Magnetic shielding performance of thin metal sheets near power cables

Sang-Beom Kim[a], Joon-Young Soh[a], Yun-Seog Lim[a], Sung-Ho Myung[b]

[a] Korea Electric Power Research Institute, Daejeon, South Korea
[b] Korea Electrotechnology Research Institute, Changwon, South Korea

Mitigation of magnetic field generated from power facilities has been a matter of concern due to not only its interference with electron beam devices [1] but also possible health effects of magnetic field [2]. In contrast to overhead transmission or distribution lines, magnetic shielding is easily applicable to power cables owing to their electrical insulation. Compared to Ni-based alloys, such as mumetal and permalloy, electrical steels are much cheaper in price and have higher permeability at a strong magnetic field strength. Considering shielding factor is inversely related to permeability of material, it is expected that electrical steels show better shielding performance in the vicinity of power sources. For a typical distribution cable system, it is difficult to wrap a narrow conduit with 0.3 mm thick commercial steel sheets. In this work, wrapping conductors with thin soft magnetic materials is proposed as a magnetic shielding method. The 0.1 mm thick grain-oriented (GO) and non-oriented (NGO) steel sheets were produced from commercial grade grain-oriented (0.3 mm in thickness) and non-oriented (0.5 mm in thickness) electrical steels by cold rolling and followed high temperature annealing. The 0.1 mm mumetal (PC) sheets were prepared from 0.35 mm thick commercial sheets after cold rolling and heat treatment suggested by the manufacturers.

Figure 1 shows the schematic diagram of the experimental setup. The middle region of the long conduit that contains three conductors was spirally wrapped with the metal sheets of 100 mm in width. The desired magnetic field at the reference point was obtained by changing magnitude of 3-phase electric currents given to the conductors. Figure 2 exhibits changes in shielding factor with magnetic field at the reference point. Here, shielding factor is described as the ratio of the shielded magnetic field to the unshielded one. A weak magnetic field of 10 μT is effectively shielded by PC, yielding a shielding factor less than 0.1. At a strong magnetic field over 50 μT, however, electrical steels are more effective than PC. Permeability of GO was higher than that of PC above magnetic field strength of 0.4 Oe, which explains the result well. Furthermore, wrapping with both GO (inner) and PC (outer) results in shielding factor less than 0.1 even at 50 μT: a strong field is primarily reduced by GO, and the consequent weak field is successively shielded by PC.

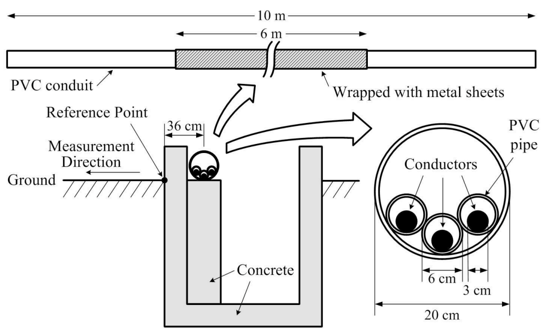

Figure 1: Schematic diagram of the experimental setup.

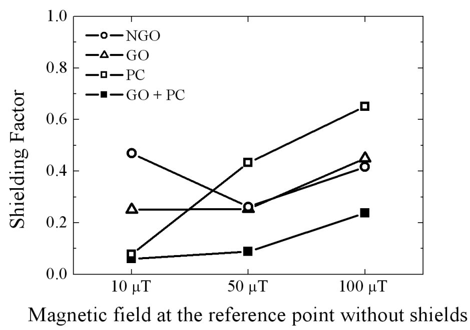

Figure 2: Changes of shielding factor with magnetic field.

[1] B. Banfai et. al., IEEE Trans. Power Delivery **15** (2000), 307-312.

[2] N. Wertheimer et. al., Am. J. Epidemiol. **111** (1979), 273-284.

Corresponding author e-mail: sabukim@kepri.re.kr