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Wave propagation in a viscous fluid with a pipeline shear mean flow and application for ultrasonic flow meter YONG CHEN, YIYONG HUANG, XIAOQIAN CHEN, Institute of Space Technology, College of Aerospace Science and Engineering, National University of Defense Technology — This paper deals with the problem of wave propagation in a compressible viscous fluid confined by a rigid-walled circular pipeline in the presence of a shear mean flow. On the assumption of isentropic and axisymmetric wave propagation, the convected acoustic equations are mathematically deduced from the conservations of continuity and momentum, leading to a set of coupled second-order differential equations with respect of the acoustic pressure and velocity components in radial and axial directions. A solution based on the Fourier-Bessel theory, which is complete and orthogonal in Lebesgue space, is introduced to transform the differential equations to an infinite set of homogeneous algebraic equations, thus the wave number can be calculated due to the existence condition of a non-trivial solution. After the discussion of the method's convergence, the cut-off frequency of the wave mode is theoretically analyzed. Furthermore, wave attenuation of the first four wave modes due to fluid viscosity is numerically studied in the presence of the laminar and turbulent flow profiles. Meanwhile, the measurement performance of an ultrasonic flow meter based on the difference of downstream and upstream wave propagations is parametrically addressed.

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