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WHY THE NEGATIVE CORONA CURRENT IN AIR DECREASES?

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Introduction

The time dependence of negative corona current I, called by Gagarin like "relaxing of CV-characteristics", is a phenomena observed and mentioned by some authors [1,2,3,4]. This phenomena can be easily observed only if the negative corona is initiated between electrodes situated in closed discharge reactor filled with air(no-flowing regime). When the suitable step-like voltage is applied on electrodes, the main current I continuously decreases from initial value I_0, to the saturated value I_s, which is 30 - 50 % below the initial value. The saturated value and the rate of decay depends on the volume of the discharge reactor as it was conclude by Schwab and Zentner, who first described such phenomena [1].

The observed phenomena was explained by two theoretical models [3], [4] considering the ion-molecule and chemical reactions in the NCD in air., especially the ozone production. The aim of presented paper is to discuss the discrepancies of above mentioned models, to re-examine the earlier experimental data and presumptions used in models in a light of the latest experimentally confirmed facts

Experimental Apparatus

The experiments have been carried out in ambient air at pressures 40 - 80 kPa and at temperature 20 ^{0} C. All details concerning to apparatus are described in our earlier paper [4].

Experimental results and discussion

One set of selected time dependencies of mean current I and ozone concentration measured by absorption of UV light in discharge reactor C are shown in Fig. 1a and 1b.

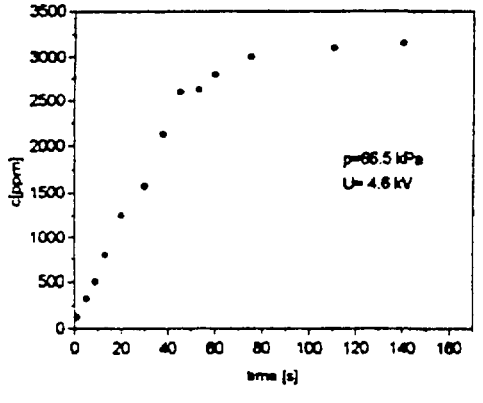

Fig 1a

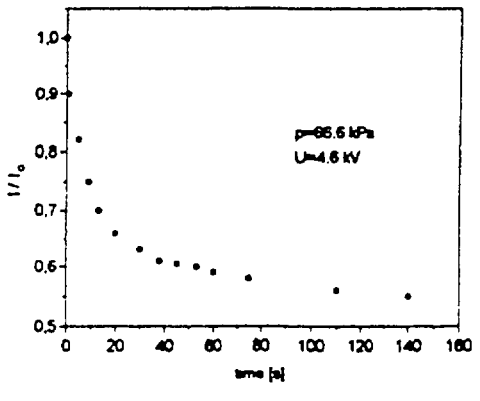

Fig 1b

The similarity of both curves as well as the time T_S needed for saturation of I and C suggests, that the decay of mean current is caused by the increase of the ozone concentration in the discharge gap. The principal difference between above mentioned models is the mechanism of ozone effect. Gagarin [3] presumed only the charge transfer ion-molecule reactions in which the primary negative ion O^-, created via dissociative attachment

$$e + O_2 \rightarrow O^- + O \qquad (1)$$

are changed to negative ions having larger mobility. He presupposed that the equilibrium of process influencing the current decay is reached if the concentration of ozone in discharge gap C is of range 10^{19} cm^{-3}, i.e. comparable with the concentration of oxygen in air. As it follows from theoretical calculations [5], the saturated concentration of ozone produced by NCD in air can not be higher like $10^{16}cm^{-3}$. Thus the calculated values of T_S should be 10^3 times shorter as measured data. .

On the contrary to the model [4], in our calculations the free electrons are taken into account. We presumed that a part of free electrons is attached by three-body process by ozone generated in the discharge [5]

$$e + O_3 + O_2 \rightarrow O_3^- + O \qquad (2)$$

On a base of new experimental facts the doubtful process (2) was replaced by dissociative attachment

$$e + O_3 \rightarrow O^- + O_2 \qquad (3)$$

The revised model was used for calculation of attachment coefficient k_{10} by simple formula presented earlier [6] from the old experimental data [4]. The mean value $k_{10}=2.5 \times 10^{-9}$ $cm^3.s^{-1}$ is very close to the values calculated from attachment cross section [7] and practically in agreement with data Gibalov et.all [8].

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