A finite element approach for the acoustic modelling of perforated dissipative mufflers with non-homogeneous properties.

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ABSTRACT

In this work, a finite element approach is presented for modelling sound propagation in perforated dissipative mufflers with non-homogeneous properties. A uniform mean flow is considered within the central passage and a perforated duct separates the flow from a heterogeneous absorbent material. The spatial variations of the acoustic properties can arise, for example, from uneven filling processes and degradation associated with the flow of soot particles within the absorbent material. First, the finite element method is applied to the wave equation for a stationary propagation medium with variable properties (outer chamber) and a moving homogeneous medium (central passage). For the case of a dissipative muffler, the characterization of the absorbent material is carried out by means of its equivalent complex density and speed of sound. To account for the spatial variations of these properties, a number of coordinate-dependent functions are proposed for the resistivity of the absorbent material, including both longitudinal and also asymmetric dependence. The acoustic impedance of the perforated central duct includes the influence of the material resistivity and its spatial variations as well. A detailed study is finally presented to assess the influence of the heterogeneous properties, the mean flow Mach number and the perforated duct porosity on the acoustic attenuation performance of the muffler.