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(54) **Manufacturing method of geogrid**

Herstellungsverfahren für in Erdbau anwendbarem Gitter

Méthode pour la fabrication de géogrilles

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EP 0 989 216 B1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an improved method for manufacturing geogrids with enhanced properties. More specifically, the present invention relates to an improved method for manufacturing woven geogrids, which can be used with foundations, soils, rock, earth, or other geomechanical materials to provide selective separation and reinforcement. The method disclosed in the present invention has many distinct advantages in that (1) it can be readily and easily implemented on-site; (2) it reduces manufacturing costs and minimizes or eliminates waste disposal problems that can cause environmentally pollution concerns; and (3) the geogrids so manufactured exhibit superior qualities, especially their ability to retain excellent strength after elongation.

BACKGROUND OF THE INVENTION

[0002] Geogrids have been used in various civil engineering and mining applications such as soil stabilization, reinforcement, and other applications. Geogrids, which as their names imply, are primarily two-dimensional in form, can be provided in soft or hard forms. Typically, the soft geogrids comprise intersecting (typically via weaving process) strands made from high tensile strength filaments so as to provide high load support characteristics. The grid openings formed from the intersecting stands typically are rectangular or square in shape, with the strands being placed at an angle of about 90 ° relative to each other. However, other shapes and/or relative angles may be used. Depending on the size of the grid, composition of the strands, and other factors, the commercially available geogrids may also be called geocells, geonets, or geocomposits. One of the companies that market these products is Tenax Company, located in Baltimore, Maryland.

[0003] The most common process in making geogrids involves the five main steps of: (1) spinning high-strength filament yarns; (2) warping; (3) weaving to form a two-dimensional net structure; (4) coating with polyvinyl chloride (PVC) or asphalt; and (5) drying/solidification to form the final geogrid. The purpose of the step of coating with PVC or asphalt is to cause the high-strength filament yarns to form filament bundles that are aggregated and covered by this matrix of binder material, which also serves as a protective material. The step of prepregging with PVC or asphalt also imparts many desired properties, such as UV-resistance and acid/base-resistances, to the grid structures.

[0004] It was observed by the co-inventors of the present invention that the geogrids made from the conventional process have several drawbacks. The most notable inadequacy with the conventional geogrids is that, because the only the fiber bundles (i.e., the so-called "ribs" of the geogrid) and the intersections thereof (i.e., the "nodal points") of the geogrids are covered by the PVC binder material, and no binder material is provided between the individual fibers, their junction strength is very poor. This severely limits the types of engineering projects that geogrids can be utilized with confidence. Furthermore, because the fiber bundles are prepregged with PVC or asphalt, the conventional process has raised serious environmental pollution concerns and causes clean-up problems.

[0005] In U.S. Pat. No. 5,091,247, it is disclosed a process for making woven geotextile grid (i.e., geogrid) for earth reinforcement applications. The grid is formed of woven fabric which is coated with a suitable polyvinylchloride or other plastic coating. The fabric is formed of a plurality of spaced-apart pick (i.e., transversal) yarn bundles which are interwoven with a plurality of spaced-apart warp (i.e., longitudinal) yarn bundles. The pick yarn bundles are held in place in the warp yarn bundles with locking yarns which run parallel to the pick yarns and which are positioned adjacent to the edges of the pick yarn bundles. The warp yarns extend between the pick yarn bundles and locking yarns to lock the pick yarn bundles into place. A plurality of pairs of leno yarns oriented parallel to the warp yarns additional strengthen the fabric by interlocking with one another in the spaces between the pick yarn bundles and locking yarns. After the fabric leaves the loom, it is dipped in a heated polyvinylchloride bath and dried using heating elements before being rolled for storage or shipment. The process disclosed in the '247 patent basically follows the convention process by dipping the woven fabric into a PVC bath, followed by drying/heating to form the geotextile grid. Again, because the PVC coating is only applied to the bundle surface and there is no adhesion force between the individual fibers, its junction strength is poor.

[0006] In U.S. Pat. No. 5,045,377, it is disclosed a process for making continuous fiber reinforced composite grid. The grid structures are formed by joining continuous fiber reinforced/resin matrix compound composite strands with similar compound composite strands, or with simple unreinforced plastic strands. The compound composite reinforced strands are formed by using prepreg, which comprises reinforcing fibers embedded in a plastic resin matrix. The prepreg tapes are fed from a supply roll into a die, and are continuously pulled through the die. In a separate route, a thermoplastic resin is supplied into the die and deposited onto the tapes to provide encapsulation of the prepreg in a second layer of plastic. Thereafter, thermoplastic resin is allowed to flow out to form transverse strands, thus resulting in a web or grid structure. The process discloses in the '377 patent differs from most of the conventional processes in that, among other things, first, it utilizes glass-fiber reinforced composites, thus its cost is substantially higher. Second, since the transverse direction strands are deposited onto the machine direction strands, the geogrids so produced are not woven geogrids; rather, they are non-woven geogrids. The geogrids produced from the '377 process provided several advantages while also suffer disadvantages. However, the '377 process still utilizes the same basic approach as the conventional process in that the thermoplastic resin is heated and melted to thereby provide a coating on the surface of the composite fiber.

[0007] In U.S. Pat. No. 5,199,825, it is disclosed a process for making a grid composite for protecting men and long well mining equipment during long well shield recovery. In this invention, a polymer grid is connected to a grid composite consisting of a polymer grid and a geotextile. The grid composite is formed by use of a polymer grid which is heat bonded to a continuous filament polyester, non-woven needle-punched engineering fabric. The engineering fabric or geotextile is bonded to the polymer grid using an open flame heat source or using a heated roll as a heat source. During the process, plastic pellets are melted and compressed by an extruder, and a gear pump and a melt mixer are used to provide a homogeneous melt. Since the process discloses in the '825 patent involves the step of bonding a polyester geotextile to a biaxial grid material formed by needle-punching, the geogrids so produced do not solve the lack of junction strength problem encountered in the conventional geogrids.

[0008] As discussed above, the conventional geogrids have a major limitation in that, because there is no binder material between the individual fibers within each fiber bundle, they lack the desired junction strength. While sever inventions have be disclosed to improve the properties of geogrids, they have not solved this problem. Therefore, it is desirable to develop an improved process so as to overcome this problem and enhance the applicability of geogrids. It is also equally desirable to develop an improved process which would make the manufacturing of geogrids environmentally compatible.

[0009] In order to improve the strength of the geogrid, U. S. Pat. No. 5,669,796 discloses a heat bonded geogrid fabric having a woven or warp knit, weft inserted grid. It comprises a bicomponent fiber with filaments each having a sheath of an adhesive polyolefin material comprising a polyolefin and an adhesive and containing about 0.5 wt% to about 2 wt% carbon black and a core of polyethylene terephthalate having an intrinsic viscosity of at least 0.89 deciliters per gram as determined from a solvent base of orthochlorophenol at 25 °C. The bicomponent fiber having the sheath-core configuration is prepared by melt-extruding polymer from a spinneret. Before reaching the spinneret, the molten polymer, which contains polyolefin, adhesive and carbon black, is filtered. The sheath polymer and the core polymer are pumped separately into their respective channels in each spinneret and are extruded through the spinneret holes to form the bicomponent fibers. The method disclosed in the '796 improves the coverage of the core polymer by the sheath polymer; however, because it involves a relatively complicated procedure, it may be more expensive to manufacture.

SUMMARY OF THE INVENTION

[0010] The primary object of the present invention is to develop an improved process for making woven geogrids which can be advantageously used in various civil engineering projects to provide selective separation and reinforcement for foundations, soils, rock, earth, or other geomechanical materials. More specifically, the primary object of the present invention is develop an improved method for manufacturing geogrids, which can be used with various types of civil engineering projects with improved long-term mechanical strengths. The method disclosed in the present invention provides many distinct advantages in that: (1) the process can be readily and easily implemented on-site; (2) it reduces manufacturing costs and is highly environmentally compatible; and (3) the geogrids so manufactured exhibit superior qualities, including excellent mechanical strength and low rate of elongation. One of the main advantages of the method disclosed in the present invention is that it can greatly enhance the retention of mechanical strength of geogrids after elongation, without substantially increasing the manufacturing cost thereof. Most geogrids will be elongated after they are applied onto the intended objects such as earth, etc. Thus, ability to retain mechanical strength is a very important parameter gauging the characteristics of a geogrid.

[0011] Another main advantages of the process disclosed in the present invention is that it does not require the equipment and steps for receiving, containing and melting a thermoplastic (or asphalt) feed, and coating (i.e., dipping) the molten thermoplastic onto a geotextile fabric, as required by the prior art processes. Because the prior art processes involve the handling of a very hot (typically above 150 °C) molten polymer or asphalt mass, they require relatively expensive equipment and often result in a highly hazardous work environment. Furthermore, the unused thermoplastic resin or asphalt can cause serious disposal problems and often are environmental headaches.

[0012] Yet another distinct advantage of the process disclosed in the present invention is that, while most of the prior art processes can only achieve the purpose of applying a binder composition covering the yarn bundles and leaving the individual fibers uncovered, the present invention allows the coating composition to effectively penetrate into and intimately cover the individual fibers in an ubiquitous manner. The ubiquity of the coating composition down to the individual fiber level allows the geogrids made from the process disclosed in the present invention to exhibit superior qualities over those made from the prior art processes, especially with regard to the junction strength. While the process disclosed in the '796 patent can achieve this purpose by using a sheath-core bicomponent fiber configuration, it involves a relatively complicated procedure and thus high manufacturing cost.

[0013] In a related research, the inventors of the present invention discovered that by combining one or more high-melting point filament yarns with one or more low-melting point filament yarns to form a hybrid bundle, and after warp beaming, weaving or twisting the hybrid bundle into a net structure with a predetermined grid pattern. Good coverage of the high-melting point filament yarns can be achieved. However, such coverage is only linear, and it may not provide complete coverage around the circumference of the high-melting point filament yarns.

[0014] In the process disclosed in the present invention to form a geogrid, unexpectedly superior results were observed when one or more high-melting point filament yarns and one or more low-melting point staple fibers are first co-spun into a composite yarn. The composite yarn is woven into fabrics with a net structure with a predetermined grid pattern. The grid pattern of the fabrics can be a rectangular or square shape with a predetermined grid opening. The net-structured fabric is then passed through a heat treatment causing the low-melting point staple fibers to melt and thereby ubiquitously bind the individual composite yarn. After cooling, a soft geogrid with excellent mechanical and chemical properties is produced. The grid structure can be made in a plant off-site or at the construction site.

[0015] The composite yarn disclosed in the present invention comprises at least one high-melting point filament yarn and a plurality of low-melting point staple fibers. The high-melting point filament yarn should possess the qualities of high strength, high modules and low strain rate, so as to provide the function as a reinforcement material for the woven geogrid. Examples of the high-melting point filament yarns that can be used in the present invention include polyesters, such as polyethylene terphthalate (PET), polybutylene terephthalate (PBT), etc; polyamides, such as nylon 6, nylon 66, etc; glass fibers; polyvinyl alcohol fibers; carbon fibers; and aramid fibers. On the other hand, the main function of the low-melting point staple fibers is to serve as a matrix or binder, and its strength is of relatively secondary consideration. Examples of the low-melting point staple fibers that can be used in the present invention include polyethylene, polypropylene, co-polyesters, polyamides such as nylon, etc. It is preferred that low-melting point staple fibers are selected such that the melting point of the high-melting point filament yarns is at least 20°C greater than that of the low-melting point staple fibers. The low-melting point staple fibers can be selected from the same class of polymers that can be used as the high-melting point filament yarns, the main point is they must have a lower melting point.

[0016] It is preferred that the composite yarn contains the high-melting point filament yarns and the low-melting point staple fibers in a weight ratio of 50 ~ 70% to 30 ~ 50%. These two types of fibers are spun into a bobbing. Thereafter, the composite yarn can be subjected to the weaving operation. Because the yarns formed in the present invention belong to the type of spun yarns, they can be used in various types of weaving machines, such as rapier loom or warp knitting machines, to form the desired grid structures. Typically, the grid dimension can be square 20 x 20 or rectangular 20 x 30 mm, etc. After the weaving process, the woven product can be placed in an oven, or other heat treatment devices, and heated at temperatures preferably about 10 ~ 50 °C above the melting point of the low-melting point staple fibers, to thereby form the final geogrid product.

[0017] By using the composite yarn, the present invention does not require the costly and messy prepregging step which has always been required in the prior art processes. By doing so, the process disclosed in the present invention eliminates the need for the coating facility, its also reduces the size of the processing plant as well as the cost of other related equipment. But more importantly, the process disclosed in the present invention greatly reduces the processing time and minimizes potential environmental pollution problems. Furthermore, with the process disclosed in the present invention, the high-strength fibers (i.e., the high-melting point fibers) are intimately bonded by the binder or matrix resin (formed from the low-melting point staple fibers), excellent adhesion is provided between the individual composite yarn and at the intersections of the yarns. This results in greatly improved junction strength and overall strength of the geogrids so produced.

BRIEF DESCRIPTION OF THE DRAWING

[0018] The present invention will be described in detail with reference to the drawing showing the preferred embodiment of the present invention, wherein:

Fig. 1 is a schematic drawing showing the steps of forming a polymeric geogrid according to the most common prior art processes.

Fig. 2 is a schematic drawing showing the steps of form a polymeric geogrid according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] The present invention discloses an improved process for making polymeric geogrids, which can be used with foundations, soils, rock, earth, or other geomechanical materials to provide selective separation and reinforcement. The method disclosed in the present invention provides many distinct advantages. First, the process can be readily and easily implemented on-site without requiring excessive extra equipment. Second, it reduces the manufacturing time and cost and is highly environmentally compatible. Third, the geogrids manufactured from the process disclosed in the present invention exhibit superior qualities, including high junction strength, low elongation, and high overall strength. As discussed earlier, one of the distinct advantages of the method disclosed in the present invention is that the geogrids so prepared can retain a significant portion of their designed strength after elongation, without incurring substantially increased manufacturing cost.

[0020] As described above, the process disclosed in the present invention does not require the equipment and steps for receiving, containing and melting a thermoplastic (or asphalt) feed, nor does it requires the equipment and steps for coating the molten thermoplastic onto a geotextile fabric. Both of these elements are required by the prior art processes, which involve the handling of a very hot (typically above 150 °C) molten polymer or asphalt mass. As a result, the prior art processes often require relatively expensive equipment and often result in a highly hazardous work environment. Furthermore, the unused thermoplastic resin or asphalt mass can cause serious disposal problems and often present environmental headaches.

[0021] The process disclosed in the present invention also allows the binder composition (i.e., the low melting point stable fibers) to effectively and intimately cover the filament yarn. This is another distinct advantage over all of the prior art processes, in which the binder composition only covers the filament bundles. The wrapping of the binder fiber composition outside and around the individual composite yarn allows the geogrids made from the process disclosed in the present invention to exhibit superior qualities over those made from the prior art processes, especially with regard to the junction strength and retained strength after elongation. The present invention thus not only allows a superior geogrid to be made, it also enables the product to be made in a more cost-effective and environmentally-conscientious manner.

[0022] In the process disclosed in the present invention, at least one high-melting point fiber filament yarn and a plurality of low-melting point fibers are first spun to form a composite yarn. The composite yarn is then woven into a net structure with a predetermined grid opening, which can be a rectangular or square shape with a predetermined grid dimension. The woven net structure made from the composite yarns is then heated to cause the low-melting point staple fiber to melt and thereby forming a wrapping outside and around the high-melting point fibers. After cooling, a soft geogrid with excellent mechanical and chemical properties is provided. The grid structure can be made from a manufacturing plant or at the construction site.

[0023] The composite yarn disclosed in the present invention preferably comprises one or more high-melting point multi-filament yarns and a plurality of low-melting point staple fibers. It is preferred that the composite yarn contain the high-melting point filament yarns and the low-melting point multi-filament yarn at a ratio of 50 ~ 70% to 30 ~ 50%, by weight, of the fibers. The high-melting point and low-melting point fibers can be provided as simple fibers, or the low-melting point fibers can be provided as bi-component fibers. If bi-component staple fibers are used, they can be either sheath-and-core type or side-by-side type. The high-melting point filament yarn, which provides the function as a reinforcement material for the polymeric geogrid, should possess the desired qualities of high strength, high modules and low strain rate. Preferred examples of the high-melting point fibers that can be used in the present invention include polyesters, such as polyethylene terephthalate (PET), polybutylene terephthalate (PBT), etc; and polyamides, such as nylon 6, nylon 66, etc. Glass fibers, polyvinyl alcohol fibers, carbon fibers, and aramid fibers may also be used as the reinforcement component. The main function of the low-melting point staple fibers is to serve as a matrix or binder to wrap the reinforcement component (i.e., the high-melting point multi-filament yarn), and its strength is of secondary consideration. Preferred examples of the low-melting point staple fibers that can be used in the present invention include polyethylene, polypropylene, polyester copolymers, polyamides such as nylon, etc. It is preferred that low-melting point fibers are selected such that the melting point of the high-melting point fibers is at least 20°C greater than that of the low-melting point fibers.

[0024] The high- and low-melting point fibers are spun then subjected to warp beaming; optionally, they can be subject to other processing steps before warp beaming. Thereafter, the yarn bundles can be subjected to the weaving operation. Because the yarns formed in the present invention belong to the type of spun yarns, they can be used in various types of weaving machines, such as rapier loom, warp weaving or warp twisting machines, to form the desired grid structures. Preferably, the grid dimensions are 20 x 20 or 20 x 30 mm. Other dimensions can be easily implemented. After the weaving process, the woven product is placed in an oven and heated at temperatures preferably about 10 ~ 20 °C above the melting point of the low-melting point fibers, to thereby form the final geogrid product.

[0025] A distinct feature of the process disclosed in the present invention is that the present invention does not require the costly and messy coating step which has always been required in the prior art processes. Rather, the present invention uses the composite yarn comprising high-melting point filament yarns and low-melting point staple fibers in the weaving process. This novel approach allows the process disclosed in the present invention to eliminate the need for the coating equipment, its also reduces the plant size and the cost for other equipment. As a result, the process disclosed in the present invention was able to greatly reduce the processing time and minimize potential environmental pollution problems. In addition to the cost savings, the geogrids produced from the process disclosed in the present invention also exhibit unexpectedly superior qualities. With the process disclosed in the present invention, the reinforcement fibers are intimately wrapped by the binder fibers, thus, excellent bonding is provided between the individual fibers and at the intersections of these fibers. This resulted in greatly improved junction strength as well as excellent overall strength. The wrapping of the filament yarns by the staple fibers also allows eventually excellent enclosure by the binding component.

[0026] Now refer to the drawings. Fig. 1 is a schematic drawing showing the steps of forming a polymeric geogrid according to the most common prior art processes. High strength filament fibers 2 are provided from the bobbin support 1 and combined to form yarns 3. The yarns are processed through a warp beam 4 and are woven in a weaving machine 5 to form a woven net structure consisting of grid ribs and nodes formed of fiber bundles. The net structure is then passed through a dipping bath 6, and a pair of padders 7. The dipping bath 6 contains a coating composition, typically polyvinyl chloride, to apply a layer of protective and binder composition covering the fiber bundles. Finally the coated woven net structure is heated and dried in an oven 8 and taken up by a take-up roller 9 to form a geogrid.

[0027] Fig. 2 shows a schematic drawing showing the steps of forming a polymeric geogrid according to a preferred embodiment of the present invention. Composite yarn bobbins 12 are provided from the roll support, or creel, 10. The composite yarn are processed through a tension unit 15 and woven in a weave machine 13 to form a woven net structure consisting of grid ribs and nodes formed of composite yarns. Instead of passing through the dipping bath as shown in Fig. 1 of the prior art processes, the woven net structure is directly fed to the oven 15, through guide rollers 14, where the woven net structure is heated and dried, and then is cooled and taken up by a take-up device 16 to form a geogrid. The elimination of the dipping bath greatly simplifies the manufacturing process, reduces the manufacturing cost (in both the capital cost and operation cost), improves the manufacturing condition, and ameliorates environmental pollution concerns.

[0028] The present invention will now be described more specifically with reference to the following example. It is to be noted that the following descriptions of examples, including the preferred embodiment of this invention, are presented herein for purposes of illustration and description, and are not intended to be exhaustive or to limit the invention to the precise form disclosed.

Example 1

[0029] In this example, the high-melting point fibers were high-strength polyethylene terephthalate (PET) filament yarns of 2,000d/192f, and the low-melting point fibers were a polypropylene staple fibers with a fiber denier of 2.5 and nominal fiber length of 2 inches. Three bundles of the high-strength PET filament yarns were combined then spun with the polypropylene staple fibers to form a composite yarn. The composite yarn was then woven into a net structure having a grid opening of 20 x 20 mm. The woven net structure was heated at a temperature of 190 °C for 2 min so as to cause the low-melting point staple fibers to melt and bind the high-strength PET filament yarns. After cooling, the net structured solidified to form the geogrid ready for use.

Table 1 shows a comparison of relevant physical properties between a commercial geogrid and the geogrid of the present invention. Both geogrids have same specification, i.e., nominal strength, of 150 kN/m.

	Commercial Geogrid	Example 1
Weaving type	Weaving	Weaving
Polymer type	150 kN/m	150 kN/m
Specification	PET/PVC	PET/PP
Ultimate Strength	168.9 kN/m	164.0 kN/m
Ultimate Elongation	15.21 %	13.1 %
Strength at 5% Elongation	39.3 kN/m	60.1 kN/m
(% of Ultimate Strength)	23.3 %	36.6 %
Junction Strength	11.7 Kg	15.5 Kg
Basis Weight	796.5 g	502.7 g

[0030] The comparative results Table 1 clearly show that the geogrid of the present invention provided superior results, an improvement of about 32.5% over the commercial product of the same specification, with regard to junction strength. But at least equally importantly, the geogrid of the present invention exhibited better than 57 % improvement over the commercial product, in the retention of the ultimate strength at 5% elongation.

Claims

1. A method for manufacturing geogrids comprising the steps of:

    (a) combining at least a high-melting point fiber in the form of a filament yarn with at least a low-melting point fiber in the form of a staple fiber to form a composite yarn, wherein said low-melting point fiber has a melting point that is at least 10 °C lower than the melting point of said high-melting point fiber;

    (b) weaving said composite yarn to form a net-structured fabrics;

    (c) heating said net-structured fabrics to cause said low-melting point fiber to melt and wrap about said high-melting point fiber; and

    (d) cooling said net-structured fabrics to form a geogrid.

2. A method for manufacturing geogrids according to claim 1 wherein the melting point of said low-melting point fiber is at least 20 °C lower than the melting point of said high-melting point filament fiber.

3. A method for manufacturing geogrids according to claim 1 wherein said composite yarn comprises a plurality of said high-melting point filament yarns and a plurality of said low-melting point staple fibers.

4. A method for manufacturing geogrids according to claim 1 wherein said high-melting point fiber is selected from the group consisting of polyethylene terephthalate, polybutylene terephthalate, polyamides, glass fibers, aramid fibers, and carbon fibers.

5. A method for manufacturing geogrids according to claim 4 wherein said polyamide is nylon 6 or nylon 66.

6. A method for manufacturing geogrids according to claim 1 wherein said low-melting point fiber is selected from the group consisting of polyethylene, polypropylene, polyester copolymers, and polyamides.

7. A method for manufacturing geogrids according to claim 6 wherein said polyamide is nylon 6 or nylon 66.

8. A method for manufacturing geogrids according to claim 1 wherein said low-melting point fiber is a bi-component fiber.

9. A method for manufacturing geogrids according to claim 8 wherein said bi-component fiber is a sheath-and-core type or side-by-side type fiber.

10. A method for manufacturing geogrids according to claim 1 wherein said composite yarn comprises about 50 to 70 percent by weight of said high-melting point fiber and about 30 to 50 percent by weight of said low-melting point fiber.

11. A method for manufacturing geogrids according to claim 1 wherein said high-melting point fiber has a melting point above 150 °C.

12. A method for manufacturing geogrids according to claim 1 wherein said high-melting point fiber and said low-melting point fiber are combined by co-spinning to form said composite filament yarn.

13. A method for manufacturing geogrids according to claim 1 or 11, wherein said step (a) comprises co-spinning at least one high melting point fiber in the form of a filament yarn with at least one low melting point fiber also in the form of a staple fiber to form a composite yarn.

14. A polymeric geogrid comprising a plurality of intersecting longitudinal and transversal composite yarns, each of said composite yarns comprising a plurality of first fibers wrapped by a polymeric binder resin in a spaced-apart manner, said polymeric geogrid being made from a process comprising the steps of:

(a) co-spinning a plurality of said first fibers in the form of filament yarns with a plurality of second fibers in the form of staple fibers which is made from said polymeric binder to form a composite yarn, wherein said first fiber has a melting point that is at least 10 °C greater than the melting point of said second fiber;

(b) weaving said composite yarn to form a net-structured fabrics;

(c) heating said net-structured fabrics at a temperature which causes said second fiber to melt and wrap about said first fiber; and

(d) cooling said net-structured fabrics to form a geogrid.

15. A geogrid according to claim 14 wherein said first fiber is selected from the group consisting of polyethylene terephthalate, polybutylene terephthalate, polyamides, glass fibers, aramid

16. A geogrid according to claim 14 wherein said first fiber wherein said second fiber is selected from the group consisting of polyethylene, polypropylene, polyester copolymers, and polyamides.

Patentansprüche

1. Verfahren zur Herstellung von Geogittern umfassend die folgenden Schritte:

(a) Verbinden von wenigstens einer Faser mit einem hohen Schmelzpunkt in Form eines Fadengarns mit wenigstens einer Faser mit einem niedrigen Schmelzpunkt in Form einer Stapelfaser, um ein Kompositgarn zu bilden, wobei die Faser mit einem niedrigen Schmelzpunkt, einen Schmelzpunkt von wenigstens 10 °C unterhalb des Schmelzpunktes der Faser mit einem hohen Schmelzpunkt besitzt;

(b) Weben des Kompositgarns, um netzstrukturiertes Gewebe zu bilden;

(c) Erhitzen der netzstrukturierten Gewebe, um die Faser mit dem niedrigen Schmelzpunkt zum Schmelzen zu bringen und die Faser mit dem hohen Schmelzpunkt zu umhüllen; und

(d) Abkühlen der netzstrukturierten Gewebe, um ein Geogitter zu bilden.

2. Verfahren zur Herstellung von Geogittern nach Anspruch 1, wobei der Schmelzpunkt der Faser mit einem niedrigen Schmelzpunkt wenigstens 20 °C unterhalb des Schmelzpunktes der Fadenfaser mit einem hohen Schmelzpunkt liegt.

3. Verfahren zur Herstellung von Geogittern nach Anspruch 1, wobei das Kompositgarn eine Vielzahl von Fadengarnen mit einem hohen Schmelzpunkt und eine Vielzahl von Stapelfasern mit einem niedrigen Schmelzpunkt umfasst.

4. Verfahren zur Herstellung von Geogittern nach Anspruch 1, wobei die Faser mit einem hohen Schmelzpunkt ausgewählt wird aus der Gruppe, bestehend aus Polyethylenterephthalat, Polybutylenterephthalat, Polyamiden, Glasfasern, Aramidfasern und Kohlenstofffasern.

5. Verfahren zur Herstellung von Geogittern nach Anspruch 4, wobei das Polyamid Nylon 6 oder Nylon 66 ist.

6. Verfahren zur Herstellung von Geogittern nach Anspruch 1, wobei die Faser mit einem niedrigen Schmelzpunkt ausgewählt wird aus der Gruppe, bestehend aus Polyethylen, Polypropylen, Polyestercopolymeren und Polyamiden.

7. Verfahren zur Herstellung von Geogittern nach Anspruch 6, wobei das Polyamid Nylon 6 oder Nylon 66 ist.

8. Verfahren zur Herstellung von Geogittern nach Anspruch 1, wobei die Faser mit einem niedrigen Schmelzpunkt eine Zweikomponentenfaser ist.

9. Verfahren zur Herstellung von Geogittern nach Anspruch 8, wobei die Zweikomponentenfaser eine Faser vom Hüllen-und-Kern-Typ oder Seite-an-Seiten-Typ ist.

10. Verfahren zur Herstellung von Geogittern nach Anspruch 1, wobei das Kompositgarn ungefähr 50 bis 70 Gewichtsprozent der Faser mit einem hohen Schmelzpunkt von ungefähr 30 bis 50 Gewichtsprozent der Faser mit einem niedrigen Schmelzpunkt umfasst.

11. Verfahren zur Herstellung von Geogittern nach Anspruch 1, wobei die Faser mit einem hohen Schmelzpunkt, einen Schmelzpunkt von oberhalb von 150 °C besitzt.

12. Verfahren zur Herstellung von Geogittern nach Anspruch 1, wobei die Faser mit einem hohen Schmelzpunkt und die Faser mit einem niedrigen Schmelzpunkt durch gleichzeitiges Verspinnen gebildet werden, um das Kompositfadengarn zu bilden.

13. Verfahren zur Herstellung von Geogittern nach Anspruch 1 oder 11, wobei der Schritt (a) ein gleichzeitiges Verspinnen von wenigstens einer Faser mit einem hohen Schmelzpunkt in Form eines Fadengarns mit wenigstens einer Faser mit einem niedrigen Schmelzpunkt in Form einer Stapelfaser umfasst, um ein Kompositgarn zu bilden.

14. Polymeres Geogitter, umfassend eine Vielzahl von sich überkreuzenden längsgerichteten und quergerichteten Kompositgarnen, wobei jedes der Kompositgarne eine Vielzahl von ersten Fasern umfasst, die auf eine voneinander getrennte Weise von einem polymeren Bindemittelharz umhüllt sind, wobei das polymere Geogitter nach einem Verfahren, umfassend die folgenden Schritte hergestellt wird:

(a) gemeinsames Verspinnen einer Vielzahl von ersten Fasern in Form von Fadengarnen mit einer Vielzahl von zweiten Fasern in Form von Stapelfasern, die aus diesem polymeren Bindemittel hergestellt sind, um ein Kompositgarn zu bilden, wobei die erste Faser einen Schmelzpunkt besitzt, der wenigstens 10 °C höher ist als der Schmelzpunkt der zweiten Faser;

(b) Weben des Kompositgarns, um netzstrukturierte Gewebe zu bilden;

(c) Erhitzen der netzstrukturierten Gewebe, um die Faser mit dem niedrigen Schmelzpunkt zum Schmelzen zu bringen und die Faser mit dem hohen Schmelzpunkt zu umhüllen; und

(d) Abkühlen der netzstrukturierten Gewebe, um ein Geogitter zu bilden.

15. Geogitter nach Anspruch 14, wobei die erste Faser ausgewählt wird aus der Gruppe bestehend aus Polyethylenterephthalat, Polybutylenterephthalat, Polyamiden, Glasfasern, Aramidfasern und Kohlenstofffasern.

16. Geogitter nach Anspruch 14, wobei die zweite Faser ausgewählt wird aus der Gruppe bestehend aus Polyethylen, Polypropylen, Polyestercopolymeren und Polyamiden.

Revendications

1. Procédé de fabrication de géogrilles comprenant les étapes suivantes :

(a) combiner au moins une fibre à haut point de fusion sous forme de fil à filaments avec au moins une fibre à bas point de fusion sous forme de fibre à crochets pour former un fil composite dans lequel la fibre à bas point de fusion a un point de fusion inférieur d'au moins 10°C au point de fusion de la fibre à haut point de fusion ;
(b) tisser le fil composite pour former un tissu à structure en filet ;
(c) chauffer le tissu à structure en filet pour amener la fibre à bas point de fusion à fondre et à envelopper la fibre à haut point de fusion ; et
(d) refroidir le tissu à structure en filet pour former une géogrille.

2. Procédé de fabrication de géogrilles selon la revendication 1, dans lequel le point de fusion de la fibre à bas point de fusion est d'au moins 20°C inférieur au point de fusion de la fibre à haut point de fusion.

3. Procédé de fabrication de géogrilles selon la revendication 1, dans lequel le fil composite comprend une pluralité de fils à filaments à haut point de fusion et une pluralité de fibres à crochets à bas point de fusion.

4. Procédé de fabrication de géogrilles selon la revendication 1, dans lequel la fibre à haut point de fusion est choisie dans le groupe comprenant le téréphthalate de polyéthylène, le téréphthalate de polybutylène, des polyamides, des fibres de verre, des fibres aramides et des fibres de carbone.

5. Procédé de fabrication de géogrilles selon la revendication 4, dans lequel le polyamide est du Nylon 6 ou du Nylon 66.

6. Procédé de fabrication de géogrilles selon la revendication 1, dans lequel la fibre à bas point de fusion est choisie dans le groupe comprenant le polyéthylène, le polypropylène, des copolymères de polyester et des polyamides.

7. Procédé de fabrication de géogrilles selon la revendication 6, dans lequel le polyamide est du Nylon 6 ou du Nylon 66.

8. Procédé de fabrication de géogrilles selon la revendication 1, dans lequel la fibre à bas point de fusion est une fibre à deux composants.

9. Procédé de fabrication de géogrilles selon la revendication 8, dans lequel la fibre à deux composants est du type à gaine et coeur ou du type à fibres côte à côte.

10. Procédé de fabrication de géogrilles selon la revendication 1, dans lequel le fil composite comprend environ 50 à 70 % en poids de fibre à haut point de fusion et environ 30 à 50 % en poids de fibre à bas point de fusion.

11. Procédé de fabrication de géogrilles selon la revendication 1, dans lequel la fibre à haut point de fusion a un point de fusion supérieur à 150°C.

12. Procédé de fabrication de géogrilles selon la revendication 1, dans lequel la fibre à haut point de fusion et la fibre à bas point de fusion sont combinées par co-filage pour former le fil composite à filaments.

13. Procédé de fabrication de géogrilles selon la revendication 1 ou 11, dans lequel l'étape (a) comprend le co-filage d'au moins une fibre à haut point de fusion sous forme de fil à filaments avec au moins une fibre à bas point de fusion sous forme d'une fibre à crochets pour former un fil composite.

14. Géogrille polymère comprenant une pluralité de fils composites longitudinaux et transversaux se coupant, chacun des fils composites comprenant une pluralité de premières fibres enveloppées d'une résine liante polymère de façon espacée, la géogrille polymère étant fabriquée par un procédé comprenant les étapes suivantes :

(a) co-filer une pluralité de premières fibres sous forme de fils à filaments avec une pluralité de secondes fibres sous forme de fibres à crochets qui est formée à partir du liant polymère pour former un fil composite, dans lequel la première fibre a un point de fusion inférieur d'au moins 10°C au point de fusion de la seconde fibre ;
(b) tisser le fil composite pour former un tissu à structure en filet ;
(c) chauffer le tissu à structure en filet à une température qui amène la seconde fibre à fondre et à envelopper la première fibre ; et
(d) refroidir le tissu à structure en filet pour former une géogrille.

15. Géogrille selon la revendication 14, dans laquelle la première fibre est choisie dans le groupe comprenant le téréphthalate de polyéthylène, le téréphthalate de polybutylène, des polyamides, des fibres de verre, des fibres aramides et des fibres de carbone.

16. Géogrille selon la revendication 14, dans laquelle la seconde fibre est choisie dans le groupe comprenant le polyéthylène, le polypropylène, des copolymères de polyester et des polyamides.

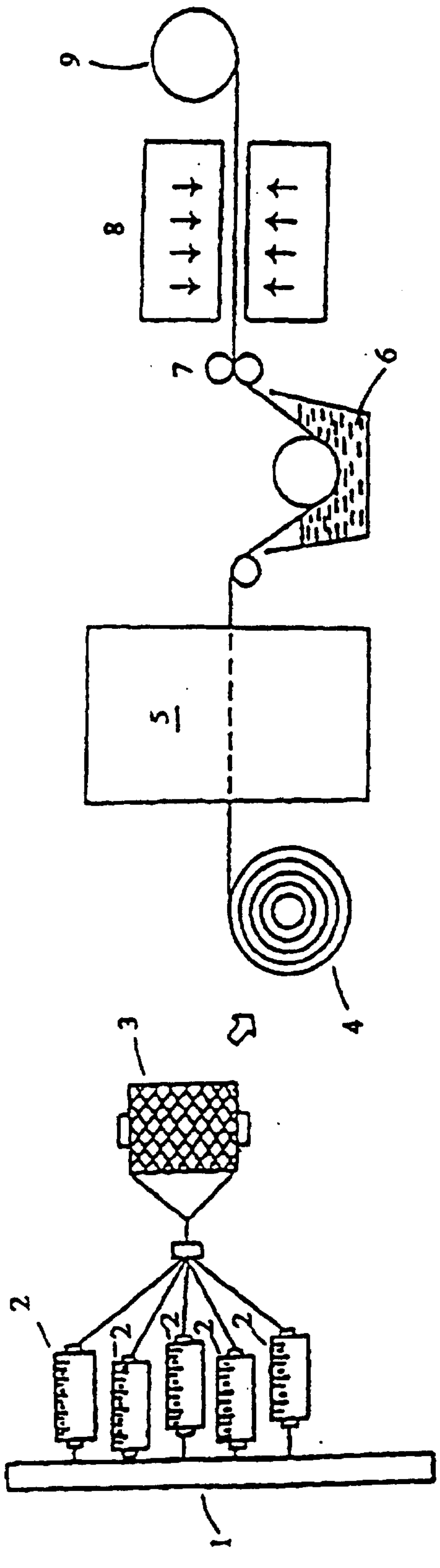

Fig. 1

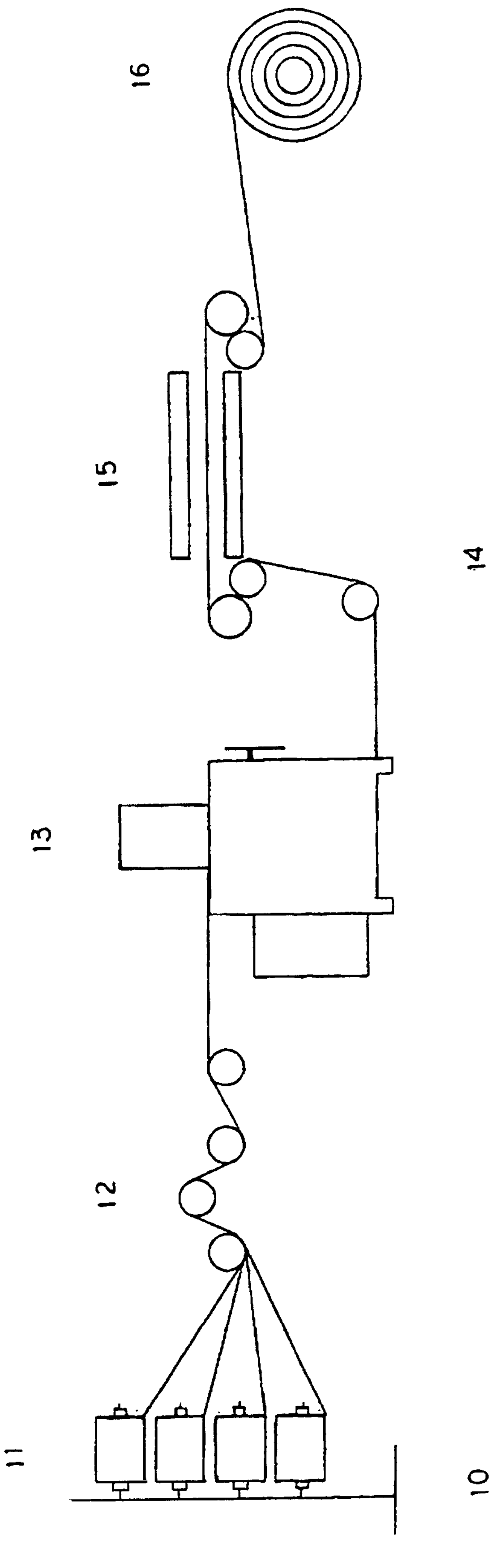

Fig. 2