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Symposium: Process Modeling & Simulation Using Computational Techniques

In Tsiklauri & Beresnev, Phys Rev E 64, 036303 (2001), we investigated new phenomena brought about into the classic peristaltic mechanism by the inclusion of non-Newtonian effects based on the model of a Maxwell fluid. In Tsiklauri, J Acoust Soc Am 112, 843 (2002), the effect of nonzero boundary slip velocity in fluid-saturated porous media was studied. Here we present a new advanced model of peristaltic flow which includes all relevant physical effects such as: non-zero boundary slip, non-Newtonian effects, and compressibility. Based on this model, the backflow (reflux) effect is also investigated which is a likely cause of vesico-ureteral reflux in urology. This study was motivated by the recent discovery of boundary slip Craig et al., Phys Rev Lett 87, 054504 (2001). The present work is the most general model of peristalsis created to date with wide-ranging applications in biological, geophysical and industrial fluid dynamics.