Induced sheath voltages and currents in cross-bonded power cables with consideration of improper connections of the bonding leads

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ABSTRACT

In this paper, induced voltages and currents in power cables sheaths are calculated and measured for an existing three-phase single-core 132 kV cable system with cross- bonded sheaths. The calculated values of induced voltages and currents were compared to the actual measured quantities, at different values of earth and contact resistances, with the aim of providing the effect of these parameters on the accuracy of the calculated values.
Occasionally, mistakes are made by connecting bonding leads in a wrong sequence. The paper also examines such situations and discusses the effect of these mistakes on the induced voltages and the resulting circulating currents.

KEYWORDS

Induced voltage; induced current; cross-bonding.

INTRODUCTION

Currents flowing in single-core high voltage power cables can induce voltages and circulating currents in their metallic sheaths. The sheath induced currents are undesirable because they generate power losses and reduce cable ampacity whereas the induced voltages can generate electric shocks to the public. This means that, when installing and operating the single-core high voltage power cables, it is very important to consider and regularly check the values of the sheath currents. The induced voltages and currents of high voltage power cables are discussed in [1-6]. The values of the circulating currents depend on different parameters, such as the sheath grounding system, the geometry of the cables, the space between them, and so on. In the steady state, the induced voltages and currents may reach value of several hundred volts and tens of amperes, respectively. Thus, risks of an electric shock and cables de-rating exist. Because of a complexity associated with the calculations of induced voltages and currents of cross bonded systems, formulas provided by international/ national standards ignore the influences of some factors that may have a significant effect on the computed values. In this work, the influence of some important parameters has been studied. Also the importance of the proper design and implementation of the sheath bonding configuration of the single-core power cables in transposed flat formation has been illustrated through practical measurements.

SHEATH BONDING ARRANGEMENTS

The IEEE Standard 575-1988 [1] introduces guidelines concerning various methods of sheath bonding. The most common types are:

- Sheaths bonded at one end only
- Sheaths bonded at several-points
- Sheaths cross bonded
- Sheaths cross bonded with cable transposition

Sheaths bonded at .one end only

If the sheaths are bonded and earthed at one end only, the circulating currents will not flow but there will be a standing voltage at the unbonded end. The magnitude of the induced voltage will be a function of both the load current and the circuit length. Method of one end sheath bonding is shown in Fig. 1.

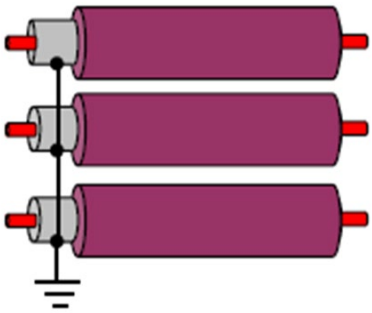

Fig.1 : Single -point bonding

Sheaths bonded at multiple-points

In multi-point bonded system, the induced voltages drive a circulating current in the sheaths. The current in the sheath loop is proportional to the load current, the sheath resistance and several other factors. The circulating current in the sheath heats the cable and, thus, reducing its current rating. There is no standing voltage problem in such case. Method of sheaths bonded at multiple-points is shown in Figure 2.

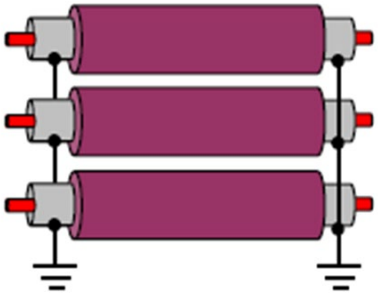

Fig. 2: Multiple-point bonding