

IMPROVED COOLING OF HIGH VOLTAGE CABLES

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ABSTRACT

To cope with the ever-increasing electric power demands in metropolitan areas will require a greater underground cable transmission capability. Since it will be difficult to obtain permission for new cable routes, especially in densely populated areas, cables will be installed closer together plus crossing of cables will be more common. The heat generated by the cables creates a problem by reducing the transmission capacity of the circuit. Several ways of cooling the cable using separate cooling systems have been described for cables in tunnels in Berlin, Vienna and Osaka [1], [2]. This means that the cables and water pipes are laid separately and in two stages with both systems in need of mechanical protection. To install an effective cooling system, first the hot spots along the route must be identified and then the hot spots cooled using special installations of cooling pipes. To improve cooling efficiency and ease hot spot mitigation, engineering development work was carried out to develop a cable system that could be directly cooled by adding an encompassing water pipe to the cable.



Figure 1.: Installation of XLPE cables with cooling protection

This provides the advantage that the heat generated by the cable is removed immediately and, thus, either increasing the transmission capacity or reducing the conductor temperature. Today, similar safety pipes exist that are used for transporting gases and petrol safely in petrol stations, refineries or chemical plants. One could use similar technology with a cable inside while utilising the safety features of these pipes as a cooling system. In which case, the cable is directly cooled and the surrounding air or ground is not heated, thus reducing the risk of soil drying and the resultant increase of the thermal resistivity.

INTRODUCTION

Today's cable circuits are being loaded closer to their thermal limits. In addition, more cables are laid in the ground, introducing additional problems of mutual heating of crossing cable circuits. Therefore, knowledge of exact cable temperatures and the possibility of removing of the resulting heat are of the utmost importance.

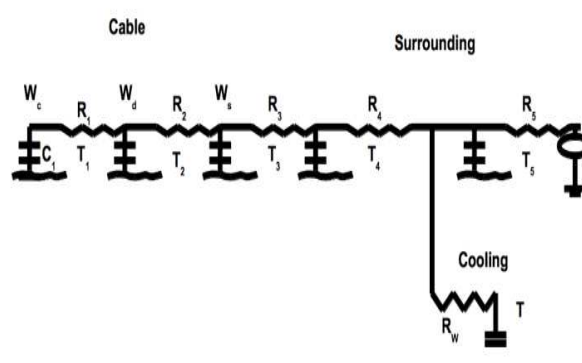


Figure 2.: Standard Cooling Design with External Cooling

Where

R_{1-n} : thermal resistance

C_{1-n} : thermal capacitance

W_c conductor losses

W_d electrical losses

W_s sheath losses

W_g heat removed by water

T_{1-n} Temperatures

Because of the increased heat dissipation requirement, sometimes a bigger conductor is specified than is really needed and warranted by the ampacity requirements so as to avoid a bottleneck in the transmission capacity. If one considers today's raw material prices, especially metals, a reduction in the cable size can have several measurable advantages.

To improve cable transmission capability, it is recommended that a detailed survey identifying the hot spots or critical points along the transmission right-of-way be performed. Since the number of these critical spots is normally limited, it could be beneficial to employ a partial cooling of the cable in the affected areas. Thus, having a cable whose metal jacket could be used as a cooling tube would be very beneficial. In the pipeline industry, it is quite common to install the security pipes transporting gas and petrol with a second metal sheath as a protection. A similar design is described in this paper, where an additional external tube is used to cool the cable surface