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Three-dimensional velocity field for blood flow using the power-law viscosity function

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Abstract

The three-dimensional model associated with blood flow in vessels with viscosity depending on shear-rate, e.g., power-law type, is a complex model to obtaining computational implementation, which in many important situations reveals impracticable. In order to simplify the three-dimensional model, and as an alternative to classic one-dimensional models, we will use the Cosserat theory related fluid dynamics to approximate the three-dimensional velocity field, and thus obtain a one-dimensional system. Therefore, this system consists on an ordinary or partial differential equation depending only on time and on a single spatial variable, the flow axis. From this reduce system, we obtain the unsteady equation for the mean pressure

gradient depending on the volume flow rate, Womersley number and the flow index over a finite section of the tube geometry. Attention is focused on some numerical simulations for constant and non-constant mean pressure gradient using a Runge-Kutta method and on the analysis of perturbed flows. In particular, given a specific data we can get information about the volume flow rate and consequently we can illustrate the three-dimensional velocity field on the constant circular cross-section of the tube. Moreover, we compare the three-dimensional exact solution for steady volume flow rate with the corresponding one-dimensional solution obtained by the Cosserat theory.

Keywords: Cosserat theory, blood flow, shear-thinning fluid, one-dimensional model, power-law model, volume flow rate, mean pressure gradient.

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References

[1] D.A. Caulk, and P.M. Naghdi, Axisymmetric motion of a viscous fluid inside a slender surface of revolution, *Journal of Applied Mechanics*, 54, pp. 190–196, 1987.

[2] F. Carapau, P. Correia, and R. Conceição, Three-dimensional velocity field for blood flow using the power-law viscosity function, *Submitted*, 2018.

[3] F. Carapau, and A. Sequeira, 1D Models for Blood Flow in Small Vessels Using the Cosserat Theory, *WSEAS Transactions on Mathematics*, 5(1), pp. 54–62, 2006.

[4] B.R. Bird, R.C. Armstrong, and O. Hassager, *Dynamics of Polymeric Liquids*, John Wiley & Sons Edition, 1(2), 1987.