Chapter 10
Factors Affecting the Sheath Losses in Single-Core Underground Power Cables

ABSTRACT

Power losses in underground cables cause temperature rise of the cables during their operation, there are two types of a power losses generated in the cables: current dependent powers and voltage dependent powers. Current dependent powers refer to the heat generated in metallic cable components (conductors, sheaths etc.); voltage dependent powers refer to the powers in cable insulation . Sheath losses are current dependent and their values in single-core underground power cables cannot be disregarded as they, in some cases, could be greater than power losses in the conductors. Sheath losses in single-core cables depend on a number of factors, these factors are:

1. *Sheath bonding and cable layout formation*
2. *Cable parameters (conductor resistivity & conductor size)*
3. *Cable spacing*
4. *Sheath resistance*
5. *Phase rotation*
6. *Conductor current*
7. *Power frequency*
8. *The minor section length in cross-bonding arrangement*
9. *Cable armoring. In this chapter these factors are investigated depending mainly on IEC 60287.*

10.1 CABLE LAYOUTS FORMATION

Two types of cable layouts formation usually used in practice are studied in this chapter:

1. A trefoil arrangement of three single-core cables, where the cables are laid as at the corners of an equilateral triangle. In this formation two single-core cables are laid close together with one cable forming an upward apex, (Figure 1a).

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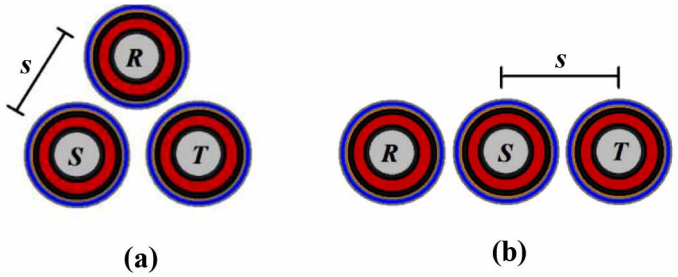
Figure 1. Single-core cable layouts (a) Trefoil formation (b) Flat formation



2. A flat arrangement of three single-core cables, where the three cables are laid in the same horizontal plane with the middle cable equidistant from two outer cables, (Figure 1b).

More details of power cables installation, ratings and laying are reported by Halperin, H., & Miller, K. W. (1929). Buller, F. H. (1949), Thue, W. A. (2003), IEEE Std. 575. (1988), British Standard BS 7430. (1998), King, S.Y., & Halfter, N.A. (1982), Anders, G. J. (2005). Riba, J. R., Ruiz, X., Alabern, M. (2006). Ma, H., Song, J., Ni X., & Zhang, L. (2008) and IEC Standard 60287. (2001).

10.2 MATHEMATICAL ALGORITHM

The single-core cables components are shown in (Figure 2).

10.2.1 Induced Sheath Voltages, Sheath Circulating Currents and Losses

The following assumptions are introduced in order to simplify the calculations of sheath losses in three phase power systems:

1. The sheath may be considered as a thin tube, of radius equal to the mean of outer and inner radii of the sheath.
2. The capacitive currents returning along the cable sheaths will not appreciably affect the sheath losses.

Figure 2. Unarmored single-core cable components