

POWERFLOW FOR HVAC SYSTEM AND BLOWER NOISE



3DEXPERIENCE®

Applicable industries: Automotive, Commercial Vehicles, Off-Highway Equipment & Trains

As vehicle manufacturers seek to reduce the noise levels experienced by passengers, the noise due to the heating, ventilation, and air conditioning (HVAC) system becomes a target for improved acoustic performance. An HVAC system is complex, consisting of a blower and mixing unit coupled to many ducts through which air is transported to various locations, including faces and feet of front and rear passengers, as well as windshield and side glass defrost. The blower must supply sufficient pressure needed to achieve the desired airflow rates for each thermal comfort setting. Noise is generated by blower rotation and the turbulent airflow in the mixing unit, through the twists and turns of the ducts, and exiting the registers (ventilation outlets). When designing an HVAC system, it is difficult to predict whether noise targets will be met, and achieve multi-disciplinary performance optimization. Compromises between flow, thermal, and acoustic performance can result in late design changes or degraded passenger comfort. The effects of integrating an HVAC system into a vehicle, which changes the performance relative to the test bench, can also result in degraded performance, driving late design changes.

Technical Challenges

Noise heard by passengers due to the HVAC system involves many sources and paths. The blower is a radial fan that generates noise from the interaction of the moving blades with the surrounding air, and the impact of the moving air on nearby static components. This fan noise is acoustically propagated through the complex network of ducts, out of the registers, and into the cabin. The duct and mixing unit airflow noise sources are generated mainly by flow separations and vortices resulting from airflow past the detailed geometric features, and are also acoustically propagated through the system. Noise due to the flow exiting the registers depends on the fine details of the grill and its orientation, and the resulting outlet jets that mix with the ambient air and can impact a solid surface (such as defrosting the windshield). Therefore, the requirements for the numerical flow-acoustic prediction are challenging and include handling of very complex geometry, prediction of fan- and flow- induced noise sources, and their acoustic propagation all the way through the system to the passenger locations. Accurate prediction of fan noise has been a key challenge and an unsolved problem in the field of aeroacoustics.

1.1. SIMULIA Solution

PowerFLOW is the only solution to provide accurate numerical noise prediction for fully detailed automotive HVAC systems. PowerFLOW's unique technology, an inherently transient solution, provides accurate prediction of the complex flow structures, corresponding noise sources, and resulting propagated acoustics to the passenger head space locations, including effects of geometric details throughout the integrated system. The transient flow characteristics and acoustics are fully simulated directly within the PowerFLOW solver, including rotating fan flow and noise (using the true rotating geometry capability), as well as direct prediction of acoustic propagation throughout the system without the need to couple to another solver. PowerFLOW enables you to obtain early noise assessment of proposed designs and evaluate potential design

options, and diagnose and improve noise problems on an existing design. Easy-to-use analysis and visualization capabilities (using PowerACOUSTICS and PowerVIZ) provide identification and insight into the noise sources, including band-filtered pressure analyses to isolate phenomena at specific frequency bands of interest. Optionally, you can convert predicted spectra at passenger locations to audio files for comparative listening to the effects of various design options. Complex geometry handling and efficient post-processing support rapid turnaround time so you can assess and improve the design. Because PowerFLOW provides accurate HVAC system pressures, flow rates, and thermal mixing behavior, it can be used to assess multi-disciplinary design trade-offs. These capabilities enable you to design an HVAC system with optimal aerodynamic, thermal, and acoustic performance using a single model.