Multiphysics Simulations of Automotive Muffler

A. Prasad[1], R. C. Thiagarajan[1]
1. ATOA Scientific Technologies, Bengaluru, India

Introduction: Internal combustion engines act as the heart of automotive vehicles. The engine mechanism generates loud exhaust noise during combustion process, which is the main cause of traffic noise pollution. Mufflers plays an important role in reducing exhaust noise, hence depend on its complex design followed by trial and error methods. In this experiment a reactive muffler model is analyzed numerically to predict the muffler performance compared to traditional built & test methods.

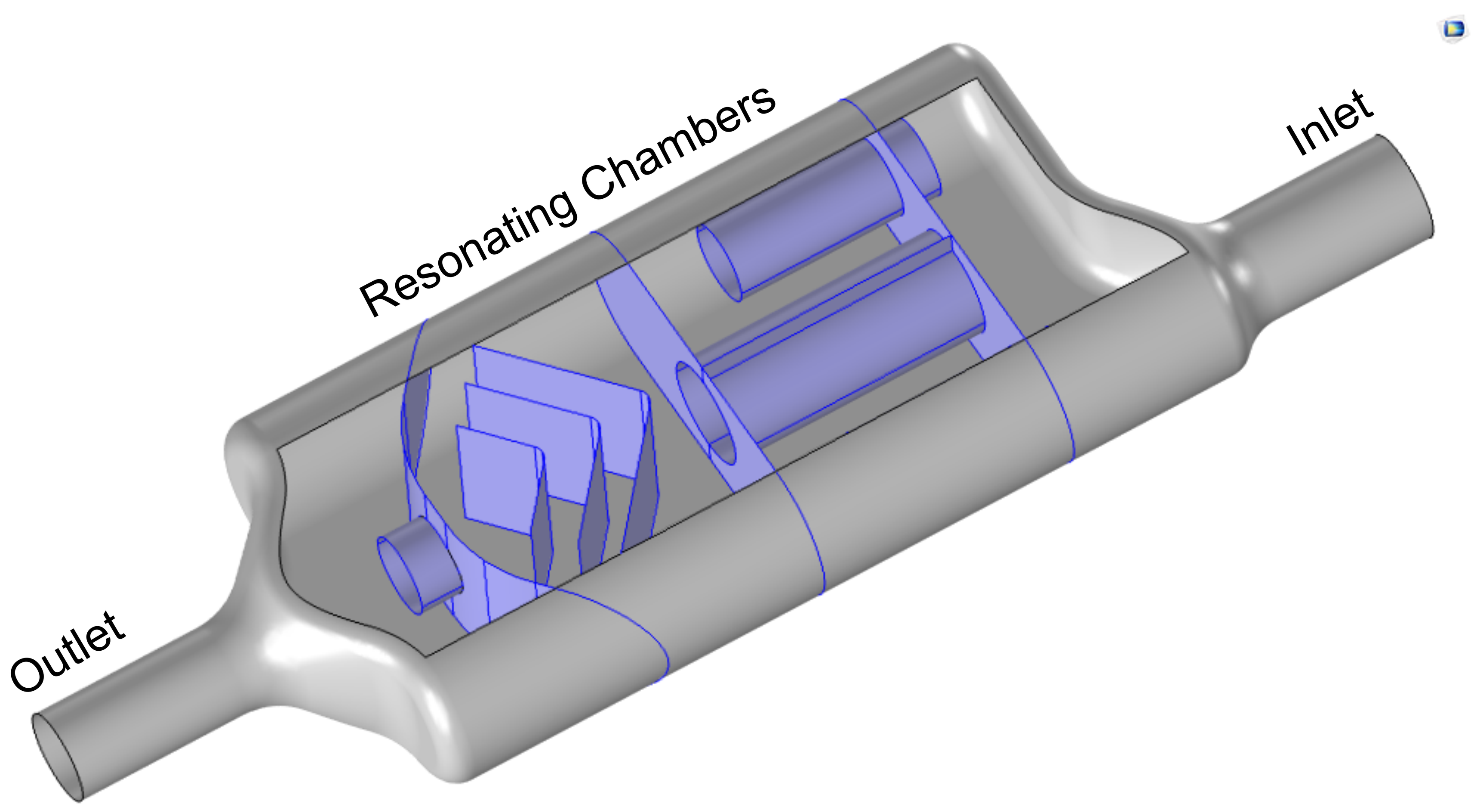

Fig 1. CAD Model of Muffler

Computational Methods: Numerical CAE Simulation model of a reactive muffler is developed using COMSOL 5.1. The numerical problem is solved using Pressure Acoustics Frequency Domain interface in frequency range of 100 Hz to 2000 Hz & 1 Pa incident pressure. The governing equations are shown below.

$$\nabla.\left(-\frac{\nabla p}{\rho}\right)-\frac{\omega^2 p}{c^2\rho}=0$$

$$TL = 10\log\left(\frac{P\,in}{P\,out}\right)$$

ρ = Density, **c** = Speed of Sound
ω = Angular Frequency
TL = Transmission Loss

Results: Simulation results shows the generated Sound Pressure level & Transmission Loss for the muffler design in a specified frequency range. A minimum exhaust Sound Pressure (2.5 dB) at tailpipe, respective to higher Transmission Loss (90 dB) is obtained at 1350 Hz of frequency.

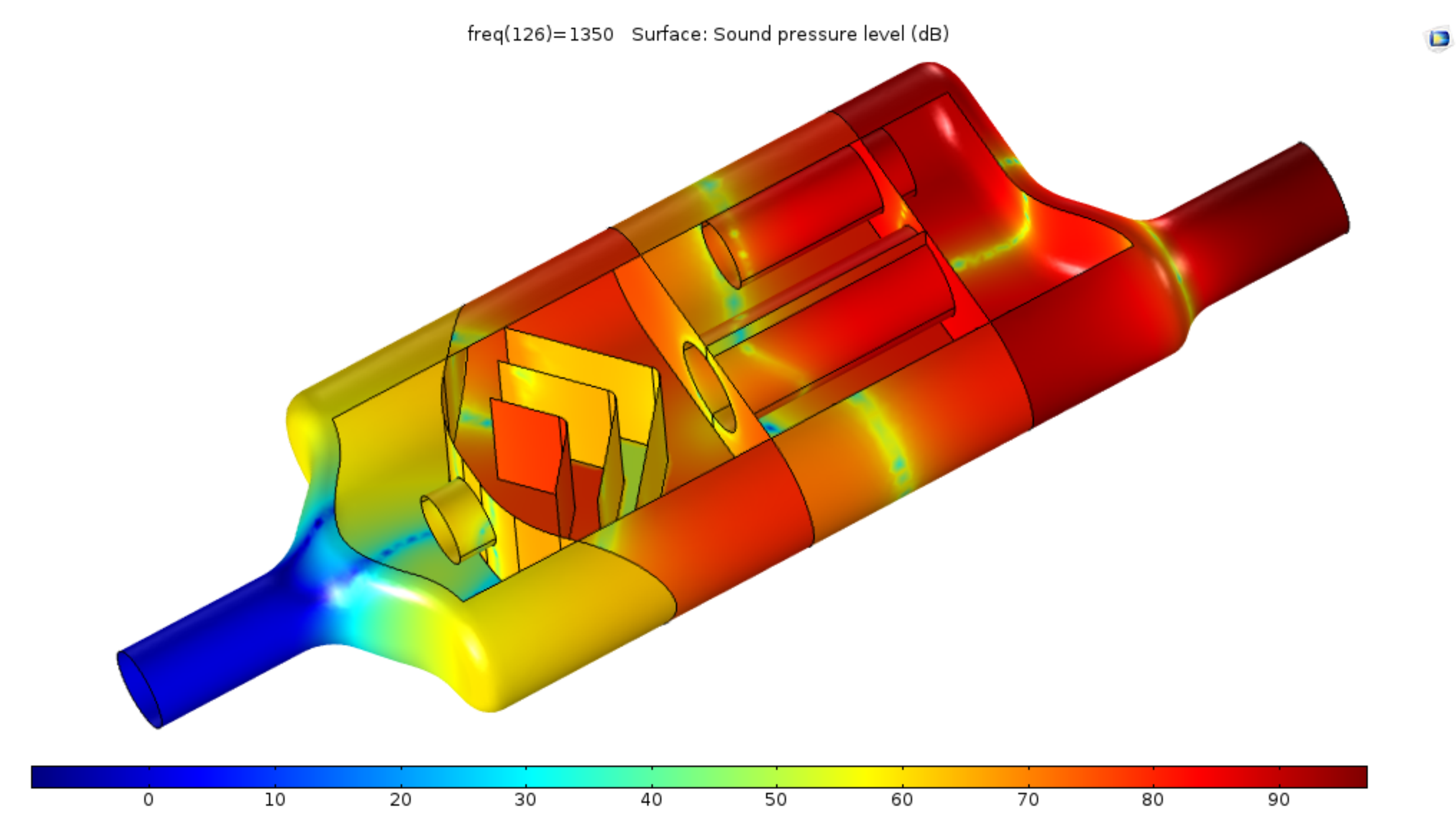

Fig 2. Sound Pressure level at frequency 1350 Hz

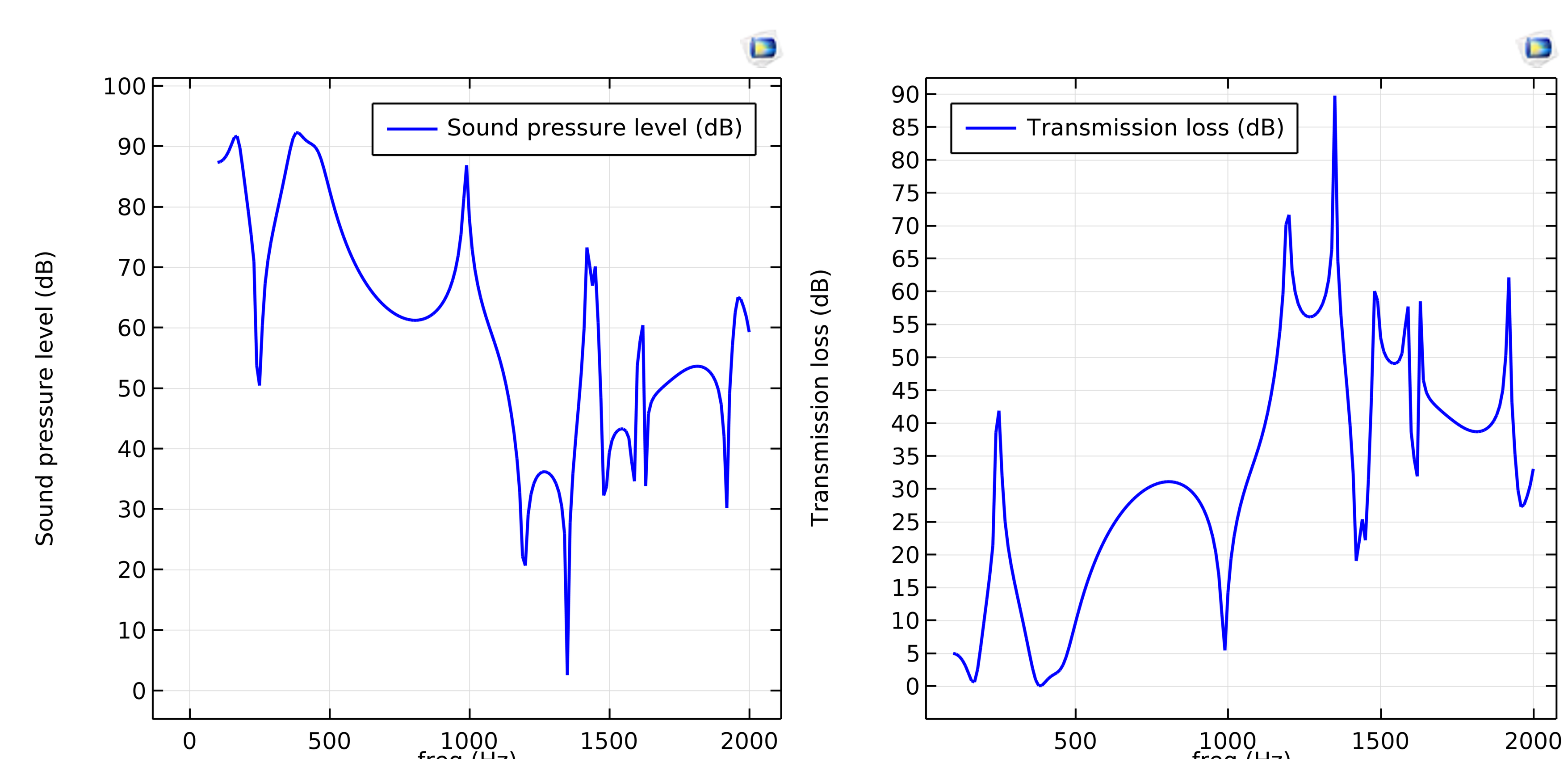

Fig 3. Sound Pressure level and Transmission Loss

Conclusions: The numerical modelling methods helped to predict performance of complex muffler design and save design time compared to traditional built and test methods. This numerical model can further be used to optimize muffler-design, for superior sound cancellation and higher engine performance in automobiles.

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