



Solid Motor Thrust Oscillation Due to Inhibitor Vortex Shedding



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Purpose:

Solid rocket motors have a potential for thrust oscillations caused by vortex shedding which leads to anomalies during flight. These thrust oscillations are thought to be amplified at harmonic frequencies that cause resonance with the structure. To avoid this resonance, a study was launched to correlate vortex shedding with thrust oscillations.

Methodology:

- 48 x 6 x 6 inch test chamber
- Z-type schlieren for flow visualization
- Extended point light source using a halogen automotive headlamp
- 125 psig air was flown through test section to create vortices
- 2 Dynamic pressure transducers
- 4 Static pressure transducers
- High speed camera used to record images (1000 frames per second)
- LABVIEW control system to read and record data

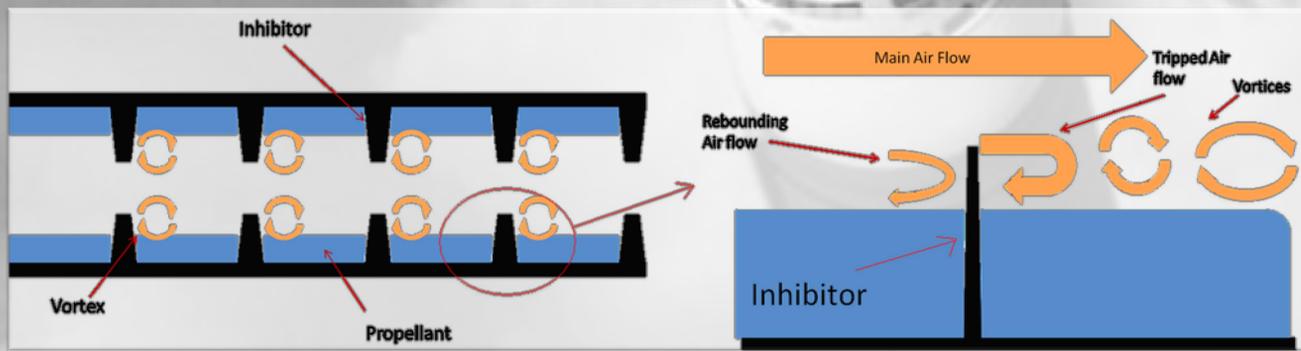


Figure 1: Vortex Shedding in Solid Motor

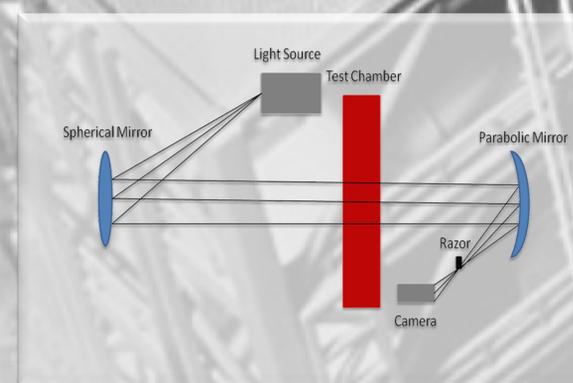


Figure 3: Z-Type Schlieren Setup



Figure 4: Experimental Setup

Background:

- Little information exists on the effect inhibitors have on resonance which is needed for improving the effectiveness of solid rocket motors.
- Major thrust oscillations are attributed to vortices over inhibitors, propellant cavities, and casing/nozzle walls.
- Existing empirical models and CFD capabilities fall short of characterizing these phenomena related to vortex shedding due to high percentage error.
- The cold flow apparatus integrated with schlieren photography in this study can be used to accurately visualize vortices and establish trends.

Technology Payoff:

- Understanding of motor resonance resulting in improvements on existing solid rockets.
- Inhibitors, wall/nozzle casings, and propellant grains can be designed to eliminate any resonance at the structure's harmonic frequencies and allow solid rocket missions to be safer with reduced risk of structural fatigue.
- Improves existing technology for future launch vehicles with solid rocket motors, specifically the proposed heavy launch program.
- Improves CFD modeling for full scale motors.



Figure 2: Test Chamber

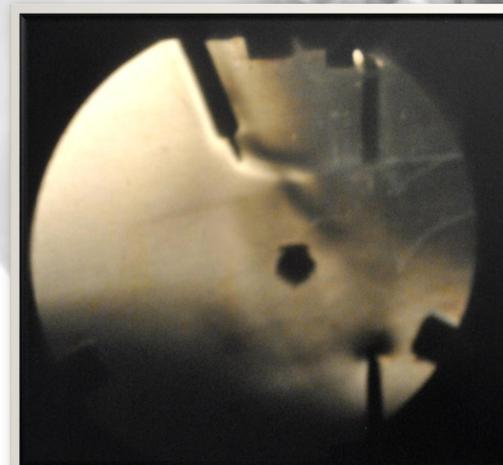


Figure 5: Schlieren Image of Soldering Iron

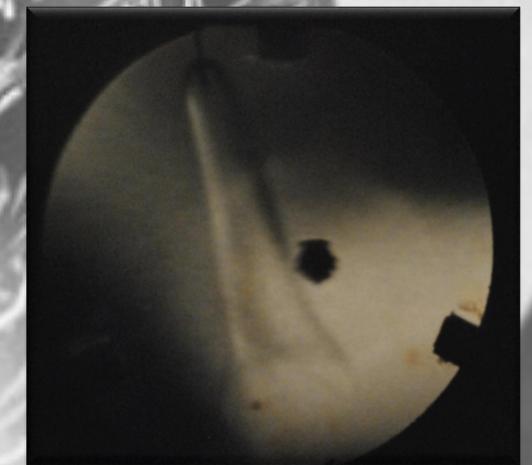


Figure 6: Schlieren Image of Match Burning

