Detonation Initiation Techniques for Pulse Detonation Propulsion

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Abstract

The paper outlines recent efforts of the research team directed by the author on the development of efficient means for reducing the deflagration-to-detonation transition (DDT) run-up distance and time for liquid-fueled air-breathing Pulse Detonation Engine (PDE) applications. The main objective of the studies was to ensure fast DDT in a PDE tube at the lowest possible ignition energy, at the shortest distance, with the lowest pressure loss, and using aviation kerosene TS-1 (Russian analogue of JetA) as fuel and air as oxidizer. Various novel approaches were suggested and tested experimentally and computationally. Among them are: (1) stimulation of shock-to-detonation transition (SDT) by a traveling ignition source, (2) SDT due to coherent shock interaction with prechamber cloud autoignition, (3) SDT due to shock focusing in curved tube segments (U-tubes and tube coils, (4) DDT in tube segments with regular shaped obstacles, etc. The use of certain combinations of these approaches made it possible to achieve DDT in kerosene TS-1–air mixture in a tube 51 mm in diameter at a DDT distance of about 2 m, applying ignition energy as low as 5 J. Figure 1 shows measured mean shock velocity as a function of the distance travelled by the shock along the tube in 12 runs with different ignition energy. Figure 2 shows the pressure records in 7 locations along the tube in the run with the ignition energy of 5 J.

This work was partly supported by the International Science and Technology Center project #2740.

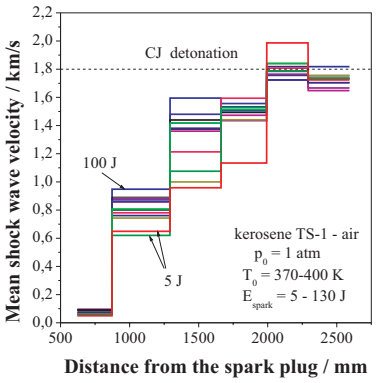

Fig. 1 Measured mean shock wave velocities as a function of distance from the igniter in 12 runs with the ignition energy varied from 5 to 130 J

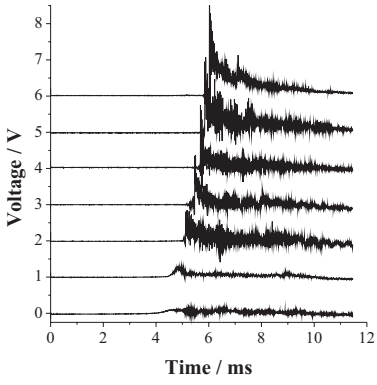

Fig. 2 Pressure records in the run with igniter energy of 5 J