

NACA0012 and NACA63(3)-018 Noise Analysis in a Hybrid Anechoic Wind Tunnel

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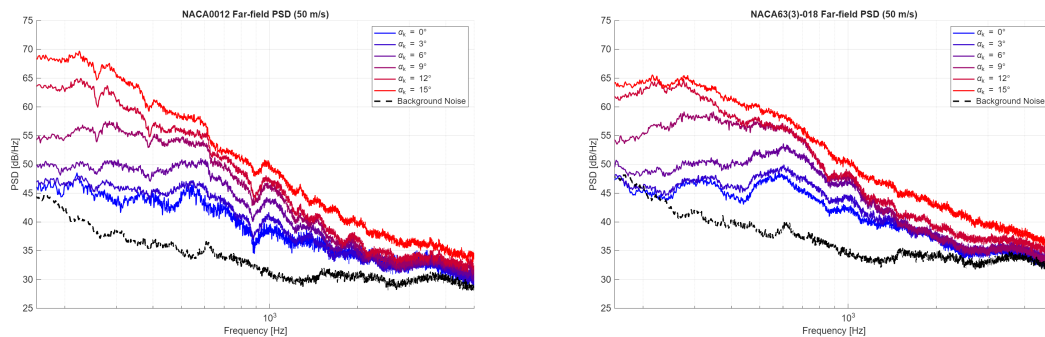
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Hybrid anechoic wind tunnels provide a unique capability to simultaneously achieve aerodynamic fidelity and acoustic accuracy for aeroacoustic measurements. While conventional open-jet configurations minimize acoustic reflections, they introduce flow distortion through shear layer interactions and jet deflection under lift. The Hybrid Anechoic Wind Tunnel (HAWT) overcomes these limitations using acoustically transparent Kevlar walls, which confine the flow while preserving acoustic access. However, this configuration alters the effective boundary conditions, influencing boundary-layer development and the resulting trailing-edge noise generation.

This study presents a comparative experimental investigation of TBL-TE noise for the NACA0012 (fully turbulent) and NACA63(3)-018 (laminar-flow-optimized) airfoils. Measurements were performed over freestream velocities of 30–50 m/s and angles of attack from 0–15°, enabling assessment of Reynolds number scaling and spectral behavior. Far-field acoustic spectra was obtained using a single microphone at a distance of 1m away from the trailing-edge.



(a) Far-Field Spectra for the NACA0012 airfoil at 50m/s. (b) Far-Field Spectra for the NACA63(3)-018 airfoil at 50m/s.

Figures 1a and 1b show clear differences in broadband noise between the two airfoils across all angles of attack. The NACA0012's sound levels rise noticeably with angle of attack, especially at low-to-mid frequencies, reflecting thicker boundary layers and stronger turbulence near the trailing edge. The NACA63(3)-018 has lower low-frequency energy and a smoother spectral decay, indicating thinner boundary layers and weaker large-scale turbulence. In both cases, spectra remain well above background noise, confirming trailing-edge noise as dominant. These trends align with TBL-TE scaling and support interpretation using Amiet's model, linking spectral differences to wall-pressure fluctuations and spanwise coherence.

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