COMPUTATION OF THE TRAILING EDGE NOISE OF AN AIRFOIL BASED ON STEADY FLOW COMPUTATION

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A method is applied to calculate the broadband noise emitted from the interaction between the trailing edge of an airfoil and its boundary layer based on a steady Reynolds-averaged Navier-Stokes (RANS) solution of the flow field. For this purpose the pressure spectrum on the airfoil surface near the trailing edge is calculated from the mean velocity and RANS turbulence data using a statistical model proposed by Panton & Linebarger. The obtained wall pressure spectra are 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 adverse pressure gradient and a flat plate boundary layer without pressure gradient. The influence of some 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 RANS simulation on the calculated spectra is investigated using three different turbulence models. Obviously it is advantageous to use a turbulence model which accounts directly for the turbulence anisotropy near the walls, such as Reynolds stress or v^2f turbulence model, to achieve good spectral results.

The method is first applied to the case of a Valeo Controlled-Diffusion airfoil placed in a jet wind tunnel in the anechoic facility of Ecole Centrale de Lyon. Also for this case different turbulence models are applied for the RANS solution, the wall pressure spectrum near the trailing edge is calculated using the statistical model and the radiated noise is computed with Amiet's theory. The agreement of the calculated spectra with experiments is of the same quality as it was found for results of large eddy simulations (LES) of the same problem. However, the computational costs are by orders of magnitude lower compared to LES.

As a second application case the NACA0012 airfoil in a jet wind tunnel is chosen. The angle of attack corresponds to a near-stall flow regime. Flow computations can not be validated with the data available, but for the wall pressure spectrum near the trailing edge experimental data are available for comparison.

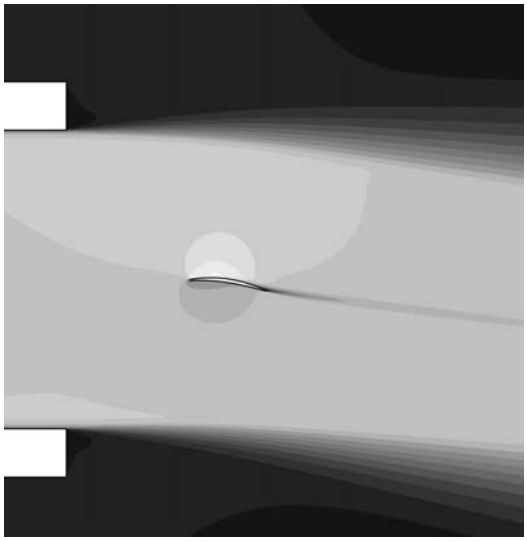

Figure 1: Controlled-Diffusion airfoil in the jet wind tunnel

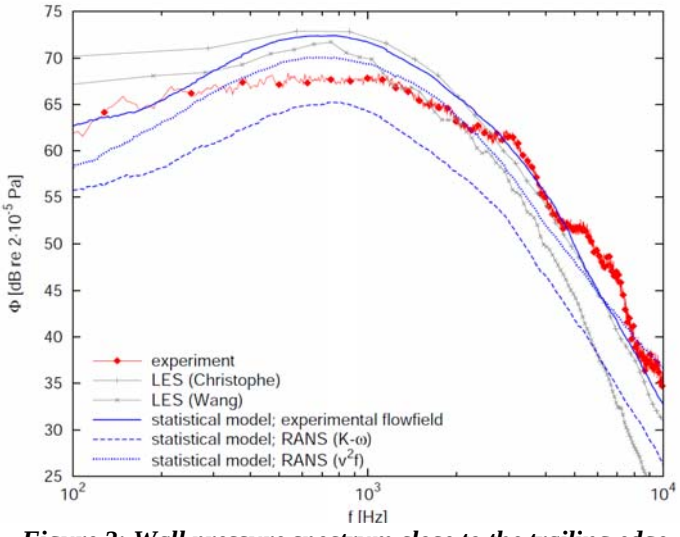

Figure 2: Wall pressure spectrum close to the trailing edge