Acoustics of Coupled Tubes

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Introduction

The acoustics of a sound absorbing wall with quarter-wave resonators has been investigated previously[1]. The wall can be optimized for a high sound absorption at a specific frequency (see Figure 1).

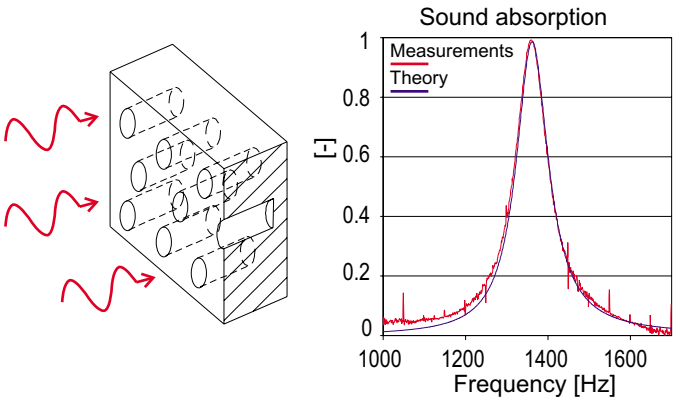

Figure 1. Optimized sound absorbing wall.

For a more complex sound absorbing material, like acoustic foams or glass wool, the holes in the material can be modeled as a network of small tubes (see Figure 2).

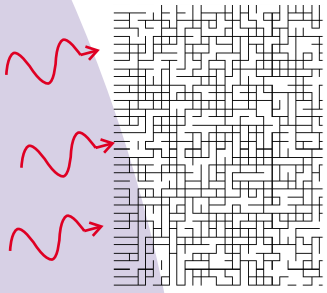

Figure 2. Network of tubes to model sound absorbing material.

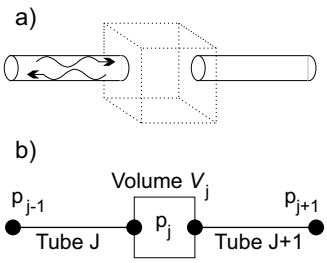

Figure 3. A geometric (a) and schematic (b) view of a volume with two coupled tubes.

Objective

The existing model has to be extended and tested for a network of tubes.

Model

For a slender tube an acoustic model which includes the viscous and thermal effects is used. The tubes are coupled to a volume (see Figure 3) which may be zero. In this way a recursive formulation is obtained[2].

Test set-up and Results

A number of tubes and volumes are connected to each other as shown in Figure 4. The effect of the double Helmholtz resonators on the sound transmission in the square tube was predicted and measured.

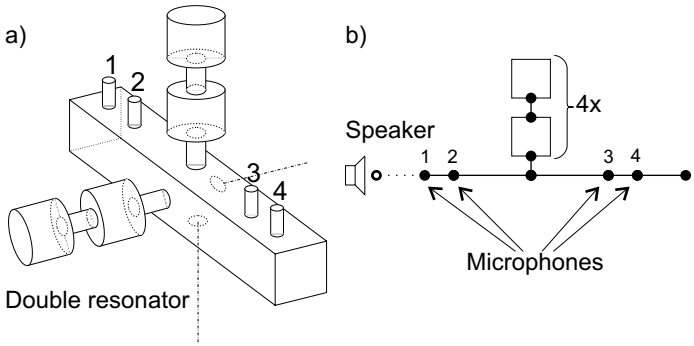

Figure 4. Experimental (a) and numerical (b) set-up with Helmholtz resonators.

Figure 5 shows that the model is rather accurate and that the viscous and thermal effects cannot be neglected.

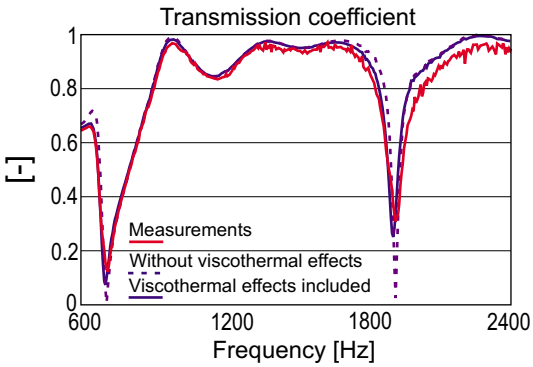

Figure 5. Transmission coefficient of 4 double resonators.

Conclusions

The acoustic behaviour of a network of slender tubes and volumes can be predicted accurately.

Possible applications are: sound absorbing materials, air-conditioning ducts and mufflers. Provided that the mean flow is low.

References

1 van der Eerden *et al.* 'Acoustics of a Sound Absorbing Wall', poster and presentation at first EM symposium, Rolduc, 1998

2 van der Eerden *et al.* 'Acoustic impedance of coupled tubes including viscothermal effects', Inter-Noise 99, Ft Lauderdale, 6-8 December,1999