Application of an equivalent fluid model for the simulation of sound absorption properties of microperforated panels in 3D environments

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The acoustical pre-evaluation of new designs in the fields of HVAC-systems, automobiles and aircrafts becomes more important as the regulations to reduce noise pollution become more strict. Beside the standard sound absorbing fibrous materials and foams, the popularity of microperforated panels (MPP) increases due to their special characteristics, like tunable broadband high sound absorption, robustness in harsh environments and durability.
The behaviour of such panels can be modelled via an equivalent fluid, where physical viscous and thermal effects are accounted for with a modified density ($\tilde{\rho}_{eq}$) and bulk modulus ($\tilde{K}_{eq}$). Within the finite element software CFS++[1] a modified Helmholtz equation

$$\frac{\omega^2}{\tilde{K}_{eq}}\tilde{p}' + \bigtriangledown \cdot \frac{1}{\tilde{\rho}_{eq}} \bigtriangledown \tilde{p}' = 0 \tag{1}$$

is solved for the sound pressure field in the porous absorber. The MPP is modelled with the parameters porosity, radius of the perforations and thickness of the plate in accordance with the Johnson-Champoux-Allard formulation [2].
In this contribution we investigate and compare the numerical simulation of the transmission loss of a simple expansion chamber with physical 4-microphone-measurements. The measurement design allows for the analysis and assessment of different MPP arrangements within a frequency range up to 8 kHz as well as the quality of the porous absorber model both in the case of a plane wave grazing sound field and for the propagation of higher order modes.

References

[1] M. Kaltenbacher. Numerical Simulation of Mechatronic Sensors and Actuators: Finite Elements for Computational Multiphysics, 3rd Edition. Springer (2015)

[2] L. Jaouen, F-X. Bécot. Acoustical characterization of perforated facings, J. Acoust. Soc. Am., Vol. 129, No. 3, March 2011

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