Combined Strategies of Detonation Initiation in a Liquid-Fueled Air-Breathing PDE

Frolov S. M., Basevich V. Ya., and Aksenov V. S.
N. N. Semenov Institute of Chemical Physics, Moscow, Russia

The results of the experimental studies aimed at evaluating the practical feasibility of a liquid-fueled air-breathing PDE prototype are presented. To reduce the initiation energy of *n*-hexane and *n*-heptane spray detonation, a 28-millimeter-diameter, 1-meter long predetonator transitioning via a conical and abrupt transition sections to a 52-millimeter-diameter, 0.6-meter long main tube is used. The fuel–air predetonator comprises the air-assist liquid-fuel atomizer, two electric (arc) dischargers, Shchelkin spiral, and tube coil. The atomizer provides the entire flow rate through the predetonator. The first discharger repeatedly generates the primary shock wave in a continuous two-phase flow. The second discharger is mounted at the exit of the tube coil and is activated in phase with the primary shock wave arrival at its position by a digital controller. The minimal attained rated energy of detonation initiation with two successively triggered dischargers is about 30 J at the discharge efficiency of about 20%. The continuous two-phase flow in the main tube is provided by the centrifugal air compressor and a standard automobile fuel injector. To start the PDE in the multipulse detonation mode, the main tube is first operated on a continuous deflagration for a short time. The predetonator is activated after the tube wall attains the preset temperature. Multipulse 5-hertz operation of the setup in the detonation mode was successfully demonstrated at the total fuel–air ratio close to stoichiometric. Thrust measurements have been performed using a pendulum technique. It has been shown that the operation process is relatively low sensitive to variations in the fuel–air ratio and operation frequency as compared with the PDE configuration with a single discharger.