simulation of propagating streamers branches in the dielectric liquids

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Abstract

This paper is devoted to the study of the generation and propagation modeling multichannel streamer in a dielectric liquid subjected to an electric field diverge. With Matlab-simulink our model is proposed in this work in order to study the initiation and propagation of streamer in insulating liquids .The model suggested (geometry or system point-plan) allow us to model the generation and the propagation of the streamers which are near the infected zone. By 2D simulation we achieved typical tree structures of discharge made up of streamers and which are in fact small cylindrical channels of 10 µm of ray in the dielectric liquids in geometry point-plan (distance inter electrode 20 mm).The obtained filamentary structures allow us to identify a number of parameters such as stopping length, injected currents and charges, electric field, propagation velocity and mobility of charge that can be used to characterize streamer phenomenon.

Keywords: Discharge, propagation streamers, insulating liquid, system point-plan, simulation, dielectric liquid, Electrical circuit, field, mobility.

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1. Introduction

This work is intended for the design of a simulation model of the dynamics of branched (multichannel) streamers in liquid dielectrics subjected to a divergent electric field (geometric point-plane system) namely the generation and the advancement of trees (**Figure 1**) near the area of asperities in order to determine the currents, voltages, the charges injected into the dielectric medium and the electric potential at the head of the streamer.

Figure 1: Generation of trees (streamers) Hexachlorobiphenyl in tip-plane geometry [1]

To overcome the complexities presented by the electrical circuit associated with branched streamers, we adopt the installation and network analysis. This model is essentially based on measurements of network current and voltage intensities in order to simulate the propagation of multichannel streamers using Matlab-Simulink software. Taking into account that the studies carried out previously have relied on the vaporization energy of the liquid insulation (local heating) as a propagation criterion and on that of the electric field at the head of the streamers. We will show that this model allows us to deduce the load, the energy, the power injected, locally the value of the electric field, the speed of propagation and the mobility of the charge carriers, We will compare our results with those obtained experimentally by other researchers. These measures require the use of Faraday cages and various shielding and protection systems. The entire environment can be strongly parasitized by the electromagnetic disturbances generated by pre-breakdown and breakdown phenomena.

Lightning surges or switching overvoltages are performed with Marx generators (from a few tens of kilovolts to more than 2 MV). Pulse generators, more specifically intended for research, make it possible to realize very short rise time voltage steps (a few nanoseconds) producing very stable levels. Various devices are described or referenced in the general works on the breakdown and others, more recent, in [2] [3].

Recently, some measurements of pre-disruptive currents and pulsed, alternating and continuous voltage charge quantities have been performed. These measurements are particularly difficult because these currents comprise both very intense peaks of extremely short duration superimposed on a very small DC component. The use in point-plane geometry of a screen around the tip [2], and then of a differential measurement system between two points provided with a shield [4], made it possible to accurately measure the currents during the propagation and generation of streamers under voltage niche.

2. Elements of the electric circuit of the streamers

From the various studies reported in the review of literature [5, 6], the streamers consist of a set of more or less cylindrical conductive channels (of conductivity σ, of length 1 and of radius r 0). Resistances R is calculated in the following way: