KINETICS OF PLASMA ASSISTED COMBUSTION AT LOW REDUCED ELECTRIC FIELDS

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The mechanism of plasma assisted ignition has been intensively discussed in recent years. Several possible mechanisms have been proposed to enhance the ignition with electrical discharges [1]. Among them, the excitation of molecules to vibrational and electronic states by plasma seems to be quite interesting due to its higher efficiency than others. The purpose of this paper is to study numerically the ignition of a hydrogen-oxygen mixture under influence of single delta oxygen (SDO, $O_2(a^1\Delta_g)$). A kinetic mechanism of the effect of singlet oxygen molecules was determined by calculating numerically the ignition characteristics. The efficiency of various electric discharges for enhancement of combustion is also presented. The ignition process was numerically simulated using the kinetic scheme given by [2], which include 12 particle species (H_2, H, O_2, O, O_3, O(1D), $O_2(a^1\Delta_g)$, $O_2(b^1\Sigma^+_g)$, OH, HO_2, H_2O_2, H_2O) and 80 reactions. Calculations were carried out in the zero-dimensional approximation at a fixed gas pressure.

In calculations, we determined the ignition delay time as the interval between the instant at which singlet oxygen molecules were injected and the onset of abrupt increase of gas temperature. To validate the calculated results, the comparison has been made between the experiment from [3] and our simulations.

We have made a numerical study of the ignition of hydrogen-oxygen mixtures with the participation of singlet oxygen molecules and showed that it agrees well with the measurements from experiment. It follows from the analysis of the calculated results that, with single delta oxygen molecules, the great amount of active species with fast reactions lead to the decrease of ignition delay time. Besides, in order to obtain best results at various conditions, relatively low E/n (~10 Td) is required in pure oxygen electric discharge, while larger value of E/n (~300 Td) is recommended for high efficiency in air plasma.

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