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Andersen, Peter Risby; Cutanda Henriquez, Vicente; Aage, Niels; Marburg, Steffen

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An Acoustic Hypersingular Boundary Element Formulation Including Viscous and Thermal Losses

Peter Risby Andersen[1], Vicente Cutanda Henríquez[1], Niels Aage[1], Steffen Marburg[2]

[1] Centre for Acoustic-Mechanical Micro Systems, Technical University of Denmark, Kgs. Lyngby, Denmark

[2]Vibroacoustics of Vehicles and Machines, Technical University of Munich, Garching b. München, Germany

To correctly estimate the behavior of small complex acoustic devices, the inclusion of viscous and thermal losses becomes necessary. Practically all domain losses in small setups take place in very thin layers near boundaries. Finite Element formulations including losses exist where boundary layers need to be properly discretized, adding to the computational cost [1]. On the other hand, meshing of boundary layers can be avoided by using the Boundary Element Method [2,3]. However, the existing Boundary Element formulation with losses relies on the use of tangential finite difference pressure derivatives, which might lead to computational difficulties at low frequencies where the element size is much smaller than the wavelength.

This work presents a new implementation of the acoustic Boundary Element Method with losses, where by means of an extra set of hypersingular tangential derivative Boundary Element equations, it is possible to avoid the use of the troublesome first and second finite difference pressure derivatives in the coupling of the fundamental equations. The new proposed formulation introduces, however, hypersingular integration kernels that require nodal C^1 continuity [4]. These difficulties will be discussed and the new implementation will be evaluated through simple test cases.

References

[1] P. Risby Andersen,V. Cutanda Henriquez, N. Aage and S. Marburg, *Numerical Acoustic Models Including Viscous and Thermal losses: Review of Existing and New Methods*, Proc. DAGA 2017, 6-9 March 2017, Kiel, Germany.

[2] V. Cutanda Henriquez and P. M. Juhl, *An axisymmetric boundary element formulation of sound wave propagation in fluids including viscous and thermal losses*, Journal of the Acoustical Society of America **134**(5) (2013), 3409–3418.

[3] V. Cutanda Henriquez and P. M. Juhl, *Implementation of an acoustic 3D BEM with visco-thermal losses*, Proc. Internoise 2013, 15–18 September 2013, Innsbruck, Austria.

[4] R. Gallego and A. E. Martinez-Castro, *Boundary integral equation for tangential derivative of flux in Laplace and Helmholtz equations,* International journal for numerical methods in engineering, **66** (2005), 334-363