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Laminar Tube Flow of Complex Fluids and Heat Transfer Enhancement[1] DENNIS SIGINER, Wichita State University, MARIO LETELIER, Universidad de Santiago de Chile — The flow structure and the heat transfer enhancement in steady pressure gradient driven flow of a class of non-affine nonlinear viscoelastic fluids in straight tubes of arbitrary shape is analyzed analytically when the tube wall is maintained at constant temperature. Enhancement components due to constitutive elasticity as well as shear-thinning are identified. The former is due to secondary flows generated by the non-affine constitutive structure of the fluid and overwhelms the enhancement due to the latter with increasing inertia. Heat transfer enhancement increases as the strength of secondary flows increases with increasing elasticity or pressure gradient without any significant additional energy input to drive the secondary flows. Enhancement is an order of magnitude larger than its Newtonian counterpart under the same conditions. The variation of the average Nusselt number for each component of the enhancement with Weissenberg and Reynolds numbers in various non-circular cross-sections is presented. Work in progress concerning the possible implications on the heat transfer enhancement of the change of type of the vorticity equation is discussed.

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