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Direct simulation of aerodynamic noise of an axial-flow fan with volume penalization method

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Aerodynamic noise from an axial fan with struts in a duct was directly predicted based on the compressible Navier-Stokes equations. The rectangular computational grid was utilized, and the volume penalization method [1] was adopted in order to predict flow and acoustic fields around complex geometries and moving objects such as the struts and the rotor.

The predicted pressure rising was in good agreement with the measured value. This means that the present computations can capture the performance of the fan correctly. Also, Fig. 1 shows the measured and predicted sound pressure spectra for the maximum flow rate. The frequency was non-dimensionalized by the blade passing frequency of nZ_b. Both results show that the tonal sound at the frequency four times higher than the blade passing frequency, which is due to the interactions of the wake of the rotating blade with four struts, is radiated.

Figure 2 shows the phase-averaged sound pressure fluctuations with the blade passing frequency, where the fine fluid dynamical components were filtered to elucidate the acoustic pressure waves. As shown in this figure, a staggered pattern is formed on the plane vertical to the axis. This is because the four struts form the acoustic sources with a phase offset.

The direct aeroacoustic simulations for the axial fan have been performed. As a result, the sound field due to the interactions of the wake of the blade and struts in the duct was clarified.

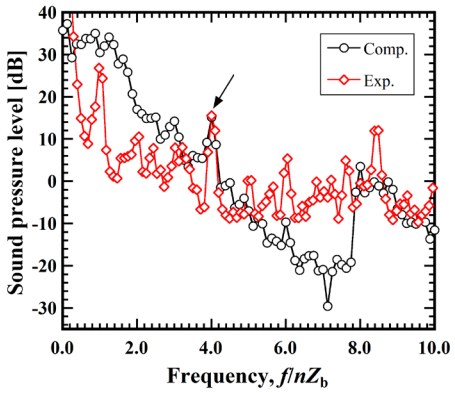

Figure 1 Predicted and measured sound pressure spectra in upstream of fan.

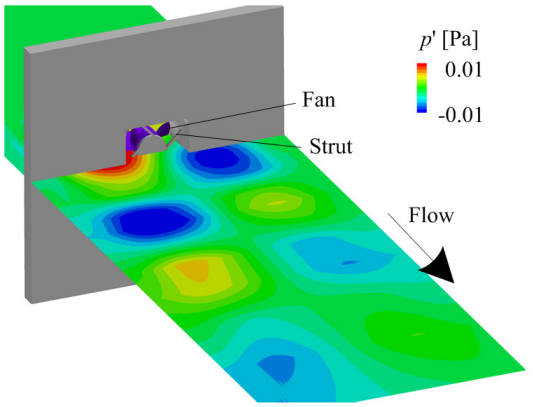

Figure 2 Predicted contours of sound pressure fluctuations.

REFERENCES

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