The numerical study of hydrogen-air mixture ignition under laser photo-dissociation of O_2 molecules

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Numerical modeling and investigation of the peculiarities of the hydrogen-air mixture ignition under the impact of a focused resonance laser radiation pulse with a wavelength of 193 nm, leading to photodissociation of O_2 molecules, are carried out. Initial distribution of atomic oxygen in the initiation zone of ignition was obtained on the basis of a detailed one-dimensional calculation of the absorption of laser radiation in the Schumann-Runge bands taking part the spatial temperature distribution in the region under consideration.

Modeling the ignition and combustion of H_2-O_2 mixture in a closed reactor was carried out in a two-dimensional axisymmetric formulation using the quasilaminar combustion model and the detailed kinetic mechanism of hydrogen oxidation [1] extended by the block of reactions responsible for the formation of electronically excited OH($A^2\Sigma^+$) molecules [2]. The initial distribution of the O atoms in the region of the impact of the laser radiation was borrowed from the data obtained at the first calculation stage.

The results of the calculation of the induction time τ_{in} and velocity of combustion wave propagation U_f are in a good agreement with experimentally measured values. The effect of fuel equivalence ratio φ and mixture pressure on τ_{in} and U_f values is analyzed. During modeling, the features of distribution of OH и OH($A^2\Sigma^+$) radical concentrations behind the combustion front depending on φ were revealed.

The work was partially supported by the Russian Foundation for Basic Research (grants 17-08-01423-a, 18-38-00365)

References

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