Threshold Measurements of Discharges from Floating Metal Particles in a Homogeneous Electric Field in Air

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Threshold values of homogeneous electric field strength for discharge from metal particles of different forms and sizes in atmospheric air were measured. Threshold electric field value increases with reduction of particles sizes. The influence of particles form variations on the threshold electric field value diminishes with variations size decreasing. Particle of any form with size less than 0.5 mm does not cause discharge process in normal atmosphere at under-breakdown homogeneous electric field.

Gas discharge initiated by conductive particles in external electric field takes place in many natural and technological processes. Many experimental, theoretical and computational investigations [1-10] concerns with determination of threshold electric field value for corona onset from hydrometeors of different types, especially water drops, subjected to DC electric field. As it was shown in these and others works corona from water drop in air at normal atmospheric pressure is preceded by electrostatic instability of drop surface significantly distorting its form. Thus the dependence of corona proper threshold on form and size of a conductive particle remains unclear. *K.Asano, et al.* [11] had investigated bipolar corona discharge from filamentary metal particle. Only one form parameter, particle length, was variable in this experiment and the range of variation (4 – 10 mm) was not wide. Therefore it is impossible to generalize the results of this work to full range of particles forms and sizes.

The aim of the work reported was to measure threshold electric field value for discharge onset (that may be bipolar corona or streamer breakdown) from conductive particles of different forms and sizes and to analyze possible influence of conductive floating particles to electric strength of air.

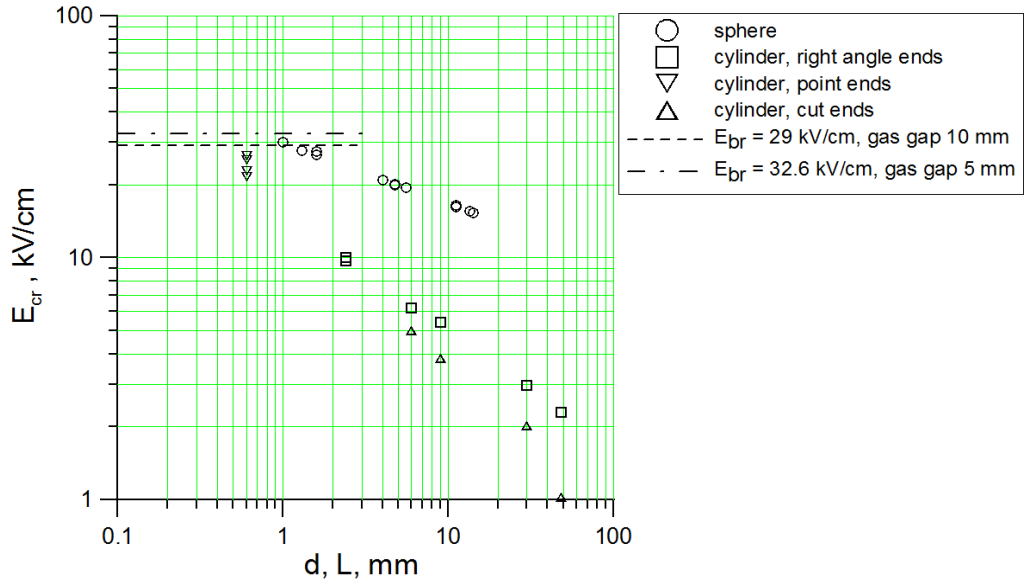

Figure: The dependence of discharge onset threshold electric field value E_{cr} on sphere diameter d and cylinder length L. The relation of L to cylinder diameter equals 30.

To reveal the dependence of threshold field value on particle size we have fulfilled experiments with sets of metal particles of one form but different sizes. There were spheres and two sets of cylinders (pieces of wires) with relation of length to diameter equaled 30. The sets of cylinders differed by ends form. The ends of cylinders of one set were cut to form a right angle, and ends of cylinders of another set were sharpened to form cone with angle 45^0. The experiments were performed in atmospheric air.

A bipolar corona discharge from the ends of cylinders started if electric field attained threshold value. Corona discharge stage was absent in the case of spheres, electric field reaching threshold value followed by streamer breakdown of gas gap. The results of the threshold electric field measurements are shown on the Figure. Threshold field values for all particles increase with reduction of particles sizes and at some critical sizes become equal to the hollow gas gap breakdown field. Particles of sizes less than critical one do not influence on discharge process in a gas gap. Since the gas gap breakdown electric field value depends on the gas gap length the particle critical size changes with the distance between electrodes. As it can be seen on Figure the critical size for spheres in a gas gap of 5 mm length is equal ~0.7 mm and for cylinders with relation of length to diameter equaled 30 in a gas gap of 10 mm length it is ~0.5 mm. Threshold for discharge onset from a cylinder with point edges is lower than from a cylinder of the same size with right angle edges but the difference diminishes with cylinders size reduction and becomes undetectable at cylinders length less than 2 mm (diameter less than 0.1 mm). Also threshold electric field value does not depend on diameter of cylinder if it is less than 0.1 mm. So threshold electric field value for metal cylinders with relation of length to diameter equaled 30 should be close to minimal threshold value among particles of all forms but with main size less than 3 mm.

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