Corona Effect Prediction Methodologies For Grounded Sphere-sphere Configurations

Agurtzane Etxegarai[1], Manuel de la Hoz[1], Ane Miren Larrea[1], Javier Mazón[1]

[1]University of the Basque Country UPV/EHU

Abstract

In the manufacturing of high voltage electrical equipment, an important step to guarantee a right dielectric design can be carried out through the prediction of a possible occurrence of the corona effect or, in the worst case, of dielectric breakdown, preferably in early stages. For this purpose, several prediction criteria have been used throughout history to verify when such phenomena occur [1].
In COMSOL Multiphysics, a new calculation option has been added within the Plasma Module that allows predicting the discharge conditions considering the electric field due to the configuration. On COMSOL Application Gallery, the Application ID 74081 includes the implementation of that feature for a grounded sphere-sphere configuration. This configuration is characterised by the fact that the electric field values have a slightly non-uniform distribution throughout space. Such configuration was already numerically verified by Pedersen [2], but applying a semi-empirical criterion different from that implemented in COMSOL to predict the discharge conditions. Later, Warne et al. established in [3] other conditions due to the electric field non-uniformity, in addition to the conditions that support the criteria implemented in the Plasma Module, which are derived from research carried out by the same author [4].
The present paper aims to compare the results obtained with the updated Plasma Module against Pedersen criterion. Additionally, we want to check the impact of the modification of the global and local curvature on the prediction of corona effect on the grounded sphere-sphere configuration, as well as to introduce the application of these criteria on a ellipsoid configuration. The results of such simulations show that the K coefficient resulting from the integration of the ionization coefficient, α, by the number density N, is not the same either in the criteria or in each of the configurations under study. In this way, we can establish the difference between both criteria (Pedersen and the one established by COMSOL) and its dependence on the curvature, which is related to the non-uniformity of the electric field. Thus, we will be also able to conclude which of the criteria is the most conservative in its prediction.

[1] J. P. Donohoe, "A Comparison of Air Breakdown Criteria for Slightly Divergent Fields," in Proceedings IEEE SOUTHEASTCON '97. "Engineering the New Century," 1997, pp. 118-120.
[2] A. Pedersen, "Calculation of Spark Breakdown or Corona Starting Voltages in Nonuniform Fields," IEEE Trans. Power Appar. Syst., vol. PAS-86, no. 2, pp. 200-206, 1967.
[3] L. K. Warne, R. E. Jorgenson, and E. E. Kunhardt, "Criterion for spark-breakdown in non-uniform fields," J. Appl. Phys., vol. 115, no. 14, p. 143303, 2014.
[4] L. K. Warne, R. E. Jorgenson, and S. D. Nicolaysen, "Ionization Coefficient Approach to Modeling Breakdown in Nonuniform Geometries," Albuquerque, USA, 2003.

Figures used in the abstract

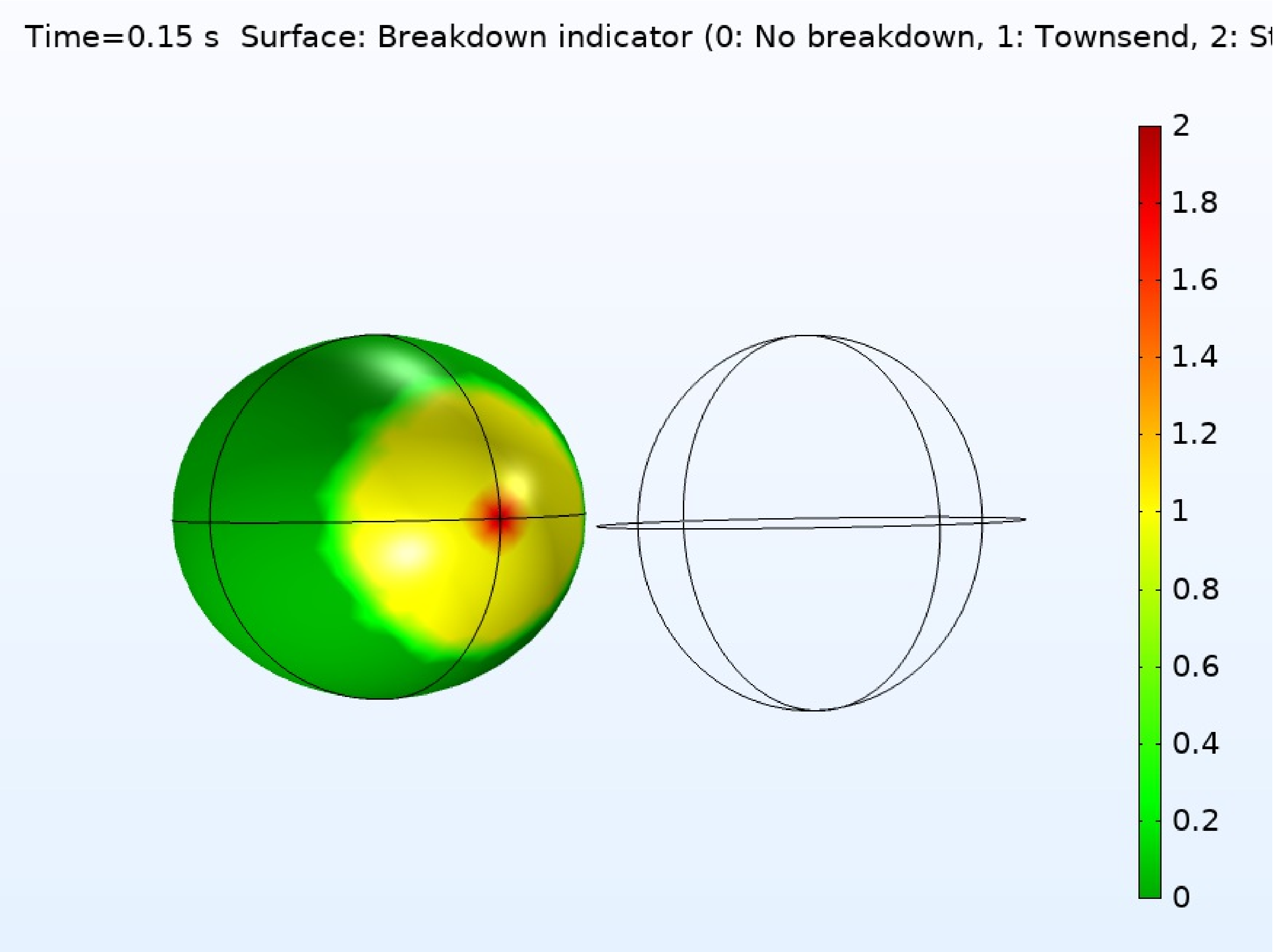

Figure 1 : EBDI applied on ellipsoid with a=1.7 cm and d=2.5 cm at Vapp=-49.8 kV