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(54) **A FLUID-PERMEABLE TUBE**

(57) A fluid-permeable tube comprising a tube body provided with holes for the passage of fluid in the radial direction, and one or more fluid -permeable filtration layers encompassing the outer wall of said tube body is provided., The tube body comprises biodegradable polymer and said one or more fluid-permeable filtration layers comprising biodegradable polymer.

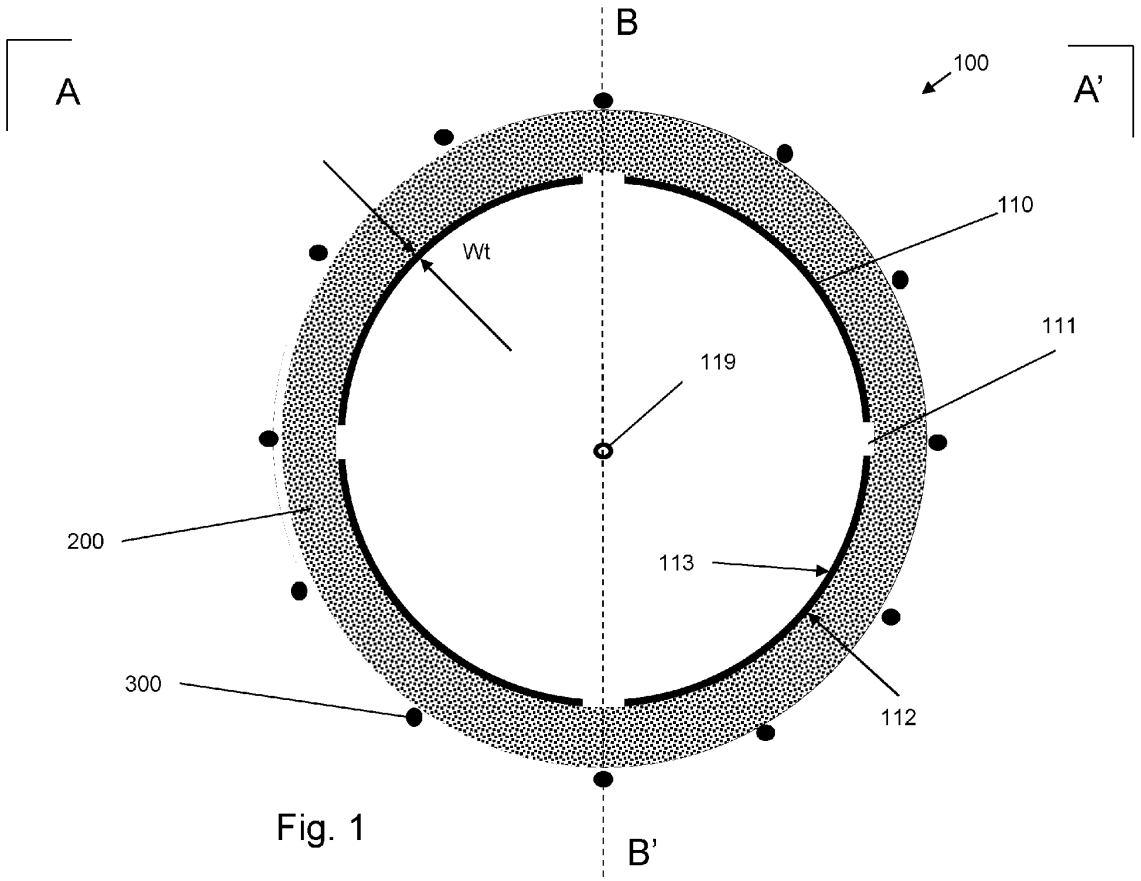

Fig. 1

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Description

Field of the Invention

[0001] The present invention generally relates to fluid-permeable tubes, in particularly fluid-permeable tubes for aeration or water content management of soils.

Background of the Invention

[0002] Fluid-permeable tubes for aeration or water content management of soils are known in the art. Polymeric and perforated tubes, wound with polymeric fiber fleeces are inserted in the soil to drain off water from the soil, or to infiltrate soil with air or water.

[0003] A challenge at present is the provision of biodegradable tubes for such purposes. This because in various applications, this fluid-permeable tube needs top be provided only temporarily or for a relative short period in time. Taking back the tube out of the soil is usually not possible or time consuming hence expensive. The non-biodegradable tubes stay in the soil as waste.

[0004] Biodegradable polymers, like polylactic acid polymer or starch based polymers are known, even in tube form, e.g. from EP2718076.

Summary of the Invention

[0005] The challenge to provide biodegradable fluid-permeable tubes for aeration and/or water content management of soils remains, in particularly tubes having a predictable service time and biodegradation time.

[0006] According to a first aspect of the invention, a fluid-permeable tube comprising a tube body provided with holes for the passage of fluid in the radial direction, and one or more fluid -permeable filtration layers encompassing the outer wall of said tube body. The tube body comprises biodegradable polymer and the one or more fluid-permeable filtration layers comprise biodegradable polymer.

[0007] According to some embodiments, the tube body may be provided with holes for the passage of liquid in the radial direction, and said fluid -permeable filtration layers is liquid-permeable. According to some embodiments, the tube body may be provided with holes for the passage of gas or air in the radial direction, and said fluid -permeable filtration layers is gas-permeable.

[0008] In the scope of this invention, biodegradable means that the material is able to decay naturally and without harming the environment and is demonstrated by certification according to at least EN14995 (Plastics. Evaluation of compostability. Test scheme and specifications)

[0009] The tube body is provided with holes for the passage of fluid in the radial direction of the tube body. These holes may be openings spread over the total surface of the tube body. Preferably the holes, also referred to as openings, are distributed evenly over the surface of the tube body. The open area of the holes may form about 1 to 40% of the total surface of the tube body, more preferably between 2 to 25%, such 3 to 20%. The holes may be circular perforations or have any other circumference, like having a square circumference, an oblong circumference, e.g. rectangular, rounded angle rectangular, oval or racetrack-shaped. The open area of each hole may be about 2 to 500 mm^2, more preferably 12 to 50 mm^2, even more preferably 4 to 20 mm^2.

[0010] The holes may be provided according to a regular distribution, e.g. in groups of holes, each group being provided at a given axial position of the tube body. The interdistance between groups may be about identical between the groups. The holes of each group may be evenly distributed around the perimeter of the tube, e.g. with about equal qual angles between two adjacent holes.

[0011] The tube body may have a rectangular, even square, a circular or an oblong radial cross section. Preferably the tube body has a circular radial cross section. The outer diameter of the tube body may be in the range of 5 to 2500 mm, more preferably in the range of 10 to 160 mm, most preferably in the range of 40 to 105mm, e.g. from 55 to 105mm, e.g. in the range of 55 to 85 mm such as 45mm, 50mm, 55mm, 60mm, 65mm, 70mm 75mm or 80mm.

[0012] Said filtration layer or layers may be referred to as sleeve or filter cover. In the context of this invention, the term "filtration" in filtration layer is to be understood as the property that the layer prevents soil particles from penetrating the tube body.

[0013] The filtration layer or layers together or each layer individual may have pore diameter O90 of less than or equal to 2000 μm, measured in line with the certification BRL1412 of Kiwa Nederland B.V.

[0014] The composition of the biodegradable polymer of the filtration layer or sleeve may comprise polylactic acid (PLA), starch (like maize starch, corn starch, rice starch and alike), polyhydroxyalkanoates (PHA), polyhydroxybutyrates (PHB), biodegradable polyurethane (PU) and copolymers of similar mono-, oligo- or polymers , and combinations of those polymers.

[0015] Optionally the fluid-permeable tube may comprise more than one fluid-permeable filtration layer, such as 2, 3, 4, 5 or even more fluid-permeable filtration layers, each comprising biodegradable polymer. The layers which may be provided form the same or from different material, may encompass one or more other layers. As such they form a layer of layers.

[0016] According to some embodiments, the one or more fluid permeable filtration layers may comprise biodegradable manmade polymer. The fluid permeable filtration layers may be liquid and/or gas-permeable.

[0017] In the scope of this invention, manmade polymer refers to polymer or polymer composition that is made though the intervention of a human. Manmade may also be referred to by semi-synthetic or synthetic polymer, in comparison to natural polymers. Manmade

polymer fibers refers to fibers being provided from manmade polymer.

[0018] The pore diameter O90 according to the certification BRL1412 of Kiwa Nederland B.V. of the one or more fluid permeable filtration layers, each of the layers or the combination of layers of the fluid-permeable tube according to the invention, may vary between 300μm and 2000μm, e.g. between 300μm and 1500μm, such as between 350μm and 1150μm, e.g. between 400μm and 1100μm, e.g. may be 450μm plus or minus 100 μm, 700μm plus or minus 100μm, or 1000μm plus 150μm or minus 250μm or minus 150μm.

[0019] According to some embodiments, the pore diameter O90 according to the certification BRL1412 of Kiwa Nederland B.V. of the one or more fluid permeable filtration layers is between 300μm and 2000μm, such as between 300μm and 1500μm.

[0020] According to some embodiments, the one or more fluid permeable filtration layers may comprise biodegradable manmade polymer fibers.

[0021] Optionally the fluid-permeable tube may comprise more than one fluid-permeable filtration layer, each comprising biodegradable manmade polymer fibers. The layers may comprise identical, similar or different biodegradable manmade polymer fibers.

[0022] The composition of the biodegradable manmade polymer fibers of the each of the one or more fluid permeable filtration layers may comprise polylactic acid (PLA), starch (like maize starch, corn starch, rice starch and alike), polyhydroxyalkanoates (PHA), polyhydroxybutyrates (PHB), biodegradable polyurethane (PU) , and copolymers of similar mono-, oligo- or polymers , and combinations of those polymers.

[0023] The composition of the biodegradable polymer of each of the one or more fluid permeable filtration layers may comprise more than one type of biodegradable manmade polymer fibers, each biodegradable manmade polymer fiber being provided from polylactic acid (PLA), starch (like maize starch, corn starch, rice starch and alike), polyhydroxyalkanoates (PHA), polyhydroxybutyrates (PHB), biodegradable polyurethane (PU) , and copolymers of similar mono-, oligo- or polymer, and combinations of those polymers.

[0024] The biodegradable manmade polymer fibers may be combined with other biodegradable fibers, like natural biodegradable fibers. The biodegradable manmade polymer fibers may provide 2%w or more, such as 20%w or more or even 50%w or more of the fibers in each of the one or more filtration layers, and preferably this in a combination of biodegradable manmade polymer fibers with natural biodegradable fibers.

[0025] The biodegradable manmade polymer fibers may provide at least 60%w of the fibers in each of the one or more filtration layers. Preferably the biodegradable manmade polymer fibers may provide at least 75%w of the fibers of the fibers in each of the one or more filtration layers, even at least 80%w or even at least 90%w of the fibers of the fibers in each of the one or more filtration layers. Possibly the biodegradable manmade polymer fibers may provide 100%w of the fibers in each of the one or more filtration layer. Hence each of the one or more filtration layers may even consist of biodegradable manmade polymer fibers. Hence according to some embodiments, the biodegradable manmade polymer fibers may provide at least 60%w of the one or more fluid permeable filtration layers.

[0026] The other part of the fibers in each of the one or more the filtration layer may preferably be natural fibers, such as sisal, coconut fibers, cotton fibers, wool fibers and alike, optionally such fibers in chopped state or a rest stream of textile processes processing such fibers, or other manmade, such as polymer, fibers. More preferably the other part of the fibers in each of the one or more the filtration layer may be natural fibers, such as sisal, coconut fibers, cotton fibers, wool fibers, miscanthus fibers, fibers from cattails, seaweed fibers, or other natural fibers and alike, optionally such fibers in chopped state or a rest stream of textile processes processing such fibers.

[0027] The fibers, preferably long staple fibers or filaments, may be wound in one or more layers of fiber bundles around the tube body, thereby providing one of the one or more filtration layers. Possibly more than one bundle is wound, where at least one bundle is wound in a first winding direction, at least one is wound in opposite direction around the tube body. Possibly the plurality of bundles are braided around the tube body.

[0028] In alternative ways, the fibers, preferably long staple fibers or filaments, may be laid down as a fleece of fibers, which fleece, or a stack of such fleeces is wound or plied around the tube body, thereby providing one of the one or more filtration layers.

[0029] The fluid-permeable tube according to the present invention, in particularly when comprising fluid-permeable filtration layer or layers comprise biodegradable manmade polymer, more preferred biodegradable manmade polymer fibers, has the advantage that the service life and degradation time may be estimated more accurately, and is more uniformly predictable and definable.

[0030] In comparison with natural fibers, like coconut fibers or sisal fibers, biodegradable manmade polymer fibers may have a longer and more predictable service time. As such the service time of the fluid-permeable tube, once embedded in the soil, is more predictable in function of the type of soil in which the fluid-permeable tube is embedded. Natural fibers will degrade depending on the large variation they expose or have been exposed to, like variation in thickness, variation in lengths, variation in maturity, variation in origin, variation in pretreatments, and many more. All these variation cause the biodegradation to be very unpredictable. Though the properties of biodegradable manmade polymer fibers may vary as well to some extent, these variations are controlled and may be kept limited. The biodegradation hence can be estimated and predicted better, based upon these properties showing less variation.

[0031] In comparison with non-biodegradable manmade fibers, such a polyethylene or polypropylene fibers, the use of these biodegradable manmade polymer fibers may degrade during a more predictable period during or after its service time, while non-biodegradable manmade fibers will remain as waste in the soil for decades if not longer.

[0032] The composition of the fiber or fiber blend, preferably biodegradable manmade polymer fibers or a composition of biodegradable manmade polymer fibers and natural fibers, may vary in function of the filtration properties required. Depending on the use of the fluid-permeable tube according to the first aspect of thein invention, this filtration properties must meet given rates. As an example, in case the fluid-permeable tube according to the first aspect of thein invention is used as drainage tube in sand soil, the pore diameter may be in the range of 300μm to 450μm, whereas when this fluid-permeable tube is to be used in peat, the pore diameter may be in the range of 750μm to 1000μm.

[0033] Hence the biodegradable manmade polymer fibers may not only differ in chemical composition, but may differ in diameter, average diameter, equivalent diameter, outer radial cross section, length, average length and alike. These properties may vary in function of the filtration property required.

[0034] When several bundles are used, and/or a number of fleeces are used to cover the outer surface of the tube body, the composition may vary between bundles or fleeces as well.

[0035] The fineness of the biodegradable manmade polymer fibers may preferably range from 2 to 1000 dtex, more preferably being in a range of 4 to 500 dtex, such as in the range of 6 to 250 dtex.

[0036] According to some embodiments, the equivalent diameter of the biodegradable manmade polymer fibers may range from 1 to 10000 μm. The equivalent diameter of the biodegradable manmade polymer fibers may preferably range from 2 to 5000 μm, more preferably being in a range of 6 to 1000 μm. The equivalent diameter is the imaginary diameter of a perfectly round cross sectional fiber, having the same radial cross section surface as the surface of the radial cross section of the fiber in question.

[0037] The biodegradable manmade polymer fibers used in the one or more fluid permeable filtration layers may be straight fibers or have some degree of crimping. The cross section of the fibers may be circular.

[0038] The average length of the biodegradable manmade polymer fibers may preferably range from 20 to 250 mm, more preferably being in a range of 30 to 150 mm, such as in the range of 60 to 90 mm. The biodegradable manmade polymer fibers hence may be staple fibers.

[0039] The composition of the biodegradable polymer of the tube body may comprise polylactic acid (PLA), starch (like maize starch, corn starch, rice starch and alike), polyhydroxyalkanoates (PHA), polyhydroxybutyrates (PHB), biodegradable polyurethane (PU), and co-polymers of similar mono-, oligo- or polymers , and combinations of those polymers.

[0040] According to some embodiments, the composition of the biodegradable polymer of the tube body and the composition of the biodegradable polymer of the one or more filtration layers, may be similar or even may be identical.

[0041] Preferably the composition of the biodegradable polymer of the tube body and the composition of the biodegradable polymer of the one or more filtration layers, optionally the fibers, may be similar if not identical. Similar in this context means that the main components of the composition, i.e. a component being present in a weight percentage (%w) of more than 10%w over the total weight of the composition, are identical. The %w of these main components however may differ between the composition of the biodegradable polymer of the tube body and the composition of the biodegradable polymer of the one or more filtration layers.

[0042] The biodegradable tube body may have a wall thickness in the range of 0.1 mm to 20 mm, such as in the range of 0.5mm to 5mm , e.g. in the range of 0.8mm to 2mm. This wall thickness may provide 1 to 8 % of the diameter of the tube body, such as providing 1,5 to 3% %, e.g. providing 1,6 to 2 %. When the tube body does not have cylindrical outer surface with an equal diameter along the axis of the tube body, the maximum outer diameter of the tube body defines the diameter of the tube body. The tubes may have a circular cross section, or may have any other cross section, such as oval or elliptical, racetrack shaped, polygonal such as rectangular, square, triangular, hexagonal or alike. Optionally, the angles of the polygonal cross section may e rounded.

[0043] The tube body may have a cylindrical outer surface with an equal diameter along the axis of the tube body, or may have a ribbed outer surface, where along the axis of the tube body, the diameter of the outer surface of the tube body varies. Such variation may be varying by repeating, in axial direction, a first substantially flat zone where the diameter of the outer surface of the tube body is minimum, a first transitional zone where the diameter of the tube body increases from this minimum diameter to the maximum diameter, a second substantially flat zone where the diameter of the outer surface of the tube body is maximum and a second transitional zone where the diameter of the tube body decreases from this maximum diameter back to the minimum diameter. At the inner side of the tube body, the inner diameter may follow a similar if not identical variation profile.

[0044] The difference between the minimum and maximum diameter may range from 2mm to 10mm, but may be also more or may be less. The width in axial direction of the tube body of the different zones may each vary between 0.5mm and 5 mm, such as between 1mm to 20 mm, e.g. from 2 to 10 mm.

[0045] Additionally or alternatively, the inner or outer surface of the tube body may have, in axial direction, inwards or outwards facing ribs or recesses. Such re-

cesses may be parallel to the axis of the tube body, or may follow one or more spiral paths around the axis of the tube body.

[0046] As already mentioned, the properties of all or each of the one or more filtration layers encompassing the tube body, may be tuned in function of the properties required for the filtration layer. In particular the density and the thickness of the filtration layer or layers may be tuned.

[0047] According to some embodiments, the thickness of at least one of the one or more the filtration layers may range from 0.2mm to 40mm. The thickness of the filtration layer or layers is the thickness measured on the tube body at the maximum diameter of the tube body.

[0048] Preferably the thickness of more than one, optionally all the filtration layers of the one or more fluid permeable filtration layers may range from 0.2mm to 40 mm e.g. from 0.5mm to 25mm, e.g. from 3mm to 20mm.

[0049] Around the filtration layer, a retaining means may be provided to keep the filter layer or layers fixed to the tube body. This retaining means may comprise one or more biodegradable polymer filaments, such as monofilament of filament yarns, spirally would around the filtration layer or layers, or even braided around the filtration layer or layers.

[0050] The composition of the biodegradable polymer of the retaining means, biodegradable polymer filaments, such as monofilament of filament yarns, may comprise polylactic acid (PLA), starch (like maize starch, corn starch, rice starch and alike), polyhydroxyalkanoates (PHA), polyhydroxybutyrates (PHB), biodegradable polyurethane (PU), and copolymers of similar mono-, oligo- or polymers , and combinations of those polymers.

[0051] The diameter of the monofilaments may be in the range of 0.01 mm to 2mm, such as in the range of 0.1 to 1.5mm, e.g. in the range of 0.2mm to 1mm.

[0052] More than one filament or filament yarn may be used to fix the filter layer or layers to the tube body. As an example, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 or even more filaments or filament yarns may be used to fix the filter layer or layers to the tube body. The filaments or filament yarns may be spirally wound around the filter layer or layers, or may be braided around the filter layer or layers.

[0053] According to a further, second aspect of the invention, a fluid-permeable tube according to the first aspect of the invention is used for aeration or water content management of soil. This fluid-permeable tube according to the first aspect of the invention may be used for water drainage of soil and/or water infiltration in soil. This fluid-permeable tube according to the first aspect of the invention may be used for aeration of soil.

[0054] The fluid-permeable tube according to the first aspect of the invention hence may be a drainage tube and/or a soil aeration tube, e.g. to aerate threes, crops and/or plants and/or a water infiltration tube.

[0055] It is understood that features of one aspect of the present invention may be combined with one, some or all feature of another aspect of the invention.

[0056] In the context of this invention, when reference is made to a range, said range is to be understood inclusive, except when explicitly mentioned differently.

Brief Description of the Drawings

[0057]

Fig. 1 illustrates schematically a radial cross section of a fluid-permeable tube according to the first aspect of the invention.

Fig. 2 illustrates schematically a longitudinal cross section of this fluid-permeable tube according to the first aspect of the invention.

[0058] In the different figures, the same reference signs refer to the same or a similar feature.

Detailed Description of Embodiment(s)

[0059] A fluid-permeable tube 100 according to the first aspect of the invention is shown in figures 1 and 2. The fluid-permeable tube 100 comprising a tube body 110 with an axis 119, the tube body being provided with holes 111 for the passage of fluid in the radial direction. The outer and inner surface 112 respectively 113 of the tube body 110 have parallel longitudinal zig-zag shapes. There are, in alternating order, first flat zones 201 where the diameter of the outer surface of the tube body 110 is minimum, and first transitional zones 202 where the diameter of the tube body increases from this minimum diameter to the maximum diameter. Adjacent there are second flat zones 203 where the diameter of the outer surface of the tube body is maximum and second transitional zones 204 where the diameter of the tube body decreases from this maximum diameter back to the minimum diameter. The maximum diameter Dt of the tube body may be preferably between 20 and 200 mm, such as about 60 mm. The wall thickness Wt of the tube is preferably in the range of about 0.5mm to 2mm, such as 1mm.

[0060] The tube body is an extruded body, in which by vacuum suction the zigzag profile is provided. the tube body is provided from PLA.

[0061] The tube body is provided with substantial rectangular and uniformly distributed holes 111, having a width of about 1mm and a length of about 6mm. The open area of the holes 111 may provide about 3% to 20% of the surface of the tube body.

[0062] One or more fluid -permeable filtration layers, in this embodiment only one fluid -permeable filtration layer 200, encompasses the outer wall 112 of the tube body 110. The fluid -permeable filtration layer 200 comprises PLA polymer fibers, hence biodegradable manmade polymer fibers. Possibly two different fibers are used, one type of fibers having an equivalent diameter different

from the other type of fibers.

[0063] In an alternative embodiment, this one fluid -permeable filtration layer 200, encompasses the outer wall 112 of the tube body 110 comprises PLA polymer fibers, hence biodegradable manmade polymer fibers, optionally comprising fibers of different equivalent diameter, another part being natural fibers like sisal or coconut fibers. Ratio of manmade polymer fibers and natural fibers is 66/33.

[0064] The fluid-permeable tube 100 itself, i.e. the combination of the tube body 110 and the fluid -permeable filtration layer 200 may have a diameter D of about 22mm to 240mm, e.g. 80mm. Hence the thickness of the fluid -permeable filtration layer 200 is about 1mm to 20mm, e.g. 10mm.

[0065] Around this combination of tube body 110 and fluid -permeable filtration layer 200, 16 monofilaments 300 are wound all substantially equally spaced around the circumference of tube body 110 and fluid-permeable filtration layer 200. The monofilaments are provided from biodegradable manmade polymer being PLA, have a circular cross or radial section, and have a diameter of about 0.5mm.

[0066] Although the present invention has been illustrated by reference to specific embodiments, it will be apparent to those skilled in the art that the invention is not limited to the details of the foregoing illustrative embodiments, and that the present invention may be embodied with various changes and modifications without departing from the scope thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein. In other words, it is contemplated to cover any and all modifications, variations or equivalents that fall within the scope of the basic underlying principles and whose essential attributes are claimed in this patent application. It will furthermore be understood by the reader of this patent application that the words "comprising" or "comprise" do not exclude other elements or steps, that the words "a" or "an" do not exclude a plurality, and that a single element may fulfil the functions of several means recited in the claims. Any reference signs in the claims shall not be construed as limiting the respective claims concerned. The terms "first", "second", third", "a", "b", "c", and the like, when used in the description or in the claims are introduced to distinguish between similar elements or steps and are not necessarily describing a sequential or chronological order. Similarly, the terms "top", "bottom", "over", "under", and the like are introduced for descriptive purposes and not necessarily to denote relative positions. It is to be understood that the terms so used are interchangeable under appropriate circumstances and embodiments of the invention are capable of operating according to the present invention in other sequences, or in orientations different from the one(s) described or illustrated above.

Claims

1. A fluid-permeable tube comprising a tube body provided with holes for the passage of fluid in the radial direction, and one or more fluid -permeable filtration layers encompassing the outer wall of said tube body, **characterized in that** the tube body comprises biodegradable polymer and said one or more fluid-permeable filtration layers comprising biodegradable polymer.

2. A fluid-permeable tube according to claim 1, wherein said tube body is provided with holes for the passage of liquid in the radial direction, and said fluid -permeable filtration layers is liquid-permeable.

3. A fluid-permeable tube according to any one of the preceding claims, wherein said one or more fluid permeable filtration layers comprise biodegradable manmade polymer.

4. A fluid-permeable tube according to any one of the preceding claims, wherein said pore diameter O90 according to the certification BRL1412 of Kiwa Nederland B.V. of the one or more fluid permeable filtration layers is between 300μm and 1500μm.

5. A fluid-permeable tube according to any one of the preceding claims, wherein said one or more fluid permeable filtration layers comprise biodegradable manmade polymer fibers.

6. A fluid-permeable tube according to claim 5, wherein said biodegradable manmade polymer fibers provide at least 60%w of the one or more fluid permeable filtration layers.

7. A fluid-permeable tube according to any one of the claims 5 to 6, wherein the equivalent diameter of the biodegradable manmade polymer fibers range from 1μm to 10000 μm.

8. A fluid-permeable tube according to any one of the claims 5 to 7, wherein the c equivalent diameter of the biodegradable manmade polymer fibers range from 2μm to 5000 μm.

9. A fluid-permeable tube according to any one of preceding claims, wherein the composition of the biodegradable polymer of the tube body and the composition of the biodegradable polymer of the one or more filtration layers, are similar or are identical.

10. A fluid-permeable tube according to any one of pre-

ceding claims, wherein the thickness of at least one of the one or more the filtration layers ranges from 1 to 25mm

11. The use of a fluid-permeable tube according to any one of the preceding claims, for aeration or water content management of soil.

12. The use of a fluid-permeable tube according to claim 11, for water drainage of soil and/or water infiltration in soil.

13. The use of a fluid-permeable tube according to claim 11, for aeration of soil.

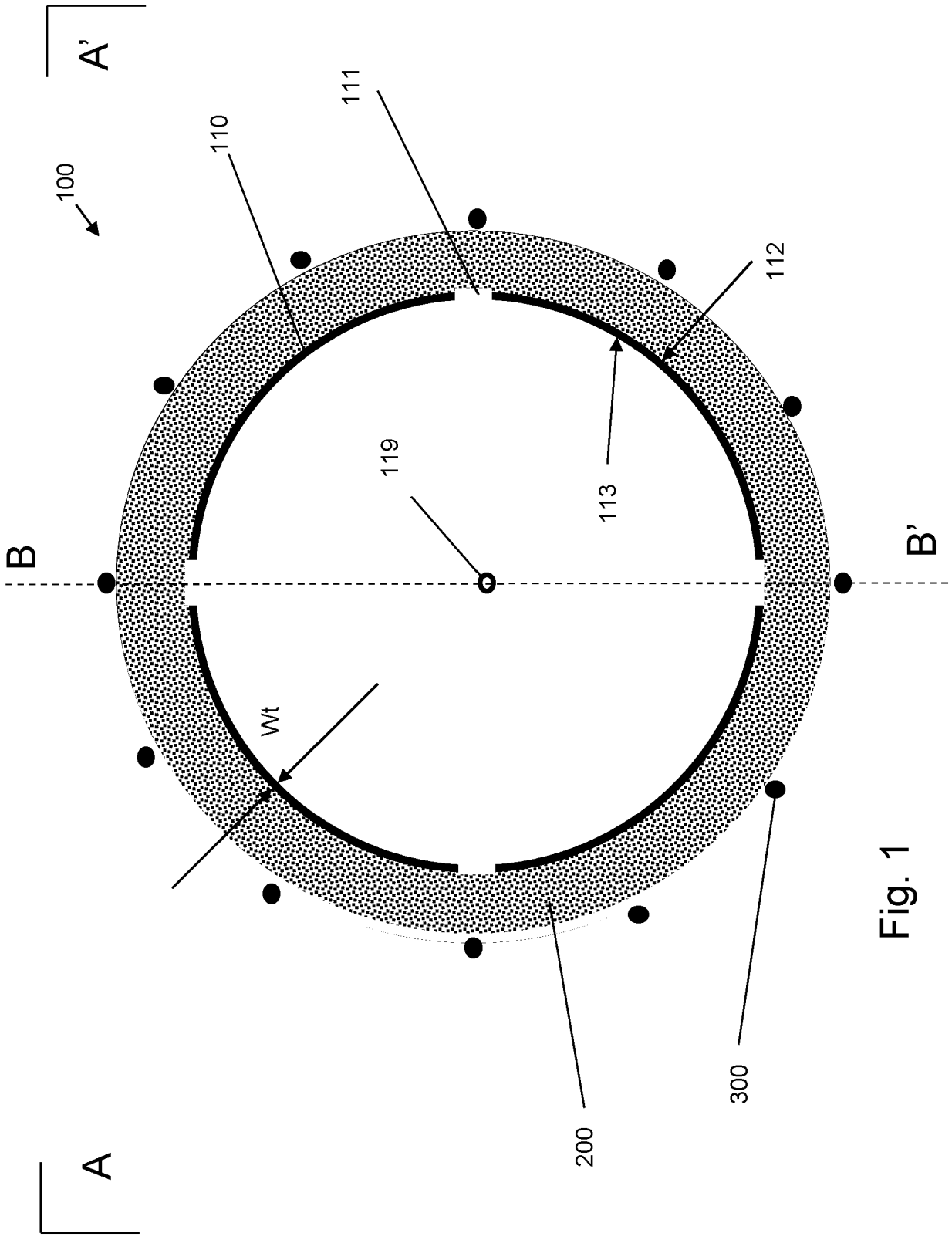

Fig. 1

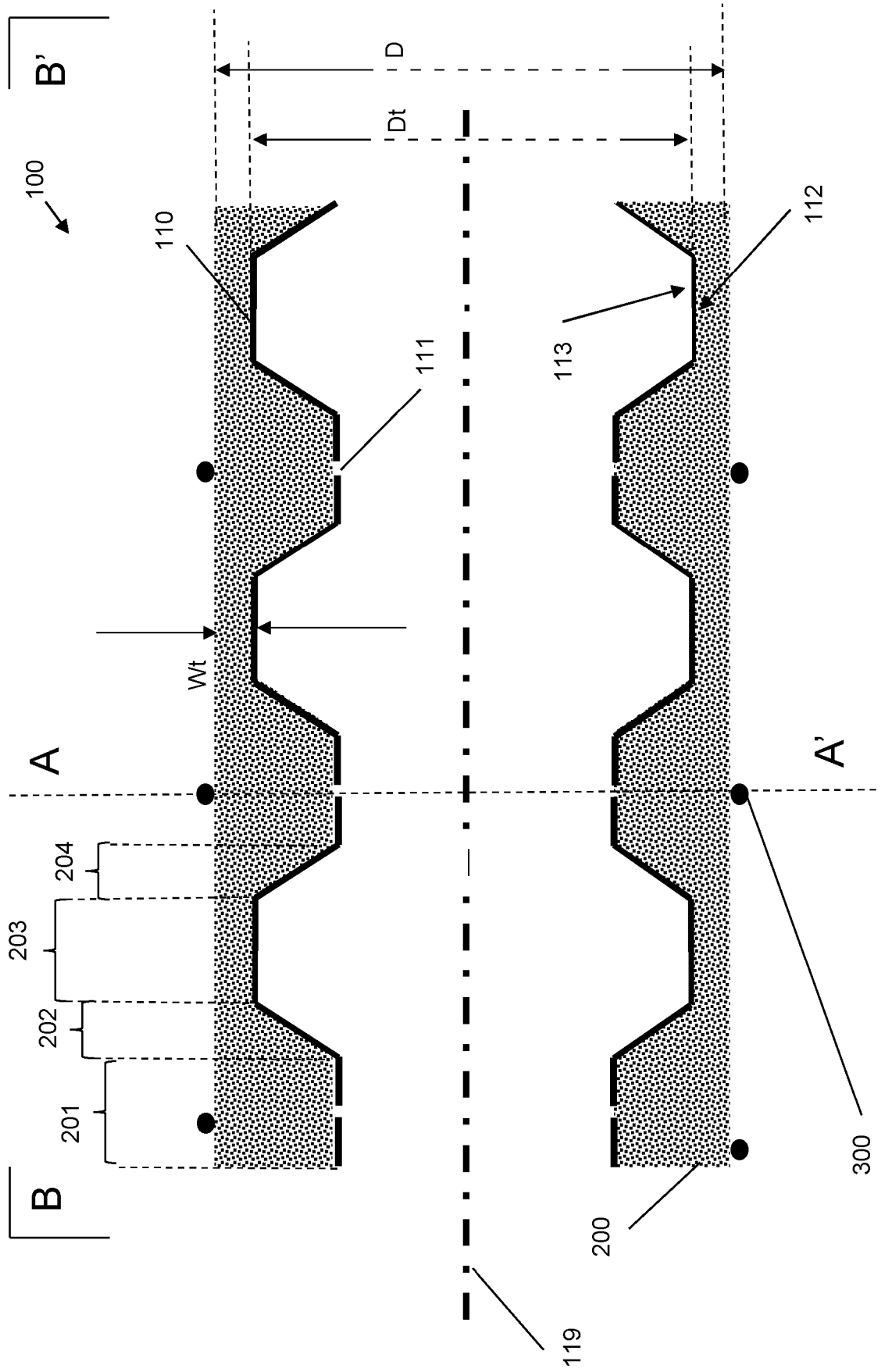

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 8669

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	KR 101 207 895 B1 (KIM YONG SOO [KR]; YUN YEONG GWON [KR]) 4 December 2012 (2012-12-04) * the whole document *	1-13	INV. E02D3/10
A	KR 2011 0086221 A (LEE DEUG GEUN [KR]) 28 July 2011 (2011-07-28) * abstract * * paragraphs [0022] - [0038]; figures 2-4 *	1-13	
A	JP 2002 030646 A (PENTA OCEAN CONSTRUCTION; KINJO RUBBER CO LTD; DAICEL CHEM) 31 January 2002 (2002-01-31) * the whole document *	1	
A	JP 2005 194807 A (ASHIMORI IND CO LTD) 21 July 2005 (2005-07-21) * the whole document *	1	

TECHNICAL FIELDS SEARCHED (IPC)
E02D
E02B
E01C
C08L
B29K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 April 2024	Koulo, Anicet

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 20 8669

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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11-04-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR 101207895 B1	04-12-2012	NONE	
KR 20110086221 A	28-07-2011	NONE	
JP 2002030646 A	31-01-2002	NONE	
JP 2005194807 A	21-07-2005	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 2718076 A **[0004]**