

Preface

This book has originated from a compendium of lecture notes prepared by the author to a graduate course in Rheology and Non-Newtonian Fluids at the Norwegian University of Science and Technology. The compendium was presented in Norwegian from 1993 and in English from 2003. The aim of the course and of this book has been to give an introduction to the subject.

Fluid is the common name for liquids and gases. Typical non-Newtonian fluids are polymer solutions, thermoplastics, drilling fluids, granular materials, paints, fresh concrete and biological fluids, e.g., blood.

Matter in the solid state may often be modeled as a fluid. For example, creep and stress relaxation of steel at temperature above ca. 400 °C, well below the melting temperature, are fluid-like behaviors, and fluid models are used to describe steel in creep and relaxation.

The author has had great pleasure demonstrating non-Newtonian behavior using toy materials that can be obtained from science museum stores under different brand names like Silly Putty, Wonderplast, Science Putty, and Thinking Putty. These materials exhibit many interesting features that are characteristic of non-Newtonian fluids. The materials flow, but very slowly, are highly viscous, may be formed to a ball that bounces elastically, tear if subjected to rapidly applied tensile stress, and break like glass if hit by a hammer.

The author has been involved in a variety of projects in which fluids and fluid-like materials have been modeled as non-Newtonian fluids: avalanching snow, granular materials in landslides, extrusion of aluminium, modeling of biomaterials as blood and bone, modeling of viscoelastic plastic materials, and drilling mud used when drilling for oil.

Rheology consists of Rheometry, i.e., the study of materials in simple flows, Kinetic Theory of Macromaterials, and Continuum Mechanics.

After a brief introduction of what characterizes non-Newtonian fluids in [Chap. 1](#) some phenomenal characteristic of non-Newtonian fluids are presented in [Chap. 2](#). The basic equations in fluid mechanics are discussed in [Chap. 3](#). *Deformation Kinematics*, the kinematics of shear flows, viscometric flows, and extensional flows are the topics in [Chap. 4](#). *Material Functions* characterizing the

behavior of fluids in special flows are defined in [Chap. 5](#). *Generalized Newtonian Fluids* are the most common types of non-Newtonian fluids and are the subject in [Chap. 6](#). Some linearly viscoelastic fluid models are presented in [Chap. 7](#). In [Chap. 8](#) the concept of tensors is utilized and advanced fluid models are introduced. The book is concluded with a variety of 26 problems.

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