Plasma decay in repetitively pulsed high-voltage nanosecond discharge in hydrogen- and hydrocarbon-containing gaseous mixtures [[1]](#footnote-1)\*)

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The utilization of gas discharge plasma for plasma-assisted ignition and combustion of air-fuel mixtures is a promising application of non-equilibrium plasmas. High-voltage nanosecond discharges are frequently used for this purpose. The plasma generated in these discharges allows accelerated fuel ignition, ignition at temperatures below self-ignition threshold and reduction of toxic emissions [1]. To justify and predict these effects, numerical solution of plasma chemistry and combustion chemistry equations is required. To solve these equations, it is necessary to know the rates of plasmachemical and chemical reactions. In this work, the main attention is focused on electron-ion recombination in the afterglow of a high-voltage nanosecond discharge in combustible mixtures at gas temperatures below the self-ignition threshold. The study of the plasma decay is of considerable interest, because little is known about rate coefficients of electron recombination with simple and especially cluster hydrocarbon ions [2].

In this work, plasma decay in a high-voltage nanosecond discharge was experimentally studied in a gaseous stoichiometric mixture of propane and oxygen for pressures 1-3 Torr and gas temperatures 300-600 K. A similar study was also carried out in a stoichiometric mixture of hydrogen and oxygen for pressures 1-4 Torr at room gas temperature. To oxidize the fuel, the pulsed nanosecond discharge was repeated at a frequency of 10 Hz during the experiments. Using a microwave interferometer, the history of electron density was measured in the discharge afterglow after each voltage pulse. Measurements were accompanied by a numerical simulation for various gas temperatures. Plasma decay was simulated in the mixture of propane and oxygen after the first voltage pulse and after a large number of pulses, when fuel oxidation was complete. For the hydrogen and oxygen mixture, a more complicated calculation was performed. Here, a numerical simulation of changes in the composition of neutral species and ions after each discharge pulse was made together with plasma decay calculations. In both cases, agreement was obtained between the experimental data and the results of numerical calculations taking into account the non-equilibrium behavior of the discharge plasma. Comparison of the results of numerical calculation and experimental data made it possible to clarify the recombination coefficients and their temperature dependences for simple and cluster hydrocarbon ions, as well as for water cluster ions, which were generated due to the formation of water vapor during fuel oxidation.

References

1. Starikovskiy A.Yu., Aleksandrov N.L., Progress in Energy and Combustion Science, 2013, 39, 61-110
2. Florescu-Mitchell A.I., Mitchell J.B.A., Physics Reports, 2006, 430, 277-374

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Pt/ru/GN-Popov.docx) [↑](#footnote-ref-1)