NEW CHARACTERIZATION AND DESIGN OF POWER CABLES SYSTEMS

Josu **ORELLA**, Jesús **BESTEIRO**, Virginia **MACIAS,** josa@iberdrola.es, jbn@iberdrola.es, vmacias@iberdrola.es

ABSTRACT

Electricity demand in Spain grew from 1990 at rates higher than those of developed countries, due to changes in the industrial sector towards more intensive energy consumption, the growth in services and increased income and household equipment. Also in recent years, the population growth in Spain has an important effect on demand. The Spanish energy networks are increasing and evolving in order to meet the increase of consumption and generation demands for new connections. Not only is the use of HV and UHV OHL steadily increasing in but also insulated cables.

Therefore knowing the thermal behaviour in both static and dynamic of the trench surroundings enables the designer engineer to maximize the investment, reduce the safety margins and reflect a more realistic situation used in the design stage. Basically, this leads to cost savings and optimization on new cable systems, but also it can avoid or postpone costly changes or network upgrades.

The main limiting aspect for the rating of underground power cables is the maximum allowable temperature of the insulation material. During the operation, the cable heats up due to the electrical and dielectric losses. In addition long response time of the surrounding materials and the trench have a significant impact while in operation.

Consequently, having a good characterization of the surrounding environment has a big impact on the design and it is deemed as essential to know what the behaviour of the trench materials and adjacent covering soils is. Their sensibility to different parameters is key for a correct engineering of the underground power systems

This paper deals with a new approach for an optimized way of characterizing and designing power cable systems. It seeks to capture the variation of the power sensibility on various factors, including: The concrete resistivity, resistivity and ground temperature, phase separation and the provision of cables for different voltage levels

KEYWORDS

Rating, thermal resistivity, temperature, humidity, moisture, pore, map, concrete, soil, geotechnical, survey

INTRODUCTION

The knowledge of the thermal behaviour in both static and dynamic of the trench surroundings enables the designer engineer to maximize the investment, reduce the safety margins and reflect a more realistic situation used in the design stage. Basically, this leads to cost savings and optimization on new cable systems, but also it can avoid or postpone costly changes or network upgrades.

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Iberdrola Engineering & Construction conducted an extensive analysis of the different main parameters that have a large impact on the cable rating. The aim was to have the specific tools, proper knowledge and design data to reliably and easily design underground power lines. Based on international standards, it was developed an affordable and trustworthy methodology to gather all this information.

THERMAL RESISTIVITY

Generally known as one of the main factors reducing the underground power lines, it is related with other values dependant on the material properties.

The thermal resistivity determinations are made in laboratory following standard operating protocols based on ASTM D5334-00 (Heat press transient method).

The next figure shows resistivity values for different soil moisture between saturation and air-dry (laboratory compacted specimen).

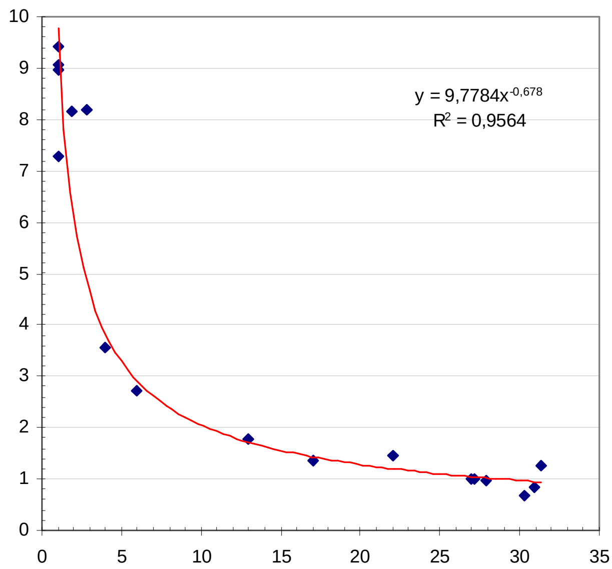

Fig. 3: Thermal resistivity vs. soil humidity

Also, it shows the typical pattern of a humidity-resistivity curve. From saturation to critical moisture values, as the s pores are emptied, there is a mild increase in resistivity. In this range, the heat flux is due to sensible heat flux (due to temperature difference) and especially the latent heat flux associated with evaporation and condensation of water within the soil pores (latent heat). When the soil is dry enough, the amount of water present is not sufficient for the three mechanisms: evaporation, condensation and