Medium Voltage Power Cables XLPE-insulated

6/10 kV, 12/20 kV, 18/30 kV

Since about 1970 the cross-linked polyethylene (XLPE)-insulated power cables have been used in Germany. The XLPE-insulation possesses very good electrical, mechanical and thermal characteristics in medium voltage networks. This type of insulation is very chemically resistant and also resistant to cold. Due to various advantages, the XLPE-insulated type has vastly displaced the traditional classical paper-insulated types in many sectors.

In order to prevent the penetration of moisture and also to extend the duration of life, the XLPE-insu-lated medium voltage cables are designed with longitudinally water-proof screen including an addi-tional swell tape and a PE outer sheath.

The manufacture of this sheath is based on high density polyethylene (HDPE), in which an additive organic peroxide is mixed. Due to the heating and pressure the molecule chains are joined to each other, assuring the transition from thermoplastic to elastic condition.

In comparison to PVC and paper-insulated cables, the advantage of XLPE-insulated medium voltage power cables is that they possess a low dielectric factor, such as it is 100 times smaller than of PVC-insulated cables.

Moreover, a better dielectric constant value has an effect on the low mutual capacitance, the short-circuit to ground and the charging current of XLPE-insulated cables.

The good properties of XLPE-insulated cables remain constant through a wide temperature range.

Characteristics of XLPE

• permissible operating temperature	
– For permanent (normal) operation	+ 90°C
– In short circuit	+250°C
– In overload operation and damage by sea	up to +130°C
• Specific heat resistance	3,5 K · m/W
• Dielectric constant	2,4
• Specific resistance (20°C)	min. 10^{16} Ohm · cm
• Loss factor (tan δ) (20°C)	max. 0,5 · 10^{-3}
• Density	0,92 g/cm³
• Breaking strength	min. 200%
• Tensile strength	min. 12,5 N/mm²

Conductor

– Copper or aluminium, round, multiwire stranded and compact, according to VDE 0295 and HD 383.

Inner semi-conducting layer

– Semi-conducting compound, cross-linked, mini-mum wall-thickness 0,3 mm.

Insulation

– Cross-linked polyethylene (XLPE), compound type 2XI1 according to DIN VDE 0207 part 22 and HD 620.1.
– Insulation nominal wall-thickness
for 6/10 kV = 3,4 mm
12/20 kV = 5,5 mm
18/30 kV = 8,0 mm

Outer semi-conducting layer

– Outer semi-conducting layer is extruded together with the inner semi-conducting layer and the insulation in one working process and are spliced with each other.
– Semi-conducting compound, cross-linked, wall-thickness 0,3 to 0,6 mm.

Concentricity of conductor

– The difference between the maximum and mini-mum value of 0,5 mm should not be exceeded.

Semi-conducting type

– Over the outer semi-conducting layer, a semi-con-ducting tape must be used.

Screen

– Screening of copper wires must have a minimum diameter of 0,5 mm and over that a copper tape applied helically with a minimum thickness of 0,1 mm.
– Copper cross-section according to DIN VDE 0273 and 0276 to the corresponded table 2.

Separator

– Over the screen as well as under outer jacket, a separating layer must be used (e. g. taping).

Outer jacket

– PE compound DMP2 according to HD 620.1 and 2YM3 to DIN VDE 0276 part 3, black or
– PVC compound DMV6 according to HD 620.1 and YM5 to DIN VDE 0207 part 5, red
– Wall-thickness = 2,5 mm,
for 1x 500 mm² /30 kV = 2,6 mm

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Laying of Cable

In order to avoid any damage, the XLPE-insulated medium voltage cables should carefully laid and installed. It must be ensured that the cables should not be pulled over the hard or sharp edges.
The cable ends must be water-tight-sealed.
After cutting the length both ends must be sealed immediately.
A laying depth of 60 to 80 cm is recommended.
Single conductor cables are normally arranged in a trefoil touching or triangular shape.
For laying in conduits, the influence of thermal insulation of air space between the cable and the inner wall of conduit should be specially considered.
The inner diameter of the conduit should be at least 1,5 times that of the diameter of the cable.

Bending radius

During the laying of XLPE cables, the bending radius should not be below of the following values:

- Cable without metal sheath = 15 x cable Ø
- Cable with Alu-laminated sheath = 30 x cable Ø

Temperature range

During the installation, the temperature should not be below the following values:

- for XLPE-insulation + PVC jacket = – 5°C
- for XLPE-insulation + PE jacket = –20°C

Max. permissible tensile strength

By pulling the conductors with a pulling head (not for armoured cables)

P = No. of cores x conductor cross-section x δ
δ = permissible pulling tension N/mm²
– For Cu-conductor: 50 N/mm²
– For Alu-conductor: 30 N/mm²

Current carrying capacity

according to VDE 0276 part 620, –5C or HD 620 S1

Laying in earth (ground)

- Laying depth 0,7 –0,8 m
- Earth temperature in the laying depth 20°C
- Specific heat resistance 1,0 K m/W
- Load factor 0,7 (EVU-Load)

Laying in air

- Air temperature 30°C
- Load factor (permanent load) 1,0

Laying in conduits

Cables for conduit systems laying in earth, a reduction of the current carrying capacity with a factor of 0,85 is recommended.

Test voltages

Kind of voltage test	Voltage test in kV		
	U_0/U = 6/10 kV	U_0/U = 12/20 kV	U_0/U = 18/30 kV
Voltage test a. c. in kV	15	30	45
Voltage test d. c. in kV	48	96	144
Voltage test a. c. (voltage test = 1000 h)	18	36	54

Voltage test to cable system

During the operation or after laying the medium voltage power cables, the dielectric can be tested with alternating or direct current. The test duration continues 30 minutes.

Kind of voltage test	U_0/U = 6/10 kV	U_0/U = 12/20 kV	U_0/U = 18/30 kV
Voltage test a. c. in kV	12	24	36
Voltage test d. c. in kV	34 up to 48	67 up to 96	76 up to 108