ELECTRICAL, THERMAL AND THERMO-MECHANICAL DESIGN OF MV XLPE CABLES

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ABSTRACT

The design phase is the first part of a cable's life cycle. Here the customer's requirements and the network configuration have to be translated by the design engineer into adequate system's components, accurate ratings at different load regimes and into an optimal engineering for the complete underground transmission systems.

XLPE is dominating extruded insulation due to its higher operating temperatures and lower cost. XLPE is available for all voltages, transmission and distribution.

Cable performance and integrity is dependent upon on the individual component that goes to make up the cable.

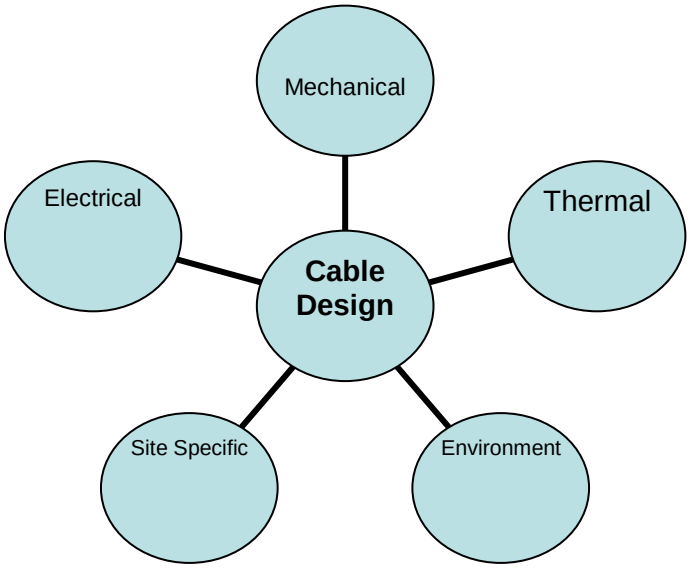
Some study on how every component has effect on cable performance is stated here. Effort is to provide utilities an added value in a standard solution.

KEYWORDS

XLPE; Cable; Thermal, Mechanical, Electrical design, components of cables.

INTRODUCTION

Factors affecting performance of underground cables are design of cable, materials used, actual techniques in manufacturing, installation methods and maintenance in service.
Facets of cables design are (Fig.- 1)



From the engineering point of view, cables are systems whose electrical behaviour is very much dependent upon the materials used within the cable construction. Since a cable system consists essentially of a metallic conductor surrounded by a dielectric, which is in turn wrapped in a metallic screen and protected from the environment, by a non-metallic sheath. The metallic and dielectric materials utilised in the construction thus largely determine its electrical characteristics.

ELECTRICAL CABLE DESIGN

Electrical cable design and cable insulation material properties are directly related to overall cable performance. The trends are

- Limits on Contaminants and voids sizes in insulation– super clean compound. The potential defects in the polymeric part of the cable core refer to any structure that has different characteristics compared to the polyethylene matrix.
- Awareness on Cleanliness and smoothness of semi-conducting compound. Optimization of the material characteristics of the conductor screen e.g. type and content of carbon black as well as peroxide content which has significant impact on micro-crack formation during operation.
- Use of Strippable semi-conducting compound
- Use of Milliken conductor for bigger sizes
- Replacement of lead sheath with Aluminium sheath or Poly-Al tape + copper wires.

Considering limitations of XLPE core of the cable, which is less tolerant to minor manufacturing defects than paper insulated cable cores; the local stress enhancement by particles within an insulation will have contributions from their size, concentration and nature (conducting or high permittivity). These effects can be quantified and expressed in equation by consideration of selected contaminant populations with practical electrical parameters.

$$\eta = 1 - \frac{1}{\alpha}\left(0.5 \ln\frac{\lambda+1}{\lambda-1} - \frac{\lambda}{\lambda^2-1}\right)$$