On chemical inhibition of shock wave ignition of hydrogen-oxygen mixtures

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The prevention of catastrophic explosions of hydrogen is the actual problem for existing and developing energy technologies. An introduction of chemically active inhibitors which suppress the combustion and detonation development is widely considered, but their opposite influence on ignition at certain conditions has been also reported [1]. The goal of present work was the experimental study of the influence of the wide range of various inhibitors on shock-induced ignition of hydrogen. Experiments were carried out in the shock tube of standard design in the stoichiometric hydrogen-oxygen mixtures diluted with argon to 10–20% and doped with 1–3% of studied suppressants, namely CCl₄, CF₃H, C₂F₄Br₂, C₃H₉O₃P, CF₃I and C₃F₇I. The ignition delay times after the reflected shock wave propagation through the investigated cross-section were measured using the OH emission signal at wavelengths 306–310 nm. The specific values of T and P were derived from the incident shock wave velocity measured by piezoelectric pressure gauges. Modern kinetic mechanism of hydrogen combustion was used for the following modeling and analysis using ChemKin software package. Observed temperature dependencies of induction times indicates that CF₃H and C₃H₉O₃P certainly lack inhibiting activity at given conditions, while the effectiveness of halogen-containing specie dramatically increases in a row Cl→Br→I. C₃F₇I provided an unique combination of combustion suppression activity and safety for human health and ecology.

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