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COMPARISON OF LOW SMOKE NON-HALOGENATED AND HALOGENATED CABLE MATERIALS

Most conventional flame retardant cable insulations and jacket materials are compounded or include a halogenated flame retardant. The halogen most often used is chlorine. Ethylene propylene rubber (EPR) & cross-linked polyethylene (XLPE) insulations are often compounded with chlorinated additives to achieve flame retardancy. Polyvinyl chloride (PVC) insulations inherently contain chlorine. Common jacketing material include Neoprene, Hypalon (CSPE), chlorinated polyethylene (TS-CPE or TP-CPE) and polyvinyl chloride (PVC). Bromine and fluorine are also used. Bromine can be found in some insulations and is often used with chlorine in TP-CPE to obtain the desired level of flame retardancy. Fluorine is the chemical that provides the flame retardant features of cable materials such as Teflon and Tefzel.

The terms "non-halogenated" or "halogen free" are interchangeable. Properties of non-halogenated polyolefin materials are defined in ICEA Standard S-73-532 "Control Cables". By definition in the ICEA standard, "non-halogenated" and "halogen free" are not absolutely halogen free. The standard allows a very small amount of halogen, 0.2% by weight. Other ingredients in these materials can also produce acid gas. The ICEA standard allows a maximum acid gas equivalent of 2%.

Low smoke, non-halogenated flame retardants are usually aluminum oxide trihydrate or magnesium hydroxide dihydrate. These flame retardants are usually compounded into ethylene vinyl acetate (EVA) compounds. EVA materials, while not inherently fire retardant, generally accept these types of flame retardants and can be compounded to have an overall acceptable performance as a cable jacket.

In a fire, the halogen in halogenated materials competes with the available oxygen and thereby reduces the intensity of pyrolization. Low smoke non-halogenated fire retardants described above produce water vapor. This reaction tends to cool the fire. The EVA base material tends to burn with relatively little smoke.

In our comparative tests, the halogenated retardant is more effective in retarding fire. The heat from a fire can prematurely drive off the water vapor even before the fire reaches that portion of the cable. The halogenated fire retardant does not react until the material burns, thereby releasing the fire retardant at the proper time.

Although the halogenated flame retardants are very effective, they also produce two undesirable byproducts. These byproducts are acid gases and smoke. Acid gas can be very detrimental to electronic equipment and metal structures. It has been reported that even with small non-propagating fires, the limited acid gas produced caused significant equipment losses. Sometimes these losses do not show up until the acid gas has enough time to corrode the copper components.

Halogenated cables produce significantly more smoke volume for volume when compared to low smoke jackets. Smoke can damage property, but, even more importantly, can cause egress problems as a result of poor or no visibility.

The low smoke, non-halogenated insulations and jackets generally used today are not as effective as halogenated jackets when direct comparisons are made in the typical vertical tray flame tests. Usually, more damage occurs. Substituting a low smoke non-halogenated jacket for a halogenated jacket over the same cable core generally results in more damage or even can cause a failure in the flame test. (Examples are shown in Tables I & II.) Often additional design changes, such as, adding a flame resistant cable tape or more fire resistant fillers, are necessary for the cable to pass.

Just as with standard halogenated jackets, thermosetting (cross-linked) low smoke, non-halogenated (XLPO) jackets appear to be more flame retardant than thermoplastic

(TPPO) versions. The thermosetting jackets tend to stay on the cable core and provide a protective, insulating ash rather than melt or flow away as thermoplastic jackets may.

Some halogenated jacket materials, such as CSPE, form a protective insulating char when burned. This layer insulates the inner cable core, reduces the amount of fuel exposed to the fire and lessens the amount of overall damage. A comparison is shown in Fig. 1.

Non-halogenated low smoke flame retardant materials are relatively new. As such, compounding improvements are continually being developed. Recently, non-halogenated, low smoke insulations have successfully met the UL requirements for 600 volt rated 75°C & 90°C wet ratings (RHW or XHHW or RWH-2 or XHHW-2). As new materials become available, the performance differences are lessening. Low smoke or non-corrosive off-gasing materials (under fire conditions) should be considered when these attributes are important in lessening equipment damage or providing better visual egress from a fire. If these attributes are not necessary for a given installation, then halogenated cables still provide the best overall performance.

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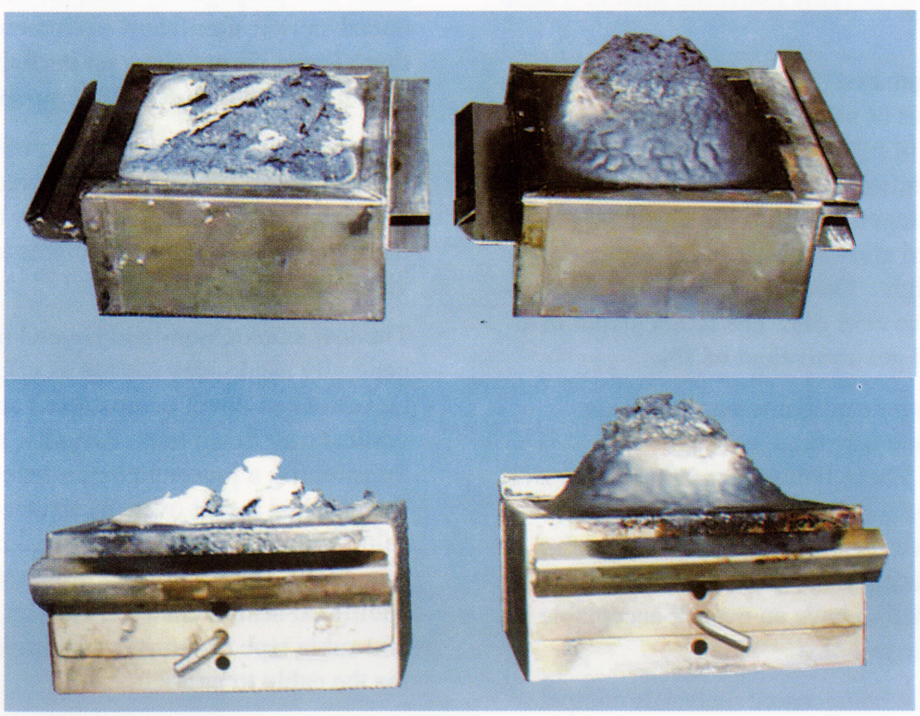
TABLE I
UL 1685
Fire Propagation & Smoke Release

(A) 600V M/C #12 XHHW, C-L-X, LSHF Jkt (B) 600V M/C #12 XHHW, C-L-X, PVC JKT			
Test Results	(A)	(B)	UL
Damage, cm	40	33	150
Peak SRR, m^2/s	0.03	1.44	0.4
Total smoke released, m^2	5.4	215	150

TABLE II
VTFT - CSPE & LSHF Jackets
1/C 1/0 15kV Power Cable
UL 1581 (IEEE 383)

Jacket	Damage	Result
CSPE	40"	Pass
XLPO*	48"	Pass
TPPO*	61"	Pass

*Required fiberglass tapes beneath jacket to pass



Comparison of LSHF (left) and CSPE (right) char formation.

Figure 1