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An index to quantify the through-thickness symmetry of sound absorbing materials

Yacoubou Salissou and Raymond Panneton
Groupe d'Acoustique de l'Université de Sherbrooke, 2500, Boul. de l'Université, Département de génie mécanique, Sherbrooke, QC, Canada J1K-2R1

In this work, an extension of the theoretical formulation of the transfer matrix to non symmetrical sound absorbing porous materials is carried out. From this extension, an index of asymmetry is proposed and discussed. This index allows one to quantify the through-thickness asymmetry of a sound absorbing porous material. This index may be used for quality control or to assess the symmetry of the material in terms of its acoustic properties (absorption, reflection, impedance, propagation constant). To validate the application of the index of asymmetry, samples made up from two layers of porous materials are studied. Each so-constructed two-layered sample is seen as an equivalent asymmetrical single porous layer with a sudden change in its physical properties. The acoustic properties of each sample are then measured in the direct and inverted configurations (i.e., when both sides of the sample are facing successively the incident wave). Their values are compared in terms of the asymmetry index of the equivalent single layer. From these tests, an index value is suggested. Above this value, the acoustic properties of a sound absorbing material should be considered as being not symmetrical.