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

(11) EP 1 236 764 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.09.2002 Bulletin 2002/36

(51) Int Cl.⁷: **C08K 3/22**, C08K 3/00, H01B 7/02, H01B 3/44

(21) Application number: **01810217.8**

(22) Date of filing: **02.03.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

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(54) Flame-retardant cable with a protection-shield rodents and/or termites

(57) The cable has a double-layer conductor insulation whose inner layer consists of a halogen-free, flame-retardant polymer and whose outer layer at least partly comprises a tough plastic coating. The insulation is on the one hand resistant to rodents and termites and on the other hand compared with well known halogenated insulation-materials highly flame retardant and less corrosive. The overall property profile of the insulation according to the invention is fulfilled by a division of functions between the two layers. The outer layer performs the function of protecting the electrical conductor from the termites and rodents. The inner layer performs in particular the function of ensuring the flame-retardant and the electrical properties of the conductor insulation.

EP 1 236 764 A1

Description

DESCRIPTION

[0001] The invention relates to a cable having an insulation which on the one hand is resistant to rodents and termites and on the other hand compared with well known halogenated insulation-materials is highly flame retardant, less corrosive and generates relatively little smoke as well less toxic gases when burned.

[0002] The cable according to the invention is in particular a electric cable, for example a electric cable for laying on or in ground containing termites or for laying in buildings, or for use in vehicle industry, or it is a signal cable, such as for example a telecommunication cable or a optical signal cable, or it is for use in premise wiring locations for voice or data transmission in local area networks.

[0003] Electric cables laid in the ground are for example cables for medium voltages as well as also low-voltage cables, that is to say cables for voltages below 1 kV.

[0004] It may be pointed out that only electric cables are described below, but that the same applies mutatis mutandis for the other cables as mentioned above.

[0005] The animal pests which damage electric cables laid in the ground include termites, which are a type of insect living in tropical and subtropical regions and also represented in parts of southern Europe. In this connection, the termites destroy the outer sheath, which is preferably made from plastic, as well as the conductor insulation of the electric cable, and thereby reduce the service life and operational reliability of the latter.

[0006] Electric cables have a core which consists of a current conductor and an insulation sheath. Medium-voltage cables, which are provided for voltages from 10 to 30 kV, further comprise a jacket containing a neutral conductor, which surround the insulation sheath. Electric cables are also used to produce multi-core, i.e. three-core cables. The latter consist of three electric cables stranded with one another, which are held together by a sheath which is formed at least partially from polyvinylchloride or polyethylene.

[0007] In order to lengthen the service life and enhance operational reliability, known electric cables which are laid on or in ground containing termites further have a protective sheath which surrounds the insulation sheath or the jacket and is made from a material which is resistant and insensitive to termites, for example a metallic protective sheath.

[0008] Thus, WO 95/20227 discloses a cable with at last one conductor that is surrounded with strips coated with mica and with an insulating polymer layer and that is embedded in a sheath made of polymer filled with inorganic material. A metallic protection shaped as a metallic sheath made of corrugated steel strip is applied to ensure the flexibility of the cable and to protect it against rodents and termites.

[0009] In their embodiment designed for the above mentioned use, such electric cables have the disadvantage that because of the additional protective sheath the production of the cable is very complicated and relatively expensive.

[0010] In addition, the electric cables provided with a metallic protective sheath, and also the three-core cables formed from these have a relatively large cross-section and are comparatively heavy, as a result of which there are disadvantages in storage, transportation and laying of the cables. Thus, for example, for the purposes of storage and transportation cable sections of electric cables or three-core cables are wound onto rollers, wherein it being necessary during winding of the cables onto the rollers to observe a drum diameter which is a function of the cable diameter, and wherein the space available on the roller as well as the permissible maximum weight cause an unfavourable restriction in the length of the cable section.

[0011] On the other hand typical flame-retardant resin compositions used for the insulation and the sheath of electric wires and cables have been heretofore known and produced by mixing antimony trioxide as a flame retardant with a polyvinyl chloride resin, chloroprene rubber or chlorosulfonated polyethylene rubber, or by mixing antimony trioxide, a chlorine flame retardant or a bromine flame retardant with a polyethylene, ethylene-vinyl acetate copolymer or ethylenepropylene rubber.

[0012] Since these compositions contain halogens in their base resins or flame-retardants, they produce at high temperatures toxic gases such as a hydrogen halide gas (hydrogen chloride gas, hydrogen bromide gas) and a halogen gas (chlorine gas) in a large amount involving a serious problem in safety. Thus, products using these compositions are not appropriate to use in a place where safety is highly required, for example, underground railway, building, ship, nuclear power plant and local area networks. Furthermore, there is a disadvantage in that the halogen gases and hydrogen halide gases corrode the adjacent conductor and the like.

[0013] In order to improve the conventional flame-retardant resin compositions in thermal resistance in addition to flame retardancy, cross-linking is made on their base resins, for example, polyethylene and ethylene-propylene rubber. Chemical cross-linking and electron beam crosslinking are frequently used for such treatment. In the chemical cross-linking the composition is heat-treated by steam, etc under a high temperature and pressure, and hence a special pressure-resistant receptacle and heating appliances are needed. On the other hand, electron beam crosslinking requires an electron beam emitting chamber and apparatus. Either cross-linking requires rather large cross-linking equipment which largely raises equipment cost and maintenance cost, thus increasing the production cost of the composition.

[0014] With respect to the conventional cable, there arises another serious problem in that when the inner structural members of the cable core such as made of polyethylene and cross-linked polyethylene are exposed to flames in a fire, they become molten and flow as a drip to the surface of the cable where they are gasified in a high temperature atmosphere and immediately catch fire, so that the cable burns and makes the fire larger.

[0015] Further, cables having the insulation and sheath materials free of any halogen are inferior in flame retardancy to cables having those components. For improving the cables having a halogen-free insulation in flame retardancy a great amount of a metallic hydrate, as for example aluminium trihydrate (ATH) and/or magnesium hydroxide, is blended in them; but this degrades the physical and electrical properties of the cable. To overcome this disadvantage, electrical cables having a two-layer conductor insulation have been developed. Thus, Swiss Patent 664 230 discloses an insulated conductor which has a halogen-free inner insulation layer comprising flame-retardant, halogen-free, crosslinked polyolefin copolymer, and an outer protective layer comprising a polyamide, a thermoplastic, halogen-free polyester elastomer or a halogen-free, aromatic polyether. It is known that the polymers of these two insulation layers are not very compatible with one another, with the result that the two-layers of the conductor insulation do not adhere to one another or adhere to one another only poorly, so that undesired limits are thereby imposed on the mechanical strength. Moreover, the conductor insulations of the electrical cables disclosed in Swiss Patent 664 230 are not produced in a single extrusion step. Instead, they are applied in two process steps independent of one another to the metallic conductor, which results in substantial disadvantages with regard to economical production.

[0016] It is the object of the present invention, starting from the insulated conductor disclosed in WO95/20227, to propose a cable which on the one hand is resistant to rodents and/or termites and on the other hand compared with well known halogenated materials is highly flame retardant, less corrosive and generates relatively little smoke as well less toxic gases when burned.

[0017] This object is achieved according to the invention by a cable having the features of claim 1, i.e. having a core-insulation which generates less toxic gases when burned and which is a coextrudate and consists of an inner and outer layer. The inner layer consists of a halogen-free, flame-retardant polymer or polymer blend and the outer layer is formed at least partially from a very tough plastic-coating.

[0018] The cable according to the invention is non-toxic for human, animals and insects. This means that the outer layer of the core-insulation does not comprise any chemical active agents, as for example insecticides, for the function of protecting the cable from termites and/or rodents and that said layer is essentially a mechanical protection shield.

[0019] Advantageous embodiments of the cable according to the invention are evident from the dependent claims.

[0020] The toxicity test of the core-insulation, i.e. at least of the inner layer which comprises non-halogenated polymer-material, can be performed in accordance with the Navel Engineering Standard Test No. NES-713 and/or with the Standard Test N.F.C. 20-454 for measuring the toxicity of generated gases during burning.

[0021] According to the invention the average toxicity in units per 100 g of the core-insulation is considerably below the allowable toxicity maximum of 5 units per 100 g.

[0022] In a preferred embodiment the cable is a electric cable. Said electric cable has a core which comprises a plurality of current conductors stranded with one another and embedded in the cylindrical insulation according to the invention.

[0023] In an other preferred embodiment the electric cable is a three-core cable, in which three electric cables are stranded with one another. These cables are for example constructed essentially in the same way as the electric cable mentioned above, each have a core, formed by stranded copper wires and a plastic insulation. The three-core cable is embedded in a cylindrical insulation consisting of the inner and outer layers according to the invention.

[0024] In these cases, the inner layer comprises an aluminium hydroxide and/or magnesium hydroxide as a flameproofing agent and at least one polyolefin or polyolefin blend as the polymer component, and the outer layer is a very tough plastic coating and comprises for example at least partially a polyethylene-polymer, such as a high density polyethylene (HDPE).

[0025] The cable of the invention fulfils the flame spread and smoke generation (or suppression) requirements of the industry standards while exhibiting low corrosion and toxicity. The cable generates relatively little smoke as well less toxic gases when burned. Further, the cable has the performances which also fulfil for example the IEC 60332-3, BS 6387 and SS299 criteria.

[0026] An electrical cable of the type according to the invention can be produced as follows. The two conductor insulation layers are applied by means of coextrusion to a stranded copper wire, in turn consisting of a multiplicity of individual wires, for which purpose two starting materials intended for the formation of the inner and outer layers and comprising polymers belonging to the above-mentioned classes of compounds are provided. During or after the extrusion, at least the inner layer of the conductor insulation can be further crosslinked by the action of high-energy electron beams.

[0027] The overall property profile of the conductor insulation according to the invention is fulfilled by a division of functions between the two layers. The outer layer performs the function of protecting the electrical conductor from termites and rodents. The inner layer performs in particular the function of ensuring the flame-retardant and the electrical properties of the conductor insulation.

[0028] The outer layer contains no flameproofing agent, the flame-retardant property of the total conductor insulation is provided by the inner layer. Accordingly, it is important to tailor the volume ratio or the thickness ratio of the two layers to one another.

[0029] In a further embodiment of the invention, the polymers of the inner and outer layers are chosen so that, in the coextruded state applied to the conductor, they adhere to one another or are bonded to one another and thus increase the mechanical abrasion resistance of the conductor insulation. To increase the adhesion between the two layers further, a compatibilizer which permits linking of functional groups between the layers, can additionally be mixed with the at least one polymer of the inner layer and/or the at least one compound of the outer layer.

[0030] In an other embodiment of the invention, the compounds of the inner and outer layers are chosen, so that the pH of the insulation is > 4,3. The result is a cable which is less corrosive and which fulfils the EN 50267-2-3 criterion.

[0031] Suitable polymers for the formation of the inner layer in the context of the invention are the following:

- polyethylene copolymers, such as, for example, ethylene-vinyl acetate (EVA), ethylene-methyl acrylate (EMA), ethylene-butyl acrylate (EBA), ethylene-ethyl acrylate (EEA), ethylene-propylene rubber (EPR), ethylene-propylene-diene (EPDM);
- polyethylene homopolymers, such as, for example, very low density polyethylene (VLDPE) having a density of < 0.920 g/cm^3;
- maleic anhydride (MAH) terpolymers based on EVA, EMA, EBA, EEA, EPR, EPDM or PE; and
- glycidyl methacrylate (GMA) terpolymers based on EVA, EMA, EBA, EEA, EPR, EPDM or PE.

[0032] The starting material serving for the formation of the inner layer has, as an essential component, one of the above-mentioned polymers or a mixture consisting of at least two polymers of this type.

[0033] In addition to the at least one polymer, the material of the inner layer comprises large amounts of halogen-free flameproofing agents, such as, for example, aluminium hydroxide or magnesium hydroxide, and smaller amounts of additives, such as antioxidants, hydrolysis stabilizers, processing assistants, crosslinking agents and coupling agents.

[0034] A guide formulation for the material for the inner layer may be defined as follows:

30-40% by weight of polymer blend
40-70% by weight of aluminium hydroxide (ATH)
0-10% by weight of additives

[0035] The outer layer consists of a very tough plastic coating. The following have proved to be materials particularly suitable for the formation of the outer layer in the context of the invention:

- very tough polyester elastomers, such as polyether-polyesters, for example Hytrel (Du Pont);
- very tough polyethylenes as for example high density polyethylenes (HDPE); and
- copolymers and polymer blends of polyethylene.

[0036] Examples of HDPE are the following:

HDPE	Density-MFI (190/2.16)
Lupolen 6021D	HDPE 0.960 - 0.2
Lupolen 6031M	HDPE 0.964 - 8.0
NCPE 1101	HDPE 0.965 - 7.5
Vestolen A6013	HDPE 0.959 - 2.0
Vesolen A6012	HDPE 0.958 - 0.9

[0037] Is the outer layer made from polyethylene, latter has a density which is at least 0,9 g/cm^3, for example at least 0,92 g/cm^3 and preferably at least 0,93 g/cm^3.

[0038] The starting material serving for the formation of the outer layer comprises, as an essential component, a polymer selected from one of these two groups. The starting material for the outer layer may however also be a mixture of at least two polymers selected from these groups.

[0039] Furthermore, the outer layer of the conductor insulation according to the invention may also comprise relatively small amounts of additives, such as antioxidants, hydrolysis stabilizers, processing assistants and crosslinking agents.

[0040] According to the invention, the at least one polymer of the inner and/or outer layer can be radiation-crosslinked, for example by using a dose of 10-25 Mrad.

[0041] It should be pointed out here that the above-mentioned formulations for the conductor insulation according to the invention represent only a selection of several possible embodiments and can be modified in various respects in the context of the invention.

Claims

1. Flame-retardant cable with a protection-shield against rodents and termites having a core and a core-insulation, **characterised in that** the insulation generates not much toxic gases when burned and is a coextrudate which consists of an inner and outer layer, that the inner layer consists of a halogen-free, flame-retardant polymer which performs in particular the function of ensuring the flame-retardant and the electrical properties of the insulation, and that the outer layer is formed at least partially from a tough plastic coating which performs the function of protecting the cable from termites and/or rodents.

2. Cable according to claim 1, **characterised in that** the outer layer does not comprise an active agent, as for example an insecticide, in order to protect the cable from termites and/or rodents.

3. Cable according to claim 1 or 2, **characterised in that** the insulation has a measured toxicity index of less than five units per one hundred grams, thereby indicating a low toxicity.

4. Cable according to one of the claims 1 to 3, **characterised in that** it is an electric cable with a current conductor which is surrounded by the insulation.

5. Electric cable according to claim 4, **characterised in that** the inner layer has an aluminium hydroxide and/or magnesium hydroxide as a flameproofing agent and at least one polyolefin or polyolefin blend as a polymer component.

6. Electric cable according to claim 4 or 5, **characterised in that** the outer layer is formed at least partially by a tough polyester elastomer and/or tough polyethylene.

7. Electrical cable according to claim 6, wherein the outer layer is formed essentially by a tough polyethylene, **characterised in that** the density of the polyethylene is at least 0,9 g/cm^3, for example at least 0,92 g/cm^3 and preferably at least 0,93 g/cm^3.

8. Electric cable according to one of the claims 4 to 7, **characterised in that** the inner and/or outer layer additionally comprises a compatibilizer for increasing the adhesive strength.

9. Electric cable according to one of the claims 4 to 8, **characterised in that** the inner and/or outer layer is cross-linked.

10. Electric cable according to one of the claims 4 to 9, **characterised in that** the ph of the insulation is > 4,3.

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EUROPEAN SEARCH REPORT

Application Number
EP 01 81 0217

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

C08K
H01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	6 June 2001	Wengeler, H

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 81 0217

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