Chapter 12
Testing of Underground Power Cables

ABSTRACT

Probably 80% of all testing performed in electrical power systems is related to the verification of insulation quality. This chapter briefly describes the fundamental concepts of insulation testing including – insulation behavior, types of tests, and some test procedures. Most electrical equipment in utility, industrial, and commercial power systems uses either 50 or 60 Hz alternating current. Because of this, the use of an alternating current source to test insulation would appear to be the logical choice. However, as will be described a little later, insulation systems are extremely capacitive. For this and other reasons, DC has found a large niche in the technology. Before we can really evaluate the value of one system as opposed to the other (e.g. AC vs DC), let us examine how each type of voltage affects insulation. Testing of underground power cables are reported by NS161. (2014). IEC 6038. (1979). IEC Standard 60228. (1979). IEC60229. (2007). IEC60230. (1974). IEC60233. (1981). IEC 60332 (1974). IEC 6071 (2008). IEC 60270. (2000), IEC 60287. (2002).

12.1 TESTING BY AC AND DC

12.1.1 Insulation Current Flow (AC)

Insulation may be simply modeled as a capacitor in parallel with a resistor as shown in (Figure 1). The current flows that results will comprise two components: the capacitive current (Ic) and the resistive current (Ir). (Figure 2) shows the time domain graph of the two currents.

For good insulation Ic is higher than 100 times Ir and Ic is leading Ir by close to 90^{o}

For marginal insulation: Ic is higher than 50 times Ir and Ic is leading Ir by close to 80^{o}

Note that the currents discussed in this chapter are the insulation currents NOT load currents

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Figure 1. Insulation with an AC voltage applied

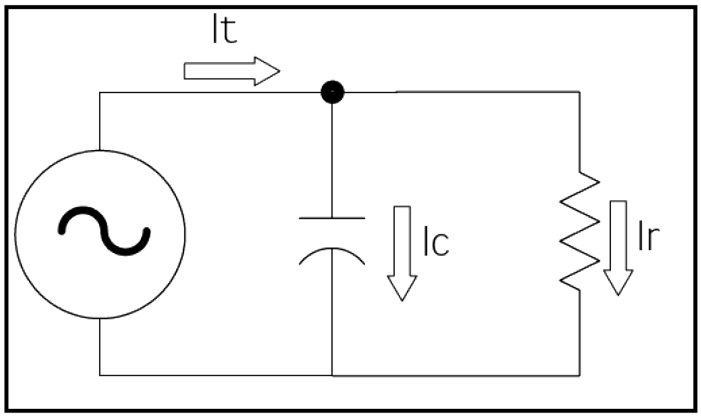
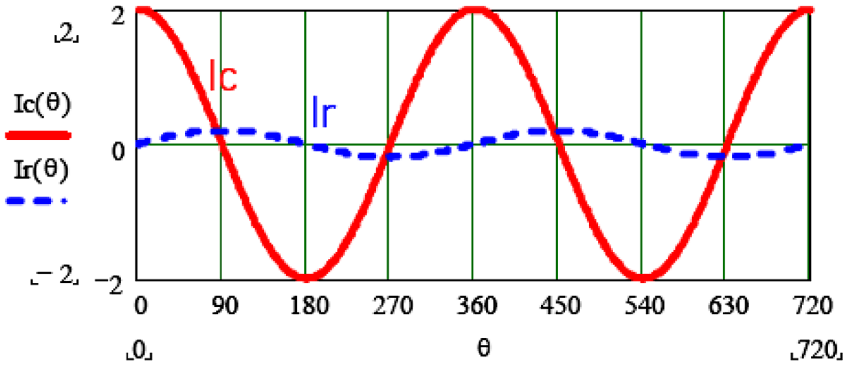


Figure 2. Insulation current with AC voltage applied



12.1.2 Insulation Current Flow (DC)

When DC current is involved, insulation may be modeled in a slightly different way. Consider (Figure 3). When switch S1 is closed, the DC supply is connected to the insulation system. In the DC model an extra capacitor has been added (dashed lines). The current that flows through this new capacitor is called the dielectric absorption current (Ida) (Figure 4) shows the time relationship for these three currents. The following paragraphs explain each of the three currents.

Capacitive Current (Ic)

The capacitive current charges the capacitance in the system. It normally stops flowing few seconds (at most) after the DC voltage is applied. The short burst of capacitive current flow may put a rather substantial stress on any test equipment that is applied to very large insulation systems such as cables or large rotating machine.