

Chapter 4

Dry Band Formation around Underground Cable

ABSTRACT

The current ratings of underground power distribution cables are affected by ambient temperature, cable laying depth, number of cables in parallel circuits, sheath bonding and thermal resistivity of soil. One important factor usually ignored is the formation of dry zones around the underground power cables. Dry zones are usually formed around underground cables when they are loaded due to the migration of soil moisture content. This in turn may cause an abrupt rise in temperature of the cable sheath, leading to thermal damage of cable insulation or reduces the insulation life time.

4.1 PROBLEM DEFINITION

The current ratings of underground power distribution cables are deformed by the soil characteristics, laying depth, ambient temperature and the method of sheath bonding, (IEC Publication 60287-1-3, 1982), gives the equations used in calculating the current ratings as function of the cable properties and the surrounding soils. In this standards the soil thermal resistivity of the surrounding soil is supposed to be varies from 0.5 to 1.2 °Cm/w .Usually backfill soils lose their moisture content around underground power cables, forming dry zones leading to an increase in the thermal resistance and decreasing in maximum current carrying capacity. The aim of this chapter is to determine the best type of artificial soil that can be used as backfill material to minimize the effect of dry zones that cause thermal failure to the cable insulation. The results of the experimental works carried out in this chapter, showed that some types of soil lost their moisture content faster than the other and the dry zone around the cable in some soils is formed faster than the others. As it is known there are many factors affecting underground power distribution cables loadings. Such these factors are ambient temperature, cable depth lying, and number of cable parallel circuits and thermal resistivity of the soil. (KEMA/Netherland report, 1981) concluded that the thermal resistively depends on the following factors:

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1. Soil properties.
2. Soil moisture content.
3. Degrees of soil compaction.

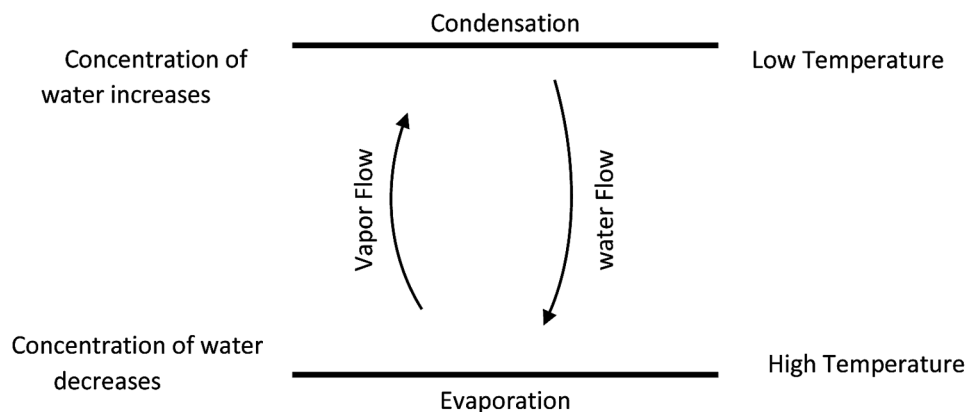
Under loading conditions of underground distribution cables, the cable losses produce heat that transfer from a buried cable through the surrounding medium .Soil moisture content by the heat changes to vapor. Vapor flow increases with temperature rise and condensates in low temperature zone. The resulting gradient in moisture content causes liquid water to flow opposite direction to the vapor flow .If the heat flux is not excessive, a dynamic equilibrium will result the vapor flow and the flow of liquid water in the opposite direction are equal. In this case there is transfer of both latent heat evaporation respectively condensation, and sensible heat. This procedure is given in Figure 1.

The increasing of vapor flow leads to temperature rise around the underground power cables and formation of dry zone around the cable. Such a dry zone has thermal resistivity higher than normal; soil by multiplier factor, ranging from 1.5 to 6 as given in (KEMA/Netherland report, 1981) .This produces in turn, a strong increase in temperature of underground power cables leading to a risk of thermal breakdown of the cable insulation. Drying out zone formation depends mainly on the soil properties cable loading and ambient temperature.

This book contains an experimental work carried out on different types of soils to investigate the formation of dry zone phenomena, Artificial and natural soils are investigated to determine the thermal resistivity of the soil under testing with and without the dry zones formation. In this book back fill artificial soil is suggested to increase the maximum current carrying capacity of the underground power cables. In this book also de – rating factors for underground power cables taking dry zone formation into account are calculated for different cable types depending on (IEC Publication-60 287-1-3, 1982).

Single-core underground power cables can induce voltages and currents in their metallic sheaths. The sheath induced currents are undesirable and generate power losses and reduce the cable ampacity whereas the induced voltages can generate electric shocks to the workers that keep the power line. This means that it is very important to know the values of sheath currents and induced voltages and the factors affecting them. So this book discussed the induced voltages in single-core cables with various voltages levels from 11 kV to 500 kV with briefly studying the factors affecting them. Studying the factors affect-

Figure 1. Diagram of developed processes by existence of a temperature gradient on a moist soil



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