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# Monte Carlo simulation of corona discharge in $SF_6$

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ABSTRACT

Sulphur hexafluoride ($SF_6$) is one of the most widely used gaseous dielectrics for electric power systems and a number of high-voltage applications. There are many industrial applications where the electric corona discharge is used. In most cases the corona discharge is an inherently dynamic process; all parameters vary in time. Monte Carlo simulation of corona discharges in gas offers several advantages to study fundamental processes. Furthermore, it gives a fair qualitative description of the corona discharge itself as a function of space and time. This paper describes the development of negative coronas in $SF_6$ in a point–plane gap. Detailed structure of avalanches is presented, the total field distribution, propagation of successive avalanches and ion distribution are studied.



## 1. Introduction

With the ever increasing need for electrical energy, high-voltage power transmission lines are constructed. Corona phenomenon is one of the problems associated with high-voltage lines. The corona discharge is important in practical high-voltage insulation systems because it can lead to deterioration of the insulating qualities of the gas as well as to production of toxic or corrosive by-products. Besides generation, transmission and distribution of electrical energy, high voltages are also extensively used for many industrial, scientific and engineering applications. High-voltage equipment is the backbone of modern power systems. In all such applications, the insulation of the high-voltage conductor is of primary importance. Sulphur hexafluoride ($SF_6$) is the preferred gaseous dielectric employed by the electric power industry for gas insulated equipment used in the transmission and the distribution of electrical energy. Due to its strong capability of attaching electrons, $SF_6$ gas is characterized by the superior electrical insulation performance. $SF_6$ has excellent dielectric strength and arc-quenching properties. Therefore, $SF_6$ is widely used for high-voltage insulation in electric power equipment such as gas insulated switchgears, gas circuit breaker, gas insulated transmission lines and gas insulated transformers. $SF_6$ has gained wide acceptance as the dielectric for a number of high-voltage applications. Since it has an excellent insulating property, $SF_6$ gas has contributed considerably to advances in miniaturization.

Safe transmission and distribution of electrical power is partly determined by the reliability of the electrical insulation system of the power lines and substations [1–4]. It is well known that the insulation performance of gas is limited, not by its uniform field dielectric strength, but by the effects of local field enhancement and in most typical industrial applications non-uniform field breakdown predominates. By applying a detailed knowledge of the fundamental discharge processes that occur prior to the disruptive discharge, one can predict the behaviour of high-voltage insulator systems in operation under all possible conditions. Both in industrial and in environmental settings, corona-based technologies have been used to treat a variety of liquid and gaseous process effluents. Electrostatic precipitators are employed in electric power plants and many industries such as cement production, chemical processing and domestic air cleaning [5,6].

Owing to its good insulating and heat transfer properties, sulphur hexafluoride ($SF_6$) is, besides air, the preferred gaseous dielectric employed by the electric power industry for gas insulated equipment used in the transmission and the distribution of electrical energy. $SF_6$ is an electron-attaching gas widely used as a gaseous insulator in high-voltage systems, these properties allow a reduction in size and enhance the reliability of high-voltage equipment, and so electrical breakdown in $SF_6$ is of interest both to gas discharge physicists and to power engineers. However, despite its advantages, the dielectric strength of $SF_6$ is very sensitive to locally high electric fields. With the increasing importance of $SF_6$ as an insulating medium, it is important to understand the mechanism of corona discharge [4,7,8].

The transient character and the small dimensions make some discharges parameters, like charged particles densities or electric

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