Towards optimum construction of HV AC cables

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ABSTRACT

Experimental measurements, in the laboratory and in the field, are of great importance to discover unknown aspects, verify the models and deliver new designs of cables. For this purpose, sample preparation is of fundamental importance to make a good characterization of the electric and thermal behaviour of the cables. Future armoring will have lower and lower losses and cable will have smaller resistance: so, the measurements need to be more accurate. In fact, the losses are measured as the difference of two separate measurements, with some temporal delay necessary to remove the armoring, possibly performed not at the ambient temperature and this increases the need for accuracy.

KEYWORDS

Sample preparation, HVAC cables, laboratory measurement, three-core cables, armoring.

INTRODUCTION

The design of HV large section three-core power cables, used for example in offshore wind farms, requires a precise knowledge of the intimate structure of the electro-magnetic behavior. Large current ratings are highly appreciated by investors, willing to save on installation and capitalization costs, so that always increasing dimensions of cables have been designed.

When testing mixed equilay-contralay cables, it is possible to prepare a perfectly balanced SZ sample, with equal lengths of each section, representative of a long cable. Pure equilay or contralay samples can also be selected and prepared, so that the researchers can perform the desired measurements: a brand-new sample is preferred.

DESIGN OF THE EXPERIMENT

The cable sample has to be prepared using a good strategy and experiment design. One of the simplest and most reliable way to characterize the cable is by using a straight sample, in isothermal conditions with laboratory ambient temperature: a long sample, when placed in the field, is subjected to daily and seasonal temperature fluctuations that can modify the electric characteristics. The sample length represents the biggest issue regarding measurement precision.

Difference in the losses measured between armored and non-armored cable were attributed in the past completely to the armoring, but it became successively clear that also the screen currents are influenced by the armoring.

SAMPLE SELECTION AND TRANSPORT

The sample is prepared for a three-phased test, in which the losses of the whole cable are measured contemporarily (three single phase measurements performed one after the other are not preferred, due to various imprecision introduced, e.g. in assembling and disassembling of the instrumentation).

Following Fig. 1 shows the arrival of the sample at the laboratory, fixed on a steel bar: the cable is placed on carriages and transferred into the electric laboratory. Very careful handling of the cable is mandatory to avoid external damages.

Fig. 1: Transferring of the sample on carriages

Sample selection

The best solution is to use a straight sample, so that the length can be measured with adequate reliability with a high precision class meter tape. Once the samples are in the laboratory, they are characterized for example by detecting the geometrical pitch of the power cores. The rotation is marked on the external surface with coloured tapes.

Fig. 2: Different samples from the same cable

Laboratory temperature must be very stable: the preferred condition is that the sample is isothermal with the laboratory temperature. To obtain this, the laboratory must maintain a constant temperature and the measuring current is applied for a short and controlled time interval; in this way, there is no need to measure the temperature of the single components of the cable, but ambient temperature is enough. Each part of the cable has its temperature that is uniform over the whole section of the component. Using