Ignition Delay Times of Kerosene(Jet-A)/Air Mixtures

V.P. Zhukov[1], V.A. Sechenov, and A.Yu. Starikovskii[2]
Moscow Institute of Physics and Technology, Dolgoprudny, Russia
vpzhukov@gmail.com

Ignition of kerosene(Jet-A)/air mixtures was studied behind reflected shock wave. To prepare the homogeneous gas mixture and to perform the experiments the shock tube and the mixture tank was placed inside a heater. The thermostatic controlling system maintained the uniform temperature of 150 ^{0}C inside the heater during the experiments. Ignition delay times of kerosene(Jet-A)/air mixtures were measured by OH emission at 309 nm ($A2\Sigma - X2\Pi$) and by the absorption of He-Ne laser radiation at 3.3922 μm. The conditions behind shock waves were calculated by one-dimensional shock wave theory from initial conditions: T1, P1, mixture composition, and incident shock wave velocity. The ignition delay times were obtained at two fixed pressures: 10 and 20 atm for lean, stoichiometric, and rich mixtures (ϕ=0.5, 1, 2) at the overall temperature range of 1040-1380 K. In the experiments the mixture composition was calculated using aggregate chemical formula $C_{11}H_{21}$ for Jet-A. The used preheated shock tube has small dimensions that limits the time available for the measurements. As a result the range of the measured delay times amounts 10–400 μs.

The used experimental setup and technique were also employed in the study of n-decane ignition at the pressures of 13 atm and 80 atm [1]. The measurements of decane ignition delay times agree well with the results of another group [2].

The ignition delay times of Jet-A follows the Arrhenius law as the most hydrocarbons at temperatures of 1000–1400 K. The obtained experimental data is approximated well by correlation expression:

$$\tau_{ign}[\text{ms}] = P[\text{atm}]^{-0.39}\ \phi^{-0.57}\ \exp(14700/T[\text{K}]).$$

According to the performed chromatography the fraction of alkanes amounts 65% in the used sample of Jet-A. Nevertheless the dependence of the ignition delay times on temperature and mixture composition is slightly different for Jet-A from higher alkanes.

[1] V.P. Zhukov, V.A. Sechenov, A.Yu. Starikovskii, Autoignition of n-decane at high pressure, Combustion and Flame, Volume 153, Issues 1–2, April 2008, Pages 130-136.

[2] U. Pfahl, K. Fieweger, and G. Adomeit, Shock Tube Investigation of Ignition Delay Times of Multicomponent Fuel/Air-Mixtures under Engine Relevant Conditions, Final Report, Subprogramme FK.4, IDEA-EFFECT, 1996.

[1] Current affiliation: Institute of Space Propulsion, German Aerospace Center (DLR), Lampoldshausen, 74239 Hardthausen, Germany.

[2] Current affiliation: Princeton University, Princeton, NJ, USA.