Airfoil Noise Analysis in a Hybrid Anechoic Wind Tunnel

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Anechoic wind tunnels provide a controlled environment to investigate the aerodynamic and aeroacoustic behavior of airfoils, enabling detailed studies of noise generation mechanisms and flow interactions. Traditionally, open-jet test sections have been employed for aeroacoustic measurements due to their minimal acoustic reflections; however, they introduce aerodynamic challenges such as jet shear layer interactions. The Hybrid Anechoic Wind Tunnel (HAWT) has been developed to mitigate these issues by incorporating Kevlar walls, which enhance aerodynamic accuracy while maintaining the acoustic benefits of an open-jet configuration. Despite these improvements, the Kevlar walls alter the flow boundary conditions, influencing both the aerodynamic performance and the measurement acoustics of the airfoils tested within this setup.

This study focuses on the characterization of trailing edge noise for two airfoil geometries: the NACA0012 and the NACA63018. Using a combination of conventional measurement techniques and Laser-Induced Plasma (LIP) excitation as a controlled acoustic source, the research aims to analyze noise generation and propagation mechanisms associated with each airfoil. LIP provides a precise and repeatable method for studying acoustic responses, allowing for direct comparisons of scattering effects and surface interactions under controlled conditions.

A series of experiments in the HAWT will evaluate airfoil noise characteristics through far-field noise spectra, directivity patterns, and surface pressure fluctuations. LIP excitation will be used to investigate acoustic scattering effects, while beamforming techniques will help localize dominant noise sources along the airfoil surface. Additionally, the influence of boundary layer characteristics and Kevlar wall interactions on trailing edge noise radiation will be examined to better understand their impact on measurement accuracy and noise propagation. By comparing the acoustic performance of the NACA0012 and NACA63018, the study aims to assess the effectiveness of the latter in reducing aerodynamic noise. These findings will provide valuable insights into noise generation mechanisms and support the development of quieter airfoil designs for aerospace applications.

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