Numerical Acoustics – Spring 2025

Exercise 10: Viscous and thermal losses in axisymmetrical BEM

In this exercise an implementation of viscous and thermal losses using the Boundary Element Method is employed in the calculation of the sound field around an oscillating (first order) sphere. The results are compared with an analytical solution. The implementation is made in axisymmetrical BEM.

Example with viscous and thermal losses

The script *VT_OscillatingSphere* in the *ViscoThermal* folder shows the implementation with losses of a hard sphere vibrating along the z axis. The implementation is finished, and the exercise will consist on identifying the calculation steps developed in the theory part and analyzing the results.

The details of the implementation are described in the publication: Cutanda Henriquez, V.; Juhl, P. M., *An axisymmetric boundary element formulation of sound wave propagation in fluids including viscous and thermal losses*. It has been uploaded in the lecture contents module. This implementation is similar to the 3D version shown in the course slides.

Items to observe:

1) Assembling of the matrix equation with losses: acoustic, thermal and viscous parts. Note the equivalence of the assembled equation (*ABah* in line 63, *ABv* in line 71 and *lhs* in line 77) with equation (26) in the paper.
2) Run the code down to line 106 (boundary results). What could be the reason for some different results for the normal viscous velocity on the z-axis? Examine the function *genderiv* in line 35. Note also that the 3D version in the lecture slides does not show this effect.
3) Continue running the code down to line 157. Then draw the figures that come afterwards one by one. These are results on field points situated in the boundary layer, very close to the moving sphere. Note the effect of the movement of the sphere on the boundary layer, given the non-slip condition. What would happen in a lossless case?

The calculations can take some time to run.

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