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Mathematical and Numerical Modelling of an Axisymmetric Valve[1] RICHARD GIBBS, JONATHAN KOBINE, University of Dundee — Current models for accurate flowrate control valves are largely empirical. Our valve device allows pressure-driven flow through the passage formed between two concentric truncated cones; the flow is controlled by varying the relative vertical displacement of the two cones. For converging steady laminar flow of an incompressible Newtonian fluid we develop a viscous flow solution for the annular channel region between the two cones, assuming that the channel is narrow. Inviscid flow is assumed in the following conical chamber. The resulting analytical model essentially captures the discharge as a function of valve opening, from comparison with finite element simulations, for low Reynolds numbers ($Re < 100$) and cone apex half-angles from 30 to 80°. For smaller cone angles the main difference between the model and the simulations occurs when the depth of the conical chamber is such that viscous effects must also be included in this region. We also give an assessment of the effect of rotation of the inner cone, which sets up an additional pressure gradient across the device, as a means of flow control.

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