

Halogen-free Security Cables and Wires

What are halogens?

Halogens "formation of salt" are the elements as fluorine, chlorine, bromine and iodine. Fluorine and chlorine are important for cables and wires as atoms in the plastic molecules, for example fluorine plastics or PVC (polyvinyl chloride) are of significance; and bromine as component of flame protection additives.

When is a cable halogen-free ?

The burning behaviour of cables and wires is very important for the installation in buildings and also in control plants.

Thereby the following points are very important:

- Behaviour under flame influence i. e. the inflammability as well as the propagation of fire
- Subsequent damage by formation of corrosive and toxic gases
- Development of smoke density (darkening of emergency exits hindered the fire extinguishing works)

Cables produced of not halogen-free (halogenated) materials such as mainly the materials with chlorine in the molecule-chain: Polyvinyl chloride (PVC), chloroprene rubber (CR), chlorinated polyethylene (CM), chlorosulfonated polyethylene (CSM) and fluorhydrocarbons.

Polytetrafluorethylene (PTFE)
Fluorethylenpropylene (FEP)
Perfluoralkoxypolymeric (PFA)

These materials have a better behaviour in case of fire.

These are hardly combustible or not flammable and vastly self-extinguishing. Due to this effect and in case of fire the released molecules constituents chlorine and fluorine, which hinder the admittance of oxygen to the fire location and suffocate the flame.

The remarkable disadvantages of these materials are existing in the fact that the released chlorine and fluorine atoms composite themselves with hydrogen which is decomposed from plastic material as well as with hydraulic acid or hydrofluoric acid from the existing air.

These compositions are extremely corrosive and also toxic. In consequence the damages by corrosion are often higher than the actual damage caused by fire.

Halogen-free cables contain no halogens, i. e. the insulation and sheath materials of these cables are composed with polymers on the basis of pure

hydrocarbons. By burning such kind of materials, produce no corrosive and toxic gases but only water vapour and carbondioxide.

Polymers like polyethelene (PE) or polypropylene (PP) are halogen-free. These materials are easy flammable and not self-extinguishing.

Halogen-free cables for the security requirements must be hardly flammable and self-extinguishing. This happens by using the special polymer compounds, containing the considerable percentage of flame protective materials.

Such kind of protective materials consist for example, of an aluminium hydroxide which on one side cools the fire location by setting free of crystal water and on the other side the released water vapour hinders the admittance of oxygen and thereby this suffocates the flame. By using of additional supporting tapes and filling yarns of glass web, mica and similar materials the functionality for example of E 90 can be realised with the suitable cable accessories.

Application

The application of halogen-free security cables and wires are specified more and more with increasing numbers for the buildings where people gather or everywhere, where safety conciousness to protect the human life and valuable materials take a special significance. For example,

- Hospitals, airports, in multi-storey buildings, stores and shops, hotels, theaters, cinemas, schools etc.
- Fire warning plants, alarm systems, ventilation systems, escalators, lifts, safety lights, operation and intensive stations, maintenance equipment
- Underground railways and other railway plants
- Data processing installations
- Power stations and industrial plants with high valuable machines and materials or risky potentials
- Mining works
- Shipbuilding and offshore plants
- Emergency power supply works

HELUKABEL-Security Cables and Wires and the advantages

- Flame retardant and hardly combustibility so that no flame propagation in case of fire can be resulted
- Halogen-free; no evolution of corrosive gases
- In case of burning, the halogen-free cables emits low smoke

Halogen-free Security Cables and Wires

- The danger of toxic gases caused by fire is far inferior
- Low caloric load
- Remarkable longer electrical functionality and flame influence
- Insulation integrity for at least 30 minutes as well as 180 minutes at 800°C under fire condition
- Suitable for emergency service up to 180 minutes
- Radiation resistance up to 200×10^6 cJ/kg (up to 200 Mrad)

These characteristics are obtained by using of a flexible halogen-free basis material – aluminium hydroxide $\text{Al}(\text{OH})_3$.

Caloric load values (heat of combustion)

For designing a building the criterions of the caloric load values are very important. The caloric load values of the modern halogen-free cables are reduced by corresponding additives.

The specific heating values of the non-metallic raw materials for cables are specified to DIN 51900. The values of the caloric load or heat of combustion for electrical cables are given per running meter in the following tables.

Combustible cable insulations or open building materials of class B1 are regarded as harmless so far as the resulted caloric load is distributed as proportionale as possible and is valid ≤ 7 kWh/m²

The conversion of the values:

1 MJ/m ²	\triangleq 0,278 kWh/m ²
1 kWh/m ²	\triangleq 3,6 MJ/m ²

Regulations

According to DIN VDE 0108 supplement 1:

- The total caloric load of the cables are allowed up to 14 kWh per m² of the field areas if only halogen-free cables with improved characteristics in the case of fire are used.

If you use PVC cables the total caloric load is only up to 7 kWh per m²

Tests

The characteristics of the security cables are tested according to DIN VDE specifications:

Behaviour in fire

According to DIN VDE 0472 part 804, test method A, test method B and test method C.

• Test method A – test on single cable \triangleq IEC 60332-2

- Test sample of 600 mm cable length shall be in a position vertically hanging. A propane gas burner (\varnothing 8 mm) shall be at an angle of 45° to the axis and the flame of approx. 100 mm below the lower edge of the sample. Flame influence max. 20 s.
- The test is passed, if the sample has not burned or the flame extinguished by itselfs and the damage by fire doesnt reach the remotest upper side of the sample.

• PVC self-extinguishing and flame retardant according to VDE 0482-332-1-2 DIN EN 60332-1-2 7 / IEC 60332-1 (equivalent to DIN VDE 0472 Teil 804 test method B).

- Test sample of 600 mm cable length shall be in a position vertically hanging. A propane gas burner (\varnothing 8 mm) shall be at an angle of 45° to the axis and the flame of approx. 100 mm below the lower edge of the sample. Flame influence, depending on cable weight, 1 to 2 minutes.
- The test is passed, if the sample has not burned or the flame extinguished by itselfs and the damage by fire doesnt reach the remotest upper side of the sample.

• Test method C – test on bunched cables similar IEC 60332-3, HD 405.3, DIN EN 60332-3, VDE 0482-332-3

- Test samples of 360 cm cable length are laying parallel side-by-side attached to a test-ladder, which is hanging vertically with a distance of 150 mm to the furnace. The sample should be flamed with a flame length of 60 cm on the test sample at approx. temperature 800°C by a burner width of approx. 250 mm. The test duration should be 20 minutes.
- The test is passed, if the sample has not burned or the flame extinguished by itself and the damage by fire does not reach the remotest upper side of the sample.

Corrosivity of cumbustion gases

According to VDE 0482 part 267/DIN EN 50267-2-2 / IEC 60754-2 (is equivalent to DIN VDE 0472 part 813). For the performance of the test procedure the insulation and sheath materials are to be put in the moveable furnace, preheated to 750 to 800°C. The burning gas is conducted through two gas-washing bottles.

- The test shall be regarded as passed when the measured pH-value is $\geq 4,3$ and the electrical conductivity $\leq 100 \mu\text{S}\cdot\text{cm}^{-1}$.
- During this test all the not desired components of the materials are precipitated such as all halogens, sulphur and nitrogen.

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Continuance of insulation effect under direct fire conditions

According to DIN VDE 0472 part I 814 IEC 60331

Test sample of 1200 mm cable length is fixed in a horizontal position, 75 mm over the gas burner. The rated voltage of 3 A fuse is fixed between the core groups. The burner flame is so to regulate that the temperature on cable should be $800 \pm 50^\circ\text{C}$. The measuring can be effected until the fuse is blown. Test voltage 400 V for power cables and wires
Test voltage 110 V for telecommunication cables

- The test shall be regarded as passed when no 3 A fuse has blown during the test period between 20 to 180 minutes.

Non-Halogen verification

According to VDE 0482 part 267/DIN EN 50267-2-1/IEC 60754-1 (is equivalent to DIN VDE 0472 part 815).

The corrosion test of gases caused by fire is carried out to the test materials, not of complete cable samples. The proof of halogen is effected by chemical analysis.

Materials with a content of:

$\leq 0,2\%$ chlorine and

$\leq 0,1\%$ fluorine

are regarded as halogen-free.

Smoke density

According to VDE 0482 part 1034-1+2 / IEC 61034-1+2 / DIN EN 61034-1+2 / BS 7622 Teil 1+2 (is equivalent to DIN VDE 0472 part 816).

The test of smoke density is effected to a single cable, laid in a horizontal position within a room of 3 meter cube. The photometrically measured absorption of light is a measuring unit (in %) of light transmittance for the smoke density.

The test is regarded as passed when the light absorption appears within 40 minutes and the following values shall be obtained for light transmission.

Cable Ø	Transmission of Light
> 3–5 mm	40%
> 5–10 mm	50%
> 10–20 mm	60%
> 20–40 mm	60%
> 40	70%

Functionality of electric cable systems

According to DIN 4102 part 12 (system test)
DIN 4102 part 12 describes the requirements and measurements necessary in achieving circuit integrity of a complete electric cable system in case of fire.

Cable systems

Regarded as cable systems are power cables, insulated power cables and wires, telecommunication installation cables for telephone and data transmission and rail-distributors including their corresponding connecting devices such as the necessary ducts and conduits, coatings and coverings, connecting elements, supporting devices, cable trays and clamps.

Functionality

According to DIN VDE 4102 part 12

The functionality is given, when during the test under fire no short circuit and no interruption of current flow occur in the tested electrical cable system.

According to this standard, the security cables are always to be tested together with the corresponding supporting devices, clamps, holder and mounting accessories.

Note: The above defined functionality has no relationship with the continuance of insulation effect under fire conditions according to DIN VDE 0472 part 814.

Test

During this test under fire a complete cable installation will be tested in a large combustion chamber, i. e. cables and wires including clamps, supporting devices, holders, dowels etc.

Test voltage for power cables:	380 V
Test voltage for telecommunication cables:	110 V
Current load:	3 A

The combustion chamber is to be heated up according to ETK (Standard temperature curve).

The test period is distinguished in 3 classes:

- E30 for the functionality ≥ 30 minutes
- E60 for the functionality ≥ 60 minutes
- E90 for the functionality ≥ 90 minutes

Raise of temperature in combustion chamber:

- For E30 to approx. 820°C
- For E60 to approx. 870°C
- For E90 to approx. 980°C

After passing the functionality test, this will be certified with the class identification as E30, E60 or E90.

Note: At the moment the class E60, which is specified in DIN-VDE standards, is not applied for economical and technical reasons.