Improved procedures for development of polymeric insulation systems using high voltage laboratory designed for model cable testing

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ABSTRACT

This paper highlights the importance to have access to a versatile high voltage laboratory designed for testing MV sized model cables. It describes how model cables can be used in material development work as prototypes for AC and DC full-sized power cables. The flexibility of the laboratory makes it easy to adapt and switch between different tests, e.g. AC voltage breakdown test, lightning impulse test, 500 Hz wet ageing test as well as measurements of dissipation factor and DC leakage current. The paper further discusses more resource-effective ways of testing for decision-making and understanding scaling up effects.

KEYWORDS

Testing, HVDC, EHV, dissipation factor (tan δ), impulse breakdown, DC conductivity, medium voltage cable (MV)

INTRODUCTION

In the search for new improved materials for extruded power cables, comprehensive electrical and non-electrical testing from early development to final qualification is required following international standards and recommendations specified by for example IEC and CIGRE. This is done to ensure that the final cable insulation system in service will perform according to expectations, in terms of both technical performance and service life. The development route normally starts with small scale testing on tapes or plaques as illustrated in Fig. 1 , as only a limited quantity of material is commonly available. After small-scale testing, the next stage in the development chain is testing on model cables, which are usually MV (Medium Voltage) sized cables with a few millimetres (3-5.5 mm) insulation thickness. Compared to plaque or tape tests, model cables involve extrusion of insulation and semiconductive screens, thus encompassing the full so-called “insulation system”, possibly revealing properties not observed during the previous small-scale testing and giving test results that are closer to the final, full-scale application behaviour. This makes model cables one of the most important test objects to verify and evaluate electrical properties before selection of a material concept that is the best candidate for further evaluation in next steps, the testing of prototype and full-scale cable objects.

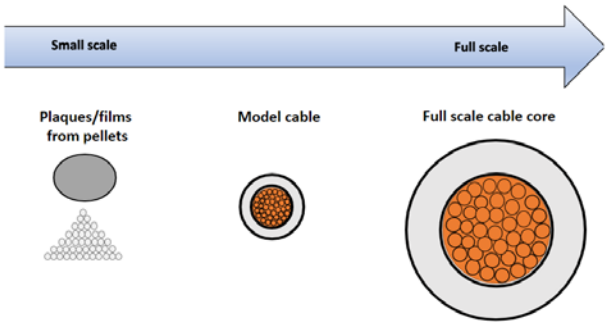

Fig. 1: The development route for new insulation systems starting from small-scale testing to model cable testing and finally full-scale cable testing

However, it is required to build up skills related to cable preparation and proper use of terminations for model cable testing at electric fields that are high above the rated cable design. For example, when performing AC breakdown testing on MV sized cables reaching several hundred kV, water terminations that are commercially available at these voltage levels are usually oversized in the diameter resulting in large resistive losses and a low quality factor when using series resonance sources.

This paper will present the design of a newly built high voltage test laboratory specialized on MV sized cable testing objects to cover cable material development from MV to EHV range including HVDC. This will be done by highlighting dissipation factor testing, high temperature lightning impulse testing and leakage current measurements. The laboratory is placed in immediate vicinity to material compounding and the model cable extrusion line, which makes the development route short and fast during material concept screening and testing.