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(54) FLUID MANAGEMENT COMPOSITE

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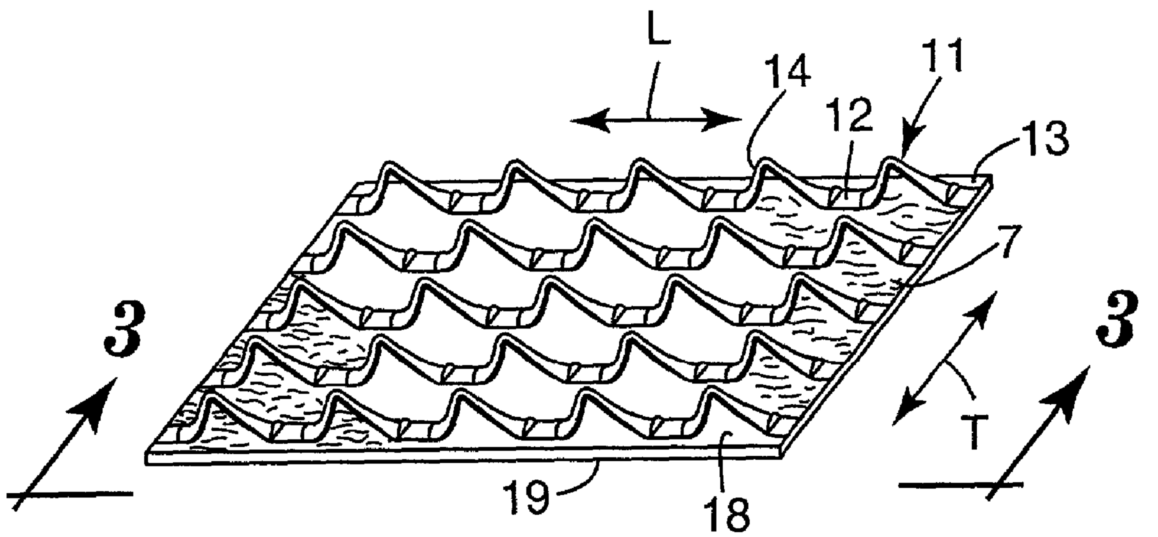
(57) **ABSTRACT**

A composite fabric for use in dewatering high solids content fluid materials comprising a multiplicity of corrugated strands of compression resistant material, and one or more sheets of porous material bonded along its length at sheet bonding locations to the strands, some of which strands have arcuate portions projecting from the strands between those sheet bonding locations. The sheet-like composite may be incorporated where there is a need to dewater high solids content fluids such as in disposable garments such as diapers or training pants.



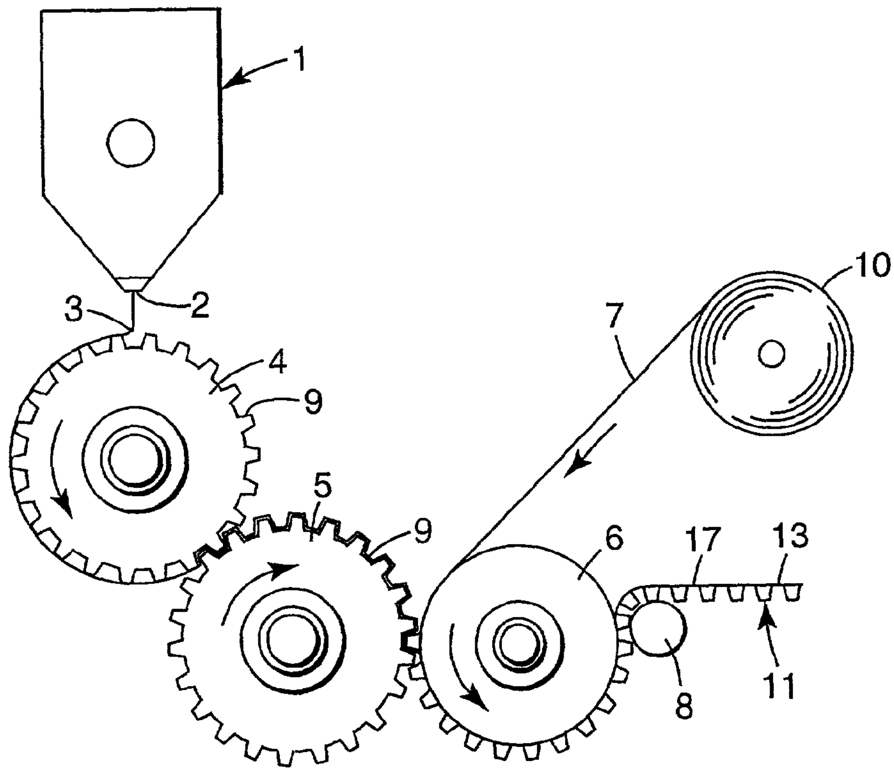


Fig. 1

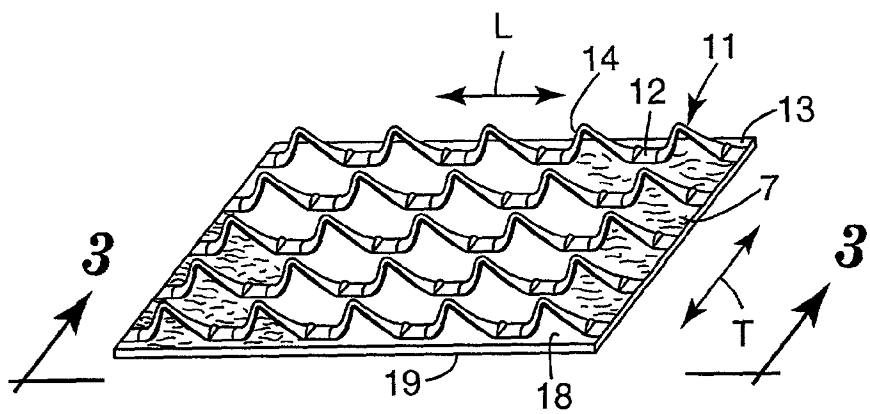


Fig. 2

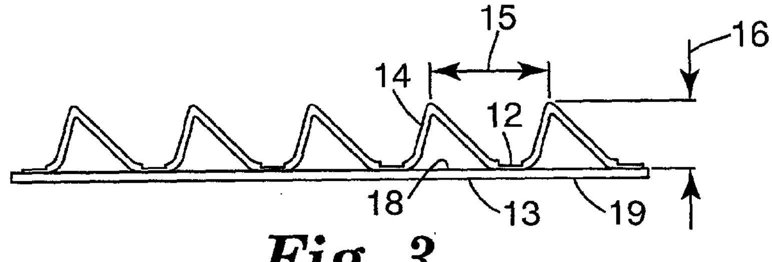


Fig. 3

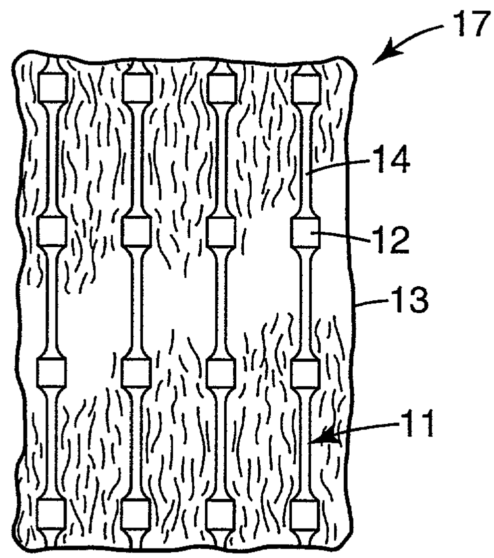


Fig. 4

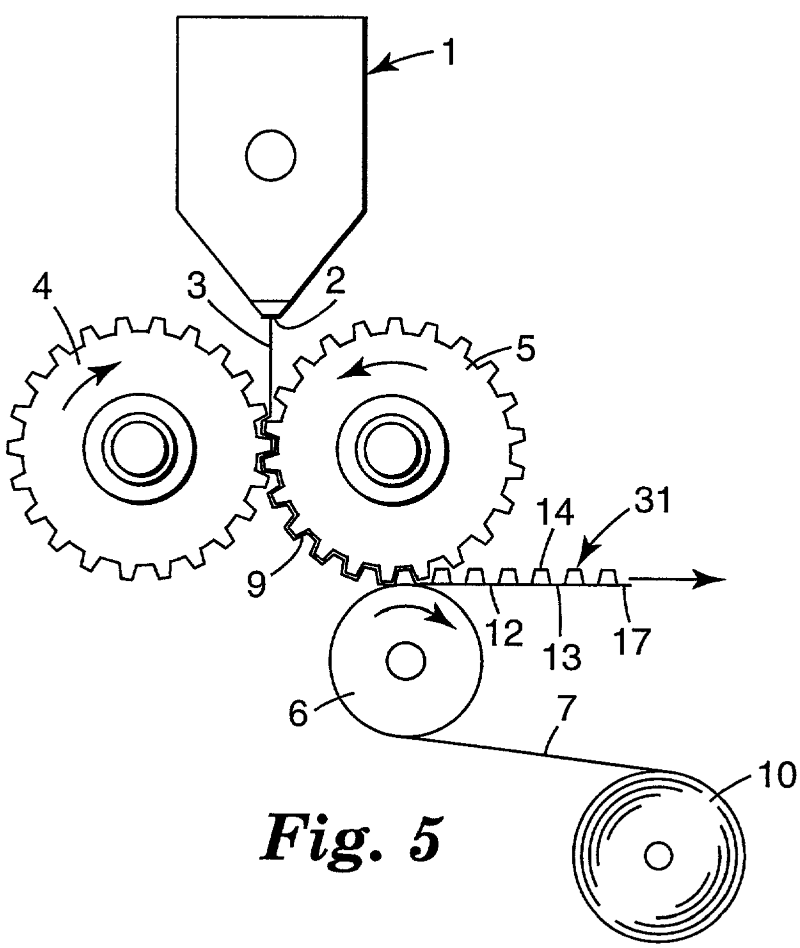


Fig. 5

FLUID MANAGEMENT COMPOSITE

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a liquid permeable fluid management nonwoven composite fabric for use in filtration, fluid transfer and absorption, for example, in disposable absorbent articles such as diapers, adult incontinence products, sanitary napkins and the like. The invention further relates to methods of producing such liquid permeable composite fabrics.

[0002] It is known, for example, in European Patent No. 963 747, that it is desirable to provide a fluid management member in a disposable absorbent article which is able to collect and retain low viscosity, high solid materials such as fecal matter, while still permitting passage of liquids such as urine. In order to manage low viscosity fecal matter the patent document proposes a structure where a fluid permeable support has a plurality of fibers woven into the support, which fibers project outwardly from the support. The support is described variously as nonwoven webs, breathable films, microporous films, apertured nonwoven webs and the like. The fibers woven into the supporting member extend generally greater than 1 mm above the support member, preferably higher. The individual fibers are preferably from 15 to 30 denier and are woven in regular intervals into arc-like forms. The woven fibers provide the laminate composite structure with a compression resistance of at least 30% under an applied pressure of about 1,000 newtons per cm^2, most preferably, at least 50% under this applied pressure. Also the materials are able to resume its shape after being subjected to this type of pressure after about 30 seconds to recover by at least 50 to 85%. The fluid management member is provided to minimize the amount of low viscosity fecal material on the skin of the wearer, preventing movement of the fecal material and also separating the fecal material into its solid and liquid components allowing the liquid components to be transported to the underlying absorbent structure.

[0003] A similar-like structure is described in U.S. Pat. No. 5,705,249. In this patent, the composite material described includes a nonwoven onto which filaments having a diameter of 0.05 to 5 mm are deposited. The filaments can be preformed or directly extruded onto the nonwoven. Following this, the filaments are intermittently bonded to the nonwoven resulting in bulges, which are created by elastic deformation of the large diameter filaments where they are not bonded. These filaments separate the nonwoven fabric from the wearer's skin. However no discussion of fecal management is described relative to this material. This material is designed solely to increase the comfort of the wearer by separating a liquid absorbent layer or fluid transport nonwoven from the wearer's skin.

[0004] U.S. Pat. No. 5,976,665 describes another approach to address the problems faced by the above U.S. Pat. No. 5,705,249 patent. A nonwoven fluid transport layer or absorbent is separated from a wearer's skin by attaching a corrugated perforated film or nonwoven. The corrugated material is formed into a series of wave-crests and wave-troughs. The wave-crests contact the wearer's skin and reduce the perceived wetness of the article. However in this patent the wave-like structure is also stated as useful in handling the solid discharges in a diaper or menstrual discharges in a sanitary appliance by trapping the solids in the wave-troughs. The corrugated layer is corrugated between the annealing surfaces of two mutually engaging corrugating cylinders and for example, thermally bonded to the underlying layer.

[0005] It is also known in the filtration area to provide netting or like material prior to a porous filter for dewatering high solid content materials. Such an approach is described in U.S. Pat. No. 5,776,567, where a multilayer laminate of flexible filter material is separate by polymeric netting that serves as a dewatering layer for high solids content material. The filter and nesting materials are simply laid up against one another and placed in a framing device.

[0006] European Patent No. 976 375 describes a fecal management member where the material structure is similar to that described in the U.S. Pat. No. 5,976,665 patent above. A sheet of fibers, preferably a nonwoven web, is corrugated and attached to an additional liquid permeable web. For example, a nonwoven sheet of fibers is fed between the enmeshed engaging portions of the mating corrugating members and joined to a second nonwoven web by thermally bonding the corrugated nonwoven. Additional fibers are deposit on top of the corrugated web. Although these various designs for fecal and fluid management members are advantageous, there remains a need for methods and materials that can do at least one, or more, of directly producing a fluid management member which is flexible, allows for good bonding between the separation member and the fluid transport member, creates a low outer surface contact area and/or can function effectively to separate high solids materials from liquids.

DISCLOSURE OF THE INVENTION

[0007] The present invention provides improved fluid management composites and their method of manufacture comprising a multiplicity of corrugated strands of resilient material and one or more sheets of porous material intermittently bonded to the corrugated strands. The corrugated strands have arcuate portions projecting from the porous material between portions of the strands that are bonded to the porous material. These corrugated strands are resistant to compression. These fluid management composites provides advantages when used in disposable garments such as diapers, training pants, adult incontinence briefs or sanitary napkin products or for dewatering high solid content fluids.

[0008] The present invention also provides novel methods for making the fluid management composites. The fluid management composites are well constructed for their intended end uses and yet simple and inexpensive to manufacture. The method is also flexible affording versatility in selecting characteristics of the fluid management composites to be produced without major modifications of the equipment.

[0009] According to the present invention there is provided a method for forming a fluid management composite which comprises (1) providing at least a sheet of porous material (e.g., a perforated polymeric film, or a sheet of woven natural or polymeric fibers, or a coherent nonwoven web of natural or polymeric fibers); (2) extruding spaced generally parallel elongate strands of molten thermoplastic material that are resilient when cooled (e.g., polyolefins); (3) forming the extruded stands to have arcuate portions projecting in the same direction from spaced anchor portions of the extruded strands; and (4) attaching the anchor portions of the extruded strands to form a porous laminate material with the arcuate portions of the extruded strands projecting outward from the porous material.

[0010] By this method there is provided a novel fluid management composite comprising a multiplicity of corrugated strands of resilient thermoplastic material extending in a generally parallel spaced relationship. The corrugated strands have anchor portions bonded at first strand bonding locations to longitudinally spaced sections of the porous material. The strands have arcuate portions projecting between the strand bonding locations.

[0011] Extruding the strands between opposing corrugating members generally causes the strands to flatten and form into corrugations having arcuate portions. The spaced apart anchor portions when joined to the porous material at the bonding locations are flattened further or indented along the parts of the strand's surfaces that are closely adjacent the anchor portions. The solidified strands generally have uniform morphology along their lengths, however the bonding locations can see a different thermal history and have a slightly different morphology. The strands can be pressed against the surfaces of the porous material at the bonding locations of the anchor portion so that the strands have a greater width between the opposite elongate side surface portions of the strands along the bonding locations than between the bonding locations to provide very firm attachment between the porous material and the strands.

[0012] In the method described above for forming a fluid management composite the forming step can comprise the steps (which can be performed in any order and may omit some steps) of (1) providing first and second generally cylindrical corrugating members each having an axis and including a multiplicity of spaced ridges defining the periphery of the corrugating member, the ridges having outer surfaces and defining spaces between the ridges adapted to receive portions of the ridges of the other corrugating member in meshing relationship with the multiple strand material therebetween; (2) mounting the corrugating members in axially parallel relationship with portions of the ridges in meshing relationship; (3) rotating at least one of the corrugating members; (4) extruding the multiple strand material onto at least one corrugating member so that the strands are fed between the meshed portions of the ridges to generally conform the strand material to the periphery of a first corrugating member to form the arcuate portions of the strand material in the spaces between the ridges of the first corrugating member and the anchor portions of the strand material along the outer surfaces of the ridges of the first corrugating member; and (5) retaining the formed strand material along the periphery of one of the first corrugating members for a predetermined distance after movement past the meshing portions of the ridges. The extruding step includes providing an extruder that, through a die with spaced openings, extrudes the spaced strands of molten thermoplastic material along the periphery of a first corrugating member within the predetermined distance. This method allows the diameter of the strands to be easily varied by either changing the pressure in the extruder by which the strands are extruded (e.g., by changing the extruder screw speed or type) and/or by changing the speed at which the first corrugating member, is moved (i.e., for a given rate of output from the extruder, increasing the speed the corrugating member is moved will decrease the diameter of the strands, whereas decreasing the speed at which the corrugating member is moved will increase the diameter of the strands). Also, the die through which the extruder extrudes the thermoplastic material can have an easily changeable die plate in which are formed a row of spaced openings through which the strands of molten thermoplastic material are extruded. Such die plates with openings of different diameters and different spacings can relatively easily be formed by electrical discharge machining or other known methods to afford different spacings and diameters for the strands. Varied spacing and/or diameters for the openings along the length of the row of openings in one die plate can be used, for example, to produce a fluid management composite which will have greater or less compression resistance as may be required for a given end use. Different effects can be achieved by shaping and or modifying the die to form hollow strands, strands with shapes other than round (e.g., square or cross-shaped) or bi- or multi-component strands.

[0013] As indicated above, the fluid management composite according to the present invention can further include a second set of strand material having anchor portions thermally bonded at second sheet bonding locations to longitudinally spaced portion of the porous material along corresponding second elongate surface portions thereof, and having arcuate portions projecting from the second elongate surface portions of the elastic strands between the second sheet bonding locations.

[0014] Using the method described above, such a second set of strand material can be provided in the fluid management composite in at least two different ways. One way is to form the second set of strand material to have arcuate portions projecting in the same direction from spaced anchor portions of the second set of strand material; and positioning the spaced anchor portions of the second set of strand material in closely spaced opposition to the spaced anchor portions of the first set of strand material with the arcuate portions of the first and second set of strand material projecting in opposite directions so that the porous material is fed between the anchor portions of both the first and second sets of strand material to bond simultaneously to the anchor portions of both the first and second sets of strand material. Another way is to provide a second set of strand material after the first set of strand material is bonded to the porous material and bond the second set of strand material to at least some of the spaced apart bond portion of the porous material.

[0015] The porous material in the fluid management composite can be any porous material that would allow the passage of fluid into the porous material and optional into and through the porous material. The porous material could be a (1) polymeric perforated film (e.g., polypropylene, polyethylene or polyester); (2) conventional woven, knitted, stitch bonded or like fibrous material; (3) nonwoven fibrous materials or laminates of a porous material to a second needle punched porous material or nonporous material. The nonwoven fibrous material can be stabilized by bonding or entangling the fibers each to the other such by hydroentangling, spunbonding, thermal bonding or bonding by various types of chemical bonding such as latex bonding, powder bonding, etc. Alternatively the fibers could be bonded externally to a second sheet material that has at least some mechanical stability. The fibers can be formed of any suitable polymer or other fiber forming materials such as of polypropylene, polyethylene, polyester, nylon, cellulose, superabsorbent fibers or polyamides Also bi- or multi-component fibers can be used, for example, a core of polyester and a sheath of polypropylene can be used which provides relatively high strength due to its core material and is easily bonded due to its sheath material. The fibers can also be mixed or blended with particles or other fibers of different materials or material combinations.

[**0016**] The fluid management composite can be conveniently included in a disposable garment (e.g., a disposable diaper or training pants, adult incontinence brief or sanitary napkin product) at a location where there is encountered fluid discharge. The fluid management composite can be adhered to an external surface or placed in a structure between a fluid transport cover layer and a further layer such as an absorbent layer.

BRIEF DESCRIPTION OF THE DRAWINGS

[**0017**] The present invention will be further described with reference to the accompanying drawing wherein like reference numerals refer to like parts in the several views, and wherein:

[**0018**] **FIG. 1** is a schematic view illustrating a first embodiment of a method and equipment according to the present invention for making a first embodiment of a fluid management composite according to the present invention;

[**0019**] **FIG. 2** is a perspective view of an embodiment of the fluid management composite according to the present invention made by the method and equipment illustrated in **FIG. 1** and **5**;

[**0020**] **FIG. 3** is a fragmentary enlarged sectional view taken approximately along line **3A-3A** of **FIG. 2**;

[**0021**] **FIG. 4** is a fragmentary enlarged top view of **FIG. 2**;

[**0022**] **FIG. 5** is a schematic view illustrating a second embodiment of a method and equipment according to the present invention for making a second embodiment of a fluid management composite according to the present invention;

DETAILED DESCRIPTION OF THE INVENTION

[**0023**] Referring now to **FIG. 1** of the drawing, there is schematically illustrated a first embodiment of a method and equipment according to the present invention for making a first embodiment of a fluid management composite **11** according to the present invention which is illustrated in **FIGS. 2 and 3**.

[**0024**] Generally the method illustrated in **FIG. 1** involves providing a sheet of porous material **7**; extruding spaced generally parallel elongate strands **13** of molten thermoplastic material on a first rotating corrugating roll **4** forming the plurality of extruded strands **11** to have arcuate portions **14** projecting in the same direction from spaced anchor portions **13** of the plurality strand material; thermally bonding the anchor portions **13** of strand material to the porous material with the arcuate portions **14** of the strand material projecting from corresponding elongate side surface portions of the porous material **7**.

[**0025**] As illustrated in **FIG. 1**, the equipment for performing the method includes first and second generally cylindrical corrugating members **4** and **5** each having an axis and including a multiplicity of spaced ridges **9** defining the periphery of the corrugating member **4** or **5**, the ridges **9** having outer surfaces and defining spaces between the ridges adapted to receive portions of the ridges **9** of the other corrugating member in meshing relationship with the strand material **3** therebetween; means for mounting the corrugating members **4** and **5** in axially parallel relationship with portions of the ridges **9** in meshing relationship; means for rotating at least one of the corrugating members **4** or **5** so that when the strand material **3** is fed between the meshed portions of the ridges **9** the strand material will generally conform to the periphery of one of the corrugating members **4** or **5** to form arcuate portions **14** of the strand material in the spaces between the ridges **9** of a corrugating member **4** or **5** and to form anchor portions **13** of the strand material along the outer surfaces of the ridges **9** of a first corrugating member **4** or **5**; optionally means (e.g., including a surface of a corrugating member **4** or **5** being roughened by being sand blasted or chemically etched or being heated to a temperature generally in the range of 25 to 150 Fahrenheit degrees above the temperature of the first sheet **12** of flexible material) for retaining the strand material along the periphery of a corrugating member **4** or **5** for a predetermined distance after movement past the meshing portions of the ridges **9**; means in the form of an extruder feeding a die with a changeable die plate **2** (see **FIG. 1**) with spaced through openings for extruding thermoplastic material to form a multiplicity of generally parallel elongate molten strands **13** of the thermoplastic material extending in generally parallel spaced relationship and for positioning the molten strands **13** along the periphery of a corrugating member **4** within the predetermined distance. Also, that equipment further includes a feed means such as roll **10** for feeding the porous material to a nip between the generally cylindrical bonding roll **6** having an axis and the corrugation member **5** carrying the strands **3**; means for rotatably mounting the bonding roll **6** in axially parallel relationship with the corrugating members **4** and **5** with the periphery of the bonding roll **6** closely spaced from and defining a nip with the periphery of the corrugating member **5** at a predetermined distance from the meshing portions of the ridges **9**; optionally the bonding roll and/or the corrugating roll can be supplied with heating means to assist in bonding the strands to the porous material **7**; and means including a nipping roller **25** for moving the sheet-like composite **10** for a predetermined distance around the periphery of the cooling roll **24** past the nip with the strands **16** in contact with the cooling roll **24** to cool and solidify the strands **16**.

[**0026**] The structure of the sheet-like composite **10** made by the method and equipment illustrated in **FIG. 1** is best seen in **FIGS. 2, 3** and **4**. The fluid management composite **11** comprises the multiplicity of generally parallel elongate strands **3** of thermoplastic material extending in generally parallel spaced relationship. Each of the strands **3** is generally a flattened cylindrical or oval-like shape that is spaced from and is adjacent another strand. The spaced anchor portions **13** of the strand are thermally bonded at strand bonding locations **12** to longitudinally spaced sections of the porous material **7** along its first surface **18**, and the arcuate portions **14** of the strand material project from the first surface **18** of the porous material **7** between the strand bonding locations **12**. The first strand bonding **17** locations are spaced about at predetermined distances from each other and aligned in generally parallel rows extending transverse to the strands **3** to form continuous rows of the arcuate portions **14** projecting at a predetermined first distance from the first surface **18** of the porous material. Because the strands **13** have been extruded in molten form the anchor portions **13** of the strand material can generally be pressed onto the first surface **18** of the porous material the ridges **9** on the corrugating member **5** and the periphery of the bonding roll **6**, in which case the still mobile thermoplastic polymer strands **16** form around and are indented by the ridges **9**. The bonds between the strand **3** anchor portions **13** and the porous material **7** at the first strand bonding locations extend along the entire part of the strand's surfaces that are closely adjacent the ridges **9**. As is illustrated in **FIG. 4**, those parts of the strand's surfaces that are closely adjacent the ridge **9** are widened along the surfaces of the anchor portions **13** by indentations of the strands **16** by the ridges **9**. Thus the areas of bonding between the strands **3** and the porous material can advantageously be made wider at the strand bonding locations to increase bond levels.

[**0027**] Alternative structures that could be provided for the fluid management composite include spacing the ridges **9** around the corrugating members **4** and **5** to produce repetitive patterns of different spacings between the anchor portions **13** of the strands **3**, thereby causing the continuous rows of the arcuate portions **14** to project at different distances from the first surface **18** of the porous material **7**.

[**0028**] **FIG. 5** illustrates a second embodiment of a method and equipment according to the present invention for making a second embodiment of a fluid management composite **31** according to the present invention, which is generally identical in structure to the fluid management composite shown in FIGS. **2-4**. The method illustrated in **FIG. 5** is somewhat similar and uses much of the same equipment as is illustrated in **FIG. 1**, and similar portions of that equipment and product have been given the same reference numerals and perform the same functions as they do in the equipment illustrated in **FIG. 1**. In addition to the general method steps described above with reference to **FIG. 1**, the method illustrated in **FIG. 5** further generally includes the step of directly extruding the strand material **3** into the nip formed by corrugating members **4** and **5**. This decreases the distance from the extruder to the bonding roll **6** reducing or eliminating the need for additional heat to be supplied to bonding roll **6** and/or corrugating member **5**. However, additional heat can of course be supplied if needed to increase the bond level to a desired level. The structure of the fluid management composite **3** made by the method and equipment illustrated in **FIG. 5** is identical to that seen in FIGS. **2-4**.

[**0029**] The fluid management composite fabric is used primarily in dewatering high solids content fluid materials in low flow conditions. The product is also generally disposable where the basis weight of the porous media and the fiber denier of the filaments or strands are low to enhance bondability at low heat bonding levels. These conditions are found often in personal hygiene products such as incontinence products, baby diapers or menstrual pads. Low flow high solids content conditions are also possible in fluid filtration such as pool drain filters, medical filters or the like.

[**0030**] The porous backing layer is a preferably a nonwoven fibrous web formed of thermoplastic fibers such as a bonded carded web, a spunlace fabric, a melt blown web, a spun bond web, a needletacked nonwoven or the like. Generally the porous backing and preferably the nonwoven fibrous web has a basis weight of from 10 to 200 g/m^2, preferably from 20 to 100 g/m^2. At higher basis weights the web can become difficult to bond to the corrugated strands and provides lower fluid passthrough. At lower basis weights the web becomes difficult to handle and unstable in its final use form. However additional porous support webs can be used if desired and joined to the porous backing layer.

[**0031**] The filaments or strands generally are any resilient thermoplastic material capable of being extruded, such as polyesters, polyamides or polyolefins with polyolefin such as polyethylenes or polypropylene polymers (including copolymers or blends) being preferred.

[**0032**] The filaments can also be multi-component filaments such as sheath core filaments where the sheath layers have a melting or softening point less than the core layer material. This can aid in bonding difficult to bond or incompatible strand or filament material. Preferably the filament is formed at least in part of a polymer having a softening point less than the softening point of the fiber forming the porous backing layer. The composite fabric in a preferred embodiment is one where the filament is a polyolefin fiber and the back layer is a polyolefin.

[**0033**] The parallel longitudinally oriented thermoplastic filaments are bonded to the fibrous backing layer at spaced apart bonding locations along the lengths of the filaments where the filament form compression resistant arcuate portions between the bonding locations. The arcuate portion of the filaments will generally have a height from the front surface of the backing layer of greater than 0.2 mm but less than 4 mm, preferably from 0.5 mm to 3 mm. The filaments generally will have a diameter of from 10 mil to 100 mil, preferably from 10 mil to 50 mil. The web should be compression resistant such that it retains at least 50% of its initial caliper under a load of one pound per square inch.

EXAMPLES

Example 1

[**0034**] A nonwoven filter sheet composite similar to the sheet-like composite **17** illustrated in **FIG. 2** was made using equipment similar to that illustrated in **FIG. 1**. A thermoplastic ethylene-propylene impact copolymer (8 MFI) commercially available under the designation 7C50 from the Union Carbide Corporation of Danbury, Conn. was placed in a 51 mm single screw extruder to form the filaments **3**. About 4.7 filaments per centimeter of the 7C50 copolymer were extruded at a melt temperature of about 238° C. through 0.76 mm orifices at 17 RPM onto an upper corrugating roll **4**. The upper corrugating roll was machined to have **4** axially parallel ridges per centimeter located completely around the periphery of the roll with a groove between each ridge. Each ridge was machined to have a flat top-surface having a width of about 0.7 mm. The upper corrugating roll was at about 88° C. The partially cooled strands were then corrugated in a nip formed by the upper corrugating roll and a lower corrugating roll **5**. The lower corrugating roll (113° C.) was machined with the same ridge and groove geometry as the upper corrugating roll and was in meshing relationship with the upper roll. A nip pressure of 100 pounds per lineal inch was used with a line speed of about 7.6 meters per minute. The corrugated strands were then bonded to a 30 gram per square meter spunbonded type polypropylene nonwoven **7** (available from Amoco Fabrics and Fibers Company of Atlanta, Ga., under the designation 'RFX') in a nip formed by the lower corrugating roll **5** and a smooth metal chill roll **6**. The chill roll was maintained at about 150° C. A nip pressure of 300 pounds per lineal inch was used to bond the strands to the nonwoven. The resulting nonwoven filter sheet composite had a basis weight of 58 grams per square meter with arcuate strand portions **11** of about 15 mm in height projecting from the nonwoven sheet **13**. The composite had a compression resistance of 93% measured as a ratio of initial caliper and caliper under a load of one pound per square inch.

We claim:

1. A composite fabric comprising:

(a) a porous backing layer; and

(b) a plurality of mutually parallel thermoplastic filaments extending in a first direction bonded to the porous backing layer at spaced apart bonding locations along the lengths of the filaments where the filaments form compression resistant arcuate portions between the bonding locations.

2. The composite fabric of claim 1 wherein the porous backing layer is a nonwoven fibrous web formed of thermoplastic fibers.

3. The composite fabric of claim 2 wherein the fibrous backing layer is a bonded carded web.

4. The composite fabric of claim 2 wherein the nonwoven fibrous web has a basis weight of from 10 to 20 g/m^2.

5. The composite fabric of claim 2 wherein the nonwoven fibrous web has a basis weight of from 20 to 100 g/m^2.

6. The composite fabric of claim 2 wherein the arcuate portions of the filaments have a height from the front surface of the backing layer of greater than 0.2 mm.

7. The composite fabric of claim 6 wherein the arcuate portions of the filaments have a height from the front surface of the backing layer of less than 4.0 mm.

8. The composite fabric of claim 6 wherein the filaments diameter is from 10 to 100 mils.

9. The composite fabric of claim 6 wherein the filaments diameter is from 10 to 50 mils.

10. The composite fabric of claim 8 wherein the filaments are homogeneous polymers or polymer blends.

11. The composite fabric of claim 8 wherein the filaments are multi-component filaments.

12. The composite fabric of claim 11 wherein the filaments are sheath core filaments.

13. The composite fabric of claim 12 wherein the multi-component filaments have sheath layers have a melting or softening point less than the core layer material.

14. The composite fabric of claim 8 wherein the filament is formed at least in part of a polymer having a softening point less than the softening point of the fiber forming the backing layer.

15. The composite fabric of claim 14 wherein the filament is a polyolefin fiber and the backing layer is a polyolefin.

16. The composite fabric of claim 8 wherein the filaments have a compression resistance such that it retains at least 50% of its initial caliper under a load of at least one pound per square inch.

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