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Behavior and diagnostic techniques of initial defects on XLPE insulated cable systems

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Résumé

Nous avons formé un comité de spécialistes qui sont concerés de compagnies d'électricité, d'universités, d'organismes d'études, de fabricants de câbles. On a compilé les connaissances concernant les défections et les techniques de diagnostic de l'isolement des câbles isolés an polyéthylène réticulé (PR) de plus de 22 kV, et avons étudié le nombre des installations à câbles PR au Japon, l'état réel des ruptures d'isolant, l'état des diagnostics et les documents concernés [1].

Parmi ces études, cette thèse se centre principalement sur les défections (initiales) à craindre lors du montage des raccords d'extrémité et des raccords intermédiaires et sur leur diagnostic.

Abstract

We set out to collect knowledge on defect behavior in 22kV and above XLPE insulated cables and associated diagnostic techniques. To this end, we first organized an experts committee made up of delegates from power companies, universities, research institutions, and cable manufacturers. Then, based on this committee, we surveyed and studied the installed capacity of XLPE cables in Japan, the current state of breakdowns and diagnostic techniques, and related literature [1].

As part of this study, this paper reports on the behavior of defects and diagnostic techniques focusing on defects (initial defects) that are feared to occur during the construction of terminals and joints.

1. Introduction

The installed amount of 22kV and above XLPE cables in Japan has been increasing dramatically since the 1970's, reaching about 14,700km in 1995. This amount is equivalent to 69% of the installed amount of 22kV and above power cables. At present, XLPE cables are used for almost all power cables up to 66kv/77kv type or less. Their use for 110kV and above power cables has also been increasing in recent years.

In particular, XLPE cables began to be used for 275kV long-distance underground transmission lines in 1989, and they are now being used to construct 500kV long-distance underground transmission lines. These accomplishments can be attributed to improvements in manufacturing and quality control in the factory and to those in process control. The latter has helped to eliminate harmful initial defects (outer damage, semi-conductive layer protrusions, contaminants, voids, gaps, etc.)[2] that tend to occur when jointing cables on site.

The following describes the results of our survey on insulation breakdown in actual cable lines in Japan, the behavior of partial discharge(PD) from harmful initial defects under applied voltage, and techniques for detecting initial defects as used in Japan.

2. Breakdown in Actual Cable Lines and its Cause

A survey and analysis was conducted on breakdowns occurring in 22kV and above XLPE cable lines up to 1995 in Japan. It was found that water trees in the cable were the most common cause for 22kV/33kV cables, and defects in joints were the most common cause for 66kV and above cables.

The failure rate of 66kV and above actual cable lines is shown in Table 1. On this table, the failure rate of 110kV and above cables results from one failure that occurred in a 275kV EMJ-type joint in 1991. The origin of this failure was intrusion of fibrous contaminants during on-site insulation extrusion.

The analysis results of failure factors in 66kV/77kV cables are listed in Table 2.

Table 1. The failure rate of actual XLPE cable lines up to 1995[1]

Nominal Voltage (kV)	Cable (Number/km/year)	Joint (Number/100Joints /year)	terminal (Number/100terminals /year)
66kV/77kV	0.043	0.0032	0.0049
110kV≦	0	0.0045	0

Table 2. Failure factors of actual 66kV/77kV XLPE cable lines[1]

(Total:79)