AERO ACOUSTIC SOLUTIONS FOR FAN NOISE PREDICTION AND VALIDATION

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FlowVision

WHITE PAPER

Introduction & Background

FlowVision can provide simulations for aero-acoustical problems by working with a third party acoustical simulation software. In an aero-acoustical problem, the sound (acoustic) pressure is generated by the turbulence or the interaction between air and a structure. Majority of commercial acoustical simulation software (including LMS Virtual.Lab Acoustics) simulates the aero-acoustical problems based on the Lighthill's Aero-Acoustic Analogy.

The aero-acoustic analogy is based on the assumption that the acoustic field has no strong coupling effect to the air (medium) flow, which means the acoustic pressure is not strong enough to affect the air flow. The sound generation is simulated by fluctuations occulting in the flow field and then propagates within the flow. In such cases, FlowVision can provide a one-way coupling simulation with acoustical simulation software to conduct fast aero-acoustical simulations.

FlowVision is the best solution for most aero-acoustical problems, especially when moving objects are involved. In many engineering problems, there is usually at least one moving machine part, such as a fan or turbine blade that interacts with the flow surrounding. The moving body simulation technology can provide realistic simulations for flow-structure interactions, and the SGGR (Sub-Grid Geometry Resolution) technology can further reduce the time required for flow field simulations.

As a result; FlowVision can provide fast, accurate and realistic simulations for flow field allowing acoustical calculations in the presence of complex body movements.

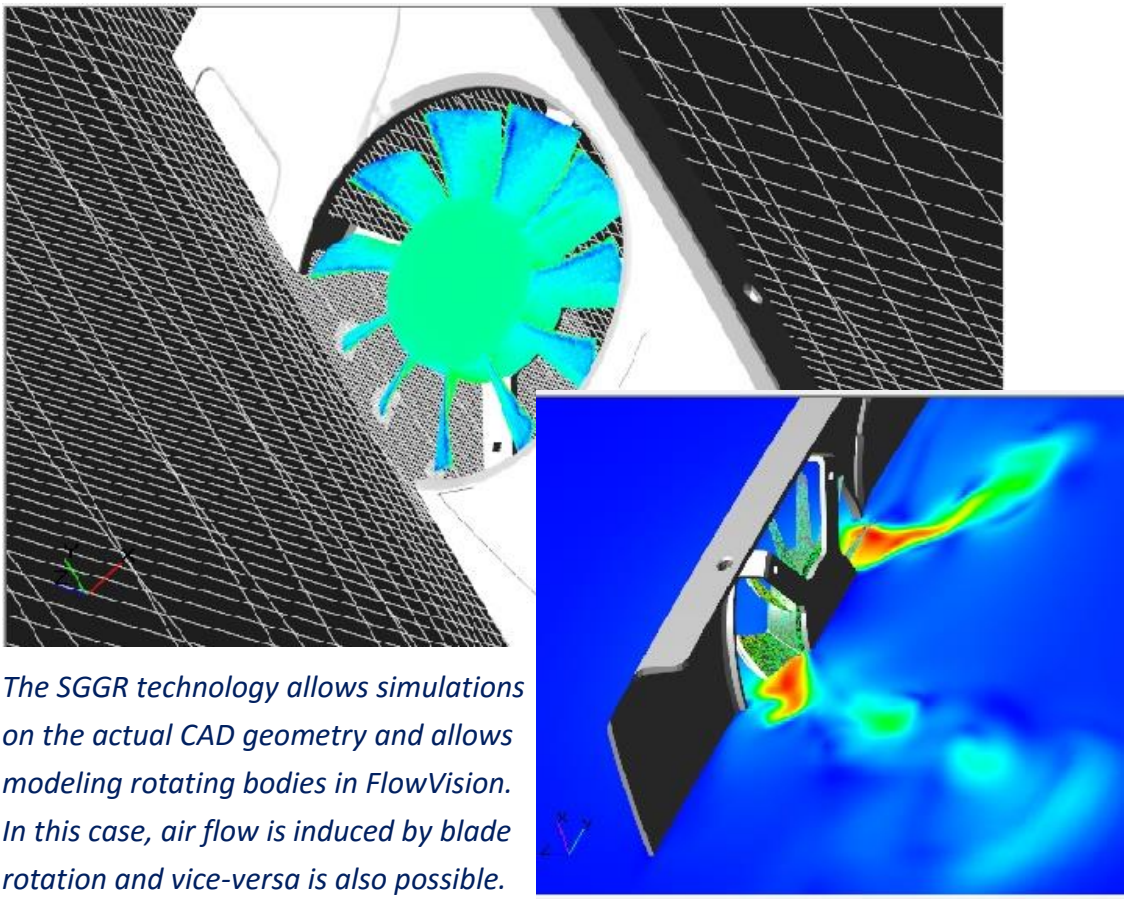
Case Study:

Fan Noise Prediction using FlowVision & LMS Virtual.Lab Acoustics

In most cooling fan cases, designers care most about the tonal noise at the fan's blade passing frequency (BPF) where loudest noise frequency

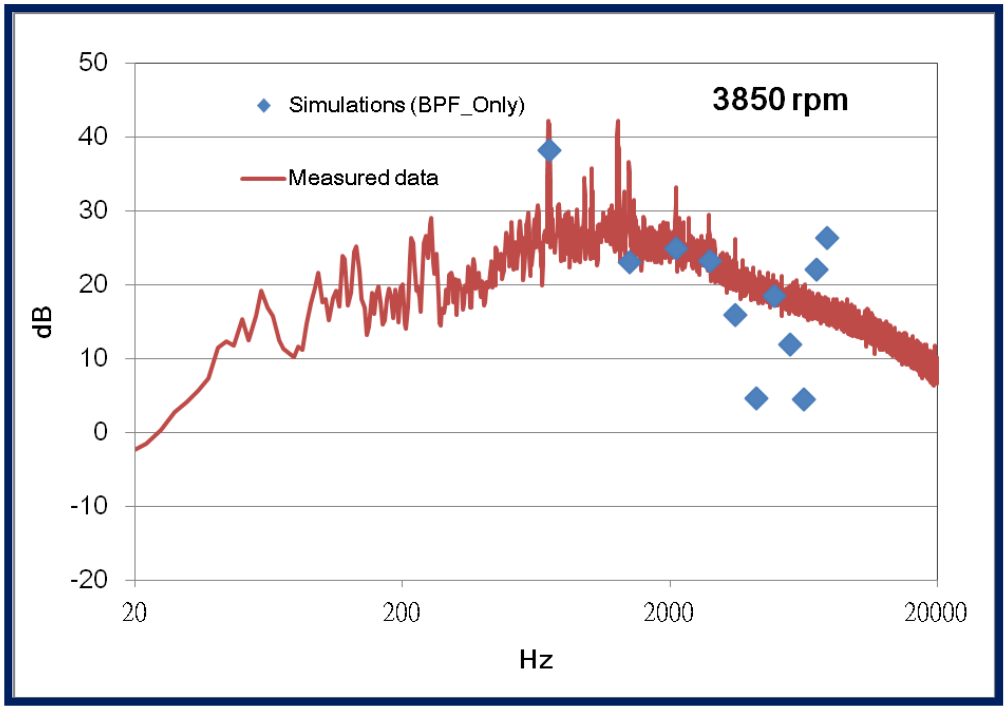
usually lies at this frequency or its harmonic for a fan. The BPF is the frequency that a volume of space is cut through by blades and is equal to the multiplication of rotational speed and blade number of a fan.

In this case, first of all, air flow induced by a rotating fan is simulated where fan is modeled as a moving body in FlowVision. Pressure data extracted from surface of a fan blade is then imported into LMS Virtual.Lab. Acoustics via CGNS files for acoustical simulations.



The SGGR technology allows simulations on the actual CAD geometry and allows modeling rotating bodies in FlowVision. In this case, air flow is induced by blade rotation and vice-versa is also possible.

In LMS Virtual.Lab Acoustics, the pressure data on the blade is used calculate the noise generated by entire fan based on Ffowcs Williams – Hawkings theory (a variety of aero-acoustic analogy). The acoustical BEM method was applied for acoustical simulations, and the housing of the fan was also added as boundary conditions in acoustical simulation. The results show that the simulation matches well with the noise spectrum measured by a sound level meter.



The above graph illustrates comparison of experimentally measured noise levels with the simulation results.

At BPF; the measured noise level is 41.8dB and the simulated noise level is 38.5dB.

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