FLOW THROUGH A MODEL OF AN ASYMMETRIC STENOSIS

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A numerical and experimental study of the steady and pulsatile flows through a model of an asymmetric stenosis is presented. Recent work appearing in the literature has focused on the flow through axisymmetric stenotic geometries [1, 2, 3], due to the usefulness of the axisymmetric assumption and the amenability of the problem to linear stability analysis techniques. The present work uses the same approach, but introduces a fully three-dimensional geometric perturbation.

The geometry under investigation consists of a long straight tube, cut by another perpendicular pipe, offset by half a pipe diameter. The configuration of the geometry can be gleaned from figure 1(a). The geometry is chosen as a three-dimensional "extension" of a two-dimensional blockage studied in [4]. Of interest will be any observed similarities between the two cases. By varying the diameter of the cutting pipe, the severity of the blockage can be controlled. Keeping the diameter of the cutting pipe the same as the main pipe results in a 50% blockage. Numerically, a fully-three-dimensional spectral-element technique is employed to simulate the flow. An experimental rig, used previously to investigate the flow through axisymmetric stenoses [1], is also employed. Particle Image Velocimetry and fluorescein dye-visualization are used to analyze the flow.

At low Reynolds number (based on pipe diameter and mean bulk fluid velocity), numerically the flow consists of a separation from the top of the stenosis surface, as can be from figure 1(b). However, unlike in the two-dimensional case studied in [4], the flow does not form a regular recirculation zone. Instead, helical flow patterns develop from the junctions of the top of the stenosis with the pipe wall. This can be observed in figure 1(a), where the λ_2-vortex definition [5] is used to show vortical structures in the flows: a short, strong "spike" emanates from each of the stenosis-wall junctions.

Experimental data will be used to validate the numerical results. Of interest will be the transition to turbulence in the experimental flow and to what Reynolds numbers our numerical simulations are useful for predicting the flow. Similarly, a full comparison with the study of the lower-dimensional case in [4] will be carried out.

(a)

(b)

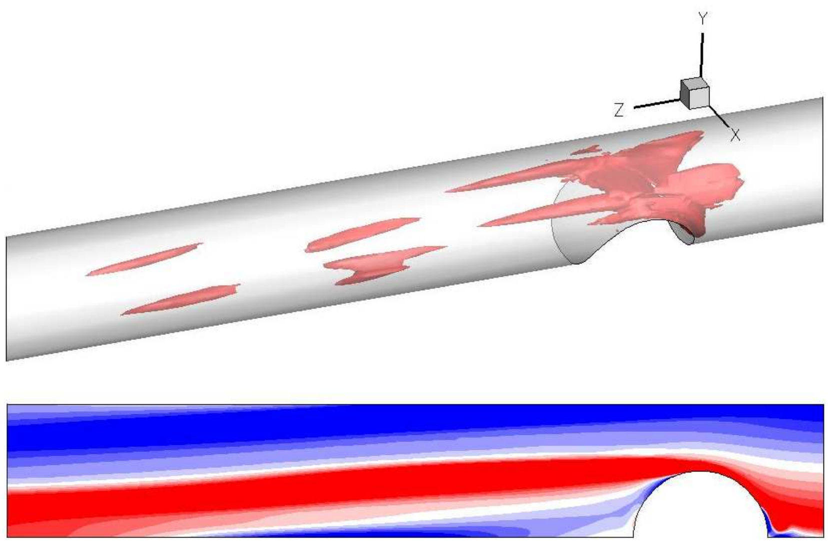

Figure 1. (a) Iso-surface of the λ_2 field for the flow at Reynolds number 500 (b) a two-dimensional slice of the flow at the midpoint of the pipe, plotting the vorticity normal to the page.

REFERENCES

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