Viscothermal Damping in Thin Gas or Fluid Layers

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Introduction

For wave propagation in thin gas or fluid layers, the effects of viscosity and thermal conductivity have to be accounted for. These effects can introduce a significant dissipation of energy. A model to describe viscothermal wave propagation was developed. It includes the effect of inertia, viscosity, compressibility and thermal conductivity. Also the interaction with a flexible structure, the acousto-elastic interaction is accounted for. The model was written in terms of dimensionless parameters. These parameters govern the validity of simplifications and they can be used to put models into perspective.

Experiments

The viscothermal acousto-elastic model is validated with specially designed experiments. A solar panel vibrating above a small airlayer was used to validate the analytical model. An air filled box with acoustically hard walls and a flexible coverplate was used to validate the numerical finite element model. Experimental and computational results agree very well. The model can thus be used to solve practical problems like the damping of double wall panels and the vibrational behaviour of folded solar panels. With barriers placed in the gap the damping can be further increased. Besides viscous dissipation, vortex shedding occurs and more vibrational energy is absorbed. This was also investigated experimentally.

References

[1] Beltman, W.M. (1998) Viscothermal wave propagation including acousto-elastic interaction, Enschede, PhD-thesis