Ansys

Ansys + Eicher Tractors

"Ansys Mechanical software helped in analyzing the transmission loss — and Ansys CFD the backpressure — of a tractor muffler, which has shown good correlation with test results and helped in improving its performance."

Pawan Singh
Senior Manager – CAE / Eicher Tractors (a unit of TAFE Motors and Tractors Limited, a wholly owned subsidiary of TAFE)

A muffler in the exhaust system of a tractor decreases the sound output while increasing the backpressure of the flowing exhaust gases. Transmission loss (TL) refers to the reduction in acoustic noise provided by a muffler and needs to be maximized (a higher TL means a quieter tractor). The engine must work against the backpressure; the higher the backpressure, the less power delivered to the power train, so backpressure must be minimized.

Simulation Evaluates Transmission Loss and Pressure Drop of a Tractor Muffler, Saving Time and Cost

/ Company Description

Eicher Tractors (a unit of TAFE Motors and Tractors Limited, a wholly owned subsidiary of TAFE) was established on April 24, 1959 in technical collaboration with the reputed Gebr. Eicher of Germany. The corporation is a unit of Tafe Motors and Tractors Ltd., a wholly owned subsidiary of TAFE. It offers 16 models and more than 150 variants, ranging from 24 hp to 100 hp models and is the market leader in low/middle horsepower air-cooled tractors. It is the second top-selling tractor brand in India by volume. The Tafe-Eicher group farm sector also has a presence in Asia, Europe and Africa.

/ Challenges

The main challenges were to maximize transmission loss and minimize backpressure in a new tractor muffler design while keeping development costs low and accelerating time to market. Engineers also had to ensure that design parameters and muffler performance predicted using Ansys simulation solutions were validated by experimental testing of the new design.

/ Technology Used

- Ansys® Mechanical™
- Ansys® Fluent

/ Engineering Solution

Ansys Mechanical was used to perform acoustic harmonic analysis to simulate and maximize transmission loss. Computational fluid dynamics (CFD) using Ansys Fluent was performed to simulate and minimize the backpressure of the muffler in the exhaust system. Experimental results obtained on a prototype muffler based on the optimized Ansys design closely matched the simulation results.
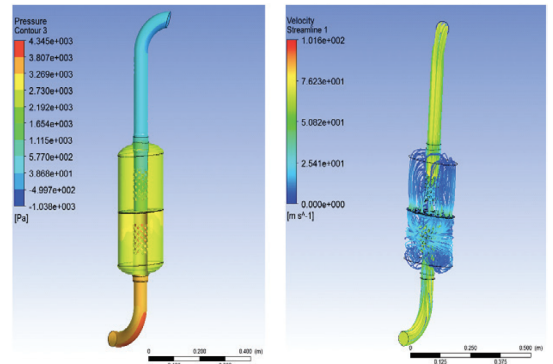
Methodology Adopted

- The exhaust fluid volume was extracted to determine the transmission loss of the muffler.
- The model was meshed in Ansys Mechanical with acoustic higher order tetrahedral elements (Fluid221).
- The density and velocity of sound were defined for air.
- The first harmonic was determined to occur at 53.725 Hz; acoustic harmonic analysis was performed for the first 10 harmonics.
- The mass source was given at the inlet port of the muffler such that the incident pressure at the inlet was unity.
- The acoustic harmonic analysis was performed using Ansys Mechanical to find the transmission loss between the inlet and outlet ports of the muffler.

Backpressure Analysis

- Hybrid meshing was used to accurately model the perforated holes of the muffler.
- A steady state CFD compressible flow simulation was performed using Ansys Fluent, with air as the working fluid and constant thermo-physical properties corresponding to the inlet temperature.
- The muffler Inlet mass flow and temperature at rated RPM were used as inputs.
- The pressure drop from the CFD simulation was validated by experimental tests on the new baseline muffler design.

Benefits

- Reduced design cycle time from 20 weeks to 8 weeks (approximate values).
- Reduced cost — including design optimization, testing, manufacturing, transportation and overhead costs — by 40%.
- Decreased time to market.
- Established a new process for design, CAE and validation, which increased productivity.
- Optimum muffler design meets all design standards.

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