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Flame Retardancy of Instrumentation and Control Cables – CPRI's Experience

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Abstract

In this paper the fire and smoke properties of special application cables such as instrumentation cables, control cables, fibre optic cables and flat travelling cables are compared for their better fire performance. The various outer sheath materials of these cables have been evaluated for its fire performance and as well as smoke performance. In case of zero halogen outer sheath materials of special application cables, only the smoke property is given importance and the fire retardant properties are not being given much importance. Hence the significance of fire retardant property is highlighted in this study.

Keywords: Flammability, Halogen, Instrumentation Cable, Smoke Release, LSZH

1. Introduction

Fire and smoke properties of Power cables are assessed by various International and Indian standards. The fire and smoke properties are mostly given attention only for outer sheath of the cables in the case of sheathed cables for insulation in the case of Unsheathed Insulated Cables. There are defined tests for assessment of FR Cables as per standards. In case of FR Cables the property of fire retardancy is evaluated by means of Oxygen Index, Temperature Index and Flammability on single and Bunch of Cables. For FRLS Cables the Fire Retardancy and as well as smoke properties of the outer covering of the cable is evaluated by means of Oxygen Index, Temperature Index, Flammability on single and Bunch of Cables, Halogen Content test and smoke Density test. For LSZH outer covering of the cables additionally pH and conductivity test is also carried out to prove that the material does not have any acid content in it.

Standards of Power Cables also specify certain limits for all these different types of cables. Now a days, cable is not only being used for power transmission and they are being used for communication purposes, signal transmission, Data Transmission and optical signal transmission. And these Cables are called as Instrumentation cables, travelling cables and Fibre Optic cables. Due to the evolvement of awareness among the people about the smoke emission and release toxic gases in the polymeric cables, the fire Retardant and low smoke properties are being incorporated with these special application cables also.

However unlike Power Cables there are no proper defined standards for assessment of the special cables and hence they are evaluated as per the applicable standards of power cables.

CPRI has also evaluated some of these special cables for its Flame retardancy and Smoke properties. In this paper the results of Fire and Smoke properties of special cables are discussed.

2. Flame Retardant Property

2.1 Flame Retardant Test on Bunch of Cables

In this test, the flame spread behavior of bunch of cables or wires mounted vertically is assessed. The flame spread depend upon the the volume of combustible material exposed to fire, the geometrical configuration of the cable,

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, the temperature at which it is possible to ignite the gases emitted from the cables, the quantity of combustible gas released from the cables for a given temperature rise, the volume of air passing through the cable installation and the construction of the cable. In this test the behaviour of polymeric materials and their fire resistance characteristic in the full scale model related to bunched cables is checked. The cable samples selected under categories A, B, C, are mounted in a vertical tray and exposed to a high intensity flame for 20 to 40 minutes using a special type burner. The fire propagation phenomena of cables is thus checked in this test

The main objective of this test is approximately simulating the real scale installation condition and to demonstrate that the bunched cables do not propagate fire even if its outer covering and insulation have been destroyed in the area of flame impingement.

A satisfactory performance is achieved when the charred section of the cable loading has reached a height of less than 2.5 meters.

Figure 1. Flammability test on bunch of cables.

Figure 2. Flammability test chamber.

2.2 Flammability Test on Instrumentation Cables

The following instrumentation cables have been tested for this Flammability test and the results are as given in Table 1. These instrumentation cables are used for transmission of analogue and digital signals in measurement and process control. The instrumentation cables tested are of either 1 Sq.mm or 2.5 Sq.mm and all these cables are tested for category C and for 20 minutes flame application

Table 1. Flammability test results

Type of Instrumentation Cables	Flammability on Bunch of Cables
2.5SQ X 21C, CU/MICA/XLPE/AL/HDPE/PA/HDPE/SWA/PVC 0.6/1 kV Cable	CAT C : 0.97 metres
2C X 2.5 Sq.mm, 0.6/1 kV CU/MICA/XLPE/HDPE/SWA/PVC Cable	CAT C : 2.62 metres (Failed)
42 C X 2.5 Sq.mm, 0.6/1 kV, CU/MICA/XLPE/PVC Cable	CAT C : 0.51 metres
1T X 1 Sq.mm, 300/500 V, CU/MICA/XLPE/ISCR/AL/HDPE/PA/HDPE/SWA/PVC Cable	Sample burnt for the entire length

From Table 1, it is evident that 1T and 2 Core Instrumentation cables are failed to meet the passing criteria. However, the 21 Core and 42 Core Instrumentation cables are meeting the requirements of the standard i.e. the length of burnt portion after application of flame was found to be less than 2.5 metres.

Among these 21 core and 42 core cables, the 42 core cables are of PVC inner and outer sheathed and hence the burnt length was only 0.51 metres. The 21 core cable, 2 Core and 1 T Cables are of either HDPE and Polyamide inner sheathed or HDPE inner sheathed, Galvanised steel wire Armoured and PVC outer sheathed cable. Since the diameter of the 21 core cable is much more than that of 2 core and 1 T cable, the fire protection given by the outer PVC outer covering and Armour is much more than that of the other two cables. Hence the inner sheath of HDPE and polyamide of 21 core cable is not much exposed to the fire and also the cable is tested for category C for 20 minutes, the cable burnt length was 0.97 metres and it meets the requirement of the specification.

In the case of 2 core and 1T cable, the thickness of outer PVC covering is less and the HDPE and Polyamide inner sheath is more exposed to fire. Since the HDPE is flame propagating in nature, the samples failed to meet the requirement of the standard and it completely burns for the entire length. Figure 3 shows the typical view of Instrumentation cables.

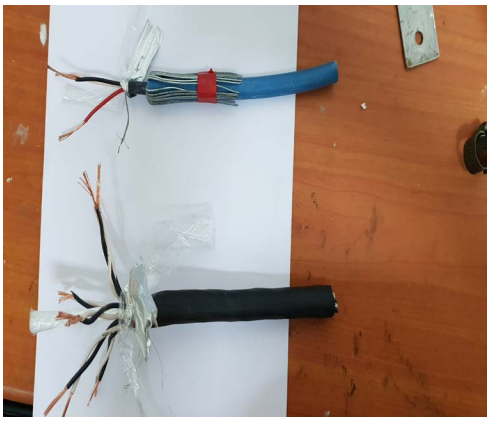

Figure 3. View of instrumentation cables.

2.3 Flammability Test on Silicone Insulated Cables

Flammability test and Fire Resistance test was carried out on Silicone Insulated Instrumentation cables also and the results are listed in the Table 2.

Table 2. Flammability test results of silicone insulated cables

Type of Instrumentation Cables	Flammability on Bunch of Cables
2X1.5 mm^2/7, 500 V Instrumentation Control Cable Cable Type : RE-2GHSWAY-fl Cl, Circular Solid Conductor, silicone rubber insulated, Low Smoke Zero Halogen Inner sheathed, Galvanised Steel Wire Armoured, PVC Outer Sheathed, flame retardant, circuit Integrity	CAT C : 0.45 metres Circuit integrity : Withstood
1X2X2.5 mm^2, 500 V Instrumentation Cable Cable Type : RE-2G(ST)H Cl Circular Solid Conductor, silicone rubber insulated, Collective screened, Low Smoke Zero Halogen sheathed, circuit Integrity	CATC : Cable has burnt for the entire length Circuit integrity : Withstood
5X3X1.5 mm^2/1 TIMF, 500 V Instrumentation Cable Cable Type : RE-2G(ST)HSWAH Cl Circular Solid Conductor, silicone rubber insulated, Collective screened, Low Smoke Zero Halogen Inner sheathed, Galvanised Steel Wire Armoured, Low Smoke Zero Halogen Outer sheathed circuit Integrity	CAT C : 0.38 metres Circuit integrity : Withstood
4X2X1.0 mm^2/7 PIMF, 500 V Instrumentation Cable Cable Type : RE-2G(ST)HSWAY-fl, Circular Solid Conductor, silicone rubber insulated, Collective screened, Low Smoke Zero Halogen Inner sheathed, Galvanised Steel Wire Armoured, PVC Outer sheathed, Flame Retardant	CAT C : 0.92 metres Circuit integrity : Withstood

In this table all the cables are of silicone insulated cables and hence all the cables passed the circuit integrity test as per IEC 60331. From the above table it is observed that the armoured cables of LSZH sheathed cables and armoured cables of PVC sheathed cables meets the requirement of the standard for flame propagation. And however the un armoured cable with LSZH cable sheathing does not meet the requirement of the standard for CAT C and 20 minutes flame application. Hence it is understood that for unarmoured LSZH sheathed Cable, this particular flame retardant test on bunch of cables is a critical test. Hence the flame retardant property of LSZH materials needs to be improved a lot.

3. Smoke and Halogen Property

In this section the smoke, halogen content and the flame retardance property of special cables are discussed

From Table 3 it is observed that the minimum transmittance observed in the smoke density test as per IEC 61034 for LSZH sheathed 1X4 Sq.mm and 1X 16 Sq.mm Cables was excellent as 87% and 82%.

Similarly, the new type cable silicon rubber cable of 3.7 kV also has better smoke property. The smoke release of BETA trans EPDM/EVA sheathing of cable is also very less as 0.28% as per ASTM D 2843. The halogen content of all the different sheathing materials of LSZH, Silicone Rubber and EPDM/EVA BETA TRANS sheathing materials are zero.

The length of burnt portion of unarmoured 4 sq.mm, LSZH insulated cable in Bunched cables flammability test is about 1.5 metres and which meets the standard. However, unarmoured 16 sq.mm, XLPE insulated and LSZH sheathed cable burnt for its entire length in Bunched cables flammability test.

From this it can be stated that unarmoured LSZH sheathed and XLPE insulated cables are prone to propagate the flame in case of vertical mounting. But in the case of LSZH insulated wires, when the LSZH material near the vicinity of flame application completely burns of there are no material available for the flame and only the copper conductor is exposed to flame and hence it meets the requirement.

It is inferred that the as a individual material the LSZH has a better flame retardant property, however when it is being exposed to fire along with inner XLPE insulation without any armour protection it aids the fire propagation. The silicone cable and Beta trans cables are having better flame retardancy property

4. Properties of Flat Travelling and Fiber Optic Cables

In this particular section the FRLS properties of LSZH material used in special application cables like Flat travelling cable and Fibre Optic Cable are discussed. Figure 4 shows the one of the Flat Traveling Cable.

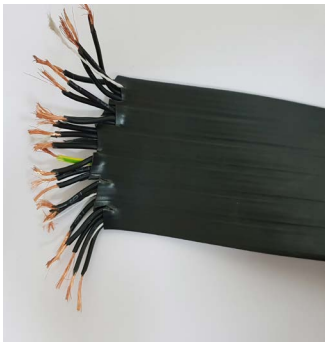

Figure 4. View of the flat travelling cable.

Table 4. FRLS properties of flat cables and fibre optic cables

Type of Cables	FRLS Properties	Halogen Acid Content
24*0.75 Sq.mm Flat Travelling Cable	OI : 22%	0%
Low Smoke Halogen Free Outer Sheath of Single mode Optical Fiber Cable for Direct Buried Installation (FR-OGNMLWBO-CTZO)	79% (IEC) OI : 29% TI : 260 Deg C	0%
FRLS Flat Travelling Cable WDZ-TY JEBP 30X0.75 mm^2 + (2+2P) X 0.75 mm^2, 300/500 V	OI – 24.5% TI- 150Deg C Smoke ASTM : 19.65%	0%

Table 3. Smoke and halogen content of special cables

Type of Cable	Minimum Transmittance Observed	Halogen Acid Content	Flammability on Bunch of Cables
1 X 4 mm2, Cu/LSHF, Un armoured Low Smoke Halogen Free (LSHF), 450/750 V Cable	87% as per IEC 6104	0%	1.5 meters
1 X 16 mm^2, Cu/XLPE/LSHFUn armoured Low Smoke Halogen Free (LSHF), 450/750 V Cable	82% as per IEC 6104	0%	Burnt for the entire length
Single Core, 70 Sq.mm, Silicon Rubber 3.7 kV Cable	79% as per IEC 6104	0%	1.1 meters
1 X 240 SQ.MM BETA TRANS 4GKW-INX Black 1.8/3.0 kV Cable	Absorbance 0.28% as per ASTM D 2863 Toxicity Index : 1.1	0%	0.38

The flat traveling cables are very good with respect to smoke and halogen content and however the oxygen index values of these LSZH outer sheath material is in the range of 22 to 25% and which indicates the poor flame retardant property of the material. The temperature Index value of this material is also very less and it is of 150 deg C.

Similarly, the Oxygen Index and the Temperature Index value of LSZH outer sheath material of fiber optic cable is of 29% and 260 deg C and which is exactly meeting the requirement

5. Conclusions

From the testing experience in evaluating the flame propagation and smoke properties of Instrumentation Cables and special cables the following points are derived

1. Flame Retardant property of LSZH sheathed special cables are poor and however they are of zero halogen and low smoke emissive nature.
2. Silicone Insulated and LSZH sheathed cables are meeting the requirement of Fire Resistance test or they maintain circuit integrity property as per standard. However, if they are not armoured, they are prone to fail in the Flame propagation test on bunch of cable.
3. Unarmoured, XLPE insulated and LSZH sheathed special cables are prone to propagate the flame.
4. The outer LSZH sheath of Flat Travelling Cables are flexible in nature and the Oxygen Index and Temperature Index values of these materials are very less.

6. References

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