Some Quandaries and Paradoxes in Fluid-Structure Interactions with Axial Flow

by

Michael P. Païdoussis
Thomas Workman Emeritus Professor
Department of Mechanical Engineering, McGill University
Montreal, QC, Canada

A number of interesting quandaries and paradoxes, some resolved and some not, are reviewed briefly; they all involve axial flow over generally slender structures, as follows.

(i) For pipes and shells conveying fluid, does post-divergence flutter occur or not?
(ii) Do aspirating pipes and shells lose stability at infinitesimally small flow rates?
(iii) Do pipes and shells with different kinds of end-support (e.g., clamped at one end and simply supported at the other) experience flow-induced damping, positive or negative, at arbitrarily small flows?
(iv) Is it always possible to obtain solutions for forward and backward propagating waves in shells containing swirling inviscid flow?
(v) In view of the similarity in the equations of motion of cylindrical structures subjected to (a) internal and (b) external axial flow, in their simplest form, how far can the analogy between internal and external flow be carried in assessing the dynamical behaviour of such systems, and what real physical effects intervene to break it down?
(vi) Should convective fluid-acceleration terms be taken into account in the analysis of the dynamics of strings or beams undergoing extrusion or deployment in dense fluid, and similarly for traveling web?
(vii) Taking annular fluidelastic systems as an example, is the precise specification of boundary conditions on the fluid at the upstream and downstream ends essential in the determination of system stability?

These are described in greater detail and clarified to the extent possible in the body of the paper.