Belgian experience with a sheath current monitoring system installed on a critical 150 kV cable

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ABSTRACT

The cable network in Belgium is permanently increasing and renewed in order to safeguard the security of supply, integrate renewable energy and enhance market development. The increase of extruded cables of different technologies (HVAC, HVDC, offshore) implies an increase of preventive maintenance activities and inspections and force grid owners to be efficient with their resources. Therefore, Elia decided to install a sheath current monitoring system on-site on two critical 150 kV HVAC cable systems. This system measures and evaluates the induced cable screen currents. The goal of the project is to investigate the possibility of such system to replace periodic sheath measurements, detect bad connections in link boxes and verify the correct functionality of the cross bonding system.

KEYWORDS

Sheath current monitoring, induced currents, EMTP, preventive maintenance, inspections

INTRODUCTION

Every conductor carrying a load will introduce an electromagnetic field. Because of the mutual coupling effect, these fields will induce voltages into parallel conductors. These voltages will lead to circulating currents in these conductors (such as metallic sheaths and Earth Continuity Conductor (ECC) cables). In case of grounding at the two extremities (solid bonding) current are induced in the cable screen. For HV cable systems where Cross Bonding (CB) is applied these sheath currents:

- are independent from ground resistance and cable screen resistance;
- are balanced in the 3-phases. The total current flowing to ground is in theory zero. In real installations there will be a small unbalance due to the different length between phases;
- are relatively small (0,5 - 5% of I_{nom}) if minor sections are equal;
- increase proportionally with the unbalance of the HV cable system and the load of the cable system.

As a consequence for cables with CB, as soon as there is a fault in the outer sheath (contact of metallic screen with the earth), the induced voltage is affected and is therefore no more well balanced.

Hence, a modification of the induced cable screen current shall occur.

Elia has installed a sheath current monitoring system (SCMS) on two 150 kV cables in the September 2017-April 2019. Both cables are installed in parallel between the same substations and follow a similar route. The SCMS compares the theoretical calculated currents, in the metallic screens of the cables and ECC's, with the measured currents.

The goal is to verify if the SCMS can detect a sheath fault and verify the correct functionality of the cross bonding system of a HV cable system by measuring the induced sheath currents. Additionally, the two theoretical models based on formulas of [1], are compared with the measured currents.

Design of the sheath current monitoring

Every 150 kV cable connection consists three major sections. Each circuit has two ECC's. To monitor each major section, current transformers are installed at each section on all cable screens and ECC's. A data logger with 4G modem connects the current transformers to send the measurement data to a central server. In figure 1 an overview of the cabinet of the monitoring system is shown.

Fig. 1: Cabinet of monitoring system

At both sides at the substation, low voltage power was provided and the existing current transformers in the 150 kV GIS measure the conductor currents.

At the middle major section, no low voltage power was available. Therefore, a solar panel with battery pack was installed to power the monitoring system. A schematic overview of the monitoring system is shown in figure 2.