HV AC TESTING OF SUPER-LONG CABLES

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ABSTRACT

The AC high-voltage testing of super-long cables requires a test power of up to 100 MVA. The different possibilities for supplying this large test power are discussed. It is shown how the necessary feeding power and losses can be reduced by choosing a low, but physically meaningful test frequency. An optimum test circuit arrangement is discussed.

KEYWORDS

- high-voltage AC withstand test
- on-site tests on long cables
- high-voltage resonant test
- partial discharge test

REQUIRED TEST POWER

The growing length and transmission voltage of extruded XLPE-cables cause an increase in the requirements for the power of proper test systems (Fig. 1). The requirements of test voltage and frequency for on-site tests of complete cable test systems are defined in the IEC-Standard IEC 62067.

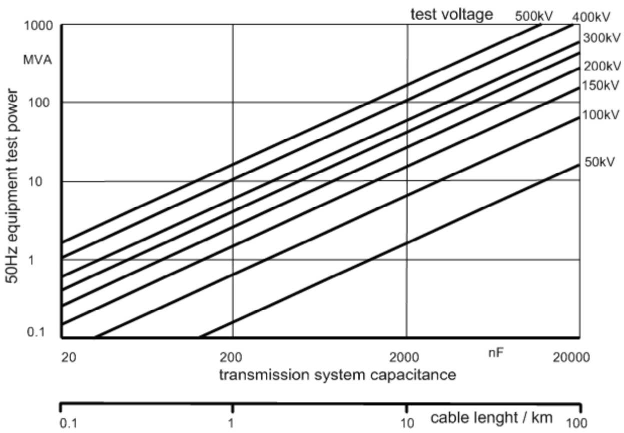

Figure 1: Required AC test power depending on cable capacitance and length respectively

The demand for reactive power is linearly dependent on the frequency when the test voltage is constant. If the test frequency is reduced from 50 Hz to 20 Hz then the demand for test power decreases to 40%. For this reason it is more suitable to substitute the classification “super-long” by the term “required test power”. The limit is drawn at a 50-Hz-equivalence-power (S_{50}) of about 35 MVA for a single test system [1].

Besides the testing of very long extruded cables for AC voltage supply networks, the AC voltage testing is also applied successfully for the testing of super-long extruded XLPE-cables for DC voltage. The HV AC testing allows a fast and easy recognition of failures inside the insulation [2]. These kinds of cables can be manufactured in one piece with lengths of up to 100 km and are used - for example - to connect off-shore oil platforms with the mainland.

SELECTION OF SUITED HV TEST SYSTEM

In general, there are three different solutions to provide the necessary AC test voltage off-line:

- compensated test transformer
- resonant circuit with variable inductance
- resonant circuit with variable frequency.

AC tests with systems based on compensated HV transformers and operated with power frequency are limited to a cable length of some 100 meters with respect to the very high apparent power.

Series resonant circuits are more suitable for the test of very long cables. Such a resonant circuit consists mainly of three parts: feeding source, inductance L (resonant reactor) and capacitance C (cable). While the high reactive power oscillates between inductance and capacitance of the HV circuit, the power source has to supply the losses (active power) only. Depending on the design of the test system components and the test object itself, these losses amount to typically 0.5 ... 2% of the test power. To operate at resonance the impedances of L and C have to be equal. This is given at a certain frequency f, the resonant frequency.

$$f = \frac{1}{2\pi \sqrt{L \cdot C}} \qquad [1]$$

This equation can be fulfilled in two ways:

- The product of L and C is adapted to a fixed frequency f (power frequency, 50 or 60 Hz). Because the capacitance C is determined by the test object, the inductance L has to be adjustable. This solution is an inductance-tuned resonant test system (ACRL).
- The frequency of the feeding source is adapted to the resonant frequency f, which is determined by the capacitance C and a resonant reactor with a fixed inductivity L. It is a frequency-tuned resonant test system (ACRF).