Mitigation of magnetic field using three-phase four-wire twisted cables

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INTERNATIONAL TRANSACTIONS ON ELECTRICAL ENERGY SYSTEMS
Int. Trans. Electr. Energ. Syst. 2013; 23:13−23
Published online 22 September 2011 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/etep.636
http://onlinelibrary.wiley.com/doi/10.1002/etep.636/pdf

[Bottom line: the more you twist wires around each other in a cable, the less of a magnetic field you get out into the room.]

As early as 100 years ago, twisted wires in telephone lines were used for reducing cross talk and noises. The phenomenon of the drastic reduction of magnetic field near power lines by twisted wires was not fully understood. Not until the 1960s did some studies discussing the magnetic field properties near twisted pair cables begin to appear [1−3]. Apart from telephone equipment, the concept of twisting wires is gradually being applied to low-voltage electronic equipment to prevent electromagnetic interference. The applications of twisted wires are mainly used to prevent interference from external magnetic fields in electronic equipment. . . .

As the magnetic field from power lines with three-phase unbalance load contains zero-sequence component, a method of using three-phase four-wire twisted cables is proposed. It reduces the magnetic flux densities of positive-sequence and negative-sequence components through twisting effect and offsets the zero-sequence components through the current in the neutral wire. . . .

The simulation results show that using three-phase four-wire twisted cables has an excellent effect on reducing the magnetic fields in multiple-circuit feeder systems.

Figure 4 shows the simulation results with the pitch-diameter ratios of 60, 35, and 25 with untwisted condition. **The twisted cable with a lower pitch-diameter ratio (higher twisted factor) has an excellent effect on magnetic flux density mitigation**. The magnetic flux densities on the calculation points of estimated path decrease rapidly with the increase in twisted degree (or with the decrease in pitchdiameter ratio). . . . The simulation results shown in Figure 5 indicate that the maximum value of magnetic flux density increases rapidly as the pitch-diameter ratio increases. In other words, as long as the pitch-diameter ratio is small enough, the maximum value of magnetic flux density can be well mitigated to be extremely low. Figure 5 also shows that the real cables with their pitch-diameter ratios ranging from

25 to 60 have a good performance on the mitigation of magnetic flux density.

The simulation results are shown in Figure 7, where A, B, C, and D curves represent, respectively, the distributions of magnetic flux density on the estimated path with A, B, C, and D cable configuration types in Table I. Type A is the three-phase three-wire untwisted cable configuration. The magnetic flux density is the highest because there is neither the **neutral wire to neutralize the zero-sequence magnetic field nor the twisting effect to reduce the positive-sequence and negative-sequence magnetic fields**.

To effectively mitigate the magnetic field from power lines with unbalanced three-phase loads, we proposed a method of using three-phase four-wire twisted cables. It not only reduces the magnetic field components of positive and negative-sequence by twisting effect through twisting cables but also neutralizes the component of zero-sequence through the current in the neutral wire. This study shows that in distribution feeders with complicated loading characteristics, using three-phase four-wire twisted cables can indeed effectively reduce the magnetic fields especially in a multiple-circuit feeder system.

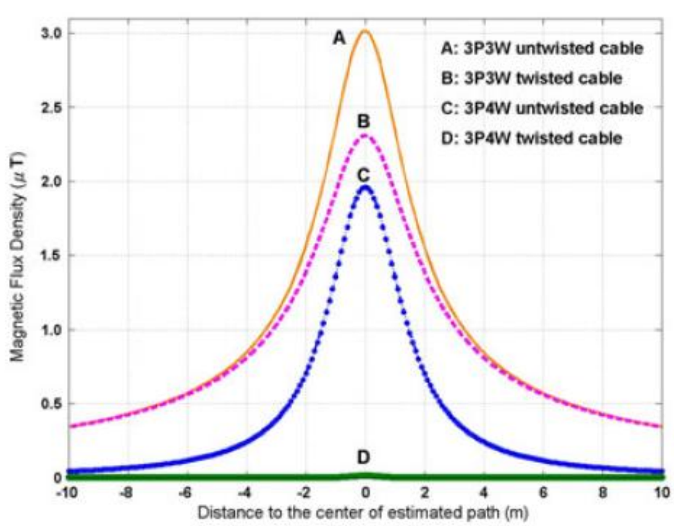

Figure 7. Comparison of magnetic flux density for different cable configurations with a pitch-diameter ratio of 25