Hybrid Noise Predictions of a Radial Notebook Blower

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Abstract

The tonal noise of a notebook radial blower in a free-field environment is investigated using an hybrid method based on unsteady Reynolds Averaged Navier-Stokes simulations and an Ffowcs Williams and Hawking's analogy to compute the acoustic far-field from the wall-pressure fluctuations recorded in the simulations. Incompressible and compressible simulations have been performed to demonstrate the effect of the compressibility on the noise sources in the very constrained environment due to the casing specific design. The complex flow in the blower yields distributed noise sources. The tongue interaction with the blade wakes and the inlet flow distortions are major contributors at the blade passing frequency, while smaller structures in the clearance are important noise sources at higher harmonics. The influence of a daisy obstruction on one of the blower inlet is also investigated. The additional inlet distortion strongly affects the noise levels at the blade passing frequency. The acoustic predictions are compared to experimental measurements and provide good agreement within the variability of the acoustic level measured between blowers of the same conception batch. The compressible simulations provide the best agreement at higher frequency when the compactness limit is overpassed.

Keywords: Aeroacoustics, radial fan noise, tonal noise reduction

Introduction

Small low-speed radial blowers are used in many cooling applications including very compact notebook systems. The noise level produced by these systems is one of the main concerns for customers to not exceed acoustic ergonomic comfort. Thus, aero-acoustic predictions are of great importance for the computer manufacturers at the design level. Notebook blower systems often yield annoying tonal noise. Aero-acoustic sources are multiple in such dense and complex computer systems. Broadband noise component is produced by a wide range of turbulent excitations, while tonal noise component is related to large coherent flow structures strongly depending on the installation. Several measurements have been achieved on small radial blowers meant for cooling notebooks and are described in a previous study by Gullbrand & Beltman [1, 2]. In the present work, unsteady incompressible and compressible numerical simulations are performed on one standard size blower to predict tonal noise components in free flow conditions. Very few numerical tools