

FULLY DRY NON-METAL FLAME-RETARDANT AND FIRE-RESISTANT OPTICAL CABLE

Field of the Invention

The present application relates to the field of optical communication cables, in particular to a fully dry non-metal flame-retardant and fire-resistant optical cable.

Background of the Invention

In recent years, fires in several large public entertainment venues, chemical industry, coal mines, and commercial buildings in China have caused heavy losses of people's lives and property. People have a deeper understanding of fire protection and fire safety; and with the rapid growth of urban population, high-rise buildings, hotels, large supermarkets, hospitals, stations, airports continue to increase, and the construction of subway and tunnel traffic, as well as the increase of large public entertainment places and public transport facilities, the importance of fire safety is highlighted. How to ensure the unimpeded communication within a certain period of time in the event of a fire, gain precious time to the greatest extent, and reduce casualties and loss of life and property are subjects that people have been constantly exploring.

At present, mica tape and low-smoke halogen-free sheathing material are generally used as conventional materials for flame-retardant and fire-resistant optical cables in the industry. The material used in this method has a certain fire-resistant performance, but the fire-resistant level is very low. Another kind of fire-resistant communication optical cable containing ceramic materials has been used, and the more common one is the ceramic polyolefin heat-resistant layer as the inner protective material extruded and wrapped on the outer layer of the optical unit. The main mechanism is that under the condition of flame combustion, the ceramic polyolefin forms a dense ceramic shell oxygen barrier layer, which can not only prevent the flame from damaging the internal structure of the cable core, ensure the integrity of the cable core, but also reduce the volatilization of flammable gases inside the cable core, thereby reducing corresponding combustion temperature.

However, as the industry requirements become more and more stringent, the requirements for fire-resistant optical cables are also getting higher and higher. The latest industry standards require fire-resistant optical cables for communication to meet the following requirements: the flame continues to burn for 90 minutes at 750 degrees Celsius, then 15 minutes is waited after the flame is extinguished, during which the optical power of the optical fiber changes less than 1db.

However, simply using ceramic polyolefin materials in the sheath layer cannot meet the above fire-resistant requirements. Moreover, the study found that even if the ceramic polyolefin material is introduced as the sheath layer, the loose tube material of the optical unit is still burned and carbonized at high temperature during the process of continuous combustion, causing the combustion residue on the outer layer material of the optical fiber to collapse inwards, thereby affecting the transmission performance of the optical fiber, and even causing the problem of fiber breakage. Moreover, during the process of cooling at the end of the combustion test of the optical cable, due to thermal expansion and contraction of the outer layer material of the optical fiber, stress release will be formed on the outer layer of the optical fiber, which will squeeze the inner layer of optical fiber, resulting in the problem of fiber breakage.

Summary of the Invention

The embodiment of the present application provides a fully dry non-metal flame-retardant and fire-resistant optical cable so as to solve the problem in the related art that the loose tube material of the optical unit is still burned and carbonized at high temperature during the process of continuous combustion when the ceramic polyolefin material is only used in the sheath layer, causing the combustion residue on the outer layer material of the optical fiber to collapse inwards, thereby affecting the transmission performance of the optical fiber, and even causing the problem of fiber breakage; and moreover, during the process of cooling at the end of the combustion test of the optical cable, due to thermal expansion and contraction of the outer layer material of the optical fiber, stress release will be formed on the outer layer of the optical fiber, which will squeeze the inner layer of optical fiber, resulting in the problem of fiber breakage.

In the first aspect, a fully dry non-metal flame-retardant and fire-resistant optical cable is provided, comprising:

- an armor layer, in which an optical fiber channel is formed, and the armor layer is made of a ceramic glass fiber material;

- an optical unit, which is provided in the optical fiber channel; and

- a flame-retardant layer, which covers the outside of the armor layer.

In some embodiments, the optical unit comprises:

- a central reinforcing member;

- a plurality of optical fiber units, the plurality of optical fiber units are distributed at uniform intervals along an outer circumferential direction of the central reinforcing member; and the optical fiber unit comprises a loose tube and a plurality of optical fibers embedded in the loose tube.

In some embodiments, the optical fiber unit further comprises a first heat insulation layer, and the first heat insulation layer covers the outside of the loose tube.

In some embodiments, the first heat insulation layer is made of ceramic polyolefin or ceramic vulcanized silicone rubber.

In some embodiments, the fully dry non-metal flame-retardant and fire-resistant optical cable further comprises a second heat insulation layer, and the second heat insulation layer is arranged between the optical unit and the armor layer.

In some embodiments, the second heat insulation layer is made of glass fiber or carbon fiber.

In some embodiments, the fully dry non-metal flame-retardant and fire-resistant optical cable further comprises a third heat insulation layer, and the third heat insulation layer is arranged between the armor layer and the flame-retardant layer.

In some embodiments, the third heat insulation layer is made of ceramic polyolefin or ceramic vulcanized silicone rubber.

In some embodiments, the fully dry non-metal flame-retardant and fire-resistant optical cable further comprises a fourth heat insulation layer, and the fourth heat insulation layer is arranged between the third heat insulation layer and the flame-retardant layer.

In some embodiments, the fourth heat insulation layer is made of one of mica tape, polyimide composite tape, basalt fiber reinforced tape and vulcanized silicon rubber composite tape.

The beneficial effects brought by the technical solution provided by the present application comprise the following: since the optical fiber channel is formed by the armor layer, the armor layer is a fire-resistant layer closest to the optical unit, and since the armor layer is made of a ceramic glass fiber material, when the optical cable catches on fire and burns, a ceramic coating in glass yarn and glass fibers are cured together to form a layer of strong and dense armor layer reinforced by the glass fiber, which is able to isolate all combustion residue on the outer layer of the armor layer and prevent the residue from collapsing into the optical unit; and during the process of cooling of the optical cable, the armor layer can form a strong barrier layer on the outer layer of the optical unit, even if the thermal expansion and contraction of the outer layer material of the armor layer generate stress release, the hard armor layer will not shrink under the squeezing of the outer layer material, therefore, the optical fiber of the optical unit will not be squeezed to then result in fiber breakage. Moreover, the strong and dense armor layer can block part of the oxygen from entering the optical unit, which plays a role in preventing the combustion of the optical unit.

The present application provides a fully dry non-metal flame-retardant and fire-resistant optical cable, since the optical fiber channel is formed by the armor layer, the armor layer is a fire-resistant layer closest to the optical unit, and since the armor layer is made of a ceramic glass fiber material, when the optical cable catches on fire and burns, a ceramic coating in glass yarn and glass fibers are cured together to form a layer of strong and dense armor layer reinforced by the glass fiber, therefore, the armor layer of the embodiment of the present application can isolate all combustion residue on the outer layer of the armor layer and prevent the residue from collapsing into the optical unit; and during the process of cooling of the optical cable, the armor layer can form a strong barrier layer on the outer layer of the optical unit, even if the thermal expansion and contraction of the outer layer material of the armor layer generate stress release, the hard armor layer will not shrink under the squeezing of the outer layer material, therefore, the optical fiber of the optical unit will not be squeezed to then result in fiber breakage. Moreover, the strong and dense armor layer can block part of the oxygen from entering the optical unit, which plays a role in preventing the combustion of the optical unit.

Brief Description of the Drawings

In order to better illustrate the technical solution in the embodiments of the present application, the following will briefly introduce the drawings needed in the description of the embodiments, and it is obvious that the drawings in the following description are part of embodiments of the present application, for those of ordinary skill in the art, other drawings may also be obtained based on these drawings without any inventive effort.

Fig. 1 is a structural diagram of a fully dry non-metal flame-retardant and fire-resistant optical cable in the embodiment of the present application;

Fig. 2 is a structural diagram of an optical unit in the embodiment of the present application;

Fig. 3 is a structural diagram of an optical fiber unit in the embodiment of the present application.

In the figures: 1-optical unit; 10-reinforcing member; 11-optical fiber unit; 110-loose tube; 111-optical fiber; 112-the first heat insulation layer; 2-armor layer; 20-optical fiber channel; 3-flame-retardant layer; 4-the second heat insulation layer; 5-the third heat insulation layer; 6-the fourth heat insulation layer.

Detailed Description of the Embodiments

In order to make the purpose, technical solutions and advantages of the embodiments of the present application clearer, the technical solutions in the embodiments of the present application

will be described clearly and completely in combination with the drawings in the embodiments of the present application. Obviously, the described embodiments are only a part of the embodiments of the present application, not all of the embodiments. Based on the embodiments in the present application, all other embodiments obtained by a person of ordinary skill in the art without inventive efforts shall fall within the protection scope of the present application.

As shown in Fig. 1, the embodiment of the present application provides a fully dry non-metal flame-retardant and fire-resistant optical cable, which comprises an optical unit 1, an armor layer 2 and a flame-retardant layer 3 distributed successively along the radial direction of the optical cable, an optical fiber channel 20 is formed in the armor layer 2, and the armor layer 2 is made of a ceramic glass fiber material; the optical unit 1 is provided in the optical fiber channel 20; and the flame-retardant layer 3 covers the outside of the armor layer 2. The flame-retardant layer 3 is a low-smoke, halogen-free flame-retardant layer, which plays an effective role in flame retardancy.

In the embodiment of the present application, since the optical fiber channel 20 is formed by the armor layer 2, the armor layer 2 is a fire-resistant layer closest to the optical unit 1, and since the armor layer 2 is made of a ceramic glass fiber material, when the optical cable catches on fire and burns, a ceramic coating in glass yarn and glass fibers are cured together to form a layer of strong and dense armor layer 2 reinforced by the glass fiber, which is able to isolate all combustion residue on the outer layer of the armor layer 2 and prevent the residue from collapsing into the optical unit; and during the process of cooling of the optical cable, the armor layer 2 can form a strong barrier layer on the outer layer of the optical unit 1, even if the thermal expansion and contraction of the outer layer material of the armor layer 2 generate stress release, the hard armor layer 2 will not shrink under the squeezing of the outer layer material, therefore, the optical fiber of the optical unit 1 will not be squeezed to then result in fiber breakage. Moreover, the strong and dense armor layer 2 can block part of the oxygen from entering the optical unit 1, which plays a role in preventing the combustion of the optical unit 1.

As shown in Fig. 2 and Fig. 3, optionally, the optical unit 1 comprises a central reinforcing member 10 and a plurality of optical fiber units 11, and the plurality of optical fiber units 11 are distributed at uniform intervals along an outer circumferential direction of the central reinforcing member 10; and the optical fiber unit 11 comprises a loose tube 110 and a plurality of optical fibers 111 embedded in the loose tube 110. The optical fibers 111 can be placed loosely in the loose tube 110, and the loose tube 110 is a sleeve made of polypropylene or nylon that protects the optical fiber 111 from internal stress and external side pressure. The loose tube 110 is filled with water-blocking material, and the water-blocking material adopts water-blocking yarn or

water-blocking powder to prevent longitudinal water seepage in the loose tube 110.

Preferably, the optical fiber unit 11 further comprises a first heat insulation layer 112, and the first heat insulation layer 112 covers the outside of the loose tube 110. The first heat insulation layer 112 effectively insulates heat and prevents the loose tube 110 from being carbonized by high heat.

Furthermore, the first heat insulation layer 112 is made of ceramic polyolefin or ceramic vulcanized silicone rubber. Both ceramic polyolefin and ceramic vulcanized silicone rubber are solidified into porcelain during combustion to form a hard shell, which effectively isolates the heat of the outer layer of the first heat insulation layer 112 and plays an effective role in heat insulation. Coating a layer of ceramic polyolefin material on the outside of the loose tube 110 by means of co-extrusion or separate extrusion can effectively insulate the heat of outer layer and prevent the loose tube 110 from melting and carbonizing. Due to the high cost of ceramic vulcanized silicone rubber and the complicated process, the first heat insulation layer 112 of the embodiment of the present application is made of ceramic polyolefin material, the first heat insulation layer 112 and the armor layer 2 together form a two-layer solid shell, and the armor layer 2 can isolate the heat of the outer layer, prevent the first heat insulation layer 112 from falling off after high temperature combustion and form an effective protection for the optical unit 1.

Optionally, the fully dry non-metal flame-retardant and fire-resistant optical cable further comprises a second heat insulation layer 4, and the second heat insulation layer 4 is arranged between the optical unit 1 and the armor layer 2. The second heat insulation layer 4 is made of glass fiber or carbon fiber with low thermal conductivity. Due to the low thermal conductivity, the glass fiber or carbon fiber can effectively insulate heat, and can be used as heat insulation material to prevent the combustion temperature from entering the optical unit 1 to a certain extent. Since the combustion of the armor layer 2 will produce a very small amount of residue, the second heat insulation layer 4 can also function to isolate the residue of the armor layer 2 after combustion from entering the optical unit 1.

Optionally, the fully dry non-metal flame-retardant and fire-resistant optical cable further comprises a third heat insulation layer 5, and the third heat insulation layer 5 is arranged between the armor layer 2 and the flame-retardant layer 3. The third heat insulation layer 5 is configured to block the heat outside the armor layer 2 so as to prevent the armor layer 2 from being directly burned by high heat and unable to play the best role in protecting the optical fiber 111.

Preferably, the third heat insulation layer 5 is made of ceramic polyolefin or ceramic vulcanized silicone rubber. Both the ceramic polyolefin and ceramic vulcanized silicone rubber

are solidified into porcelain during combustion to form a hard shell, which effectively isolates the heat of the outer layer of the third heat insulation layer 5 and plays an effective role in heat insulation. Due to the high cost of ceramic vulcanized silicone rubber and the complicated process, the first heat insulation layer 112 in the embodiment of the present application is made of ceramic polyolefin material, and the third heat insulation layer 5 plays an effective role in protecting the armor layer 2.

Optionally, the fully dry non-metal flame-retardant and fire-resistant optical cable further comprises a fourth heat insulation layer 6, and the fourth heat insulation layer 6 is arranged between the third heat insulation layer 5 and the flame-retardant layer 3. The fourth heat insulation layer 6 effectively blocks heat and protects the third heat insulation layer 5. The fourth heat insulation layer 6 is made of one of mica tape, polyimide composite tape, basalt fiber reinforced tape and vulcanized silicon rubber composite tape, and the mica tape, polyimide composite tape, basalt fiber reinforced tape and vulcanized silicone rubber composite tape can all meet the fire-resistant temperature above 1000°C and can effectively insulate heat.

The flame-retardant and fire-resistant principles of the fully dry non-metal flame-retardant and fire-resistant optical cable in the embodiment of the present application are as follows.

When the optical cable burns and heats up, the outermost low-smoke, halogen-free flame-retardant layer 3 can effectively prevent burning, and when the temperature rises further, the fourth heat insulation layer 6 can meet the fire-resistant temperature above 1000°C, effectively insulate heat, and become the first layer of fire-resistant protection for the optical cable. The third heat insulation layer 5 is made of ceramic polyolefin or ceramic vulcanized silicone rubber and will be solidified into porcelain during combustion to form a hard shell, which effectively isolates the heat of the outer protection and forms the second layer of fire-resistant protection for the optical cable. At the same time, the armor layer 2 is made of ceramic glass fiber material, which is solidified after being heated to form a layer of strong and dense armor layer reinforced by the glass fiber, forming the third layer of fire-resistant protection. The second heat insulation layer 4 of the inner layer of the armor layer 2 is made of glass fiber or carbon fiber. Due to the low thermal conductivity of glass fiber and carbon fiber, the glass fiber and carbon fiber can effectively insulate heat and can be used as heat insulation material to prevent the combustion temperature from entering the optical unit 1 to a certain extent, which insulates the residue produced by the outer material after combustion, hinders the collapse of the residue caused by stress release, prevents the residue from collapsing into the optical unit, and forms the fourth layer of fire protection. The optical fiber jacket of the optical unit 1 is provided with a loose tube 110, and the loose tube 110 is covered with a first heat insulation layer 112.

The first heat insulation layer 112 is made of ceramic polyolefin or ceramic vulcanized silicone rubber, and the ceramic polyolefin or ceramic vulcanized silicone rubber is solidified into porcelain during combustion to form a hard shell, which effectively isolates the heat of the outer protection and forms the fifth layer of protection at the innermost layer.

The optical cable of the embodiment of the present application forms a multi-layer fire-resistant protective layer from the outside to the inside along the radial direction, which has high flame resistance and fire resistance, and satisfies the requirements that the flame continue to burn for 90 minutes at 750 degrees Celsius, then 15 minutes is waited after the flame is extinguished, during which the optical power of the optical fiber changes less than 1db. At the same time, the optical cable of the embodiment of the present application belongs to a fully dry non-metal all-dielectric structure, without fiber paste, low smoke generation during combustion, and good optical transmittance during combustion, which can meet the needs of special industries such as electric power.

In the description of the present application, it should be noted that the orientation or positional relationship indicated by the terms "upper", "lower", etc. are based on the orientation or positional relationship shown in the drawings, which is only for the convenience of describing the present application and simplifying the description, instead of indicating or implying that the pointed device or element must have a specific orientation, be configured and operated in a specific orientation, therefore it cannot be understood as a limitation of the present application. Unless otherwise clearly specified and limited, the terms "installation", "connected" and "connection" should be understood in a broad sense. For example, it can be a fixed connection, a detachable connection, or an integral connection; further can be a mechanical connection, or an electrical connection; further can be directly connected, or indirectly connected through an intermediate medium, or can be the internal communication between two components. For those of ordinary skill in the art, the specific meanings of the above-mentioned terms in the present application can be understood according to specific circumstances.

It should be noted that relational terms such as "first" and "second" are only for distinguishing one entity or operation from another entity or operation in the present application, and do not necessarily require or imply any such actual relationship or order between these entities or operations. Moreover, the terms "include", "comprise" or any other variants thereof are intended to cover non-exclusive inclusion, so that a process, method, article or device comprising a series of elements not only comprises those elements, but also comprises those that are not explicitly listed, or further comprises elements inherent to the process, method, article, or device. If there are no more restrictions, the elements defined by the sentence "comprising a..."

does not exclude the existence of other same elements in the process, method, article, or device comprising the elements.

The above-mentioned are only the embodiments of the present application, so that those skilled in the art can understand or implement the present application. For those skilled in the art, various modifications to these embodiments will be obvious, and the general principles defined herein can be implemented in other embodiments without departing from the spirit or scope of the present application. Therefore, the present application will not be limited to the embodiments shown in this document, but will be subject to the widest scope consistent with the principles and novel features applied herein.

Claims

1. A fully dry non-metal flame-retardant and fire-resistant optical cable, comprising:
an armor layer (2), in which an optical fiber channel (20) is formed, and the armor layer (2) is made of a ceramic glass fiber material;
an optical unit (1), which is provided in the optical fiber channel (20); and
a flame-retardant layer (3), which covers the outside of the armor layer (2);
wherein the optical unit (1) comprises:
a central reinforcing member (10);
a plurality of optical fiber units (11), the plurality of optical fiber units (11) are distributed at uniform intervals along an outer circumferential direction of the central reinforcing member (10); and the optical fiber unit (11) comprises a loose tube (110) and a plurality of optical fibers (111) embedded in the loose tube (110);
wherein the optical fiber unit (11) further comprises a first heat insulation layer (112), and the first heat insulation layer (112) covers the outside of the loose tube (110);
wherein the first heat insulation layer (112) is made of ceramic polyolefin or ceramic vulcanized silicone rubber;
wherein the fully dry non-metal flame-retardant and fire-resistant optical cable further comprises a second heat insulation layer (4), and the second heat insulation layer (4) is arranged between the optical unit (1) and the armor layer (2);
the second heat insulation layer (4) is made of glass fiber or carbon fiber.
2. The fully dry non-metal flame-retardant and fire-resistant optical cable according to claim 1, wherein the fully dry non-metal flame-retardant and fire-resistant optical cable further comprises a third heat insulation layer (5), and the third heat insulation layer (5) is arranged between the armor layer (2) and the flame-retardant layer (3).
3. The fully dry non-metal flame-retardant and fire-resistant optical cable according to claim 2, wherein the third heat insulation layer (5) is made of ceramic polyolefin or ceramic vulcanized silicone rubber.
4. The fully dry non-metal flame-retardant and fire-resistant optical cable according to claim 2, wherein the fully dry non-metal flame-retardant and fire-resistant optical cable further comprises a fourth heat insulation layer (6), and the fourth heat insulation layer (6) is arranged between the third heat insulation layer (5) and the flame-retardant layer (3).
5. The fully dry non-metal flame-retardant and fire-resistant optical cable according to claim 4, wherein the fourth heat insulation layer (6) is made of one of mica tape,

polyimide composite tape, basalt fiber reinforced tape and vulcanized silicon rubber composite tape.