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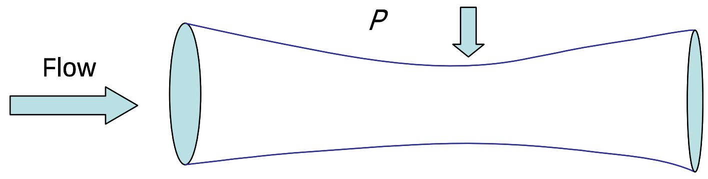

Elastic tube may collapse under external pressure

Numerical study of collapsible channel flows

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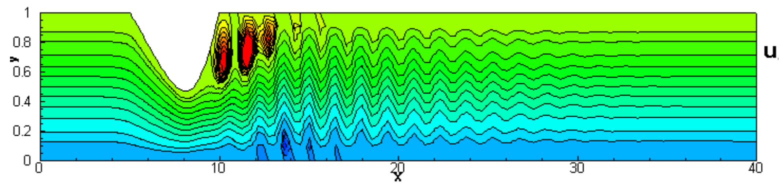
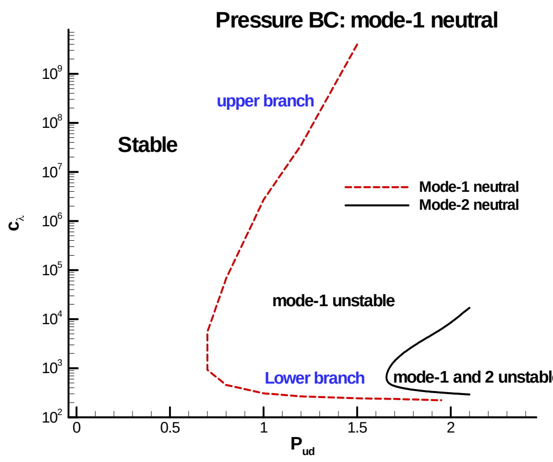


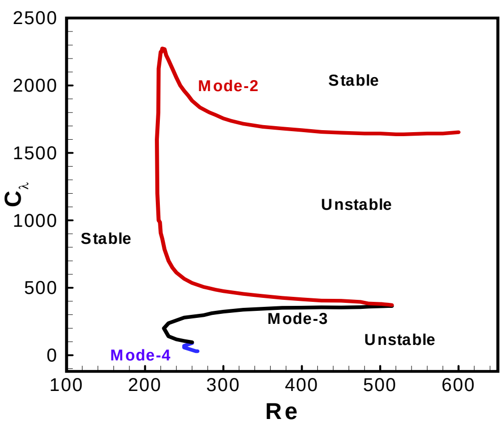
Self excited oscillations observed

Project outline

An elastic tube conveying fluid can buckle and oscillate when compressed. Applications of such a system can be found in many biological problems: blood flow in arteries and veins, urine flow in the urethra, flow in the airway, medical devices, to name just a few. In this study, we investigate the correlation of energy distribution and dynamic behaviour of collapsible channel flows under various boundary conditions. We focus on the situations where either flow or the pressure drop is prescribed at the flow entrance. An interesting cascade structure of neutral stability is observed in both situations, though the mechanisms behind it appear to be quite different. The energy budget of the oscillations is computed to explore the mechanisms behind the various modes of vibrations.

The Cascade structures





The cascade structure appears to be different for prescribed upstream pressure (left) and flow rate (right). Mode transition occurs when the wall stiffness is decreased.

Energy budget

$$P_1 = \dot{E} - F + D + P_2$$

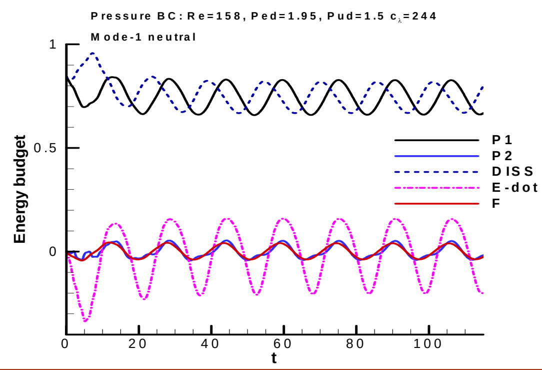
P_1 : rate of working of the upstream pressure

$\dot{E}$: net rate of change of kinetic energy

F : net kinetic energy flux into the system

D : rate of viscous dissipation

P_2 : rate of energy change at the elastic wall



Energy budget shows that for mode-1 (pressure driven): rate of working of external pressure is most important, while for mode-2 (flow driven): rate of stretch energy change is dominant.

Reference (downloadable from www.maths.gla.ac.uk/~xl/):

1. Liu H F, Luo X Y, Cai Z X & Pedley T J Sensitivity of unsteady collapsible channel flows to modelling assumptions, *(in press) Communications in Numerical Methods in Engineering, 2009.*
2. Luo X.Y, Cai Z.X., Li W.G. Pedley, T.J. The cascade structure of linear instability in collapsible channel flows, *J. of Fluid Mechanics*, 600, 45-76, 2008.

Acknowledgment

This project was funded by EPSRC (Grant No. GR/M07243).