ELECTRICAL FIELD STRENGTH ON THE POSITIVE CORONA ELECTRODE WITH THE COUNTERFLOW OF NEGATIVE IONS

N. Bogdanova, B. Pevchev, V. Popkov

To cite this version:
N. Bogdanova, B. Pevchev, V. Popkov. ELECTRICAL FIELD STRENGTH ON THE POSITIVE CORONA ELECTRODE WITH THE COUNTERFLOW OF NEGATIVE IONS. Journal de Physique Colloques, 1979, 40 (C7), pp.C7-361-C7-362. <10.1051/jphyscol:19797178>. <jpa-00219155>

HAL Id: jpa-00219155
https://hal.archives-ouvertes.fr/jpa-00219155
Submitted on 1 Jan 1979

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
ELECTRICAL FIELD STRENGTH ON THE POSITIVE CORONA ELECTRODE WITH THE COUNTERFLOW OF NEGATIVE IONS

N.B. Bogdanova, B.G. Pevchev and V.I. Popkov.

Krazhjanovskiy Power Institute, Moscow U.S.S.R.

Introduction. To calculate the corona electrode systems including corona losses in power transmission lines, one should know the electric field strength $E_c$ on electrode surface under corona. Recently this most important characteristic was measured directly by English as well as Soviet scientists /1,2,3,4/. It's clear from Soviet works /3,4/, that $E_c$ remains constant, i.e. doesn't depend on applied voltage. In case of unipolar d.c. corona, the electric field strength $E_c$ on the electrode under corona is equal to the onset strength $E_o$.

Various aspects of negative ion influence on discharge processes in air including corona were discussed in scientific literature for a long period of time. Possibility of such influence takes place for d.c. bipolar corona, for d.c. unipolar corona on positive electrode with negative ion injection into the gap from external ion source and also for a.c. corona when negative ions, created in the negative half cycle, return to the electrode at the next positive half cycle.

Measurements of electrical field strength on the positive corona electrode, in case of counterflow of negative ions carried out in the given work, were used to determine the character of influence of negative ions on corona discharge, to estimate the possibility of negative ion detachment and subsequent development of electron avalanches, and electrical field strength necessary for the detachment.

Measurement procedure. The measurements on d.c. and a.c. (50 Hz) corona were performed in coaxial electrode systems with the inner electrode, dia 13 mm, having a probe (an electrostatic fluxmeter) inserted therein and outer cylinder, dia 100 or 192 cm /3,4/. In tests with d.c. bipolar corona three wires, dia 0.08 cm, connected electrically with the external cylinder were mounted in parallel with the inner electrode (see the Scheme in Fig. 1). Three thin wires were used instead of one in order to provide the uniform distribution of negative charge over the inner electrode surface. The recording of the signal from fluxmeter was carried out by an oscilloscope or a selective nanovoltmeter. The error when measuring $E_c$, by means of an oscilloscope, according to our estimations, comprises 3%, in case of the nanovoltmeter - 1,5%.

Experimental results. The measured field strength on the inner electrode under d.c. bipolar corona was compared with that in the case of unipolar corona...
when air parameters and characteristics of the probe are constant. The forms of positive corona in both regimes are different: the unipolar corona is characterised by the appearance of streamers at overvoltages up to \( n = 1,7 \pm 1,8 \), for \( n > 1,7 \pm 1,8 \), the corona becomes uniform while the bipolar corona is uniform over the whole range of \( n \). An example of measured field strength \( E \) on positive electrode versus applied voltage \( U \) is given in Fig. 1, where, in case of streamer unipolar corona \( (n < 1,7 \pm 1,8) \) the maximum values of \( E_c \) are given. As can be seen, the field strength \( E_c \) on the positive electrode at bipolar corona \( (U > U_{o \text{, bip}}) \) is also independent on \( U \).

However, under bipolar corona condition the value of \( E_c \) is lower than that under unipolar corona. The difference between \( E_{c \text{, bip}} \) and \( E_{c \text{, unip}} \) doesn't significantly exceed the measurement error and equals to \( \approx 8\% \). The field strength under corona \( E_{c \text{, bip}} \) is equal to the onset \( E_{o \text{, unip}} \) in both cases. The similar decrease of the field strength on the positive corona electrode takes place also with some other methods of negative ion injection into the gap and also by returning of negative ions at a.c. generated during a previous half cycle. The last is illustrated in Fig. 2. After the moment of corona onset in positive half cycle the field strength decreases slightly and 1,5 ms later becomes stable at \( E_{c \text{, bip}} < E_{c \text{, unip}} = E_{o \text{, unip}} \), the difference between \( E_{c \text{, bip}} \) and \( E_{o \text{, unip}} \) not exceeding 5-7%.

In all cases studied the existance of negative ions counterflow always results in the decrease of the field strength on the electrode with positive corona. This confirms assumptions \( (5,6,7) \) on the detachment of negative ions near the corona electrode and following formation of electron avalanches. Experimental results allow to estimate the highest potential gradients when negative ions detach. This gradient is equal to or less than the field strength \( E_{c \text{, bip}} \) on the electrode surface with positive corona at bipolar regime, i.e. \( E_{\text{det}} \leq 38 \text{ kV/cm} \).

References: