(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 491 653 B9

(12) CORRECTED EUROPEAN PATENT SPECIFICATION

(15) Correction information:
Corrected version no 1 (W1 B1)
Corrections, see
Description Paragraph(s) 5, 17, 20
Claims EN 1

(48) Corrigendum issued on:
06.04.2022 Bulletin 2022/14

(45) Date of publication and mention
of the grant of the patent:
28.07.2021 Bulletin 2021/30

(21) Application number: **17739760.1**

(22) Date of filing: **15.06.2017**

(51) International Patent Classification (IPC):
H01B 7/285 $^{(2006.01)}$ ***H01B 3/44*** $^{(2006.01)}$
H01B 3/22 $^{(2006.01)}$

(52) Cooperative Patent Classification (CPC):
H01B 3/22; H01B 3/441; H01B 7/285; H01B 3/28

(86) International application number:
PCT/US2017/037616

(87) International publication number:
WO 2018/022210 (01.02.2018 Gazette 2018/05)

(54) CABLE COMPRISING FLOODING COMPOSITIONS COMPRISING BIO-BASED FLUIDS

KABEL ENTHALTEND FLUTUNGSZUSAMMENSETZUNGEN MIT FLÜSSIGKEITEN AUF BIOBASIS

CÂBLE COMPRENANT DES COMPOSITIONS D’INONDATION COMPRENANT DES FLUIDES À BASE BIOLOGIQUE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **29.07.2016 US 201662368282 P**

(43) Date of publication of application:
05.06.2019 Bulletin 2019/23

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US-A- 5 940 570

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Printed by Jouve, 75001 PARIS (FR)

Description

FIELD OF THE INVENTION

[0001] This invention relates to a cable comprising a flooding composition a polyolefin elastomer and a bio-based fluid.

BACKGROUND OF THE INVENTION

[0002] US-A-5,940,570 relates to a method for encapsulating segments of signal transmission devices such as splices, pressure blocks and end blocks with a room-temperature curable composition comprising: (1) a hydroxyl-functional compound having a molecular weight of greater than 500 and a hydroxyl functionality of 2 or more; (2) an epoxy-functional compound having an epoxy functionality of 2 or more; and (3) a curative catalyst, in an amount effective to crosslink the epoxy and hydroxyl components of the respective epoxy-functional and hydroxyl-functional compounds.

[0003] Flooding compositions are materials designed to occupy void spaces in telecommunication cables, such as the void spaces typically found around and between buffer tubes commonly used in fiber optic cables. Additionally, these compositions can be used as filling materials to suspend and protect optical fibers inside buffer tubes. Flooding compositions are free-flowing at elevated temperatures (such as those temperatures used when filling a telecommunication cable), and easily gel at lower temperatures to avoid dripping at room temperature. Additionally, easy-to-clean and non-messy flooding compositions are desirable for ease of installation and prevention of environmental contamination. Although advances have been made in the art of flooding compounds, improvements are still desired.

[0004] Another important property of a flooding composition is its compatibility with polymer materials used in cable constructions such as polyolefin, i.e., low gel pickup for good property retention and cable longevity. Current commercial flooding compounds are based on synthetic hydrocarbons; they are messy, grease/wax-like materials that stick to surfaces that come in contact with them. In case of a spill, they are not environmentally friendly. The wire and cable industry has a continuing interest in flooding compositions that exhibit reduced stickiness, reduced absorption into materials used in the manufacture of cable components such as buffer tubes, jackets, etc., and more environmental friendly.

SUMMARY OF THE INVENTION

[0005] In one embodiment the invention is a cable comprising (A) at least one optical fiber; (B) a plurality of buffer tubes; and (C) a flooding composition comprising in weight percent (wt%) based on the weight of the composition:

(1) 10-80 wt% of a first component comprising a polyolefin elastomer consisting of only α-olefin residues, the polyolefin elastomer selected from the group consisting of ethylene/α-olefin copolymers, propylene/α-olefin copolymers, and combinations thereof; and
(B) 20-90 wt% of a second component comprising a bio-based fluid.

[0006] In one embodiment, the flooding composition further comprises one or more additives, e.g., an antioxidant, a thixotropic agent, etc. In one embodiment, the second component is a mixture of a bio-based fluid and a petroleum-based oil.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Figure 1 is a cross-sectional view of a loose buffer tube fiber optic cable.
Figure 2 is a chart reporting oil absorption in weight percent by HDPE and cPP.
Figure 3 is a chart reporting oil absorption in weight percent by HDPE and cPP versus the total unsaturation percent of the oil.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Definitions

[0008] Any reference to the Periodic Table of Elements is that as published by CRC Press, Inc., 1990-1991. Reference to a group of elements in this table is by the new notation for numbering groups.

[0009] Unless stated to the contrary, implicit from the context, or customary in the art, all parts and percents are based on weight and all test methods are current as of the filing date of this disclosure.

[0010] The numerical ranges in this disclosure include all values from, and including, the lower and upper value. For ranges containing explicit values (e.g., 1 or 2; or 3 to 5; or 6; or 7), any subrange between any two explicit values is included (e.g., 1 to 2; 2 to 6; 5 to 7; 3 to 7; 5 to 6; etc.).

[0011] The terms "comprising," "including," "having," and their derivatives, are not intended to exclude the presence of any additional component, step or procedure, whether or not the same is specifically disclosed. In order to avoid any doubt, all compositions claimed through use of the term "comprising" may include any additional additive, adjuvant, or compound, whether polymeric or otherwise, unless stated to the contrary. In contrast, the term, "consisting essentially of" excludes from the scope of any succeeding recitation any other component, step, or procedure, excepting those that are not essential to operability. The term "consisting of" excludes any component, step, or procedure not specifically delineated or listed. The term "or," unless stated otherwise, refers to the listed members individually as well as in any combination. Use of the singular includes use of the plural and vice versa.

[0012] "Bio-based fluid" and like terms mean a fluid derived from a biological source, such as a plant, animal, bacteria, yeast, algae, and the like. Bio-based fluids can comprise a single bio-based fluid, i.e., a fluid derived from a single biological source, or a blend of two or more bio-based fluids, i.e., a fluid derived from two or more biological sources. Bio-based fluids are liquid under ambient conditions (23°C and atmospheric pressure), or have a wax-like consistency under ambient conditions (23°C and atmospheric pressure) and become liquid upon heating.

[0013] "Wire" and like terms mean a single strand of conductive metal, e.g., copper or aluminum, or a single strand of optical fiber.

[0014] "Cable," "power cable" and like terms mean at least one wire or optical fiber within a sheath, e.g., an insulation covering or a protective outer jacket. Typically, a cable is two or more wires or optical fibers bound together, typically in a common insulation covering and/or protective jacket. The individual wires or fibers inside the sheath may be bare, covered or insulated. Combination cables may contain both electrical wires and optical fibers. The cable can be designed for low, medium, and/or high voltage applications. Typical cable designs are illustrated in USP 5,246,783; 6,496,629 and 6,714,707.

[0015] "Residue," when referring to a monomer, means that portion of a monomer molecule which resides in a polymer molecule as a result of being polymerized with another monomer or comonomer molecule to make the polymer molecule.

[0016] "Composition" and like terms mean a mixture or blend of two or more components.

[0017] In one embodiment the invention is a cable comprising: (A) at least one optical fiber; (B) a plurality of buffer tubes; and (C) a flooding composition comprising in weight percent (wt%) based on the weight of the composition:

(A) 10-80 wt% of a first component comprising a polyolefin elastomer consisting of only α-olefin residues, the polyolefin elastomer selected from the group consisting of ethylene/α-olefin copolymers, propylene/α-olefin copolymers, and combinations thereof; and
(B) 20-90 wt% of a second component comprising a bio-based fluid.

Polyolefin Elastomer

[0018] The first component of the flooding compositions of this invention is a polyolefin elastomer. As known in the art, an "elastomer" is a polymer that experiences large reversible deformations under relatively low stress. Elastomers can either be thermoplastic or thermoset. "Thermoplastic elastomers" are elastomers having thermoplastic properties. That is, thermoplastic elastomers are optionally molded or otherwise shaped and reprocessed at temperatures above their melting or softening point. The polyolefin elastomers suitable for use herein are thermoplastic elastomers.

[0019] A "polyolefin elastomer" is an elastomeric polymer containing residues of alpha-olefin ("α-olefin") monomers. In the present invention the polyolefin elastomers consist of only α-olefin monomer residues, including ethylene. Such polyolefin elastomers are interpolymers. As used herein, "polymer" means a macromolecular compound prepared by reacting (i.e., polymerizing) monomers of the same or different type, and includes homopolymers and interpolymers. "Interpolymer" means a polymer prepared by the polymerization of at least two different monomer types. This generic term includes copolymers (usually employed to refer to polymers prepared from two different monomer types), and polymers prepared from more than two different monomer types (e.g., terpolymers (three different monomer types) and tetrapolymers (four different monomer types), etc.). As used herein, "homopolymer" denotes a polymer comprising repeating units derived from a single monomer type, but does not exclude residual amounts of other components used in preparing the homopolymer, such as chain transfer agents.

[0020] Polyolefin elastomers can include both polyolefin homopolymers and interpolymers. Examples of polyolefin homopolymers are homopolymers of ethylene and propylene. Examples of polyolefin interpolymers are ethylene/α-olefin interpolymers and propylene/α-olefin interpolymers. In such embodiments, the α-olefin can be a C_{3-20} linear, branched or cyclic α-olefin (for the propylene/α-olefin interpolymers, ethylene is considered an α-olefin). Examples of C_{3-20} α-olefins include propene, 1-butene, 4-methyl-1-pentene, 1-hexene, 1-octene, 1-decene, 1-dodecene, 1-tetradecene, 1-

hexadecene, and 1-octadecene. The α-olefins can also contain a cyclic structure such as cyclohexane or cyclopentane, resulting in an α-olefin such as 3-cyclohexyl-1-propene (allyl cyclohexane) and vinyl cyclohexane. Illustrative polyolefin copolymers include ethylene/propylene, ethylene/butene, ethylene/1-hexene, ethylene/1-octene, and the like. Illustrative terpolymers include ethylene/propylene/1-octene, ethylene/propylene/butene, and ethylene/butene/1-octene. In an embodiment, the polyolefin propylene homopolymer available from Eastman Chemical Company); and combinations thereof. In various embodiments, the polyolefin elastomers are the homogeneously branched linear and substantially linear ethylene copolymers. The substantially linear ethylene copolymers are especially preferred, and are more fully described in USP 5,272,236; 5,278,272 and 5,986,028. In another embodiment, the polyolefin elastomers are amorphous polyolefins, such as those more fully described in US Pub. No. 2004/0081795.

[0021] The polyolefin elastomers useful herein also include propylene. Such copolymers comprise a majority (i.e., greater than 50 weight percent ("wt%")) of units derived from the alkene (e.g., propylene) and a minority of units derived from another α-olefin (including ethylene). In an embodiment, the polyolefin elastomer includes a propylene-based copolymer. In further embodiments, the polyolefin elastomer comprises a propylene-ethylene copolymer. Exemplary propylene-based copolymers useful herein include VERSIFY™ polymers available from The Dow Chemical Company, and VISTAMAXX™ polymers available from ExxonMobil Chemical Company.

[0022] Polyolefin elastomers can also include ethylene-propylene-diene monomer ("EPDM") elastomers and chlorinated polyethylenes ("CPE"). Commercial examples of suitable EPDMs include NORDEL™ EPDMs, available from The Dow Chemical Company. Commercial examples of suitable CPEs include TYRIN™ CPEs, available from The Dow Chemical Company.

[0023] In one or more embodiments, the polyolefin elastomer is selected from the group consisting of ethylene-based polyolefin elastomers, propylene-based polyolefin elastomers, and combinations thereof. In such embodiments, the ethylene-based polyolefin elastomer can have an ethylene content of greater than 50 wt%, or greater than 60 wt%, based on the entire weight of the ethylene-based polyolefin elastomer, with the balance consisting of one or more alpha-olefin monomers. Additionally, the ethylene-based polyolefin elastomer can have an ethylene content ranging from greater than 50 wt% to 90 wt%, or from 60 wt% to 75 wt%, based on the entire weight of the ethylene-based polyolefin elastomer, with the balance consisting of one or more alpha-olefin monomers. In various embodiments, the alpha-olefin monomer is octene.

[0024] Furthermore, when the polyolefin elastomer is propylene-based, it can have a propylene content of greater than 50 wt%, greater than 70 wt%, or greater than 90 wt%, based on the entire weight of the propylene-based polyolefin elastomer, with the balance consisting of one or more alpha-olefin monomers (including ethylene). Additionally, the propylene-based polyolefin elastomer can have a propylene content ranging from greater than 50 to 99 wt%, from 70 to 98 wt%, or from 90 to 97 wt%, based on the entire weight of the propylene-based polyolefin elastomer, with the balance consisting of one or more alpha-olefin monomers (including ethylene). In various embodiments, when the polyolefin elastomer is propylene-based, the alpha-olefin comonomer is ethylene. Nonlimiting examples of a suitable propylene-based polyolefin elastomer include propylene copolymer and propylene homopolymer.

[0025] In one or more embodiments, the polyolefin elastomer includes an ethylene/octene copolymer and an amorphous propylene homopolymer.

[0026] In one or more embodiments, the polyolefin elastomer includes a propylene/ethylene copolymer and an amorphous propylene homopolymer.

[0027] In one or more embodiments, the polyolefin elastomers suitable for use herein can have a degree of crystallinity in the range of from 0.01 to less than 50 wt%, from 0.5 to 40 wt%, or from 10 to 35 wt%, or from 11 to 32 wt%. In other embodiments, the polyolefin elastomers can have a degree of crystallinity in the range of from 10 to less than 50 wt%, from 10 to 40 wt%, or from 20 to 35 wt%. The degree of crystallinity of the polyolefin elastomer is measured by the method described in the Test Methods section, below.

[0028] Polyolefin elastomers suitable for use herein can have a Brookfield viscosity of 500 g/cm-s (50,000 centipoise ("cps" or "cP")) or less, or in the range of from 10 g/cm-s (1,000) to 500 g/cm-s (50,000 cps), from 10 g/cm-s (1,000) to 400 g/cm-s (40,000 cps), or from 10 g/cm-s (1,000) to 300 g/cm-s (30,000 cps), or from 10 g/cm-s (1,000) to 100 g/cm-s (10,000 cps). Brookfield viscosity for polyolefin elastomers is determined in accordance with the procedure provided in the Test Methods, below, at 176.6°C (350°F) using a Brookfield viscometer with an SC-31 hot-melt spindle.

[0029] Polyolefin elastomers suitable for use herein can have a number-average molecular weight ("Mn") of greater than 2,000 g/mol, at least 4,000 g/mol, or at least 5,000 g/mol. Additionally, the polyolefin elastomers can have an Mn in the range of from 2,000 to 60,000 g/mol, or from 4,000 to 50,000 g/mol, or from 5,000 to 35,000 g/mol, or from 7,000 to 20,000 g/mol, or from 7,000 to 15,000 g/mol. Mn is determined according to the gel-permeation-chromatography method described in the Test Methods section, below.

[0030] Polyolefin elastomers suitable for use herein can have a weight-average molecular weight ("Mw") ranging from 1,000 to 100,000 g/mol, or from 5,000 to 50,000 g/mol, or from 8,000 to 30,000 g/mol. Mw is determined according to the gel-permeation-chromatography method described in the Test Methods section, below.

[0031] Polyolefin elastomers suitable for use herein can have a polydispersity index ("PDI" or "Mw/Mn") ranging from

0.2 to 20, from 0.5 to 10, or from 1 to 5. PDI is determined according to the gel-permeation-chromatography method described in the Test Methods section, below.

[0032] Polyolefin elastomers suitable for use herein can have a density of less than 0.930 g/cm^3, or less than 0.920 g/cm^3, or less than 0.910 g/cm^3, or less than 0.900 g/cm^3. Additionally, the polyolefin elastomers can have a density of at least 0.850 g/cm^3, or at least 0.860 g/cm^3, or at least 0.870 g/cm^3, or at least 0.880 g/cm^3, or at least 0.890 g/cm^3. Density is determined according to ASTM D 792.

[0033] Polyolefin elastomers suitable for use herein can have a melting point of at least 50°C, or at least 55°C, or at least 60°C, or at least 65°C, or at least 70°C, or at least 75°C, or at least 80°C, or at least 85°C, or at least 90°C, or at least 95°C, or at least 100°C. The melting point of suitable polyolefin elastomers can be as high as 120°C, or as high as 150°C, or as high as 155°C, or as high as 160°C. Melting point is determined according to the method described in the Test Methods section, below.

[0034] Polyolefin elastomers suitable for use herein can have a B value in the range of from 0.1 to 2.0, from 0.5 to 1.5, or from 0.7 to 1.0. B value is determined according to the method described in the Test Methods section, below.

[0035] Polyolefin elastomers suitable for use herein can have a crystallization temperature ("Tc") in the range of from 30 to 100°C, or 35 to 80°C, or from 50 to 75°C. Crystallization temperature is determined according to the method described in the Test Methods section, below.

[0036] Polyolefin elastomers suitable for use herein can have one, some, or all of the following properties:

(a) a degree of crystallinity from 0.01, or 10 to 35, or less than 50 wt%;
(b) a Brookfield viscosity from 10 g/cm-s (1,000) to 70 g/cm-s (7,000), or 500 g/cm-s (50,000 cps);
(c) a Mn from 2,000, or 7,000 to 55,000, or 60,000 g/mol;
(d) a Mw from 1,000 to 100,000 g/mol;
(e) a Mw/Mn from 0.2 to 20;
(f) a density from 0.850, or 0.860 to 0.890, or 0.930 g/cm^3;
(g) a melting point (Tm) from 50, or 55 to 155, or 160°C;
(h) a B value from 0.1 to 2.0; and/or
(i) a crystallization temperature (Tc) from 30 to 75, or 100°C.

[0037] A specific example of a suitable ethylene-based polyolefin elastomer is an ethylene/octene copolymer having a Brookfield viscosity of 82 g/cm-s (8,200 cps) and a density of 0.889 g/cm^3. A specific example of a suitable propylene-based polyolefin elastomer is a propylene/ethylene copolymer having a Brookfield viscosity of 10 g/cm-s (1,000 cps) and a density of 0.884 g/cm^3.

Bio-Based Fluid

[0038] The second component of the flooding compositions of this invention is a bio-based fluid (also referred to as an oil). While any bio-based fluid can be used in the practice of this invention, fluids derived from vegetable or algae are preferred. Common sources of the bio-based fluids used in the practice of this invention include, but are not limited to, coconut, corn, cottonseed, rapeseed (of which Canola oil is one variety), olive, peanut, safflower, sesame, soybean, sunflower, mustard and algae. The oil is extracted and processed from the biological material using known techniques and equipment.

[0039] In one embodiment, all or some of the bio-based fluid is functionalized by a known process to produce a functionalized oil, such as a fatty acid methyl ester (FAME) or an epoxidized fatty acid methyl ester (eFAME). A "fatty acid methyl ester" ("FAME") is a fatty acid ester typically formed by transesterifying an oil, such as with methanol. An "epoxidized fatty acid methyl ester" ("eFAME") is a fatty acid ester with at least one epoxide group. An "epoxide group" is a three-member cyclic ether (also called oxirane or an alkylene oxide) in which an oxygen atom is joined to each of two carbon atoms that are already bonded to each other. Epoxidation reactions are typically performed with percarboxylic acids or other peroxy compounds. In one or more embodiments, the bio-based fluid contains a functionalized bio-based fluid. In an embodiment, when the bio-based fluid contains a functionalized bio-based fluid, the bio-based fluid contains from greater than 0 to 100 wt%, or from 20 to 80 wt%, or from 40 to 60 wt%, or 50 wt% of the functionalized bio-based fluid, and from 0 to less than 100 wt%, or from 20 to 80 wt%, or from 40 to 60 wt%, or 50 wt% of a non-functionalized bio-based fluid, based on the total weight of bio-based fluid. In another embodiment, the bio-based fluid excludes functionalized bio-based fluids.

[0040] In one or more embodiments, the bio-based oil can have a flash point from 200°C, or 220°C, or 240°C, or 250°C, or 270°C, or 280°C, or 285°C to 300°C, or 315°C, or 320°C, or 350°C, measured according to ASTM D92. In one or more embodiments, the bio-based oil can have a flash point that is greater than 200°C, or greater than 250°C, or greater than 280°C, or greater than 285°C, or greater than 290°C, or greater than 300°C, or greater than 310°C, or equal to or greater than 315°C, measured according to ASTM D92.

[0041] In one or more embodiments, the bio-based oil can have a kinematic viscosity of 500 mm^2/s (500 centistokes ("cSt")) or less, or 200 mm^2/s (200 cSt) or less, or 100 mm^2/s (100 cSt) or less, or 50 mm^2/s (50 cSt) or less at 40°C. In one embodiment, the bio-based oil has a kinematic viscosity from 10 mm^2/s (10 cSt), or 15 mm^2/s (15 cSt), or 20 mm^2/s (20 cSt), or 30 mm^2/s (30 cSt) to 40 mm^2/s (40 cSt), or 50 mm^2/s (50 cSt), or 100 mm^2/s (100 cSt), or 200 mm^2/s (200 cSt), or 50 mm^2/s (500 cSt) at 40°C. Viscosity of the bio-based oil is measured according to ASTM D445.

[0042] Bio-based fluid suitable for use herein can have one, some, or all of the following properties:

(a) a total unsaturation level from 30%, or 40%, or 45% to 95%, or 99%;
(b) a flash point from 200, or 250, or 280 to 315, or 320, or 350°C; and/or
(c) a kinematic viscosity from 10 mm^2/s (10 cSt), or 30 mm^2/s (30 cSt) to 50 mm^2/s (50 cSt), or 500 mm^2/s (500 cSt).

[0043] In one embodiment, the bio-based oil is an oil extracted from a single biological source, e.g., soybean, or corn, or algae, etc. In one embodiment the bio-based oil is a blend of oils extracted from two or more sources, e.g., soybean and corn, or soybean and algae, etc. Algae oil typically has a total unsaturation level of 90% or greater.

[0044] In one embodiment, the second component is a blend or mixture of a bio-based fluid and a petroleum-based oil. These petroleum-based oils are hydrocarbon oils known in the art of flooding compositions. Typical examples of hydrocarbon oils include mineral oils (e.g., paraffinic oils, naphthenic oils, and aromatic oils) and low-molecular-weight polyolefin oils (e.g., polybutene oil). In an embodiment, the hydrocarbon oil is a paraffinic oil.

[0045] The hydrocarbon oil, if present, can have a number-average molecular weight ("Mn") of 2,000 g/mol or less, or 1,000 g/mol or less, or 800 g/mol or less.

[0046] The hydrocarbon oil, if present, can have a kinematic viscosity of 500 mm^2/s (500 centistokes ("cSt")) or less, or 200 mm^2/s (200 cSt) or less, or 100 mm^2/s (100 cSt) or less, or 50 mm^2/s (50 cSt) or less at 40°C. In one embodiment, the hydrocarbon oil, if present, has a kinematic viscosity from 10 mm^2/s (10 cSt), or 15 mm^2/s (15 cSt), or 20 mm^2/s (20 cSt) to 30 mm^2/s (30 cSt), or 40 mm^2/s (40 cSt), or 50 mm^2/s (50 cSt), or 100 mm^2/s (100 cSt), or 200 mm^2/s (200 cSt), or 500 mm^2/s (500 cSt) at 40°C. Viscosity of the hydrocarbon oil is measured according to ASTM D445.

[0047] An example of a suitable commercially available hydrocarbon oil is SUNPAR™ 110, which has a kinematic viscosity of 21.2 mm^2/s (21.2 cSt) at 40 °C, available from Sunoco Inc., Pittsburgh, PA, USA.

[0048] If a petroleum-based oil is used in combination with the bio-based fluid, then typically the bio-based fluid comprises at least 5, more typically greater than 10, or greater than 30, or 40, or 50 wt% of the blend of bio-based fluid and petroleum-based oil. In one embodiment, if a petroleum-based oil is used in combination with the bio-based fluid, then typically the bio-based fluid comprises from 5, or 10, or 30, or 40, or 50 to 60, or 70, or 80, or 90, or 95, or 99 wt% of the blend of bio-based fluid and petroleum-based oil.

[0049] In one embodiment, the second component is a blend or mixture of a bio-based fluid and a polyα-olefin oil. A "polyα-olefin oil" ("PAO oil") is a synthetic compound produced by polymerizing at least one α-olefin and is a liquid at 22°C and 1 atmosphere of pressure. The α-olefin may be any α-olefin disclosed herein, such as C_2, C_6, C_8, C_{10}, $C1_2$, C_{14}, and C_{20} α-olefins. These are PAO oils known in the art of flooding compositions. Typical examples of PAO oils include hydrogenated dec-1-ene homopolymer (e.g., DURASYN™ 180I and DURASYN™ 180R, available from INEOS) and hydrogenated 1-tetradecene polymer with 1-dodecene (e.g., DURASYN™ 126, available from INEOS).

[0050] The PAO oil, if present, can have a kinematic viscosity of 1500 mm^2/s (1,500 centistokes ("cSt")) or less, or 1000 mm^2/s (1,000 cSt) or less, or 500 mm^2/s (500 cSt) or less, or 200 mm^2/s (200 cSt) or less, or 100 mm^2/s (100 cSt) or less, or 50 mm^2/s (50 cSt) or less, or 10 mm^2/s (10 cSt) or less at 40°C. In one embodiment, the PAO oil, if present, has a kinematic viscosity from 10 mm^2/s (10 cSt), or 15 mm^2/s (15 cSt), or 20 mm^2/s (20 cSt), or 30 mm^2/s (30 cSt) to 40 mm^2/s (40 cSt), or 50 mm^2/s (50 cSt), or 100 mm^2/s (100 cSt), or 200 mm^2/s (200 cSt), or 500 mm^2/s (500 cSt), or 1000 mm^2/s (1,000 cSt), or 1300 mm^2/s (1,300 cSt), or 1500 mm^2/s (1,500 cSt) at 40°C. Viscosity of the PAO oil is measured according to ASTM D445.

[0051] If a PAO oil is used in combination with the bio-based fluid, then typically the bio-based fluid comprises at least 5, more typically greater than 10, or greater than 20, or 30, or 40, or 50, or 60, or 70, or 75, or 80, or 85 wt% of the blend of bio-based fluid and PAO oil. In one embodiment, if a PAO oil is used in combination with the bio-based fluid, then typically the bio-based fluid comprises from 5, or 10, or 14, or 20, or 30, or 40, to 50, or 60, or 70, or 75, or 80, or 90, or 95, or 99 wt% of the blend of bio-based fluid and PAO oil. mineral inorganic compounds, polymeric fillers, and the like. When employed, fillers can be present in any conventional amount, such as an amount ranging from greater than 0 up to 60 wt%.

Flooding Composition

[0052] The flooding composition can be prepared by simple compounding techniques known in the art. For instance, the polyolefin elastomer, the bio-based fluid (including any petroleum-based oil) and any optional additives can be compounded in a liquid operational mixer with temperature control. For instance, the ingredients can be compounded in a batch or continuous mixer. Suitable batch mixers include, but are not limited to, Banbury™, Silverson™, Dynamix™ tank mixers and agitators, and Littleford™ batch mixers. Continuous mixers include twin and single-screw extruders, Farrel™ mixers, and Buss™ co-kneaders.

[0053] The above-described polyolefin elastomer, or blends thereof, can be present in the flooding compound in an amount ranging from 10 to 80 wt%, from 20 to 60 wt%, or from 20 to 40 wt%, or from 25 to 40 wt%, or from 20 to 30 wt%, or from 30 to 50 wt%, based on the combined weight of the polyolefin elastomer and bio-based fluid (including any petroleum-based oil).

[0054] The above-described bio-based fluid (including any petroleum-based oil and/or PAO oil) can be present in the flooding composition in an amount ranging from 5 to 90 wt%, or from 20 to 80 wt%, or from 40 to 70 wt%, or from 50 to 80 wt%, or from 60 to 75 wt%, based on the combined weight of the polyolefin elastomer and bio-based fluid. In one embodiment, if a PAO oil and/or petroleum-based oil is used in combination with the bio-based fluid, then typically the bio-based fluid comprises from 5, or 10, or 14, or 20, or 30, or 40, to 50, or 60, or 70, or 75, or 80, or 90, or 95, or 99 wt% of the blend of bio-based fluid, and PAO oil and/or petroleum-based oil.

[0055] In one or more embodiments, the resulting flooding composition can have an apparent viscosity in the range of from 0.2 g/cm-s (20) to equal to or greater than 10 g/cm-s (1,000 centipoise ("cps")), from 0.5 g/cm-s (50) to 10 g/cm-s (1,000 cps), from 2 g/cm-s (200) to 8 g/cm-s (800 cps), or from 3 g/cm-s (300) to 6 g/cm-s (600 cps), as measured at 150°C according to ASTM D3236. In one or more embodiments, the resulting flooding composition can have an apparent viscosity from 0.2 g/cm-s (20 cps), or 0.3 g/cm-s (30 cps), or 0.4 g/cm-s (40 cps), or 0.45 g/cm-s (45 cps), or 0.5 g/cm-s (50 cps) to 0.6 g/cm-s (60 cps), or 0.7 g/cm-s (70 cps), or 0.8 g/cm-s (80 cps), or 0.9 g/cm-s (90 cps), or 1 g/cm-s (100 cps), or 1.1 g/cm-s (110 cps), or 1.2 g/cm-s (120 cps), or 1.3 g/cm-s (130 cps), or 1.4 g/cm-s (140 cps), or 1.5 g/cm-s (150 cps), or 1.6 g/cm-s (160 cps), or 1.7 g/cm-s (170 cps), or 1.8 g/cm-s (180 cps), or 1.9 g/cm-s (190 cps), or 2 g/cm-s (200 cps), or 2.25 g/cm-s (225 cps), or 2.5 g/cm-s (250 cps), or 2.8 g/cm-s (280 cps), or 3.0 g/cm-s (300 cps), as measured at 150°C according to ASTM D3236.

[0056] In various embodiments, the flooding composition can have a drop point of at least 65°C, or at least 70°C, or at least 75°C, or at least 80°C, or at least 90°C, or at least 100°C, or at least 110°C, or at least 120°C. In one or more embodiments, the flooding composition has a drop point from greater than 90°C, or greater than 100°C, or greater than 110°C to 120°C, or 130°C, or 140°C, or 150°C, or 160°C, or 200°C. Drop point is determined according to ASTM D127.

[0057] In various embodiments, the flooding composition can have an oil separation when aged for 24 hours at 21°C of less than 0.1, or less than 0.05, or less than 0.01. In one or more embodiments, the flooding composition has an oil separation when aged for 24 hours at 21°C from 0 to 0.01, or 0.05, or less than 0.1. In one or more embodiments, the flooding composition has no (i.e., 0) oil separation when aged for 24 hours at 21°C. Oil separation is determined according to ASTM D1742.

[0058] In one or more embodiments, the flooding composition contains:

(A) from 10, or 20 to 40, or 50, or 80 wt% of a first component comprising a polyolefin elastomer; and
(B) from 20, or 50, or 60 to 70, or 75, or 90 wt% of a second component comprising a bio-based fluid, the bio-based fluid having a total unsaturation level from 30%, or 40%, or 45% to 95%, or 99%; and

the flooding composition has one, some, or all of the following properties:

(i) an apparent viscosity from 0.2 g/cm-s (20), or 0.5 g/cm-s (50) to 2.5 g/cm-s (250), or 2.8 g/cm-s (280 cps), or 3.0 g/cm-s (300 cps) at 150°C;
(ii) a drop point from greater than 90°C, or greater than 100°C, or greater than 110°C to 120°C, or 130°C, 200°C; and/or
(iii) an oil separation when aged for 24 hours at 21°C from 0 to 0.01, or less than 0.1.

[0059] It is understood that the sum of the components in the composition yields 100 weight percent.

Fiber Optic Cable

[0060] In various embodiments, a fiber optic cable, also known as an optical fiber cable is prepared that comprises at least one optical fiber, a plurality of buffer tubes, and the above-described flooding composition.

Melt Index

[0061] Melt index, or I_2, is measured in accordance with ASTM D 1238, condition 190°C/2.16 kg, and is reported in grams eluted per 10 minutes (g/10 min). The I_{10} is measured in accordance with ASTM D 1238, condition 190°C/10 kg, and is reported in grams eluted per 10 minutes (g/10 min).

Differential Scanning Calorimetry (Crystallinity, Melting Point, Crystallization Temperature)

[0062] Differential Scanning Calorimetry ("DSC") is used to measure crystallinity in the polymers (e.g., ethylene-based (PE) polymers). About 5 to 8 mg of polymer sample is weighed and placed in a DSC pan. The lid is crimped on the pan to ensure a closed atmosphere. The sample pan is placed in a DSC cell, and then heated, at a rate of approximately 10°C/min, to a temperature of 180°C for PE (230°C for polypropylene or "PP"). The sample is kept at this temperature for three minutes. Then the sample is cooled at a rate of 10°C/min to -60°C for PE (-40°C for PP), and kept isothermally at that temperature for three minutes. The sample is next heated at a rate of 10°C/min, until complete melting (second heat). The percent crystallinity is calculated by dividing the heat of fusion (Hf), determined from the second heat curve, by a theoretical heat of fusion of 292 J/g for PE (165 J/g, for PP), and multiplying this quantity by 100 (for example, % cryst. = (Hf / 292 J/g) x 100 (for PE)).

[0063] Unless otherwise stated, melting point(s) (T_m) of each polymer is determined from the second heat curve (peak Tm), and the crystallization temperature (T_c) is determined from the first cooling curve (peak Tc).

Drop Point

[0064] Drop point is determined according to ASTM D127.

Viscosity

[0065] Apparent viscosity of the flooding compounds is determined according to ASTM D3236 at 150°C. Kinematic viscosity can be calculated by using apparent viscosity divided by fluid density.

[0066] Brookfield viscosity of polymer components (i.e., polyolefin elastomers) is determined in accordance with the following procedure using a Brookfield Laboratories DVII+Viscometer in disposable aluminum sample chambers. The spindle used is an SC-31 hot-melt spindle, suitable for measuring viscosities in the range of from 0.1 g/cm-s (10) to 1000 g/cm-s (100,000 centipoise).

[0067] A cutting blade is employed to cut samples into pieces small enough to fit into the 2.5 cm (1-inch wide), 13 cm (5-inches) long sample chamber. The sample is placed in the chamber, which is in turn inserted into a Brookfield Thermosel and locked into place with bent needle-nose pliers. The sample chamber has a notch on the bottom that fits the bottom of the Brookfield Thermosel to ensure that the chamber is not allowed to turn when the spindle is inserted and spinning. The sample is heated to 176.6 °C (350°F), with additional sample being added until the melted sample is about 2.5 cm (1 inch) below the top of the sample chamber. The viscometer apparatus is lowered and the spindle submerged into the sample chamber. Lowering is continued until brackets on the viscometer align on the Thermosel. The viscometer is turned on and set to a shear rate, which leads to a torque reading in the range of 30 to 60 percent. Readings are taken every minute for about 15 minutes, or until the values stabilize, then the final reading is recorded.

B Value

[0068] The B value is calculated as $B=P_{OE}/(2xP_OP_E)$; where P_E is a molar fraction of the ethylene component in the copolymer, Po is a molar fraction of the α-olefin component, and P_{OE} is a molar fraction of α-olefin-ethylene sequences in the all dyad sequences, where the molar fraction of each component, except the terminal component, is a value calculated, and the B value is calculated based on a chart of C-NMR(270 MHz).

Oil Absorption

[0069] A 1.9 mm (75-mil) thick compression-molded specimen ~12.7 x 5.08 mm (-0.5 x 0.2 inches) of jacket material (HDPE or polypropylene (e.g., cPP)) is immersed in the oil at 85°C. After 4 days, the oil covering the surface of the jacket material is wiped out and the weight gain of the jacket material plaque is calculated by comparing its weight before and after aging.

Gel Permeation Chromatography

[0070] A high-temperature gel permeation chromatography ("GPC") system is employed, equipped with Robotic Assistant Deliver ("RAD") system for sample preparation and sample injection. The concentration detector is an Infra-red detector (IR4) from Polymer Char Inc. (Valencia, Spain). Data collection is performed using Polymer Char DM 100 Data acquisition box. The carrier solvent is 1,2,4-trichlorobenzene ("TCB"). The system is equipped with an on-line solvent degas device from Agilent. The column compartment is operated at 150°C. The columns are four Mixed A LS 30-cm, 20 μm (20-micron) columns. The solvent is nitrogen-purged TCB

Oil Separation

[0071] After mixing the samples as described above, 50 milliliters (ml) of the melted sample is poured into a shallow aluminum pan and the sample is allowed to cool and solidify. Any oil separation will be visible on the surface after sitting for 24 hours at room temperature and the result is recorded.

[0072] By way of example, and not limitation, some embodiments of the present disclosure will now be described in detail in the following Examples.

EXAMPLES

[0073] A key requirement for cable flooding/filling compounds is oil absorption by cable components which are generally polyolefin based (e.g. buffer tube, jacket). For this reason polyolefin-compatible filling/flooding materials are higher cost as they are based on more expensive oils such as polyα-olefin oils (PAO) and polybutene (PIB, also known as isobutylene/butene copolymer). Lower cost compounds based on mineral/paraffinic oils have poor compatibility. The data in Table 2 shows that vegetable oils (e.g. soybean oil, canola) have desirably low viscosity (e.g. 32 mm^2/s (32 cSt) at 40°C for soybean oil) suitable for viscosity modification of polyolefin elastomers for the manufacture of flooding and filling compounds. Such viscosities are comparable to that of paraffinic oil, as well as a higher cost PAO fluid (DURASYN™ 126, DURASYN™ 1801, and DURASYN™ 180R) and PIB fluid (Indopol™ L-14 and Indopol™ H-100). The vegetable oils also have a desirably much higher flash point versus paraffinic oils and PIB L-14.

Table 2. Selected Properties of Various Oils

Oil	**Supplier**	**Oil Type**	**Kinematic Viscosity at 40°C (mm^2/s)((cSt))**	**Flash Point (°C)**	**M_n**
SUNPAR™ 110	Sunoco	Paraffinic	21 (21)	192	
DURASYN™ 126	Ineos	PAO	31 (31)	254	
DURASYN™ 180I	Ineos	PAO	1261 (1,261)	290	
DURASYN™ 180R	Ineos	PAO	928 (928)	290	
Soybean oil	Cargill	Vegetable	32 (32)	288	
Canola		Vegetable	42 (42)	315	
Indopol™ H-100	Ineos	PIB	215 (215) @ 100°C	210	910
Indopol™ L-14	Ineos	PIB	27 (27)	>138	370

[0074] The data in Table 3 show some vegetable oils have surprisingly low pickup in both high density polyethylene (HDPE) (DGDA-6318BK available from The Dow Chemical

Oil/ Compound	**Supplier**	**Oil Type**	**Total Unsaturated Fatty Acids (%)$^{\cdot}$**	**Oil Absorption in HDPE^4 (wt%)**	**Oil Absorption in cPP^5 (wt%)**
Algae	Formulator Sample Shop	Biomass		2.12	4.03
SUNPAR™ 110	Sunoco	Paraffinic		9.5	21.02
DURASYN™ 126	Ineos	PAO		3.33	7.65
DURASYN™ 1801	Ineos	PAO		-0.31	0.99
DURASYN™ 180R	Ineos	PAO		-0.14	1.23
UCON™ OSP 32	Dow	PAG^2		0.64	3.08

(continued)

Oil/ Compound	Supplier	Oil Type	Total Unsaturated Fatty Acids (%)*	Oil Absorption in HDPE[4] (wt%)	Oil Absorption in cPP[5] (wt%)
UCON™ OSP 680	Dow	PAG[3]		-0.89	0.09

*Total unsaturation data based on Table 1, above.

[1] INFO-GEL LA 444 is a thixotropic filling gel containing synthetic oil formulated with polymers, thixotropic agents, and additives. [2] UCON™ OSP 32 is a synthetic polyalkylene glycol (PAG) having a flash point of 216°C and a kinematic viscosity of 32 mm^2/sec at 40°C (measured in accordance with ASTM D445).

[3] UCON™ OSP 680 is a synthetic polyalkylene glycol (PAG) having a flash point of 243°C and a kinematic viscosity of 680 mm^2/sec at 40°C (measured in accordance with ASTM D445).

[4] DGDA-6318BK, available from The Dow Chemical Company, having a density of 0.954 g/cm^3.

[5] ESCORENE™ 7132, an impact copolymer available from Exxon Chemical Company.

[0075] Table 4 reports the properties of the polyolefin elastomers used in the compositions reported in Table 5.

Table 4. Polyolefin Elastomer Properties

Component	Specification / Properties		Source
propylene/ethylene copolymer (P/E 1)	% crystallization = 32 wt% Brookfield Viscosity =10 g/cm-s (1,000 cP) (@ 176.6°C) M_n = 12,796 C_2 wt% = 5.1 wt%	density = 0.884 g/cc T_c = 72°C T_m = 106°C	Internal Stock
propylene/ethylene copolymer (P/E 2)	% crystallization = 11 wt% Brookfield Viscosity = 40 g/cm-s (4,000 cP) (@ 176.6°C) M_n = 34,880 C_2 wt% = 13.1 wt%	density = 0.8639 g/cc T_c = 30°C T_m = 64.6°C	Internal Stock
AFFINITY™ GA 1875	ethylene/1-octene polyolefin plastomer crystallization = 21.7 wt% Brookfield Viscosity = 67 g/cm-s (6,700 cP) (@ 176.6°C) M_n = 7,210 C_2 wt% = 63.7 wt%	density = 0.870 g/cc T_c = 57°C T_m = 70°C	The Dow Chemical Company
ENGAGE™ 8130	ethylene/1-octene polyolefin elastomer % crystallization = 15.8 wt% M_n = 52,400 C_2 wt% = 61 wt%	density = 0.864 g/cc T_c = 38°C T_m = 56°C	The Dow Chemical Company
EASTOFLEX™ P1010	amorphous propylene homopolymer (hPP) Brookfield Viscosity = 10 g/cm-s (1,000 cP) (@190°C)	T_m = 152.1°C	Eastman

[0076] Table 5 reports the properties of the compositions based on olefin elastomers. The compositions are prepared using the following protocol: place all oils and the antioxidant (IRGANOX™ 1035, [3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate] available from BASF) into a steel paint can and place can on a hot plate. Begin stirring at 15 rpm using a steel paddle stirrer and lab stirrer such as Cole Parmer Digital Reversing Mixer EW-50004-00 and heat to about 100°C. Add the resins and continue stirring and heat to about 130-150°C until all resins are melted. Maintain the temperature at 130-150°C and mix at 25 rpm for 15 minutes after resins are melted. Take a sample out for Brookfield viscosity testing at 150°C.

[0077] The inventive examples IE1 and IE3 through IE14 show the possibility of formulating with select vegetable oils having a total unsaturation of greater than 40% (soybean and canola oils, for example; and other possibilities of blending these oils with PAO oil, as shown by Examples IE11 through IE14), to achieve desirably low compound viscosity (in some cases, much lower than the target apparent viscosity of less than (<) 10 g/cm-s (1,000 cP), or less than 4 g/cm-s (400 cP), or less than 3 g/cm-s (300 cP) at 150°C), thus the potential opportunity for additional fillers for low cost or other property improvements. Also the inventive compositions exhibit a soft solid to paste-like consistency and depending on the composition exhibits a low to no oil separation at room temperature and adequate drop point.

Table 7. Properties of Comparative and Inventive Compositions

	CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS 8	CS9	CS 10	IE1	CS10	IE3	IE4	IE5	IE6	IE7	IE8	IE9	IE 10	IE 11	IE 12	IE 13	IE 14
AFFINITY™ GA 1875	29.8	29.8	32.8	34.8	39.8	24	20	22.5	-	-	15	-	-	-	-	-	-	-	-	-	10	10	10	10
EASTOFLEX™ P1010	-	-	-	-	-	-	-	7.3	-	-	15.8	29.8	12.8	14.8	-	-	-	-	-	-	19.8	19.8	19.8	19.8
P/E 1	-	-	-	-	-	-	-	-	15	-	-	-	12.8	15	15	20	15	15	20	15	-	-	-	-
P/E 2	-	-	-	-	-	-	-	-	14.8	-	-	-	-	-	14.8	19.8	9.8	14.8	19.8	9.8	-	-	-	-
ENGAGE™ 8130	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canola Oil (Vegetable)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	70	60	75	-	-	-	-
Soybean Oil (Vegetable)	70	-	-	65	55	71.8	73.8	70	-	-	69	70	74.2	70	70	60	75	-	-	-	52.5	35	17.5	10
SUNPAR™ 110 (Paraffinic)	-	-	67	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DURASYN™ 126 (PAO)	-	-	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-	17.5	35	52.5	60
DURASYN™ 180R (PAO)	-	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AEROSIL™ 200 / 202[1]	-	-	-	-	-	4	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IRGANOX™ 1035	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
SONNEBORN ™ 683[2]	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total (wt%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Visc.[3] @ 150°C (g/cm-s) ((cP))	1.5 (155)	0.95 (95)	1.17 (117)	2.06 (206)	8.75 (875)	8.12 (812)	>10 (1000)	N/A	0.58 (58)	3.07 (307)	2.50 (250)	2.80 (280)	1.05 (105)	1.85 (185)	0.78 (78)	1.95 (195)	0.50 (50)	0.95 (95)	1.98 (198)	0.53 (53)	1.195 (119.5)	0.712 (71.2)	0.67 (67)	0.605 (60.5)
Consistency[4] @ 21°C	P	P	S	P	W/H	P	P	P	P	P	P	P	P	P	P	W	P	P	P	P	P	P	P	P
Oil Separation 24hrs @ 21°C[5]	Y	N	N	Y	Y	Y	N	S	N	N	N	VS	N	N	N	N	N	N	S	N	N	N	N	N
Drop Pt@65°C[6]			60.4							>65					>65									
Drop Pt@80°C[6]	<80	<80		<80	<80	<80	<80	<80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80	>80
Drop Pt@90°C[6]										102.8	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90	>90
Drop Pt@100°C[6]											>100	>100	>100	>100		>100	F	>100	>100	>100	>100	>100	>100	>100
Drop Pt@110°C[6]											>110	<110	>110	>110		>110		<110	<110	<110	>110	>110	>110	>110

CS = Comparative Sample

[1] AEROSIL™ 200 / 202 is hydrophilic fumed silica thixotropic agent.

[2] SONNEBORN™ Flooding Compound 683 is a comparative telecommunication cable flooding compound.

[3] Apparent viscosity of the composition is measured in accordance with ASTM D3236 at 150°C (1 cps = 1 cP).

[4] Consisency of the composition is visually determined while the composition is at 21°C. P = Paste. S = Solid. W = Waxy. H = Hard.

[5] Oil separation is measured after aging for 24 hours at 21°C according to ASTM D1742. Y = Yes. S = Slight. VS = Very Slight. N = None.

[6] Drop Point (°C) is measured in accordance ASTM D127.

Claims

1. A cable comprising:

(A) at least one optical fiber;
(B) a plurality of buffer tubes; and
(C) a flooding composition comprising in weight percent (wt%) based on the weight of the composition:

(1) 10-80 wt% of a first component comprising a polyolefin elastomer consisting of only α-olefin residues, the polyolefin elastomer selected from the group consisting of ethylene/α-olefin copolymers, propylene/α-olefin copolymers, and combinations thereof; and
(2) 20-90 wt% of a second component comprising a bio-based fluid.

2. The cable of claim 1 in which the bio-based fluid component of the flooding composition has a total unsaturation level of greater than 40%.

3. The cable of any of the preceding claims in which the bio-based fluid component of the flooding composition is sourced from vegetable or algae.

4. The cable of any of the preceding claims in which the bio-based fluid component of the flooding composition is free of any petroleum-based oil.

5. The cable of any of the preceding claims in which the bio-based fluid component of the flooding composition is used in combination with one or more petroleum-based oil.

6. The cable of any of the preceding claims in which the bio-based fluid component of the flooding composition is used in combination with one or more polyα-olefin oil.

7. The cable of any of the preceding claims in which the flooding composition has an apparent viscosity in the range of from 20 to 400 centipoise at 150°C, as determined according to ASTM D3236.

8. The cable of any of the preceding claims in which the polyolefin elastomer component of the flooding composition has an Mn of greater than 5,000 g/mol; a weight-average molecular weight ("Mw") in the range of from 5,000 to 50,000 g/mol, and a polydispersity index ("Mw/Mn") in the range of from 1 to 5.

9. The cable of any of the preceding claims in which the polyolefin elastomer component of the flooding composition has a density of less than 0.910 g/cm^3 and a melting point of at least 55°C.

10. The cable of any of the preceding claims in which the flooding composition has a drop point of at least 65°C, as determined according to ASTM D127.

11. The cable of any of the preceding claims in which the flooding composition further comprises one or more additives selected from the group consisting of antioxidants, rheology modifiers, mineral fillers, polymer fillers, and stabilizers.

12. The cable of any of the preceding claims in which the bio-based fluid component of the flooding composition has a total unsaturation level of greater than 40%.

13. The cable of any of the preceding claims in the form of a telecommunications cable.

14. The cable of any of the preceding claims in the form of an optical fiber cable.

Patentansprüche

1. Ein Kabel, das Folgendes beinhaltet:

(A) mindestens einen Lichtwellenleiter;
(B) eine Vielzahl von Hohladern; und

(C) eine Flutungszusammensetzung, die in Gewichtsprozent (Gew.-%), bezogen auf das Gewicht der Zusammensetzung, Folgendes beinhaltet:

(1) zu 10-80 Gew.-% eine erste Komponente, die ein Polyolefinelastomer, bestehend aus nur α-Olefin-Resten, beinhaltet, wobei das Polyolefinelastomer aus der Gruppe ausgewählt ist, die aus Ethylen/α-Olefin-Copolymeren, Propylen/α-Olefin-Copolymeren und Kombinationen davon besteht; und
(2) zu 20-90 Gew.-% eine zweite Komponente, die ein biobasiertes Fluid beinhaltet.

2. Kabel gemäß Anspruch 1, wobei die biobasierte Fluidkomponente der Flutungszusammensetzung einen Gesamtgrad an Ungesättigtheit von mehr als 40 % aufweist.

3. Kabel gemäß einem der vorhergehenden Ansprüche, wobei die biobasierte Fluidkomponente der Flutungszusammensetzung aus Pflanzen oder Algen bezogen wird.

4. Kabel gemäß einem der vorhergehenden Ansprüche, wobei die biobasierte Fluidkomponente der Flutungszusammensetzung frei von jeglichem Öl auf Erdölbasis ist.

5. Kabel gemäß einem der vorhergehenden Ansprüche, wobei die biobasierte Fluidkomponente der Flutungszusammensetzung in Kombination mit einem oder mehreren Ölen auf Erdölbasis verwendet wird.

6. Kabel gemäß einem der vorhergehenden Ansprüche, wobei die biobasierte Fluidkomponente der Flutungszusammensetzung in Kombinationen mit einem oder mehreren Poly-α-olefin-Ölen verwendet wird.

7. Kabel gemäß einem der vorhergehenden Ansprüche, wobei die Flutungszusammensetzung bei 150 °C eine scheinbare Viskosität im Bereich von 20 bis 400 Centipoise, wie bestimmt gemäß ASTM D3236, aufweist.

8. Kabel gemäß einem der vorhergehenden Ansprüche, wobei die Polyolefinelastomerkomponente der Flutungszusammensetzung ein Mn von größer als 5 000 g/mol; ein Molekulargewicht im Gewichtsmittel ("Mw") im Bereich von 5 000 bis 50 000 g/mol und einen Polydispersitätsindex ("Mw/Mn") im Bereich von 1 bis 5 aufweist.

9. Kabel gemäß einem der vorhergehenden Ansprüche, wobei die Polyolefinelastomerkomponente der Flutungszusammensetzung eine Dichte von weniger als 0,910 g/cm^3 und einen Schmelzpunkt von mindestens 55 °C aufweist.

10. Kabel gemäß einem der vorhergehenden Ansprüche, wobei die Flutungszusammensetzung einen Tropfpunkt von mindestens 65 °C, wie bestimmt gemäß ASTM D127, aufweist.

11. Kabel gemäß einem der vorhergehenden Ansprüche, wobei die Flutungszusammensetzung ferner einen oder mehrere Zusatzstoffe, ausgewählt aus der Gruppe, bestehend aus Antioxidationsmitteln, Rheologiemodifikatoren, Mineralfüllstoffen, Polymerfüllstoffen und Stabilisatoren, beinhaltet.

12. Kabel gemäß einem der vorhergehenden Ansprüche, wobei die biobasierte Fluidkomponente der Flutungszusammensetzung einen Gesamtgrad an Ungesättigtheit von mehr als 40 % aufweist.

13. Kabel gemäß einem der vorhergehenden Ansprüche in der Form eines Telekommunikationskabels.

14. Kabel gemäß einem der vorhergehenden Ansprüche in der Form eines Lichtwellenleiterkabels.

Revendications

1. Un câble comprenant :

(A) au moins une fibre optique ;
(B) une pluralité de tubes formant gaines ; et
(C) une composition de noyage (remplissage type *flooding*) comprenant en pourcentage en poids (% en poids) rapporté au poids de la composition :

(1) de 10 à 80 % en poids d’un premier composant comprenant un élastomère polyoléfinique constitué de

résidus α-oléfiniques uniquement, l'élastomère polyoléfinique étant sélectionné dans le groupe constitué de copolymères d'éthylène/α-oléfine, de copolymères de propylène/α-oléfine, et de combinaisons de ceux-ci ; et
(2) de 20 à 90 % en poids d'un deuxième composant comprenant un fluide d'origine biologique.

2. Le câble de la revendication 1 dans lequel le composant à fluide d'origine biologique de la composition de noyage a un taux d'insaturation total supérieur à 40 %.

3. Le câble de n'importe lesquelles des revendications précédentes dans lequel le composant à fluide d'origine biologique de la composition de noyage est issu d'un végétal ou d'une algue.

4. Le câble de n'importe lesquelles des revendications précédentes dans lequel le composant à fluide d'origine biologique de la composition de noyage est exempt de toute huile d'origine pétrolière.

5. Le câble de n'importe lesquelles des revendications précédentes dans lequel le composant à fluide d'origine biologique de la composition de noyage est utilisé en combinaison avec une ou plusieurs huiles d'origine pétrolière.

6. Le câble de n'importe lesquelles des revendications précédentes dans lequel le composant à fluide d'origine biologique de la composition de noyage est utilisé en combinaison avec une ou plusieurs huiles poly-α-oléfiniques.

7. Le câble de n'importe lesquelles des revendications précédentes dans lequel la composition de noyage a une viscosité apparente comprise dans l'intervalle allant de 20 à 400 centipoises à 150 °C, tel que déterminé selon l'ASTM D3236.

8. Le câble de n'importe lesquelles des revendications précédentes dans lequel le composant à élastomère polyoléfinique de la composition de noyage a une Mn supérieure à 5 000 g/mol ; une masse moléculaire moyenne en poids (« Mw ») comprise dans l'intervalle allant de 5 000 à 50 000 g/mol, et un indice de polydispersité (« Mw/Mn ») compris dans l'intervalle allant de 1 à 5.

9. Le câble de n'importe lesquelles des revendications précédentes dans lequel le composant à élastomère polyoléfinique de la composition de noyage a une masse volumique inférieure à 0,910 g/cm^3 et un point de fusion d'au moins 55 °C.

10. Le câble de n'importe lesquelles des revendications précédentes dans lequel la composition de noyage a un point de goutte d'au moins 65 °C, tel que déterminé selon l'ASTM D127.

11. Le câble de n'importe lesquelles des revendications précédentes dans lequel la composition de noyage comprend en sus un ou plusieurs additifs sélectionnés dans le groupe constitué d'antioxydants, de modificateurs de rhéologie, de charges minérales, de charges polymères, et de stabilisants.

12. Le câble de n'importe lesquelles des revendications précédentes dans lequel le composant à fluide d'origine biologique de la composition de noyage a un taux d'insaturation total supérieur à 40 %.

13. Le câble de n'importe lesquelles des revendications précédentes sous la forme d'un câble de télécommunications.

14. Le câble de n'importe lesquelles des revendications précédentes sous la forme d'un câble à fibre optique.

Fig. 1

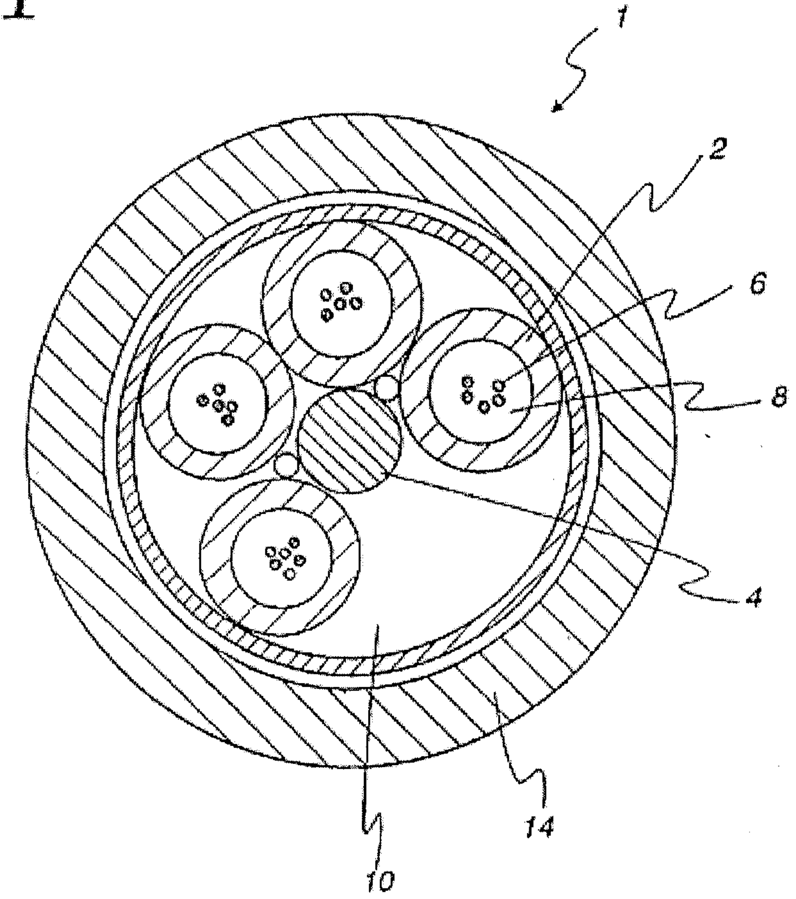


Figure 2

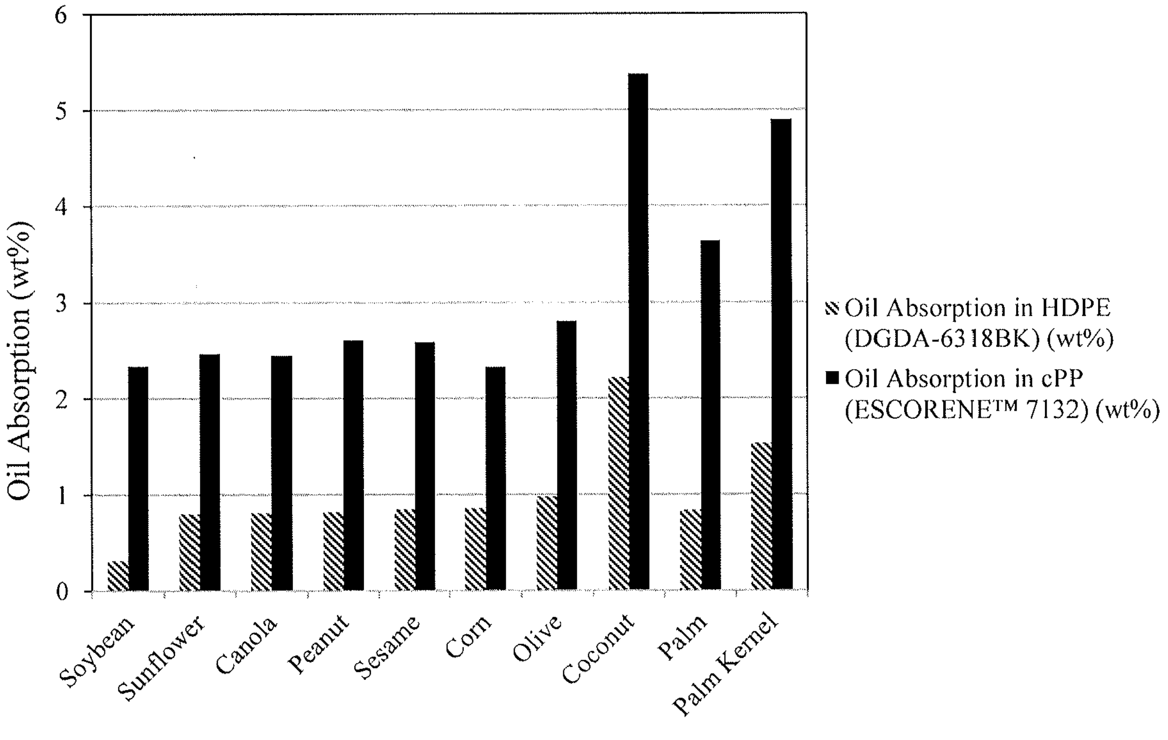
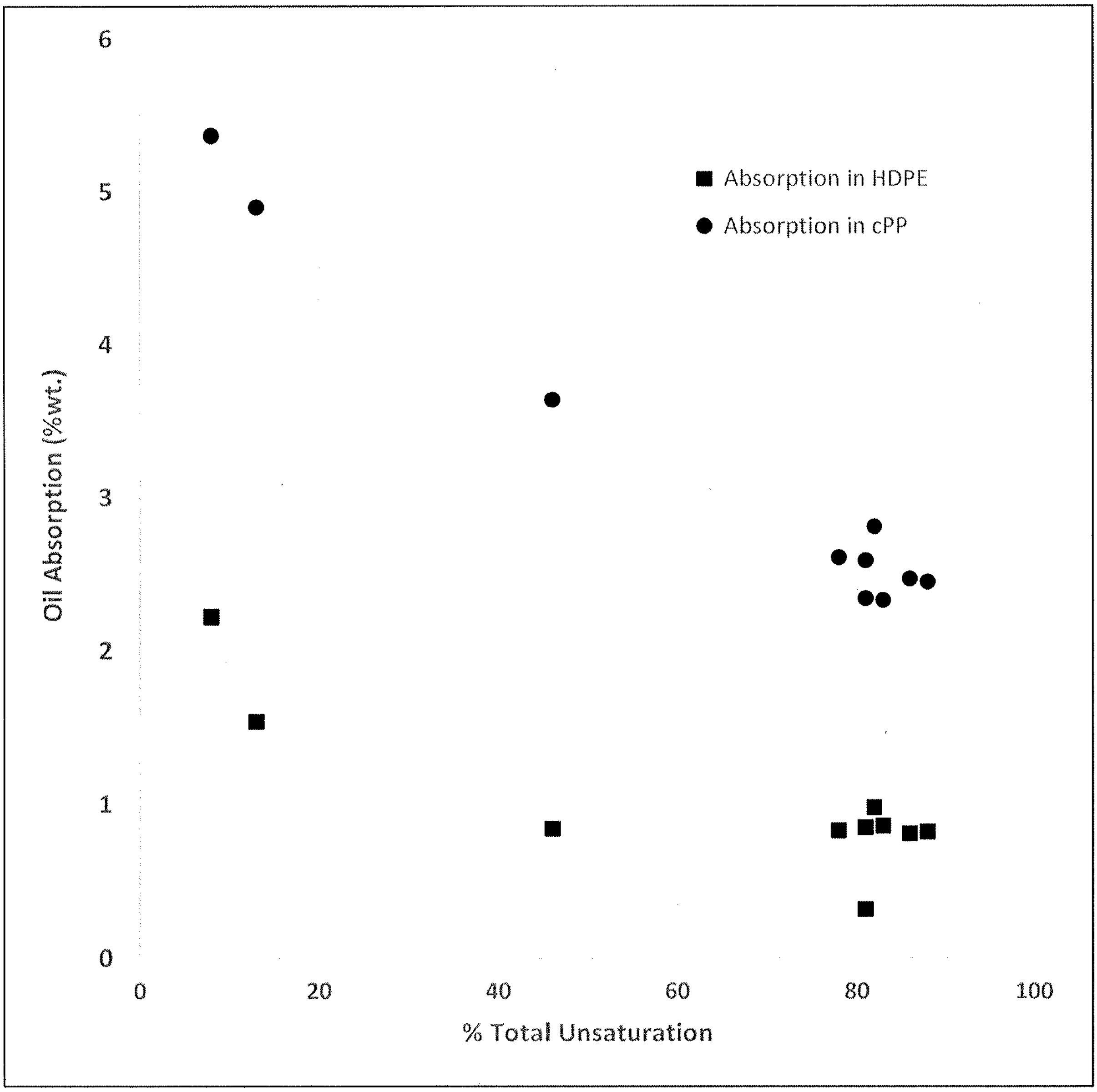

Oil Absorption (wt%)
0
1
2
3
4
5
6
Soybean
Sunflower
Canola
Peanut
Sesame
Corn
Olive
Coconut
Palm
Palm Kernel
▨ Oil Absorption in HDPE (DGDA-6318BK) (wt%)
■ Oil Absorption in cPP (ESCORENE™ 7132) (wt%)

Figure 3


6
5
4
3
2
1
0
Oil Absorption (%wt.)
0
20
40
60
80
100
% Total Unsaturation
■ Absorption in HDPE
● Absorption in cPP

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- US 5940570 A **[0002]**
- US 5246783 A **[0014]**
- US 6496629 B **[0014]**
- US 6714707 B **[0014]**
- US 5272236 A **[0020]**
- US 5278272 A **[0020]**
- US 5986028 A **[0020]**
- US 20040081795 A **[0020]**