Plasma influence on propane-air mixture by non-selfmaintained gas discharge

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Abstract

New types of plasmas created by a combined impact of electron beam, external electric field and combustion represents actual from the point of view of analysis of plasma and elementary processes in unusual situations appearing at applications.

Experiments with the electron beam created by electron accelerator EOL -400M have been made. Plasma of non-selfmaintained discharge has been realized in conditions without ignition of propane-air flow and with it. Experiments on inflammation of the flammable mixture in the chamber and injection of the beam into air and flammable mixture have been fulfilled. Experiments have shown sharp increase in the temperature at application of the non-selfmaintained discharge. Gas temperature and ion currents to electrodes in the mixture have been made at action of the non-

selfmaintained discharge under combustion conditions and without them.

General model and the plasma calculation code at combined influence of the external electric field and the electron beam was created at application of the simplified chemical model for inflammation of propane-air mixture and detailed model for air plasma. Plasma chemical reactions inherent to propane plasma were added, thus, plasma chemical model of "dry" propane-air mixture appeared, we also added plasma chemical reactions inherent to water plasma to this model, and obtained "humid" propane-air mixture plasma chemical model.

At the external electric field strength of E=3 kV/cm and the excitation velocity of electron beam W=10^{18} - 10^{19} eV/(cm^3·s) the model of "dry" propane-air mixture gives the inflammation time $7\cdot10^4$ -$1.0\cdot10^4$ μs. Gas temperature reaches a value of T ≈2800 K.

At the external electric field strength of E=3 kV/cm and the excitation velocity of electron beam W=10^{18} - 10^{19} eV/(cm^3·s) the model of "humid" propane-air mixture gives the inflammation time $7\cdot10^5$ -$1.0\cdot10^5$ μs, i.e. it decreases by 3 times. Gas temperature in this case reaches a value of T ≈2700 K.

Undertaken calculations show that in real conditions the inflammation time of the mixture at the given parameters of the excitation only by the electron beam will lie in the 10^5 -10^6 μs, and by the non-selfmaintained discharge – in the range 10^4-10^5 μs. The scatter of the calculations data is sooner connected with the decrease of temperature in the humid propane-air plasma since namely high temperature defines a velocity of chemical reactions. Description of ion-molecule , ion-ion and excited species- neutral molecule reactions require additional investigations.

Acknowledgement

Authors acknowledge our colleagues I.I. Esakov, L.P., Grachev and K.V. Khodataev for support in investigations.

The work is performed with the financial support of EOARD (Project ISTC #3775p).