Immersed porous coating

Simulation and Optimization of Porous Coatings for Aeroacoustic Applications

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In Short

- Numerical aeroacoustics
- Porous materials
- Adjoint optimization

Sound generated by the interaction of fluid with structures plays a crucial role in numerous engineering applications. One example is the flow around a circular cylinder, that exhibits a phenomenon known as the Karman vortex street, where alternating vortices are periodically shed depending on the inflow conditions. These vortices create distinct flow patterns and contribute significantly to generating aerodynamic noise, including the notable aeolian tone. Reducing this noise is crucial in engineering applications to enhance performance and efficiency. One effective approach involves the use of porous coatings. These coatings can modify flow dynamics around the cylinder, mitigating noise emissions by altering the interaction of the flow with the cylinder surface. This project aims to analyze and optimize the aeroacoustic sound generated by flow around a porous-coated bluff body, such as a cylinder. We utilize the fully compressible Navier-Stokes equations with volume penalization as governing equations to accurately capture the complex interactions between fluid flow and the porous coating. Through this innovative method, we aim to develop effective strategies for noise reduction in aeroacoustics by optimizing porous coatings tailored to specific applications. This simulation approach allows for simulating aeroacoustics without relying on traditional acoustic analogies, which can be limiting. Additional advantages of this approach include its independence from specially prepared grids and its potential for parallelization. The project involves a grid study to obtain high-fidelity reference data, followed by optimizing the porous coating under various constraints to minimize noise generation.

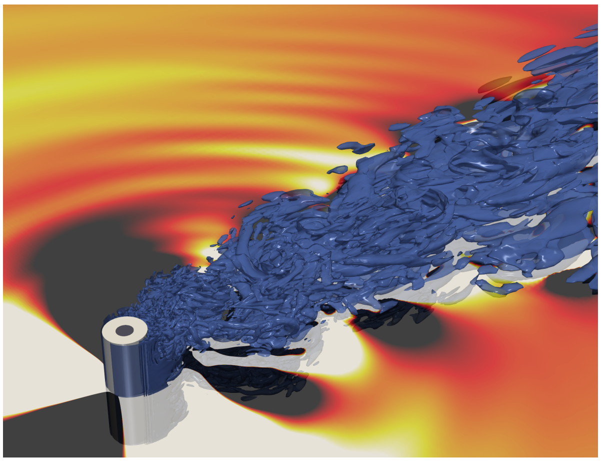

Figure 1: *Snapshot illustrating the simulation of a porous coated cylidner. Acoustic waves are visualized by summing the density gradient in the x-y plane (yellow-red), while vortex structures are depicted using an iso-surface of the Q-criterion (blue).*

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https://www.tu.berlin/cfd

More Information

[1] Lemke, M., Reiss, J., *The Journal of the Acoustical Society of America* **153(2)**, 1219–1228 (2023).

[2] Stein, L., Straube, F., Weinzierl, S., Lemke, M., *The Journal of the Acoustical Society of America* **148(5)**, 3075–3085 (2020).

[3] Lemke, M., Vincenzo C., Giannetti F., *The Journal of Fluid Dynamics Research* **53(1)**, 015506 (2021).

DFG Subject Area

402-04 Acoustics, 404-03 Fluid Mechanic