RHEOLOGY REVIEWS 2003

(ISBN: Book: 0-9538904-8-1 CD: 0-9547414-0-4)

Rheology Reviews 2003, 1-36, 97 references.

A REVIEW OF THE RHEOLOGY OF FILLED VISCOELASTIC SYSTEMS

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ABSTRACT

We are concerned here with the effect of added filler particles on the linear and non-linear rheological properties of viscoelastic systems. Whilst the addition of spherical or near-spherical filler particles will almost always *increase* the level of both the linear and the non-linear viscometric properties (so leading to increases in pressure drops, etc.), we usually find a *decrease* in the level of the elasticity (in its various measures combining the first normal stress difference and the shear stress), as manifested in such important practical features such as extrudate swell, melt fracture, size of entry vortices, stress relaxation, Weissenberg effect, etc. However, the addition of high-aspect-ratio, fibre-like fillers can *increase* the elasticity as well as the viscosity. Occasionally, the absorption of chemical species from the continuous phase onto the surface of the disperse phase particles can complicate matters due to depletion of the continuous phase.

KEYWORDS: Viscoelastic; Polymer; Worm-like micelles; Particles; Filler.

RHEOLOGY REVIEWS 2003

(ISBN: Book: 0-9538904-8-1 CD: 0-9547414-0-4)

Rheology Reviews 2003, 37-75, 122 references.

SIMPLE NON-EQUILIBRIUM THERMODYNAMICS APPLICATIONS TO POLYMER RHEOLOGY

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ABSTRACT

We review here recent developments in non-equilibrium thermodynamics and their applications to rheology.

In particular we review the application of the dissipative Hamiltonian formalism to incompressible, homogeneous and isothermal flows of flexible polymer systems. We show not only the advantages that have been brought up by the non-equilibrium thermodynamics approach but also exactly where the actual contributions are in combination from a variety of specific modeling examples ranging from simple, one-conformation models to most recent coupled multivariable examples. In all cases, special attention is paid to convey the physical significance of the models through a close association to a more detailed microscopic interpretation.

KEYWORDS: Non-equilibrium thermodynamics; Constitutive equations; GENERIC; Polymer rheology

RHEOLOGY REVIEWS 2003

(ISBN: Book: 0-9538904-8-1 CD: 0-9547414-0-4)

Rheology Reviews 2003, 77-123, 67 references.

RHEOLOGY OF MOBILE INTERFACES

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ABSTRACT

This review discusses the rheology of interfaces that separate two, immiscible fluids. Unlike interfaces at the fluid/solid boundary, these surfaces are mobile and deform. In the presence of amphiphiles that collect at these interfaces, they can become highly structured and non-Newtonian. These nonlinear responses to flow have profound implications on many physical processes and examples can be found in nature and industry. This review summarizes experimental methods in interfacial rheometry (both mechanical and optical methods are discussed), and presents their application to numerous classes of complex fluid interfaces. These interfaces come in a wide range of forms that are often directly analogous to their three-dimensional counterparts. This review presents results on classical fatty acids and alcohols, multiphase systems, rodlike amphiphiles, flexible chain amphiphiles, surface gelation, biopolymers, and two-dimensional suspensions.

KEYWORDS: Interfacial rheology; Thin films; Langmuir films; Surfactants; Amphiphiles

RHEOLOGY REVIEWS 2003

(ISBN: Book: 0-9538904-8-1 CD: 0-9547414-0-4)

Rheology Reviews 2003, 125-165, 103 references.

COMPRESSIVE RHEOLOGY : AN OVERVIEW

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ABSTRACT

Compressive rheology, or the behaviour of suspensions in sedimentation and compression has been widely studied and many theories, using different physical quantities, have evolved in parallel. This review article provides a basis for the reconciliation of these approaches via presentation of the Buscall-White (1987) approach to consolidation, which uses a compressive yield stress, $P_y(\phi)$, and a hindered settling factor, $R(\phi)$, to quantify the strength of a particle network in compression and the inter-phase drag respectively, and linking it to other theories and related de-watering parameters available in the literature. The links between behaviour of a concentrated particle system in shear and compression are then discussed and a review of the various experimental methods available for determination of the de-watering parameters is presented. The final section overviews the practical application, benefits and limitations of models for real de-watering processes.

KEYWORDS: Filtration; Sedimentation; Thickening; Consolidation; Permeability; Compressibility; Centrifugation; Yield stress.

RHEOLOGY REVIEWS 2003

(ISBN: Book: 0-9538904-8-1 CD: 0-9547414-0-4)

Rheology Reviews 2003, 167-195, 64 references.

FINITE ELEMENT METHODS FOR INTEGRAL VISCOELASTIC FLUIDS

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ABSTRACT

We review the field of finite element techniques for solving complex flows of viscoelastic fluids described by a constitutive model of the integral type. The focus is mainly put on mathematical formulations and numerical approaches. A short guide to published simulations of non-trivial flow problems is offered.

KEYWORDS: Viscoelastic fluids; Integral constitutive equations; Molecular theory; Numerical simulation; Finite elements.

RHEOLOGY REVIEWS 2003

(ISBN: Book: 0-9538904-8-1 CD: 0-9547414-0-4)

Rheology Reviews 2003, 197-233, 114 references.

PRESENT PUZZLES OF ENTANGLED POLYMERS

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ABSTRACT

Entangled polymeric fluids, including high molecular weight polymer melts, constitute a fundamental example of viscoelastic fluids. In spite of enormous advances in understanding the molecular origin of their rheology and microscopic dynamics, there are several pressing puzzles, some of them strongly linked, that offer current and pressing challenges. We review the current state of the field and nature of five current challenges.

KEYWORDS: Molecular rheology; Tube model; Viscoelasticity; Branched polymers; Entanglements; Constraint release.