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HIGH ENERGY LASERS AS A STABILITY RATING DEVICE

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Summary

A very cursory test program was performed to evaluate the feasibility of using a 100W CO_2 laser to initiate resonant oscillations in a test combustor. GOX/RP-1 were selected as propellants due to the absorption characteristics of RP-1 and due to test facility capabilities. Very low amplitude oscillations were initiated during laser pulsing that correspond to the first longitudinal mode of the test engine.

Discussion

Typically, the stability of liquid rocket engines is determined by "bomb" testing in which pyrotechnic devices are detonated inside a firing engine in hopes of exciting resonant oscillation modes. Bomb testing is expensive and tends to damage hardware. There is no well defined procedure for determining the size and location of the bomb needed to excite an oscillation. Bombs by their nature expend their energy exciting a broad band of frequencies, and do not necessarily provide an answer to the question of how a combustor responds to an oscillation at a particular resonant frequency. Other pulsing techniques such as pulse guns and sirens typically suffer from placement, cost, and inertial coupling considerations and thus are seldom used.[1] Using a laser as a stability rating device has some potentially attractive features. Recently, by piggybacking on the tail end of another test program,[2] we were able to perform a brief assessment of the feasibility of using a high energy laser as a stability rating device for a test combustor.

The pulsing system used in the experiment consisted of a laser and beam-steering optics. The optical setup is shown in Figure 1. A CO_2 laser was used with a wavelength of 10.6 microns and a beam diameter of 4 mm. A CO_2 laser was selected for several reasons. RP-1 absorbs strongly at 10.6 microns. CO_2 lasers are able to provide high energy pulses at repetition rates matching the frequency range of interest for combustion instabilities. Finally, CO_2 lasers are relatively inexpensive. The laser could be pulsed at a rate from 2kHz to 10 kHz with a 50% duty cycle. Pulse energies ranged from 32 mJ to 17 mJ per pulse at 2 and 5