PULSE PROPERTIES OF NEGATIVE CORONA DISCHARGE *

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Experimental investigation of VA characteristics of unipolar corona discharge and current pulsation in unipolar corona discharge is presented in this contribution. Experiments for negative corona discharge for the applied voltage from onset votlage to 10 kV and for single-needle and multi-needle configuration were performed. In the air at atmospheric pressure current pulses have a very fast rise time of order 1.4–1.5 ns and short duration. Amplitude and interval of these pulses are not generally constant and depend on many variables. Repetition rate and amplitude of pulses fluctuate in time. Dependence of behavior of corona pulses on gap lengths, applied voltage and number of electrodes (in multiple point mode) was investigated.

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1 Introduction

Experimental investigation of current pulsation in unipolar corona discharge is presented in this contribution. Experiments for negative polarity of the corona discharge for the applied voltage from 3 to 10 kV and for single-needle and multi-needle configuration were performed. In the apparatus were used metallic needles. VA characteristics showing the shielding effect in multi-needle configuration and dependencies of amplitude of pulses on supply voltage and plane electrode distance for negative single- and multi-point corona are presented in this article.

Current corresponding to a negative point-to-plane corona discharge consists of a train of very short pulses. Current pulses in the air at atmospheric pressure have a very fast rise time of order 1.4–1.5 ns and short length with a relatively long period between the pulses. Amplitudes and periods of pulses are not in fact constant and depend on many variables. Periods and amplitudes of pulses fluctuate in time. Since these fluctuations are subject to certain probability distribution, for the analysis of pulse fluctuations the statistical processing was used.

Negative corona discharges in the air burning in the regime of Trichel pulses [1] find widespread applications in applied electrostatics for precipitation, electrophotography, etc. A lot of remarkable work has been performed in this field [2]. The pulses often exhibit a complex waveform with a step on the leading edge and a current plateau or hump following the pulse peak [3]. Although a lot of work has been done on the subject, the basic physical description of Trichel pulses is far from complete and needs further theoretical and experimental investigation.

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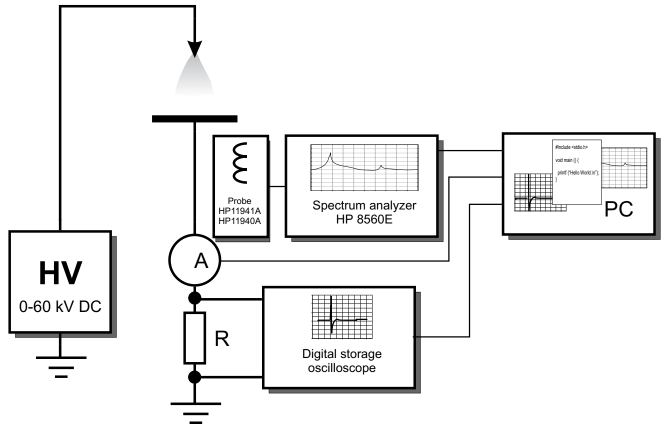

Fig. 1. Experimental set-up.

2 Experimental set-up

Schematic diagram of the experimental set-up is shown on Fig. 1. The single-point-or multi-point-to-plane electrode system is used. Pulses of corona discharge current were measured through the voltage across a serial resistor R in series with grounded electrode. The pulse shapes, amplitude and distance between pulses were registered by a storage scope and transferred into computer. In the computer were records statistically evaluated and measured dependencies were plotted.

3 Experimental results

Required size of treated area in technological operations is bigger than is possible reach with point-to-plain configuration. In such situation the multi-point-to-plain configuration can be applied. The total current is increasing, but the current normalised to one needle is decreasing in comparison with one needle configuration. It can lower efficiency of technological operation. This situation is caused by deformation of electric field by neighbouring needles. Examples of VA-characteristics for multi-needle configuration are shown on figures 2 and 3.

For evaluation of dependecies of period and amplitude on supply voltage and distance of plain electrode hundreds of records were processed. Results of the dependecies of period can be found in [4]. Results of dependencies of amplitude are presented below.

The relation between amplitude of pulses and the distance of plain electrode for single-point-to-plane configuration show figures 4 and 5. Applied voltages were 6 kV and 10 kV. Measured changes are smaller than uncertainty of measurement and measured points are scattered in wide range.

Examples of Trichel pulses amplitude dependencies on supply voltage are shown on figures 6 and 7 for single-point-to-plane configuration.

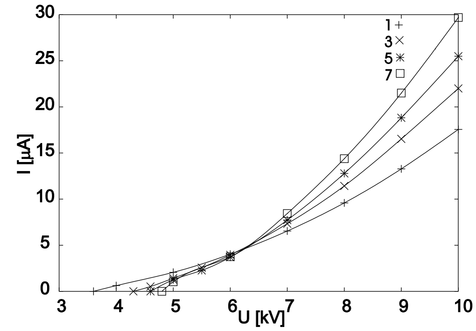

Fig. 2. VA characteristics for various multi-needle configurations. Number of needles: 1, 3, 5 and 7. Interelectrode distance 2.5 mm. Distance of plane electrode 12 mm. Radius of tip 50 μm.

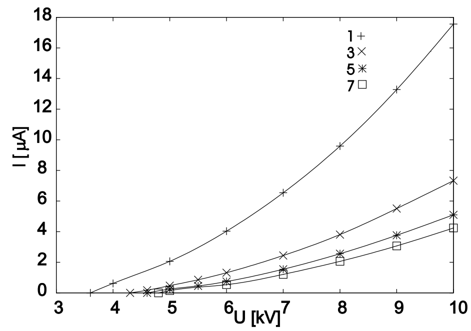

Fig. 3. VA characteristics for various multi-needle configurarions. Normalised current to one needle. Number of needles: 1, 3, 5 and 7. Interelectrode distance 2.5 mm. Distance of plane electrode 12 mm. Radius of tip 50 μm.

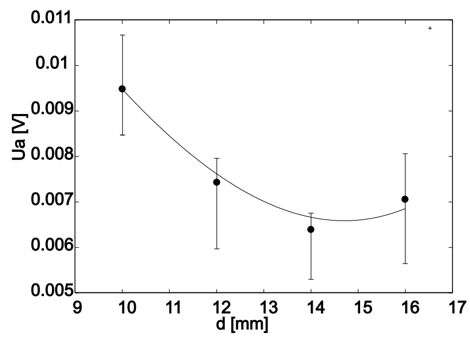

Fig. 4. Dependence of amplitude of pulses on distance of plate electrode for 6 kV. Radius of tip 50 μm.

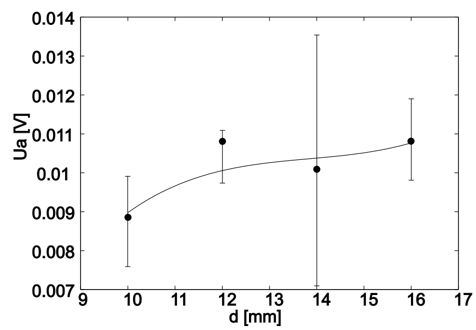

Fig. 5. Dependence of amlitude of pulses on distance of plate electrode for 10 kV. Radius of tip 50 μm.

Dependencies of amplitude of Trichel pulses on supply voltage and distance of plane elecetrode for multi-point-to-plane configuration are shown on Fig. 8 and 9.

For dependence of amplitude of pulses on supply voltage and gap size has been found, that changes of amplitude are smaller than uncertainty of measurement. Amplitude of Trichel pulses probably does not dependent on applied voltage and gap size.

Amplitudes of pulses are scattered around the average value. Example of distribution of amplitude is on fig. 10.

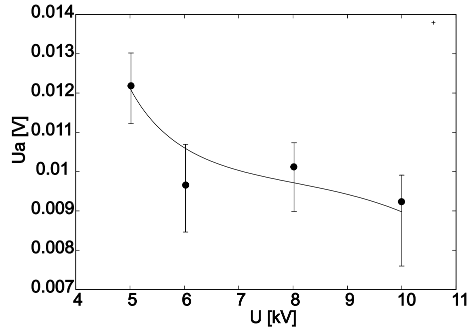

Fig. 6. Dependence of amplitude of pulses on supply voltage. Distance of plate electrode 10 mm. Radius of tip 50 μm.

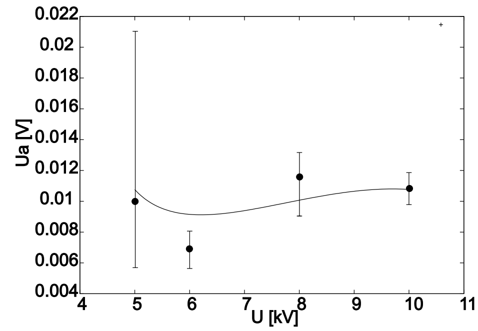

Fig. 7. Dependence of amplitude of pulse on supply voltage. Distance of plate electrode 16 mm. Radius of tip 50 μm.

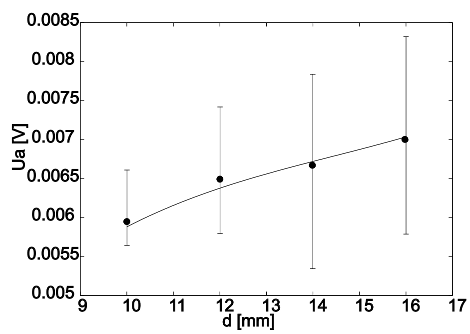

Fig. 8. Dependence of amplitude of pulses on distance of plate electrode for multi-needle. Supply voltage 6 kV.

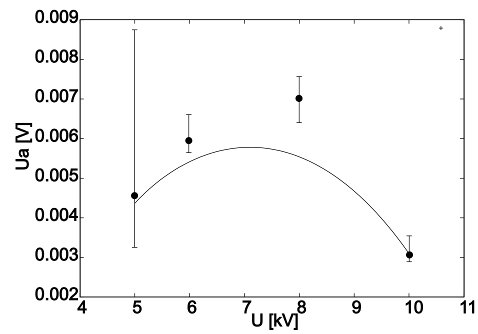

Fig. 9. Dependence of amplitude of pulses on supply voltage. Distance of plate lectrode 10 mm.

4 Conclusion

Evaluations of dependencies of amplitude of Trichel pulses on applied voltage and size of gap between point and plane electrode were performed for single-needle and multi-needle configurations.

Amplitude of pulses fluctuate in time. Since these fluctuations are subject to certain probability distribution, for the analysis of pulse fluctuations the statistical processing was used.

The amplitude is probably independent on applied voltage and gap size in used ranges of variables.

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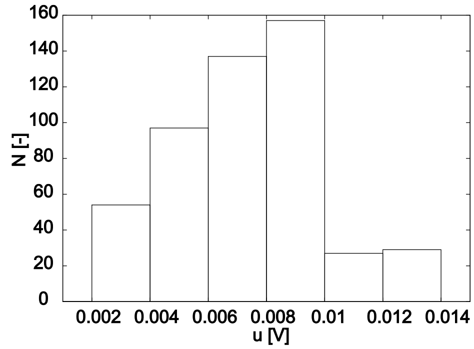

Fig. 10. Histogram of amplitude of corona discharge cureent for discharge burning on seven steel needles with interelectrode distance 2.5 mm a distance of plate electrode 10 mm. Voltage 10 kV.

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