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Development of a Non-Reflective NSCBC for the Multi-Dimensional Non-Linear Acoustic Simulation of Silencers for Internal Combustion Engines

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Abstract

When the acoustic performance of a device is evaluated, perfect anechoic terminations are required. In some instances – such as simulation of engine mufflers – classic models for non-reflecting boundary conditions lead to incorrect results, due to the residual reflections that this kind of boundary condition inevitably causes.

In the present paper, the implementation of a non-reflective Navier-Stokes Characteristic boundary condition for multidimensional, nonlinear acoustics simulation of silencers has been developed by solving the full system of governing equations (mass, energy and momentum conservation): using the Local-One-Dimensional-Inviscid relations (LODI), it is possible to substitute some differential terms with appropriate, fully-determined quantities.

A non-reflecting boundary condition has been implemented in the OpenFOAM® framework as a part of a compressible solver and it has been applied to calculate the acoustic performance of real silencers. The governing equations are solved in an explicit fashion at the beginning of each PISO iteration. Results presented in the paper show a very good agreement between calculations and experimental measurements, on different muffler geometries.

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