The Development Of An Analytical Model For The Acoustics Of A Porous Melamine Foam Material

B.P. Semeniuk[1], E. Lundberg[1], P. Göransson[1]

[1]KTH Royal Institute of Technology, Sweden

Abstract

COMSOL Multiphysics® has proven to be an invaluable "virtual laboratory" tool in assisting our development of a new generation of efficient analytical models describing the acoustics of highly porous fibre and foam materials. From the definition of the physical relations describing the fundamental viscous dissipation and oscillatory heat transfer mechanisms for microscale cylindrical geometries, we have been able to use validated COMSOL Multiphysics® Thermoviscous Acoustics and Fluid-Solid Heat Transfer models to conceptually scale-up the approach firstly towards arrays of fibres representative of thermal-insulation materials, and now targeting open porous foam materials having predominately cylindrical struts, like the Melamine foam material considered here.

This analytical approach requires only geometrical microstructure information and constitutive material parameters, thus allowing for a very efficient prediction of the acoustics of these porous materials and also other new material concepts, without the need for the inverse estimation of transport parameters from actual physical material samples.

In this paper, we begin with a representative Kelvin Cell foam geometry typical of Melamine foam materials, and utilize high resolution COMSOL Multiphysics® creeping flow CFD, Thermoviscous Acoustics and Heat Transfer simulations to validate the extension of our analytical relations for microstructural viscous energy dissipation and oscillatory heat transfer towards the three-dimensional foam geometry. This extension provides very promising results for the Melamine foam material, and can then be implemented within the Transfer Matrix approach as described in our previous work, allowing for further predictions of the acoustics of the porous material.

Figures used in the abstract

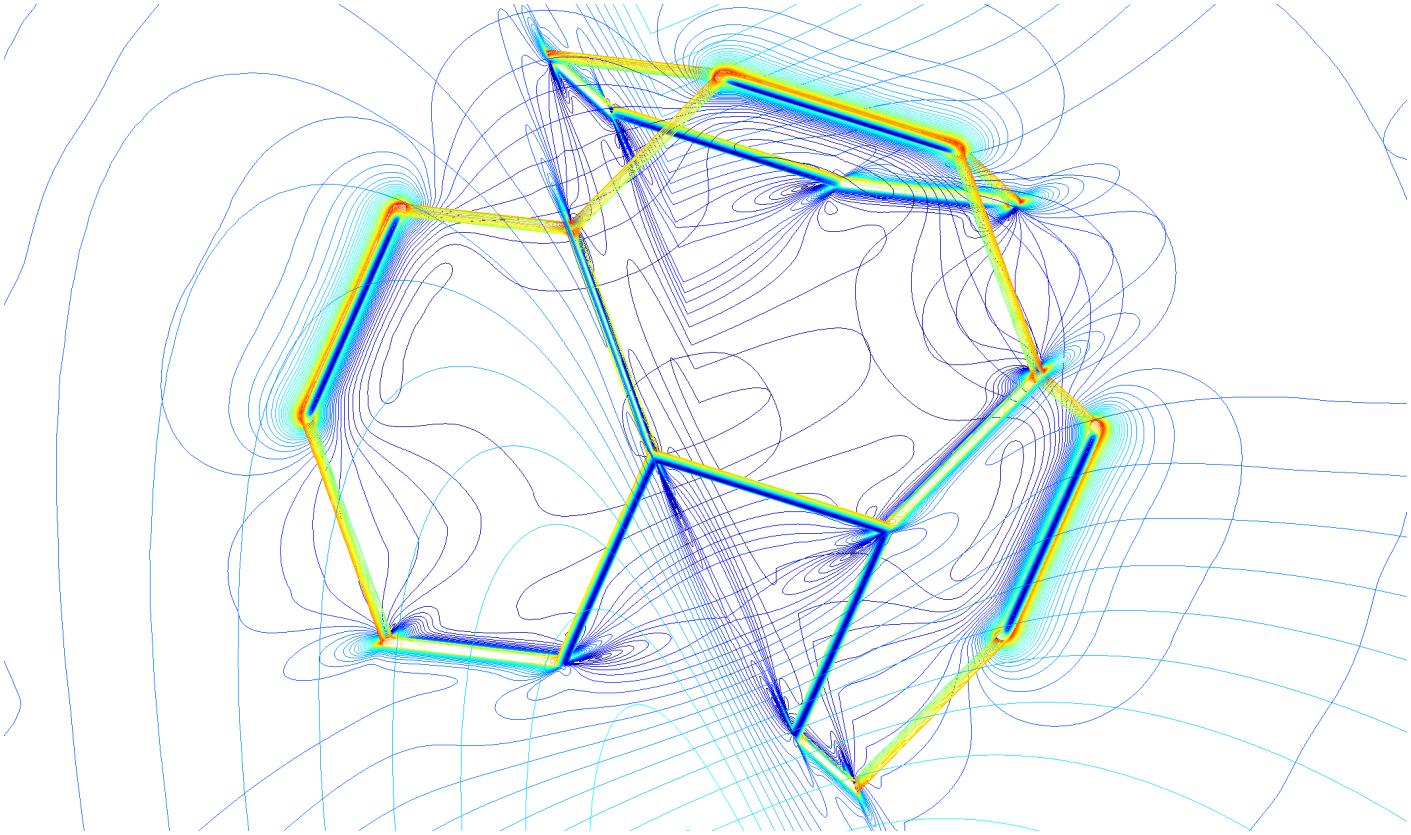

Figure 1 : Velocity field surrounding the struts of a symmetric Melamine foam cell.

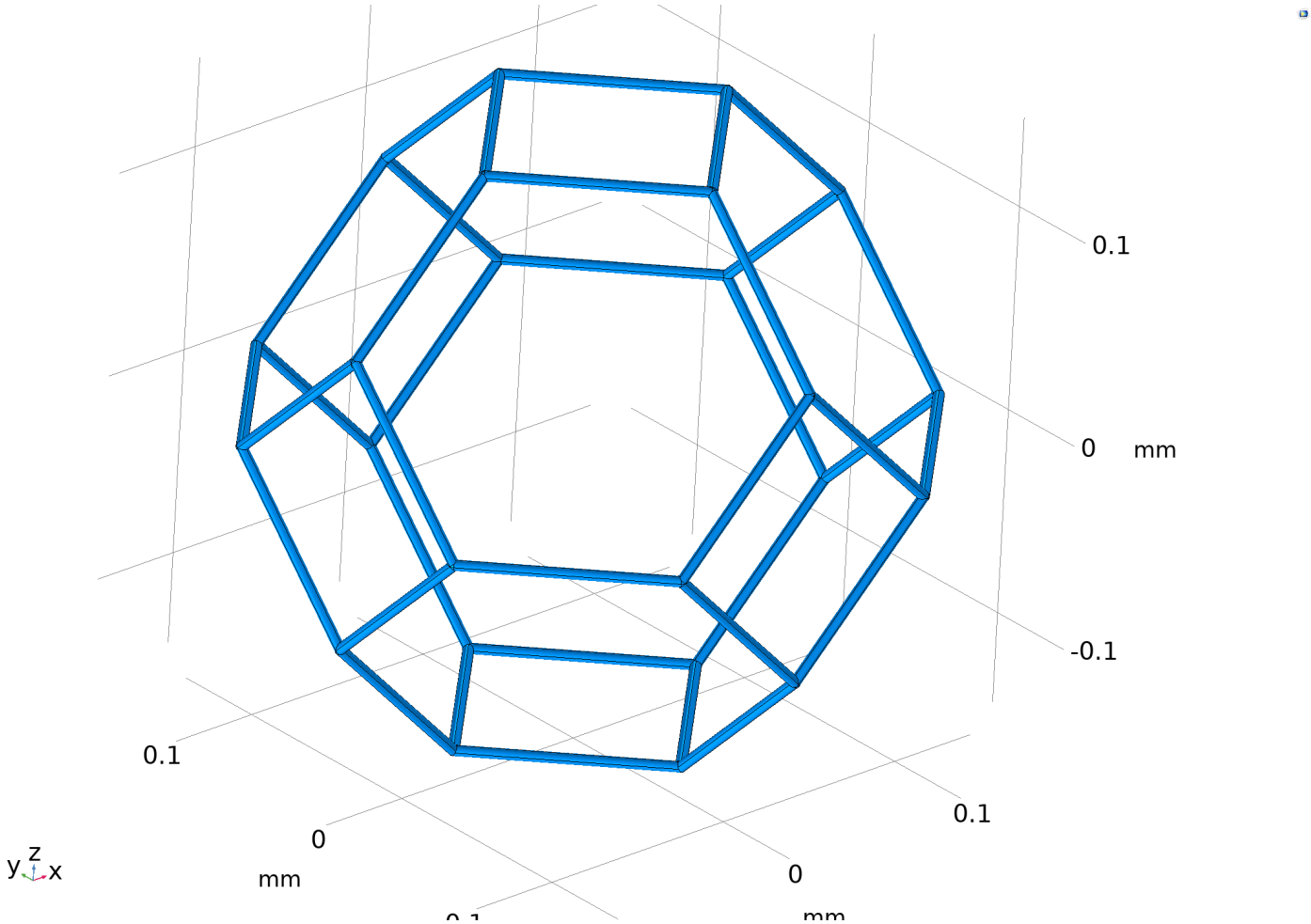

Figure 2 : Melamine foam cell geometry.