten and beaten northern kraft fibres were tested for wipe dry, a significant wipe dry improvement was detected in the beaten samples. Northern kraft fibres are considerably less thick than Brunswick pine, and have a coarseness of approximately 18 milligram/100 metres. Note that the difference in wipe dry is statistically significant in both the embossed and unembossed web variants.

A further comparison was made with green pictou, a northeastern softwood fibre having a coarseness of approximately 13 milligram/100 metres. Again, comparing webs formed from beaten pictou fibres with webs fromed from unbeaten pictou fibres indicates that beating the fine wood pulp fibres has a significant impact on wipe dry.

In this invention the mechanically worked, fine wood pulp fibres are of a papermaking length no greater than about 6.35 millimetres. Preferably these fibres have a gradation in length down to about 1 millimetre or less, and includes a significant fraction, by weight, that is retainable on a 48 mesh screen when the fibre supply is subjected to the Bauer-McNett wet fractionation technique described in TAPPI standard T233os-75. In particular, about 16 to 25% of the fine wood pulp fibres, by weight, will be retained on the 48 mesh screen when the Bauer-McNett technique is carried out with a series of screens having the following sequential mesh sizes: 14, 28, 48 and 100.

In order to explore the mechanism that might be responsible for the improved wipe dry achieved in this invention, separate air-laid fibrous webs were formed from fine wood pulp fibres collected on each of the screens employed in the Bauer-McNett fractionation operation. Webs formed from both beaten and unbeaten

fibres collected on each of the screens were then compared; the results being reported in Table II.

Within the range of experimental error, it appears that very little can be concluded with respect to the effect of beating the various fractions, with the exception of the fraction collected on the 48 mesh screen. In this latter fraction a more than three-fold increase in wipe dry level was achieved in the embossed air-laid web, and a four-fold increase was achieved in the unembossed web.

From the above observation it appears that the fine wood pulp fibres of a papermaking length employed to form the webs of this invention should include a fibre fraction capable of passing through a 28 mesh screen, but being retainable on a 48 mesh screen. Reference in the claims to wood pulp fibres "of a papermaking length" refers to wood pulp fibres having such a fibre fraction; preferably constituting over 15% by weight of such wood pulp fibres.

TABLE 1

Fiber Composition*	Adhesive (% of total weight of bonded web)	Bulk Ratio (Thickness(mils)/ basis weight (lbs./ream))	Freeness (±50)	Wipe Dry Index (± 50) Embossed Variant	Wipe Dry Index (± 50) Unembossed Variant
Unbeaten Brunswick Pine	4.5	1.085	approx 700	55	25
Beaten Brunswick Pine	4.5	1.120	450	65	50
Unbeaten Northeast Kraft	4.5	1.105	approx 700	250	205
Beaten Northeast Kraft	4.5	1.000	450	425	1000+
Unbeaten Green Pictou	4.5	1.020	approx 700	225	300
Beaten Green Pictou	4.5	0.970	450	550	475

*(1) All samples have a basis weight of approximately 40 lbs/ream of 2,880 ft^2
(2) All samples include benzyl chromium chloride debonder

TABLE II

Bauer McNett Classification	Fiber Composition*	Adhesive (% of total weight of bonded web)	Bulk Ratio (Thickness(mils)/ Basis weight (lbs./ream))	Freeness (±50)	Wipe Dry Index (±50) Embossed Variant	Unembossed Variant
14 mesh layer	Unbeaten Green Pictou	4.5	1.15	approx 700	100	100
	Beaten Green Pictou	4.5	1.15	450	210	215
28 mesh layer	Unbeaten Green Pictou	4.5	1.10	approx 700	355	350
	Beaten Green Pictou	4.5	1.15	450	375	220
48 mesh layer	Unbeaten Green Pictou	4.5	1.16	approx 700	300	250
	Beaten Green Pictou	4.5	1.05	450	1000	1000
100 mesh layer	Unbeaten Green Pictou	4.5	1.03	approx 700	320	375
	Beaten Green Pictou	4.5	1.02	450	375	450

*(1) All samples have a basis weight of approximately 40 lbs./ream of 2,880 ft^2
(2) All samples include benzyl chromium chloride debonder

CLAIMS

1. An absorbent dry formed fibrous web characterized in that a preponderance, by weight, of the fibres are fine wood pulp fibres of a papermaking length, no greater than about 6.35 mm (1/4 inch) and having a coarseness of less than 20 milligrams per 100 metres, said fine wood pulp fibres having experienced a freeness decrement of at least 150 by mechanical working.

2. An absorbent web as claimed in claim 1, characterized by a binder being included on opposed surfaces thereof for stabilizing the construction.

3. An absorbent web as claimed in claim 1 or 2, characterized by said fine wood pulp fibres having a freeness of less than 500.

4. An absorbent web as claimed in any one of the preceding claims, characterized in that the fine wood pulp fibres includes over 15%, by weight, fibres that will pass through 14 and 28 mesh screens and be retainable on a 48 mesh screen when subjected to the Bauer McNett wet fractionation technique described in TAPPI standard T233os-75.

5. An absorbent web as claimed in any one of the preceding claims, characterized by said fine wood pulp fibres including northeast kraft fibres.

6. An absorbent web as claimed in any one of the preceding claims, characterized by a basis weight of less than .1356 kg/m^2 (4 oz/yd^2).

7. An absorbent web as claimed in any one of the preceding claims, characterized by an embossment establishing a plurality of spaced apart, compressed densified regions interspersed with lower density, higher loft regions.

8. An absorbent web as claimed in any one of the preceding claims, characterized by the fibre content being 100% wood pulp fibres.

9. An absorbent web as claimed in any one of the preceding claims, characterized in that all of said wood pulp fibres are said fine wood pulp fibres.

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European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 83 30 2821

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
A	US-A-3 809 604 (P.W. ESTES) * Whole document *	1,8	D 21 H 5/26 A 47 L 13/16
A	TAPPI J. TECHN. ASS. PULP PAPER IND., vol. 62, no. 12, December 1979, pages 91-94, Atlanta, GA, US H. KOLMODIN: "Thermomechanical pulp for dry-formed disposable products" * Page 93, table I *	1,3,8	
A	US-A-4 247 362 (J.C. WILLIAMS) * Claim 10 *	1,3,8	
D,A	US-A-4 134 948 (J.H. BAKER, JR.) * Whole document *	1,2,6, 7	
A	US-A-4 217 169 (S.V. BABURIN et al.) * Whole document *	1,8,9	TECHNICAL FIELDS SEARCHED (Int. Cl. ³) A 47 L D 21 H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	04-08-1983	NESTBY K.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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