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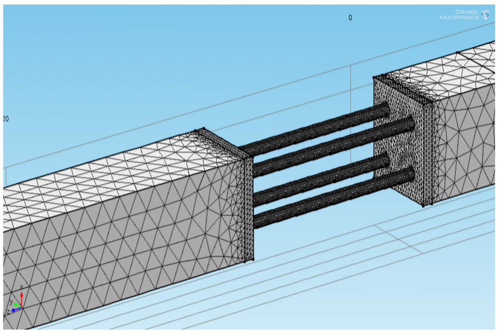
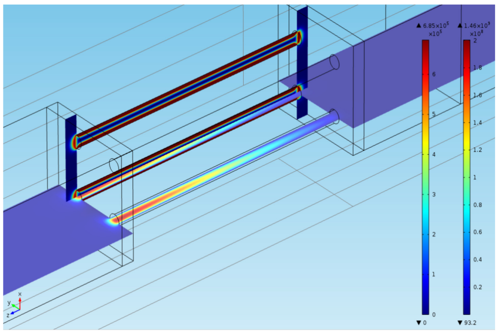
Numerical Study of Visco-Thermal-Effects on Sound Waves Propagating Through Narrow Spaces

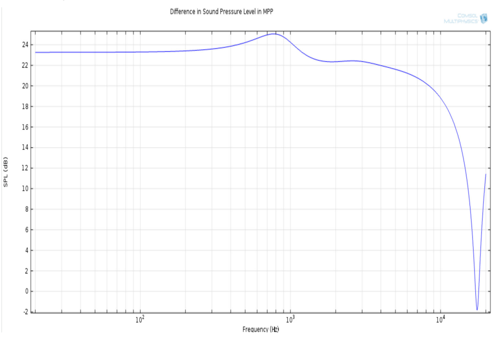
Simulating the Effects of Friction on a Molecular Level



Mesh of a Micro Perforated Plate



Frequency Displayed: 17.5 kHz Vertical Slice: Power Dissipation Losses Horizontal (W/m3); Slice: Power Intensity (W/m2)



Loss in sound pressure level in dB between inlet and outlet of the perforation within the frequency band from 20 Hz to 20000 Hz

Problem: Speakers in cars need to be protected against physical impact from passengers or transportation items. For that reason mostly plastic based perforated protection sheets are placed in front of speakers. Such protection sheets display an unwanted obstacle as sound waves are bound to propagate through them. Viscous forces in fluids cause internal friction, thus attenuating the sound pressure level. Even though the amount of thermal dissipation losses is unknown, the influence is in most cases negligible. However, in this thesis the influence shall still be investigated as to determine how great the impact is on the quality of the sound.

Proceeding: The situation is approached using two different acoustic models provided in COMSOL Multiphysics®. The primary model "PRESSURE ACOUSTICS” solves the pressure in an inhomogeneous Helmholtz-equation. Viscous forces, velocities as well as thermodynamic properties of air are neglected. The model "THERMO ACOUSTICS” on the other hand solves the full set of linearised Navier-Stokes-equations. Pressure as well as temperature and the velocity field, including viscous forces are taken into account. This equals five variables to solve compared to only one in the Pressure Acoustics model. Additionally a comparison simulation if performed with ANSYS CFX® as to determine the numerical differences between finite-elements used in COMSOL compared to finite-volumes used in CFX.

Result: Data from the simulation of the protection sheet is confidential and cannot be published. The results shown are from an alternative simulation of a micro perforated plate. MPPs are mounted on ceilings when sound disturbances, such as chatter and other noise sources are wished not to be heard. Sound waves are therefore extinguished by transforming the sound energy completely into heat. This is achieved when sound waves propagate through tiny holes (perforations), such as the ones shown in fig. 2 and 3. The effects on drop in sound pressure level between inlet and outlet of the perforations are displayed in figure 4.MODELS: The application of the TA-model makes only sense when one intends to simulate intentional sound absorption. In any other cases, e.g. sound distribution of a noise source in a room, the differences between the TA- and PA-models are negligible.CFX: The results indicate that numerical diffusion of finite volumes on a the scale of a MPP are too great. However, further inquiries are still required.