Influence of the screen/armour permeability in magnetic fields generated by HV cables

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The installation of long cables increased steadily in recent years and this trend is expected to continue in the future. A topic in need of further research, for different reasons, is the magnetic field generated by cables.

One of the reasons is the possible effects of the magnetic field in human and animal health. Changes in the behaviour of sea life has been registered after the installation of submarine cables and differences sources point out for magnetic fields as the cause.

A second reason is the overestimation of the losses in submarine cables. Several parties have measured these losses and verified that they were lower than expected. Different authors propose different reasons for this, but several indicate that the influence of the armour in the magnetic field generated by the cable is the main reason for the overestimation. Research is currently being made by Aalborg University and Energinet.dk for the development of new analytical formulae capable an accurate estimation of the losses in submarine cables. This paper is one in a series of several that will build the path for the new equations and that can also support other researchers in topics related with magnetic fields.

Typically, the magnetic fields are estimated using FEM software, as analytical equations are too complex and accurate simplified formulae have yet to be developed. This paper proposes to present the magnetic field and induced voltages/currents, estimated by means of FEM, for several cases (single-core cable, three-core cables, two cables, different screen/armour thicknesses, etc…).

The simulations are made for a large range of frequencies, from DC up to 10 kHz, and for different magnetic permeability of screens (for single-core cables) and armours (for three-core cable). Screen's relative permeability different of 1 do not have a practical meaning, but the analysis is helpful for the development of accurate formulae for the three-core case.

Besides comparing the results for the different scenarios, fitting approximation of the results, with the corresponding fitting error, will also be provided with the magnetic permeability, frequency, current and geometry as variables.

The obtained results will help understanding the reasons for the overestimation of the losses and indicate the aspects that should receive more attention in the development of new analytical formulae.