Thermodynamically Compatible Rate Type Fluid Models for Asphalt

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ABSTRACT

We derive nonlinear models for incompressible rate type fluids that describe the behavior of the viscoelastic fluids. The derivation is done with the aid of two modern concepts of nonlinear continuum mechanics based on the ideas of natural configuration and maximization of the rate of entropy production. We use them to determine the constitutive equation of the stress tensor from the knowledge of the rate of dissipation and Helmholtz free energy. The first nonlinear model was derived by [1], we modified the derivation of this model and gained a new more complicated nonlinear model. Making the linearization of the elastic response we obtain a popular model for viscoelastic fluid – Oldroyd-B model.

Then we present an experiment that documents the stress relaxation of asphalt in the cylindrical geometry and we simulate it by derived models. If it is possible, the problems are solved analytically, otherwise they are solved numerically. We find out that the nonlinear models are more capable of fitting the experimental data than the linear Oldroyd-B.

REFERENCES

[1] Rajagopal K. R., Srinivasa A. R.: A thermodynamic frame work for rate type fluid models. Journal of Non-Newtonian Fluid Mechanics, 88(3):207-227, 2000.