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Fluid–Structure Interaction Between a Power-Law Fluid and a Deformable Microtube orMicrochannel[1] VISHAL ANAND, Purdue Univ, IVAN CHRISTOV, Purdue Unive — Microfluidic devices are made of soft materials, which leads to significant deformation even for "slow" flows of viscous fluids within. This deformation affects the flow rate versus pressure drop correlation, compared to the ideal case of Hagen–Poiseuille flow. We study the steady fluid flow and the concomitant structural deformation problem for a shallow cylindrical microtube as well as a slender rectangular microchannel. In both cases, having biofluid mechanics applications in mind, the non-Newtonian fluid behavior is modeled by the power-law fluid model to account for a shear-rate dependent viscosity. The fluid–structure coupled problem is solved analytically using a perturbation expansion. A consistency check is performed by comparing the initial results with those of a Newtonian fluid obtained by Fung (1993) and Christov et. al. (2017). It is seen that for the case of microtubes, the flow rate can be expressed as an explicit function of the pressure and the power-law exponent, while for the case of microchannels, it is possible to find the flow rate as a function of pressure for only specific values of the power-law exponents. We show this is a result of the non-trivial differences between the governing equations of static deformation of thin plates and shells.

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