Abstract

Title of the document: **Design of cellular solid for acoustic noise cancellation: A lattice Boltzmann approach**

Rajat Sunil Zope, M. Tech, July 2020

Thesis advisor: Dr. Pratyush Dayal
Department of Chemical Engineering
Indian Institute of Technology Gandhinagar

Acoustic technologies based on Passive Noise Cancellation (PNC) has emerged as an excellent noise reduction strategy for both small and large environments. In general, PNC primarily focuses on designing specialty cellular materials that can effectively attenuate unwanted sounds by virtue of its intrinsic morphology. Here, we develop Lattice Boltzmann Model (LBM) to simulate wave propagation in viscoelastic cellular materials and use it to design cellular morphologies for sound-absorbing materials for a variety of acoustic scenarios. To begin with, we validate our viscoelastic LBM through the computation of attenuation coefficients, for special cases of wave propagation in viscous fluids and viscoelastic solids, and found that our LBM calculations are in good agreement with the analytical results. Based on these validations, we extend our simulations to design various morphologies of cellular viscoelastic solids for acoustic noise cancellation.

In order to establish the effect of cellular solid morphologies on the wave propagation we analyzed the acoustic characteristics of transmitted and reflected waves generated from the fluid-structure interactions. Our findings indicate that cellular solids with vertically aligned perforations are best suited for attenuation of transmitted waves whereas cellular solids with circular perforations are excellent for attenuating the reflected waves. Thus, in real-life scenarios, for sound inhibition and noise filtration systems, cellular solids with vertically striped perforations are most effective. On the other hand, for designing the indoor acoustic systems, the cellular solids with large circular perforations are a better choice. In essence, we have not only successfully implemented viscoelastic LBM for simulating the sound waves through multiphase media but also design cellular solids for a variety of acoustic applications. We envisage that our LBM framework is a significant step towards simulating fluid-structure interactions in multiphase viscoelastic materials.