In this thesis we deal with numerical simulations for flows of viscoelastic fluids. First, we introduce two models for viscoelastic fluids: (i) the Oldroyd-B, which is a classical model for viscoelastic fluids and (ii) a new nonlinear model which might be thought of as a generalization of Oldroyd-B to the case of large elastic deformations. Then, the flow at three different situations is discussed. The first of them is stress relaxation in parallel plate flow, which is an example of a 1D problem. The second one is a 4:1 planar contraction flow, which is a standard benchmark for viscoelastic flows. The third problem is stress relaxation in axially symmetric cylinder flow, which is solved as a 1D as well as a 2D problem. If it is possible, the problems are solved analytically, otherwise they are solved numerically with the aid of the finite element method using the software Comsol Multiphysics 3.3. Experimental data that document the stress relaxation of asphalt are available in the cylindrical geometry. Thus, finally, these data are fitted using both considered models.