A dewatering fabric for use in a paper machine, the dewatering fabric including a woven permeable fabric and a polymeric layer having openings therethrough, the polymeric layer connected to the permeable fabric.
DEWATERING FABRIC IN A PAPER MACHINE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a paper machine, and, more particularly, to a dewatering fabric used in a paper machine for the manufacturer of a fibrous web.

[0003] 2. Description of the Related Art

[0004] A fabric is utilized to carry the fiber web during the formation of the web. After the web takes form it is usually subjected to a drying process. The same fabric used during formation of the web or another fabric may come in contact with the web, to move the web across a vacuum section for the removal of moisture from the web. The fabric may additionally absorb moisture from the web and the moisture so absorbed is subsequently removed from the fabric at a later point in the process.

[0005] Dewatering fabrics used in the paper industry are usually referred to as press fabrics. Press fabrics are characterized by a structure that carries a lot of water. Press fabrics are normally used to transport the wet web after forming through at least one pressing point to dewater the web. This normally occurs in two ways. First, a negative pressure is applied to the press fabric to remove excess water prior to pressing. During this process, the press passes some water into the press fabric, thus increasing the solid content of the web prior to pressing. Secondly, pressing removes water through mechanical compaction. This step can be detrimental to the properties of the final dried web, specifically, the caliper and absorbency.

[0006] The method disclosed in U.S. Pat. No. 5,598,643, entitled, “Capillary Dewatering Method and Apparatus” discloses a way of dewatering the web without compaction. Additionally, U.S. Pat. No. 5,437,107, entitled, “Limited Orifice Drying” discloses a limited flow membrane. However, these disclosed dewatering methods are very different from Applicants’ invention.

[0007] What is needed in the art is a fabric, which provides dewatering of a fiber web, is less complicated and less costly to install.

SUMMARY OF THE INVENTION

[0008] The present invention provides a dewatering fabric for use in a papermaking machine.

[0009] The invention comprises, in one form thereof, a dewatering fabric for use in a paper machine, the dewatering fabric including a woven permeable fabric and a polymeric layer having openings therethrough, the polymeric layer connected to the permeable fabric.

[0010] An advantage of the present invention is that it allows airflow therethrough for the removal of water from a fibrous web.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

[0012] FIG. 1 is a cross-sectional schematic diagram of an Advanced Dewatering System using at least one of the embodiments of the dewatering fabric of the present invention;

[0013] FIG. 2 is a cross-sectional schematic view of an embodiment of a dewatering fabric used in the apparatus of FIG. 1;

[0014] FIG. 3 is a perspective view directed toward a roll side of yet another embodiment of a dewatering fabric used in the apparatus of FIG. 1;

[0015] FIG. 4 is a sectioned perspective view directed toward a roll side of yet another embodiment of a dewatering fabric used in the apparatus of FIG. 1; and

[0016] FIG. 5 is a sectioned perspective view directed toward a roll side of still another embodiment of a dewatering fabric used in the apparatus of FIG. 1.

[0017] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate one preferred embodiment of the invention, in one form, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

[0018] Referring now to the drawings, and more particularly to FIG. 1, there is shown an Advanced Dewatering System 10, which is a fluid displacement apparatus, for the processing of fibrous web 12. System 10 includes a fabric 14, a suction box 16, a vacuum roll 18, a dewatering fabric 20, a belt press assembly 22, a belt 24, a pick-up suction box 26, showers 30 and save alls 32. Fibrous web 12 is formed from a fibrous slurry and is then transported along fabric 14, which is a structured fabric 14, past suction box 16 towards vacuum roll 18. At suction box 16, sufficient moisture is removed from web 12 to achieve a solids level of between 15% and 25% on a typical 20 g/m² (gsm) web suction box 16 runs at −0.2 to −0.8 bar vacuum, with a preferred operating level of −0.4 to −0.6 bar.

[0019] As fibrous web 12 proceeds in machine direction M it comes into contact with dewatering fabric 20. Web 12 then proceeds toward vacuum roll 18 between structured fabric 14 and dewatering fabric 20. Vacuum roll 18 is operated at a vacuum level of −0.2 to −0.8 bar with a preferred operating level of at least −0.4 bar. Dewatering fabric 20, web 12 and fabric 14 are pressed against vacuum roll 18 by belt press assembly 22. A vacuum present in vacuum zone Z pulls a drying fluid, such as air, through permeable belt 24, then through fabric 14, then through web 12 and then through dewatering fabric 20. Moisture collected in vacuum roll 18 is removed through a vacuum pump (not shown) and some is discharged to save alls 32.

[0020] Fabric 14 is a structured fabric having a three dimensional structure that is reflected in web 12. Part of web 12 is embedded into structured fabric 14, these areas are usually referred to as ‘pillows’. The pillows are protected during pressing as they are within the body of structured fabric 14. As such the pressing imparted by belt press
assembly 22 upon web 12 does not negatively impact web quality, while it increases the dewatering rate of vacuum roll 18. In a No Press/Low Press papermaking machine the pressure is transmitted through dewatering fabric 20, also known as a press fabric. In such a case web 12 is not protected inside structured fabric 14. This is still advantageous, because the press nip is much longer than a conventional press, which results in a lower specific pressure and less compaction of web 12.

[0021] In the No Press/Low Press TissueFlex process dewatering fabric 20 replaces the standard press fabric, often felt, in a Crescent Former. The improvement in this type of replacement raises web solids to a level that is high enough to either eliminate or greatly reduce the need for Yankee pressing, thereby increasing the quality of web 12.

[0022] Belt press assembly 22 fits over vacuum roll 18 and it has a single fabric 24 capable of applying pressure to the non-sheet contacting side of structured fabric 14 that carries web 12 around vacuum roll 18. A hot air hood may be fit over vacuum roll 18 inside belt press assembly 22 to improve dewatering. The circumferential length of vacuum zone Z can be from 200 mm to 2,500 mm, with a preferred range of from 300 mm to 1,200 mm and a more preferred range of 400 mm to 800 mm. The solids content of web 12 leaving suction zone Z is 25% to 55%, preferably greater than 30%, more preferably greater than 35% and even more preferably greater than 40%, depending on installed options.

[0023] FIG. 2 is a side illustration of a preferred embodiment of the present invention, included is a woven single layer base fabric 50. Base fabric 50 includes machine direction yarns 54 and cross direction yarns 56. Yarn 54 is 1 ply multilament twisted yarn. Yarn 56 is a monofilament yarn. Yarn 54 can also be a monofilament yarn and the construction can be of a typical multilayer design. In either case, base fabric 50 is needlel with fine batt fiber 58 having a weight of less than or equal to 700 gsm, preferably less than or equal to 150 gsm and more preferably less than or equal to 135 gsm. The batt fibers encapsulated the base structure giving it sufficient stability. The needling process can be such that straight through channels are created. The sheet contacting surface is heated to improve its surface smoothness.

[0024] Now, additionally referring to FIG. 3 there is illustrated another embodiment of dewatering fabric 20. In this embodiment, base fabric 50 has attached thereto a lattice grid 74 made of a polymer, such as polyurethane, that is put on top of base fabric 50. The side of dewatering fabric 20 that runs against the vacuum roll is illustrated in FIG. 3. The opposite side of dewatering fabric 20 (not shown), which is an opposite side of base fabric 50, is the side that contacts web 12. Grid 74 may be put on base fabric 50 by utilizing various known procedures, such as, for example, an extrusion technique or a screen-printing technique. As shown in FIG. 3, lattice 74 is put on base fabric 50 with an angular orientation relative to machine direction yarns 54 and cross direction yarns 56. Although this orientation is such that no part of lattice 74 is aligned with machine direction yarns 54 as shown in FIG. 3, other orientations such as that shown in FIG. 4 can also be utilized. Although lattice 74 is shown as a rather uniform grid pattern, this pattern can actually be discontinuous in part. Further, the material between the interconnections of the lattice structure may take a circuitous path rather than being substantially straight, as that shown in FIG. 3. Lattice grid 74 is made of a synthetic, such as a polymer or specifically a polyurethane, that attaches itself to base fabric 50 by its natural adhesion properties.

[0025] Lattice grid 74 being a polyurethane has good frictional properties, such that it seats well against the vacuum roll. This then forces vertical airflow and eliminates any x, y plane leakage. The velocity of the air is sufficient to prevent any rewetting once the water makes it through lattice 74.

[0026] Additionally, grid 74 may be a thin perforated hydrophobic film 76 having an air permeability of 35 cmf or less, preferably 25 cmf or less having pores therein of approximately 15 microns. Here too we have vertical airflow at high velocity to prevent rewet.

[0027] Now, additionally referring to FIG. 4, which illustrates the vacuum roll contacting side of dewatering fabric 20. This is yet another embodiment of dewatering fabric 20 that includes permeable base fabric 50 having machine direction multilament yarns 54 and cross-direction multilament yarns 56, that are adhered to grid 76, also known as an anti-rewet layer 76. Grid 76 is made of a composite material, which may be an elastomeric material or the may be the same as that used in lattice grid 74. Grid 76 includes machine direction yarns 78 and a composite material 80 formed therearound. Grid 76 is a composite structure formed of elastomeric material 80, and machine direction yarn 78. Machine direction yarn 78 may be pre-coated with elastomeric material 80 before being placed in rows that are substantially parallel in a mold that is used to reheat elastomeric material 80 causing it to re-flow into the pattern shown as grid 76 in FIG. 4. Additional elastomeric material 80 may be put into the mold as well. Grid structure 76, also known as composite layer 76, is then connected to base fabric 50 by one of many techniques including laminating grid 76 to permeable fabric 50, melting elastomeric coated yarn 78 as it is held in position against permeable fabric 50 or by re-melting grid 76 onto base fabric 50. Additionally, an adhesive may be utilized to attach grid 76 to permeable fabric 50. Composite layer 76 seals well against the vacuum roll preventing x, y plane leakage and allowing vertical airflow to prevent rewet.

[0028] Now, additionally referring to FIG. 5, which illustrates the roll side of dewatering fabric 20. This structure includes the elements that are shown in FIG. 4 with the addition of batt fiber 82. Batt fiber 82 is needled into the structure shown in FIG. 4 to mechanically bind the two layers together, thereby forming a dewatering fabric 20 having a smooth needled batt fiber surface. Batt material 82 is porous by its nature, additionally the needling process not only connects the layers together, it also creates numerous small porous cavities extending into or completely through the structure of dewatering fabric 20.

[0029] Dewatering fabric 20 has an air permeability of from 5 to 100 cubic feet/minute preferably 19 cubic feet/minute or higher and more preferably 35 cubic feet/minute of higher. Mean pore diameters, as measured using a Coulter method, are from 5 to 75 microns, preferably 25 microns or higher and more preferably 35 microns or higher. Either surface of dewatering fabric 20 can be treated with a material to make it hydrophobic. Lattice composite layer 76 may be made of a synthetic polymeric material or a polyamide that is laminated to fabric 50.
Batt fiber can range from 0.5 d-tex to 22 d-tex and may contain an adhesive to supplement fiber to fiber bonding. The bonding may result from the use of, for example, a low temperature meltblown fiber, particles and/or resin. Dewatering fabric 20 is a very thin fabric, which reduces the amount of water carried therein. This improves the dewatering efficiency and reduces or eliminates a rewetting phenomena seen with prior art structures. The total thickness of dewatering fabric 20 is preferably less than 1.50 millimeters, and more preferably less than 1.25 millimeters and even more preferably less than 1.0 millimeter thick.

3. The dewatering fabric of claim 1, wherein said openings accommodate an airflow substantially straight through without an other airflow perpendicular to said airflow.

4. The dewatering fabric of claim 1, wherein said polymeric layer is a flexible polyurethane.

5. The dewatering fabric of claim 1, wherein said polymeric layer is a grid of polymeric material, said grid having a plurality of machine direction runs and a plurality of cross direction runs.

6. The dewatering fabric of claim 5, further comprising a plurality of yarns combined with said grid of polymeric material, thereby forming a composite layer, at least one of said yarns internal to each of a corresponding one of said plurality of machine direction runs.

7. The dewatering fabric of claim 6, further comprising at least one batt layer needled to said permeable fabric and said composite layer, thereby connecting said permeable fabric and said composite layer.

8. The dewatering fabric of claim 1, wherein said polymeric layer includes a plurality of yarns within said polymeric layer.

9. The dewatering fabric of claim 1, wherein said permeable fabric and said polymeric layer together have a thickness, said thickness less than 1.50 mm.

10. Dewatering fabric of claim 10, wherein said thickness is less than 1.25 mm.

11. Dewatering fabric of claim 11, wherein said thickness is less than 1.00 mm.

12. The dewatering fabric of claim 12, wherein said permeable fabric and said polymeric layer have an air permeability, said air permeability being less than 130 cfm.

13. The dewatering fabric of claim 13, wherein said air permeability is less than 65 cfm.

14. The dewatering fabric of claim 14, wherein said air permeability is less than 35 cfm.

15. The dewatering fabric of claim 15, wherein said permeable fabric includes a plurality of weft yarns and a plurality of warp yarns.

16. The dewatering fabric of claim 16, wherein said weft yarns lie in a machine direction, said weft yarns having a diameter of between approximately 0.40 mm and 0.10 mm.

17. The dewatering fabric of claim 17, wherein said diameter is approximately 0.20 mm.

18. The dewatering fabric of claim 18, wherein said diameter is approximately 0.20 mm.

19. The dewatering fabric of claim 19, wherein said diameter is approximately 0.20 mm.

20. The dewatering fabric of claim 20, wherein said diameter is approximately 0.20 mm.

21. The dewatering fabric of claim 21, further comprising a hydrophobic layer having pores therethrough.

22. The dewatering fabric of claim 22, wherein said pores have a mean pore diameter of less than 140 microns.

23. The dewatering fabric of claim 23, wherein said pores have a mean pore diameter of less than 100 microns.

24. The dewatering fabric of claim 24, wherein said pores have a mean pore diameter of less than 60 microns.
25. A machine for the manufacture of a fibrous web, comprising:
   at least one roll; and
   a dewatering fabric in at least partial contact with said at least one roll, said dewatering fabric including:
   a woven permeable fabric; and
   a polymeric layer having openings therethrough, said polymeric layer connected to said permeable fabric.
26. A permeable membrane for use in a paper machine, the permeable membrane comprising:
   at least one batt fiber layer; and
   a permeable fabric, said at least one batt fiber layer and said permeable fabric being needle punched with
   straight through drainage channels.
27. The membrane of claim 26, further comprising at least one anti-rewet layer attached to at least one of said permeable fabric and said at least one batt fiber.
28. The membrane of claim 27, wherein said anti-rewet layer is an elastomeric membrane.
29. The membrane of claim 26, wherein said elastomeric membrane is less than approximately 1.05 mm thick.
30. The membrane of claim 25, wherein said at least one anti-rewet layer is attached by melting said anti-rewet layer.
31. The membrane of claim 26, wherein said permeable fabric includes machine direction yarns and cross direction
   yarns, said machine direction yarns at least double in number per square meter than said cross direction yarns.
32. The membrane of claim 31, wherein said machine direction yarns are larger in diameter than said cross direction
   yarns.
33. The membrane of claim 26, further comprising an anti-rewet layer having a first side and a second side, said
   first side attached to said permeable fabric, said at least one batt fiber layer includes an other batt fiber layer connected to said second side.
34. The membrane of claim 33, wherein said anti-rewet layer includes pores therethrough.
35. The membrane of claim 26, wherein said pores have a mean pore diameter in the range of approximately 5
   microns to approximately 75 microns.
36. The membrane of claim 26, further comprising at least one hydrophobic layer applied to an outer surface of the membrane.
37. The membrane of claim 26, wherein said at least one batt fiber layer includes a plurality of fibers ranging from 0.5
d-tex to 22 d-tex.
38. The membrane of claim 26, wherein said permeable fabric and said at least one batt layer together have a thickness, said thickness less than 1.50 mm.
39. The membrane of claim 38, wherein said thickness is less than 1.25 mm.
40. The membrane of claim 39, wherein said thickness is less than 1.00 mm.
41. The membrane of claim 26, wherein said permeable fabric and said at least one batt layer together have an air
   permeability, said air permeability being less than 130 cfm.
42. The membrane of claim 41, wherein said air permeability is less than 100 cfm.
43. The membrane of claim 26, wherein said permeable fabric includes a plurality of weft yarns and a plurality of
   warp yarns.
44. The membrane of claim 43, wherein said weft yarn has a diameter of between approximately 0.40 mm and 0.10
   mm.
45. The membrane of claim 44, wherein said diameter is approximately 0.20 mm.
46. The membrane of claim 43, wherein said warp yarn has a diameter of between approximately 0.30 mm and 0.10
   mm.
47. The membrane of claim 46, wherein said diameter is approximately 0.20 mm.
48. A machine for the manufacture of a fibrous web, comprising:
   at least one roll; and
   a permeable membrane in at least partial contact with said at least one roll, said permeable membrane including:
   at least one batt fiber layer; and
   a permeable fabric, said at least one batt fiber layer and said permeable fabric being needle punched with
   straight through drainage channels.
49. A method of making a paper machine dewatering fabric, comprising the steps of:
   providing a permeable fabric; and
   applying an elastomeric grid to a side of said permeable fabric.
50. The method of claim 49, further comprising the step of needling at least one batt fiber layer to said permeable fabric and said elastomeric grid.
51. The method of claim 49, wherein said applying step includes one of the steps of adhering and melting said
   elastomeric grid to said permeable fabric.
52. The method of claim 49, wherein said permeable fabric includes a plurality of machine direction yarns, said
   grid not being aligned with said machine direction yarns.
53. The method of claim 49, wherein said permeable fabric includes machine direction yarns, said grid being
generally aligned with said machine direction yarns.
54. The method of claim 53, wherein said grid includes a plurality of machine direction runs having at least one yarn in a corresponding one of said plurality of machine direction runs.
55. A dewatering fabric for use in a papermaking machine, the dewatering fabric comprising:
   a woven permeable fabric having a thickness of less than 1.50 mm, said woven permeable fabric having an air
   permeability of less than 130 cfm.
56. The fabric of claim 55, wherein said fabric having an air permeability is less than 100 cfm.
57. The fabric of claim 55, wherein said fabric has a mean diameter of from approximately 5 to approximately 75
   microns.
58. The fabric of claim 57, wherein said fabric has a mean diameter of from approximately 5 to approximately 75
   microns.
62. The fabric of claim 61, wherein said pores have a mean diameter of from approximately 35 to approximately 75 microns.

63. The fabric of claim 59, wherein said pores have a mean diameter of one of equal to and less than approximately 140 microns.

64. The fabric of claim 63, wherein said pores have a mean diameter of one of equal to and less than approximately 100 microns.

65. The fabric of claim 64, wherein said pores have a mean diameter of one of equal to and less than approximately 60 microns.

66. The fabric of claim 59, wherein said pores have a mean diameter of approximately 15 microns.

67. A method of using a dewatering fabric in a paper-making machine, comprising the steps of:

transporting the dewatering fabric through an advanced dewatering system, said advanced dewatering system including a vacuum roll in at least partial contact with the dewatering fabric over a portion of a surface of said vacuum roll defining a vacuum zone;

passing air through the dewatering fabric and a fibrous web; and

applying pressure to the dewatering fabric, the dewatering fabric including a woven permeable fabric having a thickness of less than approximately 1.50 mm, said woven permeable fabric having an air permeability of less than 130 cfm.

68. A method of using a dewatering fabric in a low press/no press papermaking machine, comprising the steps of:

passing air through the dewatering fabric and a fibrous web; and

applying pressure to the dewatering fabric, the dewatering fabric including a woven permeable fabric having a thickness of less than approximately 1.50 mm, said woven permeable fabric having an air permeability of less than 130 cfm.

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