Coupled CFD-CAA Approach for Rotating Systems

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ABSTRACT

The cabin noise of modern ground vehicles is highly affected by flow related noise sources. This is especially the case, when the vehicle is not moving. Thereby, the fan-noise and outlet of the air-conditioning system are main acoustic sources and may reduce the comfort significantly. Rotating fans generate a highly turbulent flow field and can be identified as the main noise source in air conditioning units. Therefore, in addition to the aerodynamic efficiency of the fan, the acoustic signature of the fan is a main design criterion.

This contribution focuses on Computational Fluid Dynamics (CFD) simulations of rotating fans in air conditioning units using the Arbitrary Mesh Interface (AMI) which is implemented in OpenFOAM®. For the computation of the acoustic sources, highly accurate unsteady CFD simulation data is needed. Therefore, the transient simulations are carried out by using a DES (Detached Eddy Simulation) turbulence model to accurately resolve the complex flow field. In addition, CAA (Computational AeroAcoustics) simulations with the Finite-Element (FE) research software CFS++ (Coupled Field Simulation) are performed, which uses a Nitsche type mortaring to couple the acoustic field between rotating and stationary parts [1]. By introducing on the interface between moving and quiescent grid an appropriate flux term in combination with a penalization term, the method retains symmetry, consistency and stability of the algebraic system of equations. Furthermore, to precisely approximate the acoustic far field condition, we apply our recently developed PML (Perfectly Matched Layer) technique [2]. To demonstrate the applicability of our overall computational scheme, we will present CFD and CAA computations of a side channel blower, as used in automotive air-conditioning systems.

REFERENCES

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