A method for forming a low basis weight nonwoven web of randomly arranged, intermingled fibers including a major proportion by weight of short cellulose fibers of a papermaking length less than one-quarter inch, and a minor proportion by weight of longer reinforcing fibers having an average length greater than one-quarter inch. The method includes the steps of: (1) forming separate batts of the short cellulose fibers and the longer reinforcing fibers; (2) blending together the fibers in the batts in a randomly arranged and intermingled fashion; (3) conveying the blended fibers in a gaseous carrier medium to a foraminous support member; (4) passing the gaseous medium through the support member to condense the fibers on the support member into a fibrous feed mat having an average basis weight which is the greater of 12 oz/yd² and at least three times the average basis weight of the low basis weight fibrous web to be formed; (5) separating the fibers from the feed mat; (6) conveying the separated fibers in a gaseous carrier medium to a second foraminous support member; and (7) passing the gaseous medium through the second support member to condense the blended fibers on the second support member into the low basis weight nonwoven fibrous web.

3 Claims, 4 Drawing Figures
**Fig. 1**

BALED RAYON

RAYON OPENING

RAYON BATT FORMING

PULP LAP (ROLL OR SHEET)

PULP FIBERIZING

PULP BATT FORMING

RAYON BATT — PULP BATT BLENDING

BLENDED MAT FORMING

BLENDED WEB FORMING
3,862,472

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METHOD FOR FORMING A LOW BASIS WEIGHT NON-WOVEN FIBROUS WEB

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method for forming a non-woven fibrous web, and more specifically to a method for forming a low basis weight nonwoven fibrous web of randomly arranged, intermingled fibers including a major proportion by weight of short cellulosic fibers of a papermaking length less than one-quarter inch, and a minor proportion by weight of longer reinforcing fibers having an average length greater than one-quarter inch.

"Low-basis weight," as used in this application to describe the fibrous web, relates to an average basis weight in the range of from about 1 oz/yd² to about 6 oz/yd².

2. Description of the Prior Art

Low basis weight nonwoven fibrous webs formed predominately of short-length cellulosic fibers less than one-quarter inch, and including a minor proportion by weight of longer reinforcing fibers having an average length greater than one-quarter inch are becoming extremely popular. Such webs can be used by themselves, or in conjunction with other materials, as substitutes for conventional textile fabrics in articles such as disposable diapers, sanitary napkins, industrial wipers, household wipers, cosmetic pads and the like.

In one prior art approach to forming low basis weight nonwoven fibrous webs, separate batts of the short fibers and longer fibers are directed into a working station consisting of one or more pinned working rolls for separating the fibers and intimately blending them together. The blended fibers are then directed into the storage compartment of a Rando-Feeder, which is manufactured by the Curlator Company of Rochester, N.Y. The blended fibers are fed from the storage compartment of the Rando-Feeder by elevator and stripper aprons therein to a bridge section including a condenser roll with vacuum applied therethrough. A feed mat of the blended fibers is formed in the bridge section and is then directed into a Rando-Webber, which is also manufactured by the Curlator Company. The Rando-Webber employs a rotating lickerin roll to duff fibers from the feed mat, and these fibers are conveyed in a gaseous carrier medium through a duct to a foraminous support member. The gaseous medium passes through the support member, and the fibers are condensed thereon in the form of a low basis weight nonwoven fibrous web.

Employing a blending device in combination with a Rando-Feeder and Rando-Webber requires two separate fiber metering operations; one for achieving the desired blend ratio of long and short fibers to be directed into the Rando-Feeder, and one for achieving the desired feed mat weight in the bridge section of the Rando-Feeder. Metering for proper feed mat weight requires the regulation of elevator and stripper apron speeds, regulation of the level of vacuum applied through the condenser in the bridge section and regulation of condenser speed in said bridge section. Such an arrangement is not as desirable as one in which the fibers are blended and formed into a feed mat in one continuous operation, i.e., without storing the fibers in a storage compartment between the blending and feed mat forming operations.

Circulatory motion is imparted to the fibers by the action of the elevator and stripper aprons in the Rando-Feeder. This circulatory motion causes the formation of highly interangled clumps of fibers. In many instances, these clumps are not broken up during the formation of the fibrous web, and therefore, are included in the finished fibrous web. The inclusion of these clumps in the finished web results in unacceptable basis weight variations in both the cross-machine-direction and machine-direction. In addition, the presence of fibrous clumps in the finished web creates an aesthetically displeasing appearance.

The circulatory motion imparted to the fibers by the elevator and stripper aprons shakes the short fibers from the blend and deposits them in the trash chute of the Rando-Feeder. This causes a considerable wastage of short fibers.

Applicant has further discovered that the elevator and stripper aprons, aside from causing the formation of fibrous clumps, is an unacceptable feed means for directing a substantially uniform supply of fibers into the bridge section of the Rando-Feeder. Consequently, the feed mat formed in the bridge section has unacceptable variations in basis weight in both the cross-machine-direction and machine-direction. The unacceptable variations in basis weight in the feed mat result in the formation of a fibrous web which also has unacceptable variations in basis weight. Starting this another way, the uniformity in basis weight of the finished fibrous web is dependent, to a large extent, upon the uniformity in basis weight of the feed mat, and therefore, nonuniformity in the feed mat results in non-uniformity in the finished web.

A second prior art approach for forming low basis weight nonwoven fibrous webs eliminates the step of forming a feed mat. According to this approach, individual batts of the short cellulosic fibers and the longer reinforcing fibers are fed together in the form of a laminate directly into a web-forming device, such as a Rando-Webber. The web-forming device functions to separate the fibers from the laminate and blend them together. The blended fibers are conveyed in a gaseous carrier medium to a foraminous support member through which the gaseous carrier medium passes, and upon which the fibers are condensed into a low basis weight nonwoven fibrous web.

Applicant has found that it is extremely difficult to achieve acceptable basis weight variations in a low basis weight nonwoven fibrous web by omitting the intermediate step of forming a feed mat of blended fibers having a basis which is greater than 12 oz/yd² and at least three times the average basis weight of the fibrous web to be formed. To further explain, it is known in the air-laying art that basis weight variations can be more closely controlled at higher basis weight levels than at lower basis weight levels. Applicant has found that when uniform air flow conditions exist in the Rando-Webber, the percentage basis weight variation in the finished fibrous web is approximately the same as the percentage basis weight variation in the feed mat. Therefore, first forming a feed mat having a greater basis weight than the low basis weight nonwoven web to be formed permits better control in the formation of the low basis weight web than a process which omits the formation of the feed mat.

In addition, applicant has found that feeding a laminate of long and short fiber batts over the nose bar of
the Rando-Webber is difficult and unreliable. The laminate tends to jam and buckle as it is being directed by feed rolls over the nose bar to thereby cause machine downtime, and therefore increased production costs. The reason for this jamming and buckling is not understood.

A further disadvantage of forming a low basis weight nonwoven fibrous web directly from a laminate of short and long fiber batts is that an unacceptable number of unopened fiber clumps are formed in the web.

SUMMARY OF THE INVENTION

Applicant's invention resides in a process for forming low basis weight nonwoven fibrous webs in which separate fibrous barts of short cellulosic fibers of a papermaking length less than one-quarter inch and longer reinforcing fibers having an average length over one-quarter inch are directed into a fiberizing and blending device for forming a gaseous suspension of blended short and longer fibers; directing the gaseous suspension of blended fibers directly to a foraminous support member through which the gaseous carrier medium passes and upon which the fibers are condensed to form a blended fibrous feed mat, said feed mat having an average basis weight which is the greater of 12 oz./yd² and at least three times the average basis weight of the low basis weight fibrous web to be formed; feeding the fibrous feed mat directly into a web forming device in which the fibers of the feed mat are separated and blended; and conveying the blended fibers in a gaseous carrier medium to a second foraminous support member through which the gaseous carrier medium passes, and upon which the fibers are condensed to from the low basis weight nonwoven fibrous web.

In applicant's invention, the blended short and longer fibers are not directed into a storage compartment, such as the storage compartment of a Rando-Feeder. Therefore, fibers are not permitted to circulate in a storage area and form fiber clumps. In addition, the separation of large quantities of short fibers from the blend is eliminated.

In applicant's process, a feed mat of blended fibers having the desired weight is formed directly from a gaseous suspension of the blended fibers immediately after the short and longer fibers have been opened and blended. This continuous method of feed mat formation has been found to be highly superior to directing blended fibers into a storage compartment of a Rando-feeder, and then metering the fibers from the storage compartment into the bridge section to achieve a desired feed mat weight.

In applicant's process, a feed mat of blended fibers average basis weight which is the greater of 12 oz./yd² and at least three times the average basis weight of the fibrous web to be formed. Below this feed mat basis weight level a greater concentration of fiber clumps appears in the finished web. This creation of fiber clumps is believed to be caused by the action of the rotating lickerin roll in pulling clumps of fibers from the feed mat when an inadequate supply of fibers is directed to the lickerin roll.

Also, as explained earlier, when uniform air flow conditions exist in the Rando-Webber, the percentage basis weight variation in the low basis weight nonwoven fibrous web is approximately the same as the percentage basis weight variation in the feed mat from which it is formed. The percentage basis weight variation can be more easily minimized in a higher basis weight feed mat formed directly after blending the long and short fibers, than in a low basis weight nonwoven web formed directly after blending. Therefore, the instant invention of first forming a feed mat results in the formation of a low basis weight nonwoven fibrous web of greater uniformity than the prior art process of omitting the formation of a feed mat.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of the sequential process steps performed in forming a low basis weight nonwoven fibrous web according to a preferred method of this invention;

FIG. 2 is a schematic view showing apparatus for sequentially blending fibrous barts of the short and longer fibers, forming a blended feed mat, and forming a blended low basis weight nonwoven fibrous web from the feed mat;

FIG. 2a is an enlarged view of the blocked portion of FIG. 2 identified as 2a showing the fibrous barts of short and longer fibers as they are directed into the blending station according to one preferred method of this invention; and

FIG. 2b is an enlarged view of the blocked portion of FIG. 2 identified as ab showing the blended fibrous feed mat which is formed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

For the purpose of description, the method of this invention will be described in connection with the formation of a low basis weight fibrous web comprising predominately wood pulp fibers (short cellulosic fibers of a papermaking length less than one-quarter inch) and a minor proportion of longer rayon fibers (longer reinforcing fibers having an average length over one-quarter inch). Wood pulp is preferred as the short cellulosic fiber of papermaking length less than one-quarter inch because it is readily available, highly absorbent and relatively inexpensive. However, other short cellulosic fibers of a papermaking length, such as cotton linters, can be employed in the method of this invention.

Rayon is preferred as the longer reinforcing fiber because of low cost. The rayon fibers have an average length over one-quarter inch, and preferably over one-half inch. The upper length limitation is not critical, being dictated by the specific properties desired in the fibrous web. In the preferred embodiment of this invention the rayon employed is 1½ inch – 3 denier. Other long fibers (average length over one-quarter inch) can be used in this invention. The particular long fiber which is used is not critical to this invention.

Referring to FIG. 1, the process steps through "Rayon Batt-Pulp Batt Blending" have been practiced in the prior art. The present invention resides in the manner of handling the rayon batt-pulp batt blend through formation into a finished, low basis weight nonwoven fibrous web. However, the purpose of completeness, the process steps employed for forming the rayon batt-pulp batt blend will now be described.

Referring to FIG. 1, commercially available baled rayon is fed through a rayon opening step. Any suitable rayon opening equipment can be utilized; however, in the preferred embodiment of this invention the baled rayon is fed through a Rando-Feeder, which opens
the rayon slightly, and then through a Rando-Opener-Blender, which completes the opening operation. Both the Rando-Prefeed and Rando-Opener-Blender are manufactured by the Curlator Company of Rochester, N.Y. The opened rayon is then fed through a chute feed onto a conveyor for forming a fibrous batt of the rayon fibers. One chute feed which has been found to be satisfactory is the CMC-Evenfeed manufactured by CMC Corporation, of Charlotte, N.C. The rayon batt is a loosely compacted sheet of randomly arranged opened rayon fibers.

Pulp lap, whether in sheet or roll or form, is fiberized, i.e., separated into substantially individual fibers, in a fiberizing device, such as a Joa fiberizer manufactured by Joa, Inc. of North Wales, Fla. The specific fiberizer utilized does not form a limitation on the present invention, and can include other apparatus such as hammermills, disk refiners, and other fiberizers employing lickerin rolls. The fiberized wood pulp is conveyed in a gaseous medium (e.g., air) toward a foraminous conveyor through which the gaseous medium passes, and upon which a wood pulp batt of loosely compacted fibers is formed.

Referring to FIGS. 2 and 2a, the fibrous batt of rayon 10 is superposed upon the fibrous batt of wood pulp 12. The fibrous batts are directed into a blending device 14 which includes a central drum 16 having pins or teeth 18 projecting outwardly from the periphery thereof. In addition, the blending device 14 includes a plurality of satellite worker rolls 20 disposed about the periphery of the central drum 16, and these satellite rolls are provided with pins, teeth, or the like 22 which cooperate with the pins 18 on the central drum to separate fibers from the superposed batts of rayon and wood pulp, and intimately blend the separated fibers together.

The description provided thus far represents known technology in establishing substantially homogeneous blends of long and short fibers. The above sequentially described steps are preferred in applicant's invention, but can be modified. For example, the rayon opening step may be accomplished by the use of a single device, as opposed to utilizing the Rando-Prefeed and Rando-opener-Blender. Moreover, when long fibers other than rayon are utilized, the opening step may be omitted completely. In addition, the individual batts of long and short fibers need not be superposed upon each other prior to being directed into the blending device 14. It is possible to feed the batts separately into the blending device 14 from separate stations to accomplish the objective of forming a homogeneous blend of individualized long and short fibers. Moreover, equipment other than the above-described equipment can be utilized to achieve the objectives described thus far.

For example, the blending device 14 shown in FIG. 2 can be replaced by other types of devices. For example, the device described in U.S. Pat. No. 3,641,628, issued to Fehrer on Feb. 15, 1972, can be employed to blend fibers, or the fibers can be blended in a device employing a rotating lickerin roll, such as a Rando-Webber.

In applicant's invention a foraminous support member in the form of a cylindrical condenser roll 24, is positioned at the downstream exit end of the blending device 14. A stream of air is injected into the blending device adjacent the downstream end thereof through an inlet conduit 26 to aid in doffing the blended fibers from the pinned central drum 16, and to establish a gaseous suspension of the blended fibers. A vacuum is applied through a vacuum conduit 28 disposed within the condenser roll 24 to aid in directing the gaseous suspension of blended fibers toward the condenser roll 24. The gaseous carrier medium passes through the condenser roll 24 and a blended fibrous feed mat 30 (FIGS. 2 and 2a) is formed on the surface.

The blended feed mat 30 has an average basis weight which is the greater of 12 oz/yd² and at least three times the average basis weight of the low basis weight fibrous web 48 to be formed. The feed mat 30 is comprised of over 50 percent by weight of wood pulp fibers. Preferably the wood pulp is present in about 75 percent to about 90 percent by weight; the remainder of the fiber blend being the longer rayon fibers.

"Average Basis Weight" of the fibrous web is determined by removing circular, 2 inch diameter web samples along the entire cross-machine-direction of the fibrous web in three separate areas which are spaced from each other along the machine direction. The cross-machine-direction spacing between samples is approximately 3-1/4 inches from center to center. In this manner, approximately 12 or 13 2-inch diameter samples are taken in the cross-machine-direction of a blended web 40 inches wide. The basis weight of each of the samples is determined, and the arithmetic mean of all samples taken is the "Average Basis Weight."

Referring to FIG. 2, the blended feed mat 30 is directed over a supporting surface 32 into a web forming device shown schematically at 34. The web forming device 34 includes a lickerin roll 36 which is rotated to doff individual fibers from the feed mat 30. The individual fibers are suspended in an air stream which is generated by the rotating lickerin roll 36 and fan 38. The air suspended stream of fibers 39 is directed through a duct 40 toward a foraminous support member 42. Movement of the air suspended stream of fibers 39 toward the foraminous support member 42 is enhanced by applying a partial vacuum through vacuum box 44 which is positioned below a web forming run 46 of the foraminous support member 42. This partial vacuum is created by fan 38. The air of the stream of fibers 39 passes through the foraminous support member and is circulated through the fan to the positive pressure side thereof, and past the lickerin roll in a continuous, closed circuit arrangement. The fibers in the stream are deposited on the web forming run 46 of the foraminous support member 42 in the form of a low basis weight, nonwoven fibrous web 48. One or more of the rolls supporting the foraminous support member 42 are driven to convey the foraminous support member in the direction indicated by arrows 50.

The low basis weight nonwoven fibrous web 48 can be directed to post-treatment stations (not shown) such as adhesive application stations, embossing stations and the like. According to one preferred embodiment of this invention, the fibrous web thus formed, and then sprayed with adhesive, as disclosed in pending U.S. Pat. application Ser. No. 23,751, and U.S. Pat. No. 3,721,242, which issued on Mar. 20, 1973 from U.S. Pat. application Ser. No. 23,752. Both the above mentioned application and patent are assigned to Scott Paper Company.

It is extremely important in this invention that the average basis weight of the feed mat be greater of 12 oz/yd² and at least three times the average basis weight of the low basis weight nonwoven fibrous web. Below
this feed mat basis weight level a greater concentration of fiber clumps appears in the finished web. This creation of fiber clumps is believed to be caused by the action of the rotating lickerin roll in pulling clumps of fibers from the feed mat when an inadequate supply of fibers is directed to the lickerin roll.

It is known that the speed of the lickerin roll in the Rando-Webber has a direct affect on long fiber length in the finished web. The lickerin roll of the Rando-Webber tends to cut the longer fibers, and the degree of cutting is directly related to the lickerin speed, i.e., the greater the lickerin speed the greater the cutting action on the longer fibers. Excessive cutting of the longer fibers tends to adversely affect the properties, such as tear strength, of the finished web. Tear strength is an important property in products such as diaper covers. Therefore, it is desirable to minimize the lickerin speed of the Rando-Webber in order to reduce the damage of the longer reinforcing fibers.

At a predetermined speed of web formation, the speed of the lickerin roll of the Rando-Webber required to comb out clumps present in the feed mat is directly dependent upon the number of such clumps present in the feed mat and the degree of entanglement of fibers in the clumps. The greater the number of clumps and degree of fiber entanglement in the clumps, the higher the required lickerin speed. It is also known that at increased web formation speeds the lickerin speed must be increased to form a web of comparable basis weight and quality as is formed at lower formation speeds. Therefore, the quality (specific number of fiber clumps) of the feed mat has a direct affect on both production speed and physical properties of the final web. For example, it was possible to produce fibrous webs having a basis weight of 2 oz/yd² with an acceptable concentration of fiber clumps when using a Rando-Feeder feed mat at production speeds of up to about 100 feet per minute. However, when utilizing feed mats manufactured according to the process of this invention, fibrous webs having a basis weight of approximately 2 oz/yd² with an acceptable concentration of fiber clumps have been made at speeds exceeding 200 feet per minute. According to applicant's invention, low basis weight nonwoven fibrous webs having a percent basis weight variation no greater than 10 percent have been consistently achieved at web forming speeds in excess of 100 feet per minute, and approaching 200 feet per minute.

"Percent Basis Weight Variation" is calculated by taking 2 inch diameter samples across the entire cross-machine-direction of the finished web in three separate machine-direction locations, as described above in connection with the calculation of the average basis weight. The average basis weight is subtracted from the basis weight of the sample having the greatest difference from the average basis weight, and this difference is then divided by the average basis weight.

Having described our invention, I claim:

1. A method for forming a low basis weight nonwoven fibrous web including a major proportion by weight of short cellulosic fibers of a papermaking length less than one-quarter inch and a minor proportion by weight of longer reinforcing fibers having an average fiber length of over one-quarter inch, said method comprising the steps of:
   A. forming a loosely compacted batt of substantially individualized short cellulosic fibers of a papermaking length less than one-quarter inch;
   B. forming a loosely compacted batt of reinforcing fibers having an average fiber length of over one-quarter inch;
   C. separating and blending the fibers in the batts of short cellulosic fibers and longer reinforcing fibers to form a gaseous suspension of randomly arranged and intermingled fibers in which a major proportion of the fibers by weight are the short cellulosic fibers, and a minor proportion of the fibers by weight are the longer reinforcing fibers;
   D. conveying the gaseous suspension of randomly arranged and intermingled short and longer fibers toward a foraminous support member through which the gaseous carrier medium passes, and upon which the fibers are deposited in a fibrous feed mat of randomly arranged and intermingled short and longer fibers, said feed mat comprising a major proportion by weight of the short cellulosic fibers and a minor proportion by weight of the longer reinforcing fibers, said feed mat having an average basis weight which is the greater of 12 oz./yd.² and at least three times the average basis weight of the low basis weight nonwoven fibrous web to be formed; and
   E. separating fibers from the feed mat and conveying them in a gaseous carrier medium to a second foraminous support member whereat the gaseous medium passes through the foraminous support member and the fibers are deposited on said support member to form the low basis weight nonwoven fibrous web.

2. The method according to claim 1, wherein said short cellulosic fibers are wood pulp.

3. The method according to claim 2, wherein the reinforcing fibers are rayon fibers.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,862,472 Dated January 28, 1975

Inventor(s) Henry J. Norton and Brian E. Boehmer

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 24, change "one quarter" to --one-quarter--.
Column 1, line 39, change "Rando-feeder" to --Rando-Feeder--.
Column 3, line 43, change "applicant's process" to --applicant's process--.
Column 3, line 48, change "feeder," to --Feeder,--.
Column 3, line 52, change "of blended fibers" to --is formed with an--.
Column 4, line 21, change "2a" to --"2a"--.
Column 4, line 26, change "ab" to --"2b"--.
Column 4, line 60, change "the" to --for--.
Column 5, line 13, delete "or" (second occurrence).
Column 5, line 44, change "rando-opener-Blender" to --Rando-Opener-Blender--.
Column 5, line 64, change "streama" to --stream--.
Column 6, line 11, after "the" insert --blended--.
Column 6, line 58, change "iss" to --is--.
Column 7, line 2, delete the period "." (second occurrence).
Column 8, line 44, delete the "-" between medium-passes.

Signed and Sealed this
Twenty-eighth Day of December 1976

[SEAL]

Attest:

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Attesting Officer

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