Case Study: **CNH Industrial**

Actran Helps Reduce Time to Qualify Wheel Loader for Tough New Noise Standard from 1 Year to 3 Months

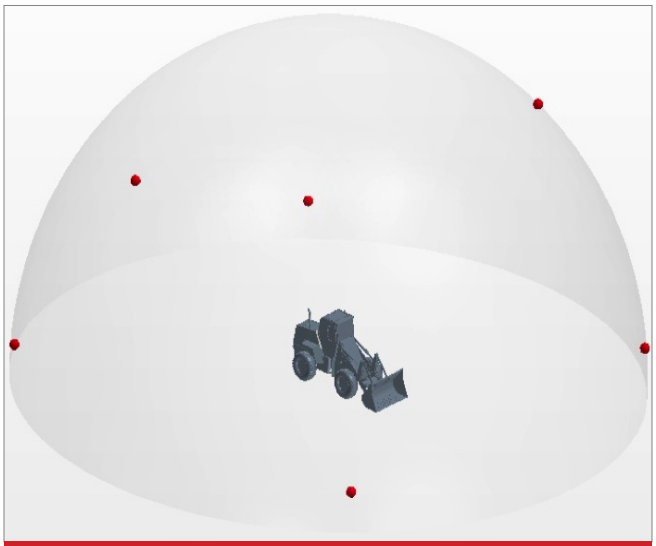
Based on an interview with Panos Tamamidis at CNH

Overview

Noise regulations in a key Latin American country were revised to a lower level, forcing CNH and other construction equipment manufacturers to reduce the noise footprint of their products.

The new specification uses a formula to determine the allowable sound pressure level based on the power of the machine. In this case, the new standard required a noise reduction of about 6 dB(A) relative to the existing design. The noise measurements are based on the ISO 6393 standard. Six microphones are arranged in a hemisphere at specified locations around the equipment and the sound pressure level is measured while the equipment is operated under high idle conditions.

CNH engineers ran physical tests in an effort to better understand the noise contributors. Among many things, they turned the fan on and off, turned the hydraulic pump on and off, and masked the sound coming from the exhaust to better understand the relative importance of the noise contributors. The analysis showed that the fan was the number one contributor.



Test/analysis set-up according to ISO 6393

“Simulating the acoustic performance of alternative approaches to noise remediation helped us meet the tighter noise specification in about three months.”

Panos Tamamidis, Global Manager at CNH Industrial

Challenge

In the past, CNH engineers relied on physical testing to evaluate potential design approaches. One problem with this approach was that a prototype had to be created for each potential design. In the case of the fan, this required ordering a fan and sometimes a shroud from a supplier which could take a few weeks to a few months to deliver. Then physical testing had to be performed which took several more weeks assuming that the weather cooperated. The amount of data provided by physical testing is limited which meant that engineers often had to guess at the best way to improve the design. “We have for a long time been able to simulate noise sources with computational fluid dynamics (CFD) but we did not have an accurate method to simulate the propagation of noise generated by these sources,” said Dr. Panos Tamamidis, Global Manager, CFD, NVH and Acoustics for CNH Industrial.

“We started working with MSC Software a few years ago to evaluate Actran,” Tamamidis said. “Actran demonstrated its ability to accurately simulate our existing products so we began introducing this capability into our product development process.” In this application, CNH engineers performed a transient simulation of the fan with Star-CCM+ CFD software from CD-Adapco. They imported the results including velocity, density and pressure fields into Actran which translated them from the time to the frequency domain and interpolated them from the CFD mesh to the acoustic mesh. Actran computed the radiated acoustic field, calculating the acoustic pressure, velocity or intensity maps and frequency response functions of sound pressure and power levels.

Solution/Validation

The simulation results provided by Actran were much more comprehensive than the information that generated by physical tests, which helped CNH understand what improvements needed to be made in the fan. CNH engineers categorized the fan noise into noise at the blade-pass frequency, the rate at which the blades pass by a fixed position, and broadband noise, which is more or less equally distributed across the frequency spectrum. Engineers concluded that to meet the specification they needed to reduce the fan noise by a total of 5 dB(A) including a reduction of 4 dB(A) at the blade-pass frequency and 1 dB(A) in broadband noise. The balance of the noise reduction was to be achieved by reducing the exhaust noise by 1 dB(A).

CNH engineers simulated the performance of alternate fan designs simply by changing the CFD model, re-running the simulation and then running a new acoustic simulation. Engineers determined that the fan speed needed to be lowered to reduce the noise at the blade-pass frequency. They looked at many different fan designs with varying blade profiles, numbers of blades, shroud designs and dimensions, with the goal of delivering the same airflow over the radiator -- to maintain constant cooling performance -- at a lower fan speed. To reduce broadband noise they focused on operating the fan at more efficient point on the fan curve to reduce turbulence. After 10 CFD iterations, they found a fan that operates efficiently at 2200 rpm to provide the needed reduction in both blade pass frequency and broadband noise. An acoustic simulation showed that

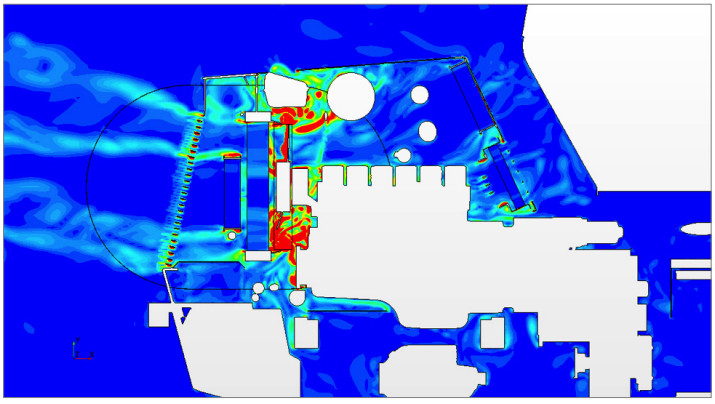
Key Highlights:

Product: Actran

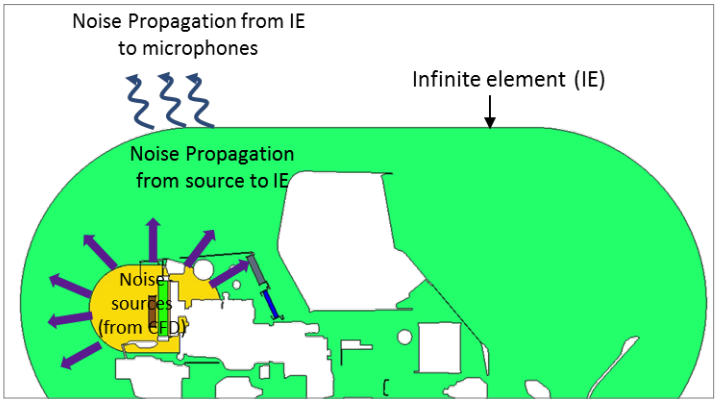
Industry: Heavy Machinery, Construction

Benefits:

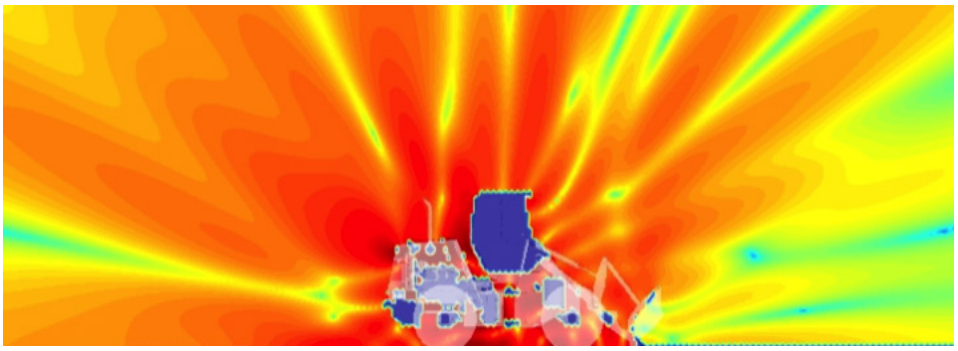
- Quicker understanding of noise contributors
- Simulations proved more comprehensive than physical test
- Met noise specifications faster
- Able to ensure acoustic performance of new designs



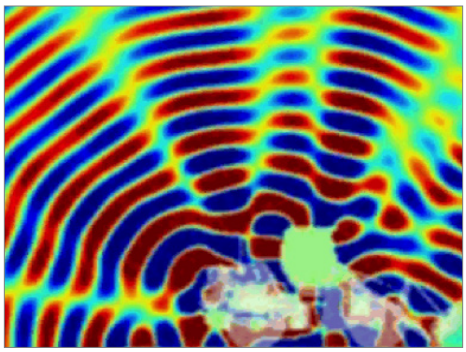
CFD results show vorticity contours at the vertical middle plane close to the fan



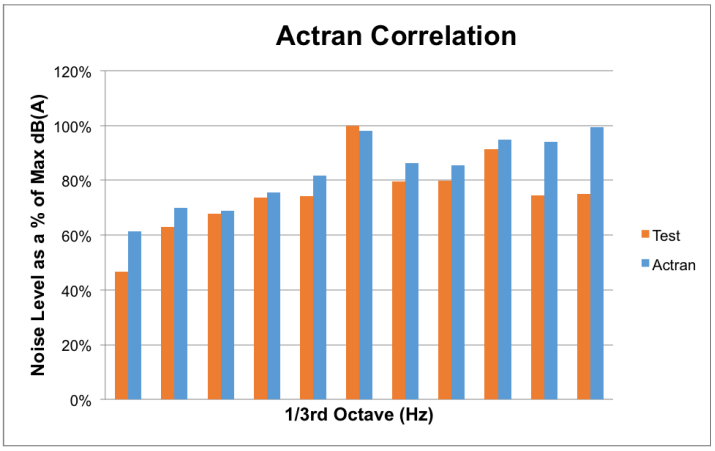
Setup of aero-acoustics model in Actran



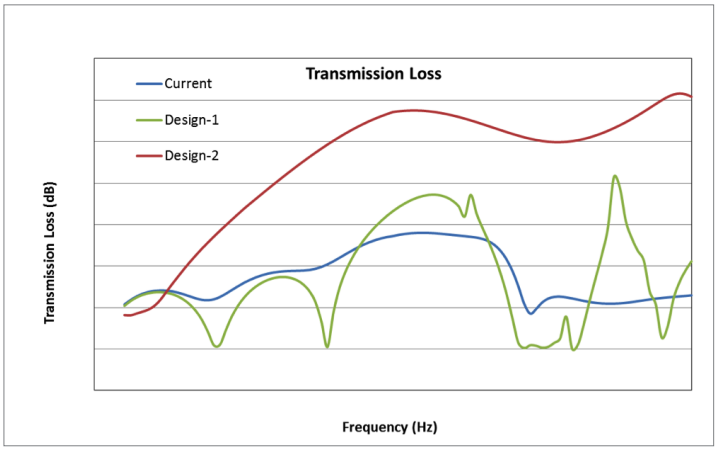
Actran results: sound pressure level (SPL) contours at blade-pass frequency



Actran results: sound propagation (phase) at blade-pass frequency



Correlation of Actran fan noise prediction with test data



Transmission loss between inlet and outlet of the muffler

this design would meet the tougher acoustic regulations. Engineers also used Actran to evaluate alternative muffler designs and found one that delivered the needed noise reduction. At this point a prototype was built and its acoustic performance closely matched the simulation results.

Results/Benefits

"Simulating the acoustic performance of alternative approaches to noise remediation helped us meet the tighter noise specification in about three months," Tamamidis said. "If we had to rely on physical testing for this project, it would have taken at least a year to reduce noise to the levels needed to meet the new spec. Due to successful projects such as this, we have integrated Actran into our product development process and use it on a regular basis to help ensure the acoustic performance of new designs and solve problems with existing designs."

About CNH Industrial

CNH Industrial designs, produces and sells agricultural and construction equipment, trucks, commercial vehicles, buses and specialty vehicles and powertrains. The company's products include tractors and combines, excavators, wheel loaders, trucks, buses, firefighting and police vehicles and powertrain solutions for on and off road and marine applications. CNH Industrial operates in more than 190 countries with 12 brands, 64 manufacturing plants, 49 research and development centers and a workforce of more than 69,000 people.

For more information on Actran and for additional Case Studies, please visit **www.mscsoftware.com/actran**

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