SECTION 1

CONFINED GASEOUS DEFLAGRATIONS AND DETONATIONS

THE EFFECT OF SHEAR LAYER CONTROL ON DDT

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Introduction

Mixing enhancement is an important element in promoting detonations. The existence of large structures in the shear layer and their relation to flow instability make it possible to control the development of the shear layer and thus affect its mixing characteristics. The authors of [1] forced a fully expanded Mach 2 circular jet using open rectangular and semicircular cavities adjacent to the jet exit plane. The observed forcing frequencies can be explained by either the convective–acoustic feedback mechanism or normal mode resonance of the cavity.

The efficiency of external acoustic excitation of a high-velocity subsonic jet has been demonstrated in [2]. Maximum excitation of the jet was obtained for a Strouhal number between 0.25 and 0.3.

In order to investigate mixing processes and turbulence, a whistler nozzle and sonic generator are used to inject the fuel and oxidizer into a detonation tube. The aim is to compare the DDT for different types of injectors.

Flow Visualization Experiments

Experiments were carried out to visualize the nonreactive flow from the injectors. The experimental equipment consisted of a shock tube connected to a vacuum chamber. The vacuum chamber was equipped with optical windows. At the end of the shock tube, different nozzles were mounted in turn. The postshock flow was visualized by IAB-451 Schlieren device. The Schlieren pictures show the time evolution of the process at intervals of 5 to 10 μs with an exposure of 1 μs. To obtain 72 images in one experiment, a high-speed optical-mechanical device VSK–5 with a frame size of 16×22 mm was used.

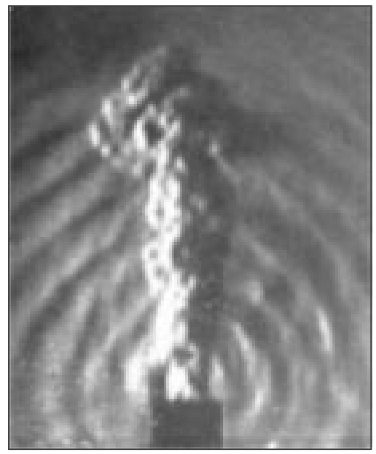

Figure 1 Supersonic nozzle performance with cavity resonator

The whistler nozzle (Fig. 1) and sonic generator (Fig. 2) excited the shear-layer perturbations in supersonic jets. Preliminarily, sonic generator performance was visualized and tested (Fig. 3). The mass flow rate through the nozzles was equal to the calculated value in detonation experiments.

Detonation Experiments

Detonation formation experiments were carried out in an 83-millimeter diameter and 660-millimeter long detonation tube connected to a receiver. Injectors were mounted at the closed end of the detonation tube. Gases were injected into the tube by using different injectors to compare their mixing performance. Detonation was initiated by a spark plug mounted near the closed end of the tube. Four measuring stations were used in the experiments: at distances 87, 174, 261, and 348 mm

Figure 2 Supersonic flow (at the center of picture) disturbed by sonic generator (on the right side)

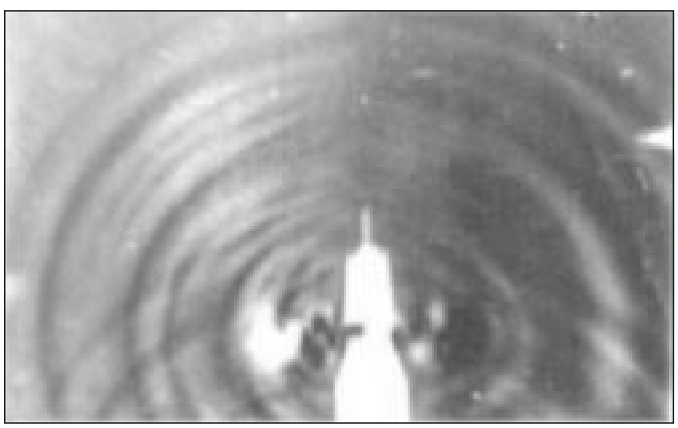

Figure 3 Sonic generator performance

from the igniter. At each measuring station, a pressure transducer PCB 113A34 and light gauge FD 256 were installed. Experiments were conducted at normal initial pressure and temperature.

The results can be useful for mixing enhancement in pulse detonation engines.

Concluding Remarks

Presented are the results of experimental studies of mixing enhancement in combustors by means of forcing supersonic fuel jets with acoustic perturbations. The results can be applied to mixing enhancement in pulse detonation engines.

Acknowledgments

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References

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2. Borisov, Y. Y., and N. M. Gybkina. 1975. Acoustic excitation of high-velocity jets. *Sov. J. Physics Acoustics* 21(3):230–33.