Optimised sound absorbing panels with quarter-wave resonators

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Introduction

In modern aircraft, boundary layer induced noise is known to dominate cabin noise at cruise conditions. In order to improve the environmental comfort of the passengers, optimised sound absorbing trim panels with quarter-wave resonators are designed to reduce this noise. The present research is part of the EU project FACE (Friendly Aircraft Cabin Environment).

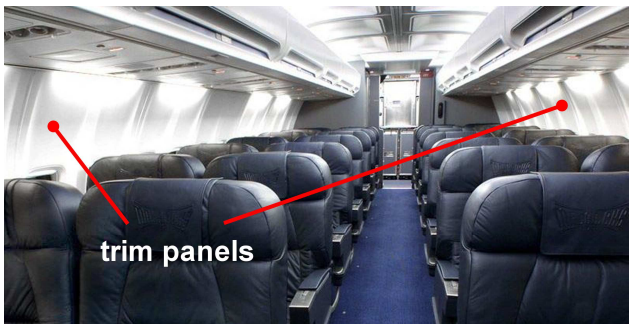

Figure 1 : Aircraft cabin with trim panels

Objective

The objective of this research is to design a sound absorbing panel with quarter-wave resonators that optimally reduces cabin noise in the relevant frequency range. By varying the dimensions of the resonators different levels of sound absorption can be obtained in different frequency ranges. Optimisation of these dimensions yields a panel with the desired absorption characteristics.

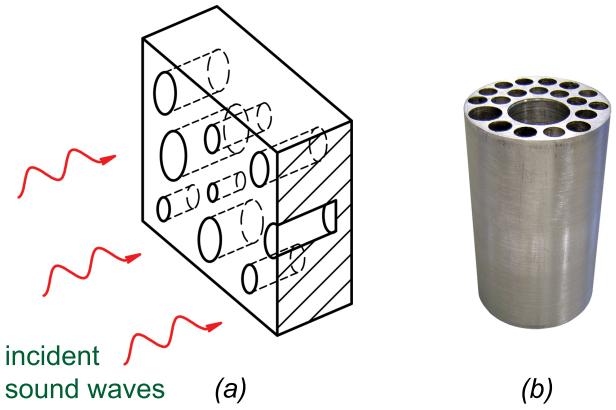

Figure 2 : (a) Schematic representation of a sound absorbing panel with different quarter-wave resonators (b) Optimised sample for experimental validation

Methods

The viscothermal wave propagation of the air inside the resonators is efficiently described by the so-called low reduced frequency model. Using this model, absorption coefficients can be calculated for different configurations.
The theory has been implemented together with an optimisation algorithm, so that the dimensions of the resonators can be optimised to satisfy any desired absorption level within a specified frequency range.
Experimental validation of the optimised configurations is performed by means of impedance tube measurements.

Results

Figure 3 shows the absorption curve that results from the optimisation of a panel with 20 different resonators. It can be seen that almost maximum absorption is obtained over the entire frequency range.

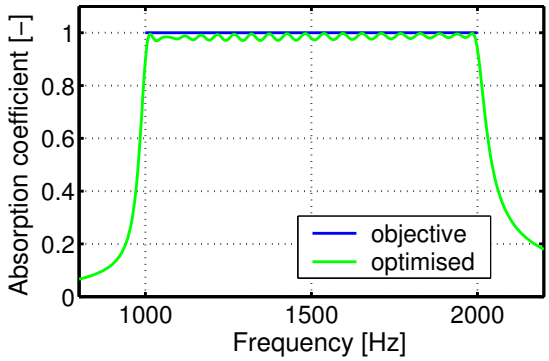

Figure 3 : Optimised absorption curve for a frequency range of 1000-2000 Hz

Further research

- Experimental validation of the optimised configurations
- Optimisation to a sound spectrum measured in a modern aircraft
- Practical implementation of the resonators

Reference

1. Van der Eerden, F.J.M. (2000) Noise reduction with coupled prismatic tubes, PhD thesis, University of Twente.