Haloarrest® Low Smoke Zero Halogen Jacket Compound

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Belden's Haloarrest jacket offers a unique solution to fit many applications. The Haloarrest jacket is a Low Smoke Zero Halogen (LSZH) alternative to traditional wire and cable jacket compounds. Cables with the Haloarrest LSZH jacket provide a useful alternative for industries that require restricted use of halogenated products. Materials that contain halogens emit potentially harmful and corrosive gases when they are burned. Haloarrest jacketed cables offer excellent flame resistance, low smoke properties, and reduced toxicity.

Halogen containing polymers, such as polyvinyl chloride (PVC) and fluorinated ethylene propylene (FEP) are widely used in wire and cable applications. PVC and FEP hold many benefits, the most notable being inherent flame retardancy. Some applications require a material where the unique properties of the Haloarrest, containing no halogens, is a better solution. Applications in which the Haloarrest jacket is most suitable include instrumentation and control cables, industrial data cables, shipboard cables, and circuit integrity cables.

In Europe, halogen free wire and cable products are used extensively. The change to halogen-free is in response to environmental concerns posed by halogen-containing plastics [1]. The popular concern arose of the possibility, when burned, of halogens harming the ozone layer. Additionally, the non-halogen containing plastics produce low amounts of smoke and acid gas at the time of burning which reduces toxicity and corrosive effects on people and equipment. In the United States, most wire and cable products still contain halogens. The reason for allowing wire and cable products to contain halogens is because superior flame retardancy can be achieved through the use of halogens [1].

A debate arises over the advantages and disadvantages of compounds containing halogens versus those that do not, but it is important to realize that both halogen and halogen-free polymers have their place in the wire and cable industry. When chosing a material for an application, it is important to understand the characteristics of each polymer. Belden's Haloarrest LSZH jacket material is the best choice in many industries and their respective applications. The reader will find a discussion of the properties of Belden's Haloarrest LSZH jacket material and from it will be able to identify applications for which it is best suited.

Low Smoke and Low Acid Gas Properties

Table 1 shows halogen content, acid gas, and other physical properties of the Haloarrest jacket. The Haloarrest LSZH material has excellent tensile strength properties. The Limiting Oxygen Index (LOI) measurement indicates the amount of oxygen necessary to sustain a flame. The LOI value of 42% shows that the Haloarrest LSZH material has good flame retardancy. As opposed to halogen-containing polymers which produce an oxygen-displacing halogen when burned, the Haloarrest LSZH material uses halogen-free flame retardants such as Aluminum Trihydhydrate and Magnesium Hydroxide. These flame retardants produce water molecules when burned, which help to extinguish the flame [1,2].

Table 1: Physical and Acid Gas Properties of LSZH Materials [3]

Physical	Tensile (min requirement) Elongation (min requirement) Tear resistance	1500 psi 100% 22 lb/inch
LOI		42
Halogen Content	IEC 754-1 MIL-C-24643	<5.0 mg/g 0%
NBS Smoke Chamber (.100" wall)	Flaming Mode Smoldering Mode	138 Dm corrected typical 152 Dm corrected typical
Acid Gas	IEC 754-2	5.4 pH, 4.6 µS/cm
Toxicity Index	NES 713	4.6

Additionally, the Haloarrest LSZH jacket material produces very little smoke and is capable of meeting the limited smoke (-LS) rating, as established by Underwriters Laboratories (UL).

Agency Ratings

The Haloarrest jacket is capable of achieving a UL continuous use temperature rating of 90° Celsius. Cables which use this LSZH jacket material have flame ratings up to UL 1685 Vertical Tray and can achieve the TC-LS (Tray Cable-Limited Smoke) rating.

Belden offers a variety of data, audio, video, security/alarm, instrumentation, and control cables with the Haloarrest jacket. After undergoing testing, various agencies have found Haloarrest jacketed constructions to earn the following ratings or approvals:

- UL rated TC-LS (Tray Cable- Low Smoke)
- MSHA (Mining Safety and Health Administration)

- FM (Factory Mutual) GP-1 cable propagation standard 3972 having a Fire Propagation Index (FPI) less than 10
- ABS (American Bureau of Shipping)
- IEEE 383 (1974)
- ICEA T-29-520 (210,000 BTU/hr) Vertical Tray Flame Rating
- UL 1685 Vertical Tray Flame Rating
- CSA FT4 Flame Rating

Use in Mining Applications

Belden's Haloarrest LSZH jacket compound gives many great reasons for making it your choice for Mining Applications. These reasons include reduced toxicity, great flame retardancy, and chemical resistance properties. Ventilation is one of the greatest concerns in limited spaces such as coal mine shafts. Limited ventilation increases the health risk of miners during a fire, but the LSZH jacket will not evolve potentially harmful acid gas. Low smoke emission and low acid gas evolution are of immense importance to the safety of miners during a fire. In addition to ensuring the safety of the miners during a fire, the LSZH jacket material can also stand up to the rigorous conditions of the mine under normal operation. In order to determine how well the LSZH material would hold up to the conditions of the coal mine, Belden performed chemical resistance testing. A brief overview of the results is discussed in the following paragraphs.

In the testing performed by Belden, samples of the LSZH jacket were immersed in a coal dust slurry of equal parts coal and water. The slurry was placed in an oven for seven days at 60°C. After exposure, the samples retained 75% of their former tensile strength and 92% of their original elongation. Identical samples were also placed in a coal dust slurry for thirty days at 23°C. After exposure, these samples retained 79% of their tensile strength and 96% of their elongation. Exposure to water, rather than the coal, caused the largest decrease in desired physical properties.

Samples of the LSZH sample were also placed in an environment consisting of dry coal dust. The samples immersed in coal dust were placed in a humidity chamber for seven days at 60°C . After the seven days, the samples retained 82% of their former tensile strength and 83% of their original elongation.

Different types of coal from different regions contain varying levels of sulfur. Typical sulfur contents range from 1-3%**.** In order to test the potentially negative effects of sulfur, the LSZH samples were submerged in a 5% sulfuric acid solution for seven days at 23°C. After exposure, the samples retained 74% of their tensile strength and 81% of their elongation.

Table 2: Results of Various Chemical Resistance Testing of Coal Mine Conditions

Type	Duration	Temperature	Tensile Retention (%)	Elongation Retention (%)
Coal Slurry	7 Days	60°C	75	92
Coal Slurry	30 Days	23°C	79	96
Coal Dust in Humidity Chamber	7 Days	60°C	82	83
5% Sulfuric Acid solution	7 Days	23°C	74	81

The Haloarrest LSZH material is an excellent choice in coal mine applications because of its unique combination of flame retardancy, low toxicity, and chemical resistance. Belden makes cable products using the LSZH jacket material which are Mining Safety and Health Administration (MSHA) certified.

Compatibility with Pulling Lubricants

Many cable installers and end-users use cable pulling lubricants to help reduce the overall cable's coefficient of friction. This helps to make for a quicker installation, especially when pulling cables through a conduit or tray. However, the installer needs to exercise due diligence when using water based lubricants with LSZH jacketed cables. Belden's lab testing shows that if the lubricant is wiped on in a very thin film, the lubricant will not harm the cable jacket. However, if the installer uses excess lubricant and allows the lubricant to accumulate, there could be some negative affects on the LSZH cable jacket such as cracking. The installer needs to be very careful to not allow the excess lubricant to remain around joints or in the conduit.

Belden tested three different water based cable pulling lubricants. These lubricants were recommended by several large cable distributors due to their popularity in the market.

Belden applied the three lubricants differently on two sets of LSZH samples. On the first set of samples, Belden used a laboratory tissue to apply a thin layer of lubricant onto each sample. The samples were then suspended in the air during an aging process. We then fully immersed a second set of samples in beakers containing each of the lubricants. Both sets of samples were placed in an oven for seven and thirty days at both 23°C and 60°C in order to age the materials.

Belden's results showed that when the lubricant was wiped onto the sample, the sample retained its physical properties and showed very little surface degradation. When the samples were fully immersed in the lubricants, the samples showed significant degradation of physical properties. The results were consistent among the different brands of lubricants and across the different grades of LSZH materials.

Table 3 shows the tensile strength retention values of one LSZH jacket material. The values in the top half of the table show that wiping the lubricants did not significantly change the tensile strength properties of the material. The values in the lower half of the table show that the method of immersing the samples in the lubricants caused a significant loss of tensile properties. While immersing the samples in the lubricant is an extreme method of experimentation, it simulated an environment the cable would have to sustain if placed in a conduit where the excess pulling lubricant remained. These results show the importance of only wiping a very thin layer on the cable jacket during installation. Any excess pulling lubricant can cause physical damage to the cable.

Table 3: Tensile Retention of LSZH jacket material after aging with Pulling Lubricants

Tensile Strength Retention	Lubricant A	Lubricant B	Lubricant C
Wiped, aged 7 days at 23°C	91%	92%	93%
Wiped, aged 7 days at 60°C	104%	101%	102%
Wiped, aged 30 days at 23°C	92%	92%	89%
Wiped, aged 30 days at 60°C	93%	92%	96%
Immersed, aged 7 days at 23°C	74%	68%	66%
Immersed, aged 7 days at 60°C	73%	66%	66%
Immersed, aged 30 days at 23°C	67%	60%	63%
Immersed, aged 30 days at 60°C	67%	64%	69%

Chemical Resistance Comparison of PVC and LSZH

Belden's Master Catalog includes a chemical resistance guide for various insulation and jacket materials in the technical information section. Table 4 shows a comparison between the halogen containing PVC and the non-halogen Haloarrest LSZH jacket material.

Table 4. Comparison of Chemical Resistance properties of LSZH and PVC.

Properties	PVC	LSZH
Oxidation Resistance	E	E
Heat Resistance	G-E	G
Oil Resistance	F	P
Low-Temperature Flexibility	P-G	F-G
Weather, Sun Resistance	G-E	G
Ozone Resistance	E	E
Abrasion Resistance	F-G	F
Electrical Properties	F-G	F
Flame Resistance	E	E
Nuclear Radiation Resistance	F	G
Water Resistance	F-G	F
Acid Resistance	G-E	G

Alkali Resistance	G-E	G
Aliphatic Hydrocarbons Resistance	P	P
Aromatic Hydrocarbons Resistance	P-F	P
Halogenated Hydrocarbons Resistance	P-F	P
Alcohol Resistance	P-F	G
Underground Burial	P-G	F-G

Legend: E=Excellent, G=Good, F=Fair, P=Poor

PVC is a very versatile jacket material for wire and cable. It can be used in a variety of applications and is resistant to many chemicals and environmental conditions. However, in many cases the LSZH jacket material is an equivalent and sometimes superior choice to PVC. LSZH also has the added benefit of not evolving potentially hazardous acid gas when burned. In many applications, the combination of chemical resistance properties and non-halogen properties makes the LSZH jacket material the ideal choice.

LSZH and PVC both have excellent resistance to heat. UL rates the LSZH jacket material as suitable for continuous operation up to 90°C. Some cables using the LSZH jacket material carry a CSA FT-4 and UL 1685 Vertical Tray Flame rating. These cables are also able to obtain the TC-LS (Tray Cable- Limited Smoke) rating. PVC is typically unable to achieve the TC-LS rating because of the high halogen content, which can make PVC a poor choice for areas with restricted ventilation.

LSZH jacket materials are more suitable than PVC in environments where nuclear radiation is present. It is also a more suitable choice than PVC when exposed to alcohol, and may be a good choice for direct burial applications. However, there are some choices where PVC is still a better choice. For example, PVC compounds can be formulated to give excellent oil resistance properties. Haloarrest LSZH jacket materials are not suitable in applications where they could be exposed to oil.

Low smoke and acid gas properties make Haloarrest LSZH the ideal choice for industrial application in restricted areas, or where ventilation is limited. The Haloarrest LSZH jacket materials have many unique resistance properties, which make them a great choice for many industrial applications.

Comparison to LSZH XLPE compounds

Some extreme applications require the exceptional robustness of a cross-linked LSZH jacket. However, there are numerous industrial environments and applications where a thermoplastic LSZH jacket material is the better choice over the cross-linked material because the thermoplastic material offers good chemical resistance and robustness at a lower cost. The thermoplastic and cross-linked LSZH jacket materials have good physical tensile and elongation properties. In certain constructions, they have the ability to pass the CSA FT4, IEEE 1202/383 70,000 BTU Flame Tests and can withstand continual use to 90°C. The thermoplastic and cross-linked LSZH jacket materials both

provide comparable UV resistance, direct burial suitability, and electrical properties. The thermoplastic LSZH jacket material is also a more environmentally friendly choice due to its ability to be recycled.

Table 5: Comparison of Thermoplastic and Crosslinked LSZH Jacket Materials

Property	Thermoplastic LSZH Jacket	Crosslinked LSZH Jacket
Tensile Strength	1500 psi (min requirement)	1500 psi (min requirement)
Elongation	100% (min requirement)	150% (min requirement)
Flame Retardancy*	Pass FT4/IEEE 1202/383 70,000 BTU Flame Test	Pass FT4/IEEE 1202/383 70,000 BTU Flame Test
Temperature Rating	90C	90C
Abrasion Resistance	Fair	Good
Oil Resistance	Poor	Poor
UV Resistance	Good	Good
Direct Burial	Fair	Fair
Recyclability	Good	Poor
Electrical Properties	Fair	Fair

*Flame Retardancy is construction dependant.

Conclusion

Belden's Haloarrest LSZH jacket material offers a unique combination of properties for a variety of applications. Most notably, the LSZH jacket material is capable of meeting the Limited Smoke requirements and is a halogen-free, low acid gas alternative to traditional wire and cable compounds. There are many areas where the Haloarrest LSZH jacket compound is a great choice, which include the mining industry, shipboard, circuit integrity, industrial data and industrial instrumentation and control applications.

References

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4. Dow Corporation, Midland, Michigan.

The Author

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