APPARATUS FOR WET PROCESSING A CONTINUOUS LENGTH OF MOVING MATERIAL

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UNITED STATES PATENTS
1,062,245 5/1913 Mathesius et al. ................. 68/179 X

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ABSTRACT
An apparatus for subjecting a continuous length of moving material to a fluid treatment. The material is initially soaked in a bath of processing fluid while in a substantially tensionless condition. Immediately thereafter, the material is guided through a treatment chamber where it is exposed to a high velocity flow of the same processing fluid.

8 Claims, 5 Drawing Figures
APPARATUS FOR WET PROCESSING A CONTINUOUS LENGTH OF MOVING MATERIAL

SUMMARY OF THE INVENTION

This application is a continuation of U.S. Patent application Ser. No. 747,409 filed June 19, 1968 (now abandoned), the latter being a continuation-in-part of U.S. Patent application Ser. No. 657,632 filed Aug. 1, 1967 (also abandoned).

In describing the invention, reference will hereinafter be made to the treatment of web material in the textile industry. It is to be understood, however, that this particular industrial application is being used for illustrative purposes only and is not to be considered as a limitation upon the scope of the claims appended hereto.

In the textile industry, continuous lengths of fabric (often in web form) are subjected to various continuous wet finishing processes such as for example dyeing, bleaching, washing, etc. It has now been discovered that the efficiency of many of these processes can be materially improved by subdividing each treatment into the following two basic steps: (1) soaking the web material for a predetermined time interval in a bath of the processing fluid; while soaking in the fluid, the material is maintained in a relaxed substantially tensionless condition; (2) immediately thereafter subjecting the material to one or more high velocity streams of processing fluid. As herein employed, the term "high velocity" is intended to include fluid velocities of at least 6 feet per second and greater, preferably in the range of approximately 15 feet per second.

By initially soaking the web material in a relaxed tensionless condition, an advantage is gained in that penetration of the processing fluid between the fibers making up the web material is greatly facilitated. In certain operations such as dyeing, complete penetration of the dye liquor is of course highly desirable. By the same token, when washing a cloth web, penetration of the processing fluid between the relaxed fibers aids in dissolving insoluble particles as well as in dissolving insoluble particles that might otherwise remain wedged between the fibers.

Subjecting the material to a high velocity stream of processing fluid immediately after the soaking period further improves the efficiency of the operation by providing a second opportunity for fluid penetration between the fabric fibers. Also, in a washing operation, this second step effectively flushes out partially dissolved soluble particles and any insoluble particles such as for example loose fibers, dirt, dye pigments, oil, etc., previously dislodged or loosened during the soaking period. Where insoluble particles are particularly troublesome, the treatment chamber may be provided with additional means for mechanically flexing and gently beating the material while it is being exposed to the high velocity flow of processing fluid so as to work any trapped particles free from between adjacent fibers. This alternate embodiment of the treatment chamber is more fully described in a copending application of the present inventor titled "Wet Processing Apparatus," U.S. Ser. No. 657,702, filed Aug. 1, 1967, now U.S. Pat. No. 3,430,466.

In light of the foregoing, it is a general object of the present invention to provide an improved apparatus for wet processing continuous lengths of material such as for example cloth webs.

Another object of the present invention is to provide an apparatus for processing continuous lengths of material which in operation includes the steps of (1) soaking the material in the processing fluid in a relaxed substantially tensionless condition; and (2) immediately thereafter subjecting the material to at least one high velocity stream of processing fluid.

A further object of the present invention is to provide means for soaking the material in the processing fluid for a period of time which can be varied independently of the speed at which the material is running through the apparatus.

These and other objects of the present invention will become more apparent as the description proceeds with the aid of the accompanying drawings of which:

FIG. 1 is a generally cross-sectional view of one embodiment of an apparatus employed in the practice of the present invention;

FIG. 2 is an enlarged cross-sectional view of the treatment chamber shown in FIG. 1;

FIG. 3 is a cross-sectional view of an alternate embodiment of the treatment chamber equipped with a vibrating reed member;

FIG. 4 is an enlarged cross-sectional view of a portion of the treatment chamber shown in FIG. 3, and

FIG. 5 is a generally cross-sectional view similar to FIG. 1 showing an alternate embodiment of the means employed to feed the web material into the apparatus.

Referring initially to FIGS. 1 and 2 wherein are best shown general features of one embodiment of an apparatus employed in practicing the present invention, a tank generally indicated by the reference numeral 10 is shown filled with processing liquid 11 to a level indicated at 12. The level 12 of the processing liquid may be controlled by feeding more liquid into the tank through feed valve 14, or draining liquid out of the tank through drain valve 16. A curved baffle member 18 cooperates with the tank walls in defining a soaking area hereinafter referred to as a "scray" 20. The scray provides an in-process storage area in which the processing liquid can react for a predetermined time interval with the material being treated.

The material to be treated, herein schematically illustrated as a cloth web 22, is fed into the scray 20 by any known means, such as for example a pair of feed rolls 24. As the cloth web leaves the feed rolls, it is deposited in the scray 20 in the form of substantially tensionless relaxed folds indicated typically by the reference numerals 26. After the web material has soaked in the scray 20 in a relaxed condition for a predetermined period of time, it is guided around an idler roll 28 upwardly to a treatment chamber generally indicated by the reference numeral 30.

The time period during which the web material 22 will be allowed to soak in the scray 20 will depend primarily on the number of folds 26 allowed to accumulate therein. Thus, where a longer soak is required, a greater amount of material will be accumulated in the form of relaxed folds 26.

As can be best seen by reference to FIG. 2, treatment chamber 30 includes two mating sections 32a and 32b which cooperate to define an inner cylindrical cavity 34. Cavity 34 is in turn connected by means of an intermediate treatment zone 36 which as herein shown may include a divergent exit area 38 facing downwardly towards the interior of tank 10. Spaced small diameter rollers 42a, 42b, 43a, and 43b are rotatably mounted within cavity 34. The web material passes upwardly through treatment zone 36 where it enters cavity 34. At this point, the material is threaded in a somewhat triangular path between rollers 42a and 42b, over rollers 43a and 43b, and then back down between the lower rollers 42a and 42b. From this point, the material passes back downwardly through treatment zone 36, where it exits from the treatment chamber. The material continues to travel downwardly beneath the level 12 of processing liquid 11, around another submerged idler 44, and then upwardly again to a second set of driven nip rolls 46 which pull the cloth to the next processing step. The processing liquid entering through feed valve 14 may be sprayed by means of a series of nozzles 47 directly onto the web immediately prior to its passing between nip rolls 46, thus providing a terminal wash effect.

A flow of processing liquid is pumped from tank 10 to treatment chamber 30 by means of a pump 48 and its associated suction and delivery piping 50 and 52. The processing liquid enters from cavity 34 of treatment chamber 30 from the side through a passageway 54 (See FIGS. 2 and 3). The volume of liquid being delivered by pump 48 is such that cavity 34 is filled with processing liquid under pressure. The processing fluid exits from cavity 34 as a high velocity stream flowing downwardly through treatment zone 36. After emerging from the treatment chamber, the stream of processing liquid simply drops back into tank 10.
In view of the foregoing, it can be seen that after having been soaked in a relaxed substantially tensionless condition in the scray 20, the material is immediately guided through treatment chamber 30. While passing through the treatment chamber and particularly while traveling through treatment zone 36, the material is exposed to a high velocity stream of processing liquid exiting from cavity 34. This stream travels in a direction substantially parallel to or direction in which the cloth is moving, and in a direction opposite to that of the material moving upwardly through treatment zone 36 into cavity 34.

By exposing the material to a high velocity stream of processing liquid immediately after the soaking step, a flushing action is created which aids in dissolving partially dissolved soluble particles and insoluble particles embedded in the web. This flushing action is aided by the fabric being bent and flexed as it passes around rollers 42a, 42b and 43a and 43b. The fluid pressure in cavity 34 and treatment zone 36 also encourages penetration of the treatment liquid through the fibers of the fabric.

As previously mentioned, there may be instances where the removal of partially dissolved soluble particles and insoluble particles from between web fibers becomes particularly troublesome. Under such conditions, it may be desirable to modify the treatment chamber 30 along the lines more fully described and claimed in U.S. Pat. No. 3,430,466. As shown in FIGS. 3 and 4, one such modification might include the mounting of a reed member 56 on a support 58 underlying the treatment chamber 30. Preferably, reed member 56 is positioned to extend upwardly between the outwardly sloping wall portions 60a and 60b defining the divergent area 38 of treatment zone 36.

As the high velocity stream of processing liquid flows downstreamly between the spaced opposed parallel wall portions 62a and 62b of treatment zone 36, some turbulence is experienced, particularly in the area adjacent the shoulders 64 formed between the parallel wall portions 62a and 62b and the continuing diverging wall portions 60a and 60b. (see FIG. 4). This turbulence causes the upper end of reed member 56 to vibrate laterally between wall portions 62a and 62b. In FIG. 4, the reed member 56 is shown in solid lines in its "neutral" position. The extremes to which the reed member will be caused to laterally vibrate are indicated in dotted as at 56a and 56b. By causing the reed member 56 to vibrate as shown in FIG. 4, the material running through treatment zone 36 is gently bent and laterally flexed. For example, in FIG. 3, the reed member is shown flexed to one extreme position, with its upper end pressing the downwardly moving web material against wall portion 62a. When deflected to this position, the reed also momentarily cuts off the flow of processing liquid to the side 66 of divergent area 38, while simultaneously directing the entire stream of processing liquid towards wall portion 60a and into the side 68 of area 38. Although at this stage, flow of processing liquid to side 66 is instantaneously cut off, the liquid already in this area continues to move downwardly due to its own inertia, thus producing a cavitation effect which results in the downwardly moving web material 22 being exposed to a condition of vacuum. At the same time, the upwardly moving web material to the left side 68 of reed member 56 is exposed to the full velocity, turbulence, and pressure of the exiting stream of processing liquid. It would therefore be seen that at the point illustrated in FIG. 3, the upper end of reed member 56 has contacted and laterally flexed the downwardly moving web material 22 to the right. This results in the following actions occurring simultaneously:

(a) the downwardly moving material is gently "beaten against" where 62a (b) the downwardly moving material in area 66 is exposed to a condition of vacuum and (c) the upwardly moving material to the left of reed member 56 is exposed to the full velocity and effect of the exiting stream of processing liquid.

When reed member 56 vibrates to the other extreme (as shown at 56a in FIG. 4), the opposite result will be obtained.

That is to say, the upwardly moving material will now be laterally flexed and beaten against wall portion 62a. A cavitation effect will be created in area 68 while at the same time, the full force and effect of the exiting stream of processing liquid will be deflected to the right towards wall portions 62a and 60a. To illustrate the efficiencies capable of being obtained with the above-described process, a test sample of cotton cloth (30 threads per square inch, 4 yards per lb.) was impregnated with a caustic soda solution of 6 percent concentration. The test sample was sewn into a continuous web of material which was then run once through the apparatus illustrated in FIG. 1 at a speed of about 110 yards per minute. Dwell time in the scray was approximately 12.5 seconds. The processing liquid, in this case water at 165°F, was pumped through the treatment chamber, the volume being sufficient to maintain a pressure of approximately 2 to 2.5 p.s.i. in the cavity 34. This produced a liquid velocity in treatment zone 36 of approximately 15 feet/second. Without a reed member 56 installed in the treatment chamber, the process succeeded in removing 94.6 percent of the caustic soda impregnated in the test sample. The addition of the vibrating reed member 56 under the same operating conditions resulted in a still higher efficiency of 95.7 percent caustic soda removal. These efficiencies are substantially above those capable of being achieved with conventional processes and apparatus operating under substantially similar conditions. To illustrate this point, one experiment was made wherein material was run through the apparatus without providing for a dwell time in the scray 20 and without a reed member 56 in the treatment chamber 30. Under these conditions, only 89.5 percent of the caustic soda was removed from the cloth sample. In another experiment, flow of liquid to the treatment chamber 30 was cut off, thus relying solely on the soaking time in the scray 20. This resulted in only 89.4 percent of the caustic soda being removed from the test sample.

In view of the foregoing, it can readily be seen that much higher efficiencies are obtained by employing a two-step process which includes a dwell time during which the material is soaked in a relaxed substantially tensionless condition, followed immediately by a flushing action achieved by exposing the material to a high velocity stream of liquid. A still higher efficiency is made possible by mechanically flexing and gently beating the material while it is being exposed to high velocity stream of liquid. An alternate arrangement for feeding web material into the apparatus is shown in FIG. 5. In this embodiment, two slanted interior wall members 70 and 72 are spaced to define a storage area 74. The incoming web material 22 is passed initially over guide roll 76, then downwardly into a bath of processing liquid 77 around roll 78 before being pulled upwardly through the nip 80 of rolls 82 and 84. Either roll 82 or 84 may be driven by conventional means. Doctor blades 85 prevent the web material from wrapping around the rolls 82 and 84. After exiting from nip 80, the web material accumulates and soaks in the lower portion of storage area 74, in the form of relaxed tensionless folds 86. The number of folds 86 which are allowed to accumulate will be governed by the soaking time desired for a particular operation. From storage area 74, the web material is pulled upwardly out of the processing fluid and over guide roll 88, then downwardly around submerged guide roll 90, and then upwardly into a treatment chamber 30 of the type shown in either FIG. 1 or FIGS. 2-4. From this point on, the web material is treated in a manner identical to that described above.

This alternate embodiment is particularly suited for application where the web material has a tendency to float on the surface of the processing liquid. Under such circumstances, it may be advantageous to pull the material downwardly into the bath of processing liquid before releasing it for soaking in the form of relaxed tensionless folds 86 in the storage area 84.

It is my intention to cover all changes and modifications of the embodiments herein chosen for purposes of disclosure which do not constitute departures from the spirit and scope of the invention.
I claim:

1. Apparatus for wet treating a continuous length of moving material comprising: a tank adapted to contain a bath of processing liquid; a treatment chamber supported at a position overlying said tank, said chamber having an opening in the bottom thereof; means for conveying the moving material through the bath of processing liquid in said tank while maintaining the material in a relaxed substantially tensionless condition; means for circulating a continuous flow of the processing liquid through said chamber; and guide means for guiding the material from said bath through said treatment chamber, said guide means being operative to cause the material passing through said chamber to enter and exit through said opening, said guide means including roller means in said chamber for changing the direction of movement of the material passing through said chamber, thereby flexing and bending the material while the material is exposed to the flow of processing liquid circulating through said chamber.

2. The apparatus as claimed in claim 1 wherein the flow of processing liquid circulating through said chamber exits through said opening and returns downwardly to the bath contained in said tank.

3. The apparatus as claimed in claim 1 further characterized by the opening in said treatment chamber being in communication with a zone of the interior of the chamber, said zone being defined in part by two spaced wall members between which the processing liquid is caused to flow when exiting from said chamber, the said guide means being operative to move the material through said zone in at least one direction opposite to the exiting flow of processing liquid.

4. The apparatus as claimed in claim 3 further characterized by vibrating means for flexing the material passing through said zone in opposite direction transverse to the direction of material movement through said zone.

5. The apparatus as claimed in 4 further characterized by said vibrating means cooperating with said spaced wall members to subject the material passing through said zone to a mechanical beating action accompanied by the alternate exposure of material sections to liquid flow and vacuum.

6. Apparatus for wet processing a continuous length of moving material comprising: a tank adapted to contain a bath of processing liquid; a housing defining a treatment chamber overlying said tank; circulating means for drawing processing liquid from said tank and for pumping said liquid into said chamber through an opening in said housing; another opening in said housing at the bottom thereof, said other opening allowing processing liquid to exit from said chamber and to return to the bath contained in the underlying tank; means for passing the moving material through the bath of processing liquid in said tank while maintaining the material in a relaxed substantially tensionless condition; and guide means for guiding the material from said tank through said chamber, said guide means including roller means in said chamber for changing the direction of movement of material passing therethrough, thereby allowing the material to enter and exit through said other opening.

7. Apparatus for wet treating a continuous length of moving material comprising: a tank adapted to contain a bath of processing liquid; a treatment chamber; means for depositing said material in said tank and allowing the material to soak in the processing liquid in a relaxed substantially tensionless condition; means for circulating a continuous flow of the processing liquid through said treatment chamber; guide means for guiding said material from said tank through said treatment chamber, a zone in said chamber defined in part by two spaced wall members; the flow of processing liquid through said zone being substantially parallel to the movement of material therethrough; means for guiding said material through said zone in at least one direction opposite that of the flow of processing liquid therethrough; and vibrating means for constantly flexing the material passing through said zone in opposite directions lateral to the direction of material movement through said zone.

8. The apparatus as set forth in claim 7 further characterized by said vibrating means being operative to subject the material passing through said zone to a gentle mechanical beating action accompanied by the alternate exposure of said material to liquid flow and vacuum.