EMF MITIGATION USING STEEL PIPES - EFFECT ON CABLE THERMAL RATING

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ABSTRACT

Installing cables in a steel pipe is a quite efficient solution for mitigation of the Electro-Magnetic Field (EMF) produced by a transmission line.

But the Joule losses in the steel pipe have to be taken into account in the cable rating.

This article deals with the computation of electromagnetic fields produced by a system of three balanced HV cables placed in a steel pipe (with cylindrical or square cross-section) or covered by a U-shaped steel shield, using Finite Element Method (FEM) or analytical solutions.

Simple formulae are proposed, accurate enough for design purpose of an underground link.

INTRODUCTION

In recent years, issues related to power frequency magnetic fields have been an important concern amid customers, because of some alleged health risks due to long-term exposure to these fields and electromagnetic compatibility issues in the form of interferences with electron-beam driven devices.

To mitigate emissions due to underground power links, various solutions are available (generally referred to as conductor management, compensation and shielding) [1].

A quite efficient shielding solution to mitigate the magnetic field intensity in the neighbouring of a link is to enclose the link inside a steel casing.

But the Joule losses due to the eddy currents in the steel casing have an impact on the current carrying capability of the link, that has to be taken into account.

This paper presents computations performed using FEM and analytical solutions.

LOSSES ESTIMATE

The losses induced into ferromagnetic pipes can be computed according to IEC60287-1-1 (§ 2.4.3) [2], where an empirical formula is given for the trefoil and cradle formations (see figure 1).

These two formations give substantially different values. The trefoil arrangement should be preferred in order not to introduce a significant derating.

Based on Meyerhoff's works, reported by Neher for typical pipes, these formulae do not take into account the permeability and conductivity of the steel.

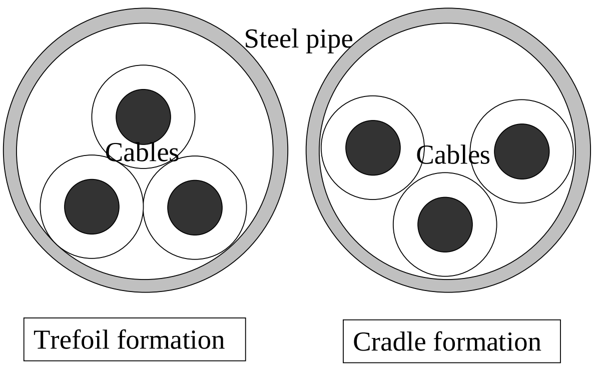

Figure 1: trefoil and cradle arrangements

As regards the trefoil formation, the cables are assumed touching.

The situation where the cables are spaced is also of interest as installing large steel pipes, possibly for several links, becomes a growing trend in railway or river crossings, the cables being generally laid in plastic ducts and the void space filled with bentonite.

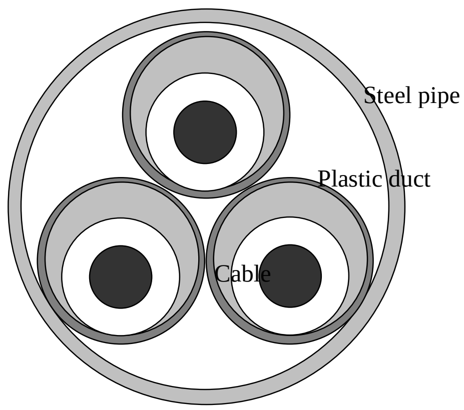

Figure 2: Typical installation for crossings