Optimization of folded resonators for broadband reduction of computer fan noise

M.J.J. Nijhof, Y.H. Wijnant, A. de Boer

Institute of Mechanics, Processes and Control - Twente
Chair of Structural Dynamics and Acoustics, University of Twente
P.O. Box 217, 7500 AE Enschede, The Netherlands
phone +31-(0)53-4893405, email m.j.j.nijhof@utwente.nl

Introduction

Cooling fans are one of the main noise sources in computers. Tonal noise produced at a multiple of the rotational frequency of the fan, the so-called blade passing frequency (BPF), and its higher harmonics generally dominate fan noise.

Objective

A setup consisting of an induct speed controlled fan and multiple acoustical resonators is optimized for broadband noise reduction. A modular approach is adopted to model the setup using acoustic duct elements, a new two-port description for axial fans and resonator elements of different geometry.

Methods

A Low Reduced Frequency based model is adopted to model circularly and cylindrically shaped resonators. To achieve a compact design, both geometries are combined to form folded resonators.

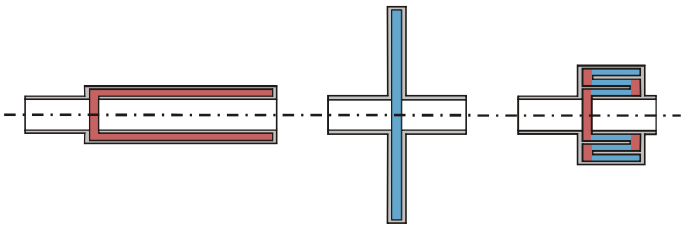

Fig.1) Cylindrical, circular and folded resonator geometry

The induct fan is modeled by assigning its active and passive properties to different acoustic elements. The active fan element produces sound waves that propagate away from the fan while scattering of incident sound waves is represented by the passive fan element (Fig. 2).

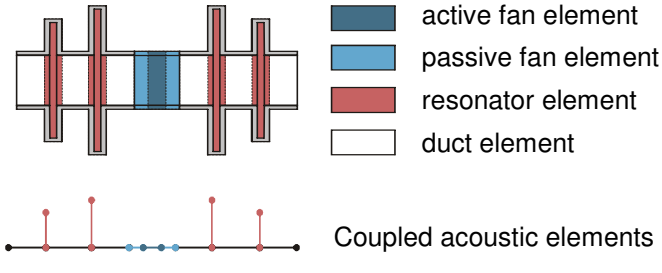

Fig.2) Schematic overview of a multi resonator setup

The different fan, duct and resonator elements are coupled by assuming continuity of pressure and conservation of mass over the element boundaries.

The coupled model is used to tune the resonator dimensions of a demonstrator for frequency intervals in which noise reduction is most needed. The optimization is an iterative process in which the resonator dimensions are changed to alternatively optimize noise reduction and compactness.

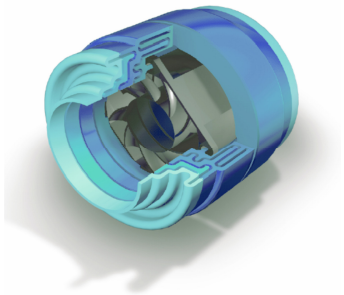

Fig.3) Optimal design of the multi resonator demonstrator

Results

An effective reduction of 5 dB(A) in sound power is achieved in case the fan runs at maximum speed. Furthermore, the tonality, an important factor in the perceived sound quality, is drastically improved by the demonstrator.

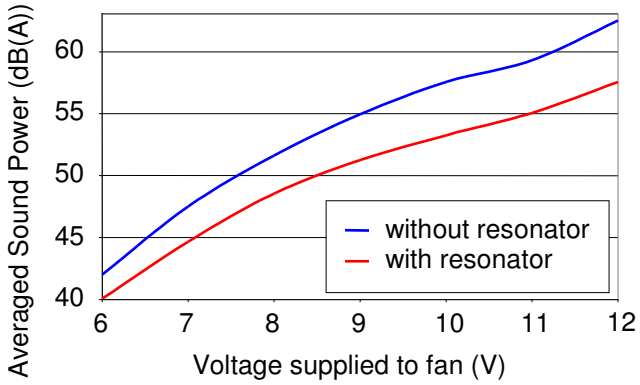

Fig.4) Sound power measurements of the demonstrator

Discussion

Multiple folded resonators are successfully applied for broadband reduction of fan noise. More research is needed to optimize for compactness. Redesign of the resonator openings would benefit the reduction of flow noise generated by the airflow.