A USER-FRIENDLY TOOL FOR SIMULATING THE TIME-DEPENDENT FIELD DISTRIBUTION IN PE INSULATION ON THE BASIS OF A PHYSICAL APPROACH

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ABSTRACT

A bipolar model of transport intended to describe the behavior of polyethylene under DC stress has been recently developed. Though the model has not been pushed yet to the stage of using it routinely, it did lead to progress in the understanding of dielectric physics in the sense that various hypotheses for explaining a given experimental observation can be evaluated.The purpose of this communication is to give the general features of the model and to introduce the graphic interface allowing simulation in polyethylene plaques. Simulation has been developed with the purpose of giving outputs directly comparable with experimental data. The latter can be external current measurements or internal space charge distribution as obtained using the Pulsed Electro Acoustic technique. A demonstration of the software will be done at the conference. A comparison between simulation and experimental results is discussed in a companion paper.

KEYWORDS

Field distribution - Space charge - Graphic Interface - 1D modelling

INTRODUCTION

In recent years, a number of numerical models have been developed with the aim to reproduce the space charge behavior in organic insulators, mainly polyethylene, under DC or AC stress [1-5]. Among the driving forces for the development of these models we can name: the trends towards more compact systems in power engineering, leading to an increase in the power density - the trends towards higher reliability of electrical systems, due to their use in critical applications - the development of new materials for electrical application with tailored properties. Moreover, the increasing demand in solutions for predicting materials behaviour under stress is to be addressed on one hand with a better understanding of physical mechanisms underlying such behaviour, and on the other with disposable tools for modelling what such mechanisms imply as macroscopic properties and to confront such predictions with the actual behaviour of materials in systems. These general principles are tackled here with regard to internal field distortions due to charge generation and accumulation into polyethylene-based insulated high voltage DC cables submitted to thermoelectric stress. State of the art numeric techniques have been applied to resolve the transport equations in non stationary conditions, providing a prevision of the macroscopic behaviour in a reasonable computing time for DC stress conditions.
In this communication, we present the physical model and the software that has been developed for that purpose [6]. In the first part, we briefly present the general features of the physical model included in the software core coded in Fortran language. In the second part, we describe the graphic interface which has been developed under Java environment. This language has underlying advantages resorting to the open nature of the source (no issues with licence agreement) and to the large portability over different operating systems, requiring only recompilation under non-Windows OS. This would permit a large diffusion of such tool in a near future.

PHYSICAL MODEL

Figure 1 shows a schematic representation of system used for the simulations. The type of model is bi-polar, and features injection of electronic charges at both electrodes, charge trapping in traps distributed exponentially in trap depth, and hopping transport. For sake of simplification, recombination of charges and internal generation are not taken into account [5].

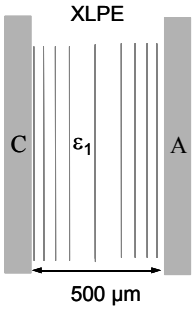

Figure 1: schematic representation of the one-dimensional system used for the simulation.

Trap distribution: The chemical structure of the material is taken into account by considering an exponential distribution of trap levels (Figure 2), i.e. a large amount of shallow traps corresponding to physical defects, and a smaller amount of deep traps corresponding to impurities. This exponential distribution of traps has a maximum limit in trap depth, and is of the form:

$$N_{t(e,h)} = N'_{(e,h)} \exp\left(\frac{-\Delta_{e,h}}{k_B T_{0(e,h)}}\right) \qquad \Delta_{e,h} \le \Delta_{max(e,h)} \qquad (1)$$

where $N_{t(e,h)}$ is the trap density distribution, for electrons and