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High Frequency Combustion Instability Suppression through the Application of Varying Bands of White Noise

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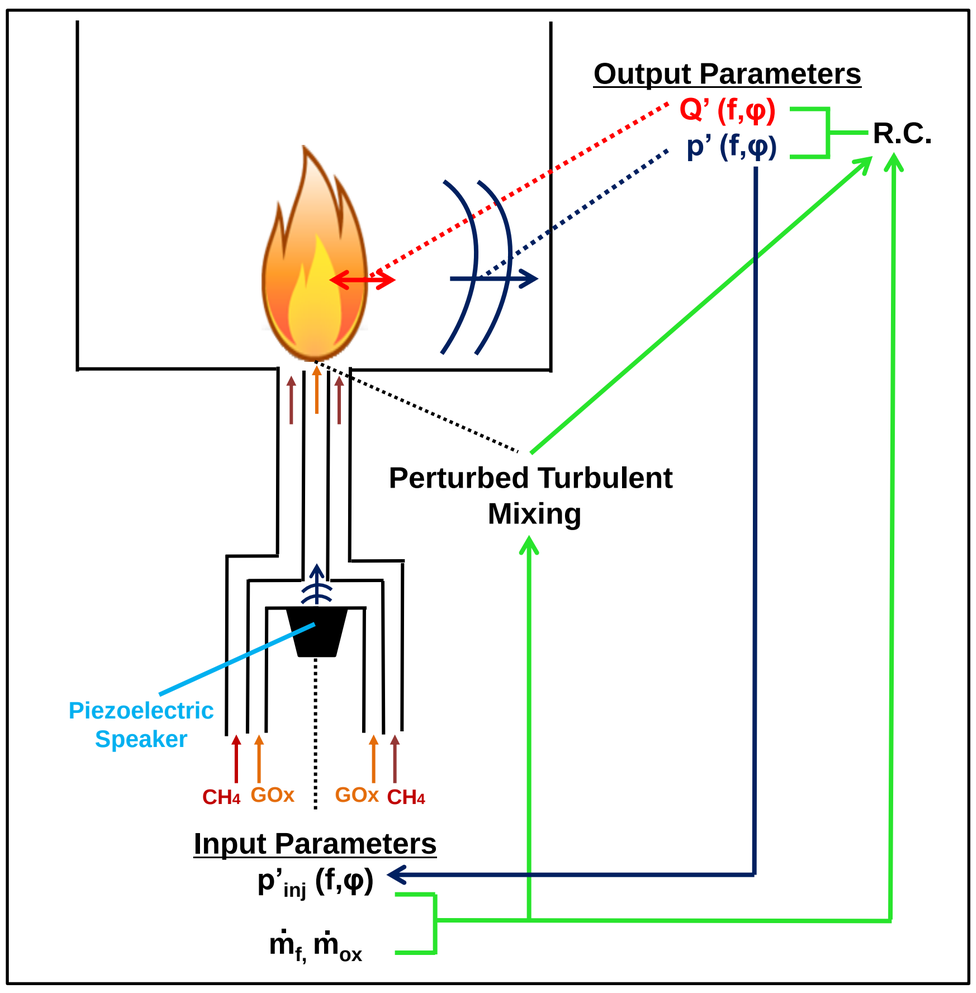
Overview

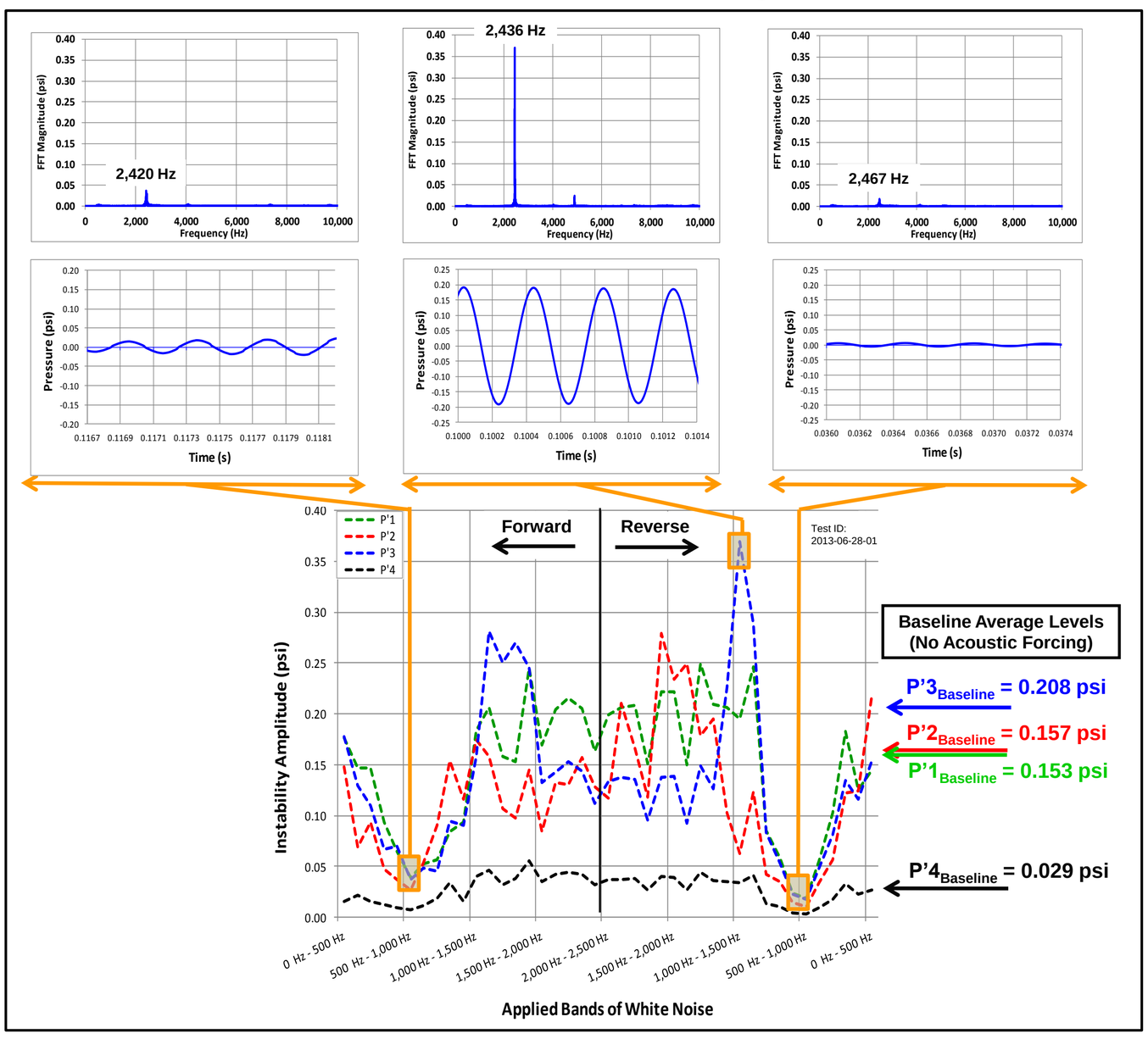
• This research investigation demonstrates a new high frequency combustion instability control approach in which the dominant instability mode is suppressed by strategically applying pressure disturbances within the oxidizer post of an injector.

• Modulating propellant flow at specific frequencies in a certain range have found to be an effective way at suppressing instabilities.

• Acoustically modulating the propellant with the appropriate frequency width band-limited white noise can provide a more effective instability suppression.



Key Findings



• Applying ≈ 500 Hz - 1,000 Hz band limited white noise at a constant amplitude of 0.3 psi rms, a f ≈ 2,430 Hz instability was found to be completely suppressed across multiple tests.

• Amplification of this instability was seen for the application of ≈ 1,100 Hz - 1,600 Hz band limited white noise.

• Larger dampening effect was apparent for the reverse application of band limited white noise. Hysteresis on the effectiveness of instability suppression may be present.

Impact

• This work will help identify the physical mechanisms by which injector acoustics control combustion instability feedback.

• Developing this instability suppression technique should assist in the design of stable and reliable combustors for liquid rocket engines in the future.

Explanation

• One of the most detrimental issues for liquid rocket engines is the spontaneous excitation of high frequency combustion instability modes.

• High frequency instability suppression techniques continue to be a topic of great interest to the aerospace community.

• Greater understanding of stable rocket engine designs will bolster the advancement of space exploration.

Acknowledgements

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