Computation of Wall-Pressure Spectra from Steady Flow Data for Noise Prediction

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A method is proposed to calculate the trailing-edge broadband noise emitted from an airfoil, based on a steady
Reynolds-averaged Navier?Stokes solution of the flowfield. For this purpose, the pressure spectrum on the airfoil
surface near the trailing edge is calculated using a statistical model from the Reynolds-averaged Navier?Stokes mean
velocity and turbulence data in the airfoil boundary layer. The obtained wall-pressure spectrum is used to compute
the radiated sound by means of an aeroacoustic analogy, namely, Amiet?s theory of airfoil sound. The statistical
model for wall-pressure fluctuations is validated with two test cases from the literature, a boundary layer with an
adverse pressure gradient, and a flat plate boundary layer without a pressure gradient. The influence of specific
model assumptions is studied, such as the convection velocity of pressure-producing structures and the scale
anisotropy of boundary-layer turbulence. Furthermore, the influence of the Reynolds-averaged Navier?Stokes
simulation on the calculated spectra is investigated using three different turbulence models. The method is finally
applied to the case of a Valeo controlled-diffusion airfoil placed in a jet wind tunnel in the anechoic facility of École
Centrale de Lyon. Reynolds-averaged Navier?Stokes solutions for this test case are computed with different
turbulence models, the wall-pressure spectrum near the trailing edge is calculated using the statistical model, and the
radiated noise is computed with Amiet?s theory. All intermediate results of the method are compared with

experimental data.

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