IMPROVED UNDERSTANDING OF EXTRUDED MV CABLE PERFORMANCE THROUGH THE MODIFICATION OF EXISTING APPROVAL PROTOCOLS

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ABSTRACT

Cable users and manufacturers have an increasing wish to gain a deeper understanding of cable performance, beyond the knowledge that it simply complies with the minimum performance level defined within a standard. Although approval test protocols have served this purpose well, they do not provide the level of sophistication that is required for a detailed analysis. This paper describes many of the common shortfalls in current test protocols and advocates a number of simple modifications to procedures. These modifications will make approval test methods better able to address the more detailed discrimination being requested today.

KEYWORDS

TESTING, MEDIUM VOLTAGE, AGEING

INTRODUCTION

Cable users and cable manufacturers have derived significant benefit in system reliability from improved medium voltage (MV) cable quality. One of the important elements in this improvement has been the widespread use of recognised qualification tests such as those outlined in CENELEC HD605, ICEA S-94-649 and IEEE 1407 [1,2,3]. These tests generally have well defined ageing and evaluation procedures. The associated “success criteria”, such as those defined in CENELEC HD605 and ICEA S-94-649, serve to discriminate and assure that cable users can be certain of minimum levels of cable performance.

However, users are now wishing to understand more about the cables they use and they find that these essentially pass / fail tests do not fully satisfy this need. The criteria and methods in these tests are designed to show differences between proposed designs and those that have historically performed poorly rather than determine an absolute performance level [4]. Thus it is difficult to use these standard tests to address issues that were not within their original scope. This paper describes a number of test programmes that extended, or upgraded, the “normal” protocols to derive a better understanding of cable performance.

The test programmes described include:
a) a five year study of the endurance performance of complete cable designs conducted in large tanks
b) an evaluation of cables of different voltage classes
c) an evaluation of cables after ageing in long tubes for twice the normal period.

These projects have highlighted a number of interesting points which are discussed in greater detail within the paper. Most of the comments reported here are directed toward tests which involve ageing over time followed by a final breakdown assessment.

ACHIEVING A ‘TRUE’ CABLE BREAKDOWN

Early cable systems tended to have low breakdown strengths [4], especially after aging. Thus it was relatively straightforward to achieve true cable breakdowns (punctures of the dielectric within the active length – central portion of Figure 1) and produce a dataset essentially free of termination failure and flashovers. However, improvements in the quality of cable has led to an increase in dielectric strength. This leads to the increased likelihood of test termination failures and flashovers (Figure 2). In addition, some HV test sets now have insufficient voltage to cause failure. These features are commonly referred to as “censored data” or “suspensions” [5 - 8]; which can most conveniently be thought of as failures that have occurred but not by the mechanism under study. The increasing proportion of these censored data reduces the number of valid data points available for analysis. The larger the number of true failures, the clearer and more significant the test conclusions will be.

Figure 1 MV cables undergoing ac breakdown testing after long term wet ageing

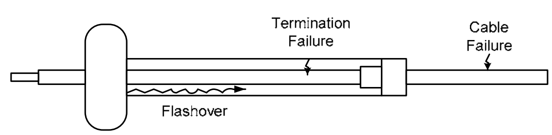

Figure 2 Types of test results – schematic showing the types of failures under test