Chapter 3
Epilogue

A unified field theory for viscoelastic, in particular, non-linear viscoelastic fluids along the lines of the Navier–Stokes equations for Newtonian fluids is still lacking. Several constitutive structures popularly used are subject to Hadamard and dissipative instabilities as a result of the omission of some fundamental continuum mechanics principles in their derivation as well as thermodynamic principles. Naturally, they have a bearing on the ability of the constitutive formulations in predicting flows in general geometries and for high *We*. A case in point is flow in arbitrary cross-sectional tubes. The longitudinal field for both generalized Newtonian and viscoelastic fluids can be predicted quite well with existing constitutive formulations, but that is not necessarily the case for the transversal field [1].

Hadamard type of instabilities may lead to blowup in numerical computations, and dissipative instabilities may preclude the use of many popular constitutive equations at high *De* numbers prevalent in materials processing industry. However, that being said the existing plethora of equations in use does provide good predictions and sometimes even quantitative predictions at low *De* numbers in experimental laboratory settings and for dilute fluids if the use of a particular constitutive equation is restricted to a class of motions. For instance, the well-known upper convected Maxwell model is quite good in predicting elongational flows at low elongation rates, but it is totally useless in predicting secondary flows. A plethora of CEs that may be stable in the Hadamard and dissipative sense and are compliant with the principles of thermodynamics predict no second normal stress difference at all. The search for a universal CE for non-linear viscoelastic fluids has led so far down many blind alleys, and it is by no means certain that success in this respect will manifest itself in the near future.

Reference

1. Siginer DA. Dynamics of tube flow of viscoelastic fluids. New York: Springer; 2014.

D.A. Siginer, *Stability of Non-Linear Constitutive Formulations for Viscoelastic Fluids*, SpringerBriefs in Applied Sciences and Technology 14,
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