

**B10.2****New grading material for terminations and joints**

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Abstract:

Today's technology for terminations and joints is grading by means of a capacitive electrode, the so called deflector. Recent developments try to avoid the deflector setup by using a grading material of high resistivity.

This paper describes the development steps and the actual status of research and development of a new material, which avoids both of the above described methods, by using a refractive (capacitive) grading. The grading is achieved by the use of a material of high permittivity ($\epsilon_r \gg 10$), which is still under development. The final aim is to produce a material, having a field strength dependent permittivity, to achieve a linear voltage distribution over an insulating surface.

Résumé :

A ce jour la majorité des extrémités et des jonctions comportent une électrode capacitive, nommée déflecteur, chargée de réaliser un gradient de tension. De récents développements tentent de remplacer la mise en place d'un déflecteur gradient par l'utilisation de matériaux à très haute résistivité.

Cette publication décrit les étapes du développement ainsi que l'état actuel des recherches et des études concernant un nouveau matériau permettant de passer des deux méthodes décrites ci-dessus, par l'emploi d'un gradient réfringent (capacitif).

Le gradient est réalisé à l'aide d'une matière de haute permittivité ($\epsilon_r \gg 10$) actuellement en cours de développement. L'objectif étant de produire un matériau dont la permittivité dépend de l'intensité du champ électrique afin d'obtenir une distribution linéaire de la tension sur la surface considérée.

1. Introduction

There are different methods known for field grading on high voltage apparatus. They can be divided generally in resistive [1,2] and refractive [3,4] methods. This paper will concentrate on refractive (or also called capacitive) grading methods. For these methods several applications are well introduced in different designs, such as conductive layers for oil immersed paper insulation on bushings or conductive electrodes (deflector) on terminations and joints. As shown very detailed in [4] the technical realization needs a lot of effort for successful and reliable operation. Therefore simplification in design and manufacturing would be of great advantage.

Even when the technical application is very different, the working principle remains the same, to introduce one or more capacitances between the high voltage and ground electrodes. One of the later attempts for a technical solution is the use of material with a comparable high permittivity to achieve this capacitive grading performance [5]. The idea is the use of a material having a comparable high permittivity and, if possible, the permittivity is depending in a certain way on the field strength

applied to the insulation material, which would cause then a self grading effect on the insulation.

2. Theoretical basis of refractive field grading

As an insulation material having a high permittivity, which also might be dependent on the field strength applied, is not industrially available on the market, the attempt is to design such a material. However in order to get an idea what values of permittivity and what kind of field strength dependency is required some basic investigations had to be done: Fig. 1 shows a simplified analytical model of a termination. To get an idea about the needed permittivity ϵ_2 in the termination material, a simple model is established. Calculations to achieve a linear voltage distribution are performed.