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A new hybrid active/passive sound absorber with variable surface impedance

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ABSTRACT

The context of the present paper is the wall treatment of flow ducts, notably aero-engine nacelle intakes and outlets. For this purpose, hybrid active/passive absorbers have been developed at the LMFA for about 15 years. A hybrid cell combines passive absorbent properties of a porous layer and active control at its rear face. Active control is mainly used to increase absorption at low frequencies by cancelling the imaginary part of the surface impedance presented by the absorber. However, the optimal impedance (i.e. the one that produces the highest noise reduction) of an absorber for flow duct applications is generally complex and frequency dependent. A new hybrid absorber intended to realise any of impedance has therefore been developed. The new cell uses one microphone on each side of a resistive cloth. Normal velocity can then be deduced by a simple pressure difference, which allows an estimation of the surface impedance of the absorber. In order to obtain an error signal related to a target impedance, the target impedance has to be reproduced in time domain. The design of a stable and causal filter is a difficult task, considering the kind of frequency response we seek. An alternative way of representing the impedance in time domain is therefore given. The new error signal is integrated into a feedback control structure. Fast convergence and good stability are observed for a wide range of target impedances. Typical optimal impedances with a positive increasing real part and a negative decreasing imaginary part have been successfully realised. Measurements in a grazing-incidence tube show that the new complex impedance absorber clearly outperforms the former active absorber.

1. Introduction

It is well known that the control of low-frequency noise by passive means requires very bulky absorbers. Active systems have therefore become an established alternative in noise control engineering. Also known as "anti-sound", the basic principle consists in superposing a secondary sound field to the undesired sound in order to create silence through destructive interference. In the case of complex sound fields, sophisticated systems involving a large number of secondary sources and error microphones are needed to create an appropriate secondary field.

An alternative to direct active control is the control of the boundary conditions of the concerned system by means of active absorbers.

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