

## **RHEOLOGY REVIEWS 2004**

(ISBN: Book: 0-9538904-9-X CD: 0-9547414-1-2)

Rheology Reviews 2004, 1-17, 39 references.

### **FAILURE AND RECOVERY OF ENTANGLED POLYMER MELTS IN ELONGATIONAL FLOW**

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#### **ABSTRACT**

Entangled polymer melts exhibit failure in elongational flow, with different failure modes characteristic of different Weissenberg number regimes. Theoretical attempts to predict failure include Reiner's dynamical theory of strength, the Considère construction for the onset of necking, and a scaling theory that associates rupture with a critical recoverable strain. Reiner's theory is not consistent with the overall trend of available data, and the Considère construction does not appear to be applicable to melt flow in regimes with dissipation. The scaling theory is in qualitative agreement with available data but falls short quantitatively, and predictive capability of failure in elongational flow remains an elusive goal. An understanding of rupture and its relation to recovery, if any, is hindered by the extremely limited experimental database on rupture and recovery of well-characterized polymers.

**KEYWORDS:** Elongational flow; Entanglements; Failure; Necking; Polymer melt; Recoverable strain; Recovery; Rupture.

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## **RHEOLOGY REVIEWS 2004**

(ISBN: Book: 0-9538904-9-X CD: 0-9547414-1-2)

Rheology Reviews 2004, 19-65, 182 references.

### **RHEOLOGY OF FOOD DISPERSIONS**

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#### **ABSTRACT**

We review the viscous and viscoelastic behaviours of concentrated food emulsions and plant food suspensions. Special attention has been given to the influence that food processing exerts on the rheological characteristics of the above-mentioned foodstuffs.

**KEYWORDS:** Viscosity; Viscoelasticity; Food; Dispersions; Processing.

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## **RHEOLOGY REVIEWS 2004**

(ISBN: Book: 0-9538904-9-X CD: 0-9547414-1-2)

Rheology Reviews 2004, 67-98, 130 references.

### **MICRO-MACRO METHODS FOR THE MULTI-SCALE SIMULATION OF VISCOELASTIC FLOW USING MOLECULAR MODELS OF KINETIC THEORY**

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#### **ABSTRACT**

We survey the field of micro-macro numerical techniques for predicting complex flows of viscoelastic fluids. The micro-macro approach couples the mesoscopic scale of kinetic theory to the macroscopic scale of continuum mechanics. A numerical solution is sought to the coupled non-linear problem involving the conservation laws and a microstructural model of kinetic theory. Although micro-macro techniques are much more demanding in terms of computer resources than conventional continuum computations, they allow the direct use of kinetic theory models in flow simulations, thus avoiding potentially inaccurate closure approximations. The focus of our survey is mainly put on mathematical formulations and numerical approaches. Applications to polymer solutions and melts, liquid crystalline polymers, and fibre suspensions, are briefly reviewed.

**KEYWORDS:** Viscoelastic fluids, Kinetic theory, Micro-macro methods.

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(ISBN: Book: 0-9538904-9-X CD: 0-9547414-1-2)

Rheology Reviews 2004, 99-142, 71 references.

### **DYNAMICS OF A LIQUID DROP IN A FLOWING IMMISCIBLE LIQUID**

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#### **ABSTRACT**

In this article we discuss the dynamics of a single drop immersed in an immiscible fluid with a given velocity field at infinity. Drop relaxation is also discussed. Newtonian and non-Newtonian fluid components are considered, to examine the effects of constitutive elasticity on drop deformation modes. Both experimental and theoretical results are reviewed. We illustrate in some detail three main issues of research of the last decade, namely, the exploitation of rheo-optical techniques, the study of large deformations and break-up, through numerical simulations, and the advancements in single drop theory for the case of non-Newtonian fluid components.

**KEYWORDS:** Single drop; Drop deformation; Drop break-up; Flow; Non-Newtonian fluids.

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(ISBN: Book: 0-9538904-9-X CD: 0-9547414-1-2)

Rheology Reviews 2004, 143-170, 126 references.

### **DRAG REDUCTION IN TURBULENT FLOW OF POLYMER SOLUTIONS**

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#### **ABSTRACT**

Progress in understanding turbulent drag reduction by polymer additives has recently been made on several fronts. The near-wall dynamics of Newtonian turbulence is becoming better understood. Detailed computations of complex flows of model polymer solutions are now possible. Insights into the effects of viscoelasticity have been gained from a number of important model flows, and the understanding of the dynamics of dilute polymer solutions, as well as the ability to perform detailed simulations of them, is maturing. We review the advances in these fronts and illustrate their contributions to the understanding of both turbulence and drag reduction. Finally, we highlight open questions and propose a general conceptual framework that would, if validated, unify observations of drag reduction from turbulence onset to the maximum drag reduction asymptote.

**KEYWORDS:** Turbulence; Drag reduction; Dilute polymer solutions; Transition to turbulence; Computational fluid dynamics.

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(ISBN: Book: 0-9538904-9-X CD: 0-9547414-1-2)

Rheology Reviews 2004, 171-196, 45 references.

### **SELF-SIMILAR BREAKUP OF NON-NEWTONIAN LIQUID JETS**

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#### **ABSTRACT**

We review similarity solutions to describe the asymptotics of the approach to breakup in non-Newtonian liquid jets. Both creeping flow and flow with inertia are considered for a variety of constitutive models. New phenomena in some models of non-Newtonian flows include the possibility of a jet breaking up simultaneously over a finite length, as well as a purely elastic breakup mechanism in which surface tension plays no role.

**KEYWORDS:** Similarity solutions; Breakup; Liquid jets; Non-Newtonian.

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(ISBN: Book: 0-9538904-9-X CD: 0-9547414-1-2)

Rheology Reviews 2004, 197-223, 90 references.

### **RECENT DEVELOPMENTS ON THE SLOW VISCOELASTIC FLOW PAST SPHERES AND BUBBLES**

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#### **ABSTRACT**

A review is presented covering the latest contributions to the slow viscoelastic flow past solid spheres and bubbles. The existing theoretical approaches are reviewed together with the available numerical methods. The proximity of container walls and its effect upon the motion of a sphere is also considered. Emphasis has been made on presenting recent experimental and numerical work intended to address some of the unresolved issues in this classic topic. Besides the so called “benchmark” problem of a viscoelastic fluid past a solid sphere centered on the axis of a long cylinder, this review addresses outstanding problems such as the wake behind the sphere, the negative wake, the depleted region effect as well as presenting some new results regarding the jump discontinuity in the velocity of rising bubbles.

**KEYWORDS:** Viscoelastic flow; Solid spheres, Bubbles, Numerical methods

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