METHOD AND DEVICE FOR MOISTURIZING A WEB, INCLUDING AN AIR HEADER WITH PERFORATED WALLS

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ABSTRACT OF THE DISCLOSURE

A system for uniformly dispersing a liquid medium, such as water, to a web. The web is continually conveyed between a header and a suction box. Within the header, two gases at different states and containing different relative amounts of the medium are mixed to produce a mist. This mist is then carried into and through the web by the action of the suction box.

BACKGROUND OF THE INVENTION

In the adding of a medium, such as water, to a continuously moving web, it is desirable to add the medium in a uniform manner. Prior methods for adding such a medium to a web were spraying, condensing, and use of medium rolls, but these prior methods had fundamental shortcomings, such as, nonuniformity of the application, limited moisture addition, dripping, lack of controlled application, and interference with production efficiency. One method of moisturizing a web is described by S. W. Speers in U.S. Pat. 3,320,676. In his method, Speers subjects a web to a mist directed to both sides of the web surface by a plurality of nozzles. The web is then conveyed through a humidity chamber for the purpose of having the moisture "soak" through the web. After the web leaves the humidity chamber, another set of nozzles sprays mists on the surfaces of the web once more. Although Speers' method is an advancement over the then prior methods of adding moisture to a web, the uniformity can be improved upon, and a simpler apparatus is desirable.

OBJECTS OF THE INVENTION

It is therefore an object of this invention to provide means and methods for adding liquid to a web with uniformity heretofore unavailable.

It is another object of this invention to provide means for uniformly moisturizing a continuously moving paper web.

It is still another object of this invention to add moisture to a web without encountering a dripping problem.

It is a further object of this invention to provide means for adding a liquid medium to a continuously moving web in a controlled manner.

It is still a further object of this invention to provide means and methods for moisturizing a paper web in an economical and simple manner.

It is another object of this invention to provide relatively simple and inexpensive means for adding a liquid medium in a uniform and controlled manner to a moving web.

These and other objects and features of the invention will become more apparent from the following description and accompanying drawings, wherein:

FIG. 1 is a schematic view illustrating web treating equipment which incorporates the principles of this invention.

FIG. 2 is a detailed cross-sectional view illustrating the means for moisturizing a continuously moving paper web; and

FIG. 3 is a diagram illustrating an example of results achieved when two bodies of air having different conditions are mixed.

SUMMARY OF THE INVENTION

The invention utilizes the mixing of two or more gas streams having different states with the intent of producing a mist of the medium. Throughout the description of the invention, the means for moisturizing a web by the use of adding moisture to an air-permeable paper web; however, it will be understood that this is for purposes of illustration only and it is not intended to be limited thereto as other condensable liquids may be added to various webs utilizing the principles expressed herein. Two or more streams of air having different temperatures or humidities are mixed with one another within a chamber that is spaced relative to a suction box. As a result of this mixing, a mist of water vapor is formed. The air-permeable web is conveyed between the chamber and the suction box and this mist is drawn therethrough by the action of the suction box on the surface of the web relative to the humidity chamber. It has been found that in this way a controlled uniform amount of moisture may be added to a paper web.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawing, a paper web treating apparatus is shown having a steam dryer roll 10 and a steam dryer roll 12. Disposed intermediate these two dryer rolls 10, 12 is a felt roll 14 about which a felt 16 travels that is subsequently conveyed about the steam roll 12. There is a second felt roll 18 on the opposite side of the steam roll to receive the felt 16. The felt 16 is a foraminous material of the general type used for support during the treating of a paper web. There are a plurality of other felt rolls 20, 22, 24 and 26 which, in cooperation with the other rolls 12, 14 and 18, convey the felt as shown in the drawing. Adjacent the felt conveying portion of the apparatus are a plurality of calender rolls 28 in tandem which calender an uncalendered paper web 30 which has been previously conveyed about the steam dryer 10, the steam dryer 12 and eventually along a horizontal and upwardly extending web path to the top nip 29 between the top two calender rolls 28.

Intermediate the felt rolls 18 and 20 is a humidiifer 32 which comprises a hollow suction box 34 and an air header 36 located on the upper and lower sides, respectively, of the web path. The air header 36 is rectangular and has side walls 38, a floor 39 and an outer top wall 40. Having a multiplicity of small openings 42 therein and facing the suction box as shown. Positioned within the air header 36 intermediate the floor 39 and the top wall 40 is an interior perforated wall 44 which extends to each of the side walls 38 and a pair of chamber 46 and 47 in the lower and upper portions of the air header, respectively. One wall 38 of the header 36 has an opening 48 confluent with the chamber 46 and receives a pipe 50 therein. Located within the upper portion of the header 36 is a plurality of ported tubes 52. The suction box 34 is rectangular in configuration and is made up of a series of walls 54 there being a flat perforated wall 56 positioned in opposed generally parallel relation with the perforated Twall 40 of the air header 36. One of the walls 54 has an opening 58 which receives a pipe 60, which pipe is in communication with a pump 62 that creates a partial vacuum within the box 34, thereby drawing air under pressure through the perforations of wall 56 and causing the air within the air header 36 to be drawn through the openings 42 and toward the suction box 34.
For mixing the two streams of saturated air to the extent required in achieving stated objects of the invention, i.e., uniformly adding a liquid to a web to uniformly moisten it, the perforated walls 40, 44 and 56, and tubes 52 of the header 56 are preferably constructed and arranged in a generally coextensive relationship along the web path as shown in Fig. 2. The perforated areas of the walls 40, 44 and 56 are shown substantially coextensive in the wide direction of these walls, i.e., the direction of web travel, as indicated by perforations corresponding to the arrows. The tubes 52 are shown generally uniformly spaced in the same wide direction within the chamber 47 to effect general distribution of air discharged from the tubes 52 throughout the chamber 47 and uniform mixing with the saturated air of different temperature entering chamber 47 from chamber 46 through the apertures of wall 44. Obviously, the wall 40 apertured as shown restricts the free escape of air therefrom and thus promotes effective mixing of the two streams within the chamber 47 before they pass in mixed and misty condition through the apertures of wall 40. As the opposing apertured areas of walls 40 and 56 are shown substantially coextensive, operation of the suction box 34 assures that the partial vacuum conditions adjacent the apertured wall 56 thereof causes the passage of misty air effluent from apertures 42 of wall 40 into and through the web 30.

In operation, the felt 16 is conveyed about the rolls 14, 18, 23, 29 and 31 as shown in Fig. 1. The paper web 30 is carried about the steam dryer roll 10 where it is partially dried. The web 30 then is conveyed intermediate the steam dryer 12 and felt 16 where it is further dried. After rotating about the roll 12, the web 30 and felt 16 are conveyed along a relatively straight path between rolls 18 and 20. The web 30 and felt 16 pass through the humidifier 32 intermediate the suction box 34 and the air header 36. Downstream from the humidifier 32 the felt 16 parts from the web 30 by rotating about roll 20 toward roll 22 and the web passes through the first nip 29 of the calender rolls 28 and subsequently leaves the calender rolls through the bottom nip 31. Alternatively, the web 30 may be diverted, as shown by the dotted arrow, so that it does not pass through the humidifier, but instead is conveyed directly to roll 24.

As the felt 16 and web pass between the suction box 34 and the air header 36, the stream created within the box 34 pulls the felt 16 and web 30 towards the perforated plate 56. Within the air header 36 relatively warm humid air is conveyed through pipe 50 into the lower chamber 46 and escapes through the multiplicity of small openings shown within plate 44 to enter the upper chamber 47. Relatively cool moist air is delivered into the upper chamber 47 through the ported tubes 52.

The two streams of air mix within the chamber 47 and through selection of the proper characteristics or conditions of these two gases, a mist is formed. This mist is then pulled through the openings 42 in the perforated plate 40, because of the action of the suction box 34, through the paper web 30 and felt 16.

The individual temperatures, relative humidities and action of the air streams may be varied to control the supply of moisture to the web 30. The system employs controlled precipitation of moisture by adding two psychrometrically prepared air streams to effect precise availability of water mist in the air. As an example of the air streams that may be used, Fig. 3 shows two air streams of sufficiently different humidity to generate a mist. Three mixing lines are shown where 70° F. saturated air is mixed with 174°, 165° and 160° saturated air. The saturated conditions are merely used as examples and, in actual practice, unsaturated air should be used to minimize dripping on the header surfaces prior to mixing. The mixing line may be used to forecast the concentration of free water, or fog, in the air and may be replaced similar to the curve shown in Fig. 3. Where equal proportions of warm and cool air are mixed, e.g., 174° F. and 70° F., 0.175 pounds of mist per pound of dry air is released, all at a temperature of 122.5°.

In a newspaper application of 2000 fpm., or 1200 pounds of paper/hr./ft wide and a 10" Hg header vacuum, it is possible to theoretically add 18.8 pounds of water per foot of suction header or 1½% moisture per foot of header. Assuming a minimum of a 66% filtering efficiency, the feasibility of adding as high as 5% in five feet has been confirmed through operation of equipment similar to that shown in the drawing.

What is claimed is:

1. A method of applying moisture to an air pervious web, such as uncalendered paper, comprising: continuously supplying substantially moisture saturated air to a first chamber by means which effects general distribution of said air within the first chamber; supplying substantially moisture saturated air to a second chamber with the second-mentioned air at a different temperature from that of the air supplied to the first chamber for formation of a mist when mixed therewith;

mixing the air of the second chamber with that of the first chamber by forcing it into the first chamber through a multiplicity of small openings to form a uniform mixture with the air of the first chamber and directing the resulting uniform mixture of air and the resulting mist through a multiplicity of small openings onto one side of the web;

2. Apparatus for moisturizing an air pervious web comprising:

a hollow suction box having a flat perforated wall; means for creating a partial vacuum in said suction box; an air header having an outer perforated wall facing said suction box wall and providing a multiplicity of small openings therethrough, an end wall spaced therefrom, side walls connecting said perforated wall and said end wall, and an interior perforated wall which extends to each of the side walls positioned between the outer perforated wall and the end wall to define a first chamber adjacent said outer perforated wall contiguous with perforations there-through, and a second chamber at an opposite side of said interior wall communicating with the first chamber through a multiplicity of small openings through said interior wall; said perforated wall of the suction box having a perforated area spaced in opposed generally parallel coextensive relationship with an area defining said multiplicity of openings of said outer perforated wall for passage of said web therethrough; means for introducing a first stream of substantially saturated air into said first chamber; means for introducing a second stream of substantially saturated air at a substantially different temperature than that of the first stream into said second chamber; said openings of said interior perforated wall and said means for introducing said first stream being relatively arranged to obtain uniform mixing of said two air streams in said first chamber adjacent said outer perforated wall; and means for conveying said web between said perforated wall of the suction box and said outer perforated wall of the air header.

3. The apparatus of claim 2 wherein:

said conveying means is a continuous felt for supporting said web; and said perforated wall of the suction box and the outer perforated wall of the header are
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spaced for passage of said web and said felt there-
between.

4. The apparatus of claim 2 wherein:
said conveying means, suction box, and header are
arranged to locate the suction box above the web
path and the header directly underneath the web
path and the suction box.

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