

Chapter 8

Sheath Bonding and Grounding

ABSTRACT

With the rapid increase in demand for electric energy and the trend for large infra-structures and vast expansion of highly-populated metropolitan areas, the use of underground power cables has grown significantly over the years. Three separate single-core cables are usually used instead of three-core cables. The principal reasons are:

1. *To transmit large quantities of power, for which three-conductors cable would be unwieldy.*
2. *To obtain phase isolation.*
3. *To gain advantage of the inherently higher unit dielectric strength of the insulation in single-conductor cable.*
4. *The handling of large multi-conductors cable can be difficult, especially compared to the relative ease of handling of several smaller conductors.*

8.1 INTRODUCTION

In a single-core power transmission cable, normally a metallic sheath is coated outside the insulation layer to prevent the ingress of moisture, protect the core from possible mechanical damage, serves as an electrostatic shield (the electric field is enclosed in between the conductor and the sheath), and act as a return path for fault current and capacitive charging currents .

When an isolated single conductor cable carries alternating current, an alternating magnetic field is generated around it. If the cable has a metallic sheath, the sheath will be in the field, the sheath of a single-conductor cable for A.C service acts as a secondary of a transformer; the current in the conductor induces a voltage in the sheath. When the sheaths of single-conductor cables are bonded to each other, as is common practice for multi-conductor cables, the induced voltage causes current to flow in the completed circuit. This current causes losses in the sheath.

The problems of the induced voltages and currents associated with using single-core cables (for example, failure of sheath insulators, failure of cable jackets and sheath corrosion) have been recognized since metallic sheathed cables were first used, and the fundamentals of calculating sheath voltages and currents have been defined for many years .

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Much work has been done, for the purpose of minimizing sheath losses by introducing various methods of bonding as reported by Halperin, H., & Miller, K. W. (1929). Any sheath bonding or grounding method must perform the following functions:

1. Limit sheath voltages as required by the sheath sectionalizing joint.
2. Reduce or eliminate the sheath losses.
3. Provide low impedance path for fault currents.
4. Maintain a continuous sheath circuit to permit adequate lightning and switching surge protection.
5. Limit abnormal sheath voltages during failure to the lowest possible values.

The above objects must be accomplished without causing the following objectionable features:

1. Excessive losses in the sheath bonding devices.
2. Introduction of triple or other harmonic currents into the sheath circuit causing inductive interference with telephone circuits.
3. Interference with proper current drainage to prevent D.C electrolysis; also adverse effect on operation of the A.C sheath bonding method by flow of stray D.C currents.
4. Excessive size, weight, space, or cost of bonding devices.

Due to the importance of the sheath losses especially in single-core cables, the factors affecting them in single-core underground cables have been studied in this book.

Before studying the factors affecting the sheath losses in single-core underground cables it is reasonable to understand how are the voltage and current induced in the metallic sheath which is known as sheath phenomena, also discussion of the various methods of sheath bonding are carried out. Finally the types of metallic sheath losses are discussed.

8.2 SHEATH PHENOMENA

When single-core power cables are used in A.C systems, the presence of a metallic sheath around each conductor causes one or both the following two phenomena:

8.2.1 Sheath Voltage

The sheath of a single conductor cable acts as a secondary of a transformer and the current in the conductor induces a voltage in the sheath. This voltage does not depend upon the sheath material as indicated by Thue, W. A. (2003).

The value of this induced sheath voltage depends on the flux interlinked with the metallic sheath, and it increases as the inter-axial spacing of the cables is increased. This value is also higher if cables are placed in separate ducts.

First, it was not industry practice to insulate the sheaths of cables, hence under normal operating conditions it was necessary to limit the sheath voltage to an acceptable level (12 V to 25 V) in order to avoid electric shock to either operating personnel and also to avoid corrosion.

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