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SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (5)

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AN EXPERIMENTAL STUDY ON HIGHLY EFFICIENT DDT ENHANCEMENT DEVICE FOR PDE

Abstract

Purpose: Pulse Detonation Engines (PDEs) have the potential to revolutionize aerospace propulsion system for future aerospace vehicles. To realize PDEs, detonation should be occurred immediately. We have proposed a new device enhancing Deflagration-to-Detonation Transition (DDT) highly efficient. The device increases the probability of generating hot spots leading to detonation initiation with quite small total pressure loss. The present work is intended to investigate the effect of the new DDT enhance device to reduce the DDT distance for the practical continuous operation.

Methodology: The DDT enhancing device is an open tube measures 16.1-mm diameter by 2.8-mm thick, which is installed in the center of a 2.0-m long detonation tube with inner diameter of 50 mm. Two types of devices have been tested. One is long, its head is located at 50 or 100 mm from the closed end of the detonation tube and tail end is same as the open end of the detonation tube. Another is short, its head is located at 50 mm from the closed end and length is 300 or 450 mm. A spark igniter is mounted on the closed end. To detect flames, two-needle ion probes are mounted along the tube wall with 50-mm intervals. The DDT distance is determined as the distance from the closed end to the position where the flame front velocity exceeds the Chapman-Jouguet velocity. The test gases are hydrogen-oxygen mixtures, the equivalence ratios of which are 0.3-2.0. Experiments are conducted at initial pressures of 50.7 and 101 kPa and at room temperature.

Results: In the case with the long device, the DDT distance is 0.7 m, while the distance without device is 1.6 m, at an equivalence ratio of 2.0 and initial pressure of 101 kPa. As for other equivalence ratios, the DDT distance is similarly reduced. At initial pressure of 50.7 kPa, the device initiates detonation under the condition that detonation does not occur in the detonation tube without device. In the case with the short device, results indicate that the short device lead to a shorter DDT distance equivalent to or greater than long device.

Conclusions: The performance of a new DDT enhancing device has been demonstrated for hydrogen-oxygen mixtures. The significant reduction of DDT distance has been observed. The results show that this device could make detonation tubes shorter and realize higher-frequency cycle operations for practical application.