Flow-Geometric Relationship during Self-excited Oscillations of a Collapsible Tube

Authors: Vikas N. Bhargav, Nicola Francescato, Holger Mettelsiefen, Abdullah Usmani, Stefania Scarsoglio, Vrishank Raghav

Compliant tubes found in biological systems such as respiratory airways, blood vessels - arteries, and veins, can exhibit open, collapsed, or oscillating states due to fluid-structure interactions. Depending on operating conditions, the tube can experience large-scale, three-dimensional, self-excited oscillations that may get translated to the flowfield over large distances downstream of the tube. This study examines the effect of dynamic tube geometry on the downstream flowfield, using, time-resolved, synchronized, stereo-photogrammetry and particle image velocimetry (PIV). While stereo-photogrammetry enables 3D measurement of tube geometry, planar PIV is performed to measure 2D flowfield over a large span downstream of the oscillating tube. Initial results show large-scale periodic deformations in the tube surface close to its trailing edge, with the region of largest collapse experiencing streamwise displacements. The downstream pressure and flow field exhibit pulsatile fluctuations synchronous to those in the tube geometry. The highest flow velocities are observed close to conditions that involve large collapse of the tube, due to throttling of the flow. Further results on flow-geometric correlations will be presented, through time and frequency domain analyses.