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Analysis of sound source localization in an axial fan

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Abstract

Numerical analyses of the tip vortex system of a ducted axial fan are conducted by a hybrid fluid-dynamics-acoustics method. First, large-eddy simulations are performed to investigate the dynamics of tip clearance flow for various tip-gap sizes and to determine the acoustic sources. The simulations are performed for a single blade out of five blades with periodic boundary conditions in the circumferential direction on a multi-block structured mesh with 140×10^6 grid points. The turbulent flow is simulated at a Reynolds number of 9.36×10^5 at undisturbed inflow condition and the results [1] are compared with experimental data [4]. The results show that increasing the tip-gap size results in various vortices in the tip-gap region, i.e., tip-leakage, separation, and induced vortices, which enlarge the diameter and the strength of the main tip vortex. For the largest tip clearance, spiral vortex breakdown occurs at the design operating condition. Second, the acoustic field on the near field is determined by solving the acoustic perturbation equations (APE) [3] on a mesh for a single blade consisting of approx. 1060×10^6 grid points. The results show that the larger the tip gap size the higher the broadband noise level [2]. Detailed results will be presented at the conference.

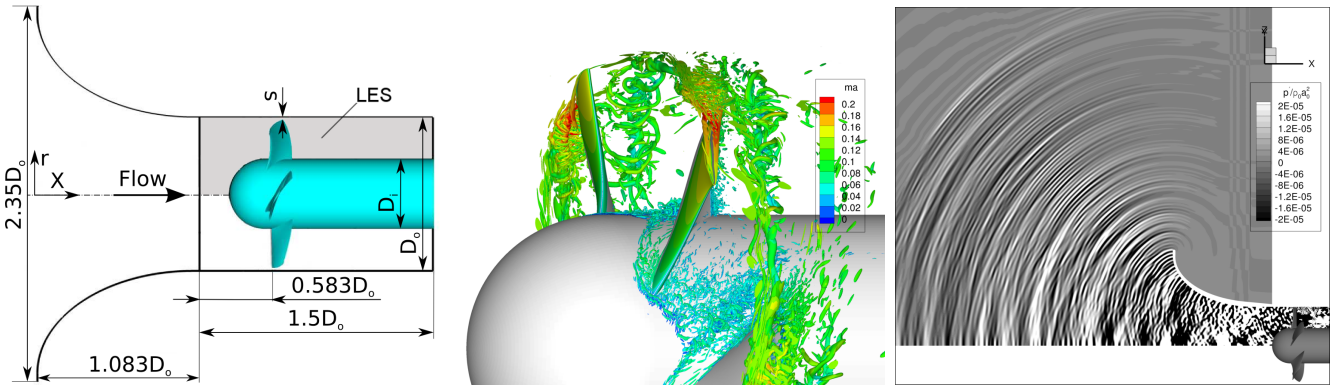

Figure 1. Front view of the flow configuration of an axial fan (left), iso-surface of the instantaneous λ_2-criterion visualizing the vortical structures of the flow field with mapped on relative Mach number distribution (middle), and the instantaneous acoustic pressure distribution for the tip-gap size of $s/D_o = 1\%$ (right) [2].

REFERENCES

[1] Seyed Mohsen Alavi Moghadam, Matthias Meinke, and Wolfgang Schröder, Analysis of tip-leakage flow in an axial fan at varying tip-gap sizes and operating conditions, *Computers & Fluids*, Vol 183, 2019, pp. 107-129, https://doi.org/10.1016/j.compfluid.2019.01.014.

[2] Seyed Mohsen Alavi Moghadam, Matthias Meinke, and Wolfgang Schröder, Numerical Analysis of the Acoustic Field of a Ducted Axial Fan at Varying Tip Clearances, *ActaAcustica united with Acustica*, Vol, 105(1), 2019, pp. 43-56, https://doi.org/10.3813/AAA.919286

[3] Roland Ewert and Wolfgang Schröder, Acoustic Perturbation Equations Based on Flow Decomposition via Source Filtering, *J. Comput. Phys.*, Vol. 188, 2003, pp. 365–398.

[4] Tao Zho, Thomas H. Carolus, Experimental and Numerical Investigation of the Tip Clearance Noise of an Axial Fan, *ASME Turbo Expo 2013*,