BOOK REVIEWS

G. V. Vinogradov and A. Ya. Malkin

POLYMER RHEOLOGY*

Reviewed by Z. P. Shul'man

Over the past thirty years, the fields of instrumental, theoretical, and applied plymer rheology have developed most intensively. With this present book the above authors have made an important original contribution to this discipline.

They have centered their work on the key aspect of polymer rheology — the fluid state. Attention is concentrated on fundamental points: a general approach to description of the mechanical properties of continous media, the results of viscosometric studies of the basic classes of polymers under simple and complex deformation schemes, shear and uniaxial extension. Heat and mass exchange factors are given a significant role (heating, cooling, and solution).

At the present time standardization of thermoplastics by their viscosity properties is generally accepted. Moreover, the viscosity of dilute polymer solutions is an important molecular characteristic. However the rheological characteristics of polymers are defined not only by their viscosity, but by an entire complex of viscoelastic properties, many of which are completely uncommon in low molecular weight substances. Among these is their unique capability for very large reversible deformation. This in turn generates many important effects, for example the production by polymers in shear of not only tangent, but also normal stresses.

The numerous monographs on polymer processing and physicochemical properties do as a rule contain a chapter dedicated to rheology. However, until now the worldwide literature has not offered an entire book on the subject. The book reviewed herein successfully fills this need. The book opens with an extensive introductory chapter which discusses the basic positions, concepts, and definitions of rheology. Various characteristics and measures of the stressed state and the degree of deformation of continuous media are considered, including a description of kinematics. The proper attention is given to rheologic equations of state. Then a description is offered of the basic peculiarities of the behavior of linear viscoelastic media. The concepts of relaxation and delay time spectra are discussed. Nonlinear viscoelasticity theories are analyzed briefly but concisely.

The chapter ends with a bibliography of the major literature on the subject.

The most important characteristic of flowing polymer systems is the internal friction, in connection with which about a quarter of the book's volume is dedicated to shear viscosity of fused polymers and polymer solutions. One must note the quite successful exposition of the question of temperature dependence of viscosity. Temperature regions for the effective use of Frankel'—Eyring theory and the concept of free volume are described. From the thermophysical viewpoint this section of the book is of great importance, both theoretically and practically. The universal method proposed by the authors permits a unique characterization of the pressure and temperature dependence of viscosity of polymer systems over a wide range of parameter variation. The invariant nature of the proposed characteristics makes it possible to use only single temperature and pressure values to specify the viscosity at various shear rates and temperatures. The problem of the viscosity anomaly is treated in depth, although perhaps the choice of term itself might be considered unfortunate. The dependence of viscosity on molecular mass and the peculiarities of molecular chain structure are described on a sound modern level. A small but important section is devoted to viscosity of polymer solutions, in which the authors have made wide use of the results of their own original systematic studies.

The third chapter analyzes the viscoelastic properties of polymer systems in the fluid state. It should be noted that the term "rheology" is treated in a somewhat narrow sense, i.e., as the sciences which considers the mechanical behavior and properties of only flowing systems. Data on the characteristics of solid polymers are absent from the book. This can only be justified by the fact that even such a restricted treatment required a large volume of material (30 pp.).

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*Published by Khimiya, Moscow, 1977, 440 pages.

The chapter considering the relaxation properties of polymers begins with a description of the behavior of dilute solutions. Unfortunately, the book as a whole contains no separate section dedicated to the properties of dilute polymer solutions. The authors emphasize consideration of dynamic polymer properties. They understand by that term harmonic regimes of polymer system deformation, which have taken on great significance in contemporary rheology. The chapter is completed by a description of the dynamic properties of polymer systems under severe deformation.

A separate chapter (Chap. 4) treats of the Weissenberg effect. In contrast to other sources the exposition of the present text commences not only from purely mechanical positions, but from molecular concepts of polymer structure and composition. Here as in the other chapters of the book, one must note the successful combination of theoretical and practical aspects of the problem. The theoretical aspects are presented and treated concisely, in quite simple form, but without vulgarization.

The final two chapters of the book consider the high elasticity of polymers in the fluid state and their behavior under uniaxial tension. High elasticity is the region of experimental rheology in which the authors' personal contribution has been most significant. This is also true of the study of uniaxial tension of polymers above the vitrification temperature, a problem which has been given special attention in the worldwide literature of the last decade.

Soviet and foreign specialists have been presented with a valuable monograph dedicated to important and interesting problems of the rapidly developing field of polymer physics and mechanics. Unfortunately, the book was published in a low volume printing which does not satisfy the needs of potential readers.

One can rest assured that the monograph will be greeted with interest by a wide range of readers.

V. A. Voznesenskii

STATISTICAL METHODS OF EXPERIMENT PLANNING

IN TECHNICAL ECONOMIC STUDIES*

Reviewed by O. G. Martynenko and V. K. Popov

One method of increasing the quality and productivity of the work of scientists engaged in experimentation is the rational use of the mathematical theory of experiment, in particular, statistical methods of experiment planning, which is the subject of V. A. Voznesenskii's book. The book's goal is to acquaint specialists engaged in experimental solutions of technical and scientific problems with the basic ideas and methods of these branches of the mathematical theory of experiment in which significant experience has been accumulated over the last ten years.

Aiming at a wide circle of readers, the author omits mathematical proofs and complex analyses of a number of the positions put forward, referring the reader to more fundamental studies.

The first chapter considers general methodological questions of system study and offers the elements of mathematical statistics. Problems of metrology and interpretation of experimental results are also considered.

The second chapter offers the basic concepts and elements of the mathematical apparatus of experiment planning. These chapters form a brief theoretical basis for further understanding of the material.

The third chapter is dedicated to selection and analysis of examples of the use of mathematical experiment planning in various fields of science and technology. The solutions of a large number of examples are given in detail and can serve as practical guidance. Practical use of the various examples will undoubtedly be simplified by the fact that the author describes various algorithms developed by him which permit operational calculation and analysis of models.

The book's bibliography contains 76 citations, mainly of Soviet authors, or of foreign authors translated into Russian. The large amount of reference material, great number of examples, and concise exposition of its theme make the book quite valuable.

Voznesenskii's book as a whole will provide valuable guidance for a wide range of specialists, including those in the field of heat and mass exchange.

The book has enjoyed a wide demand, so that in a short time it has become a bibliographic rarity. It is hoped that the Statistika publishing house will see fit to republish the book shortly.

It would be desirable that the large amount of experience accumulated in experiment planning in the field of heat and mass exchange accumulated by the author find reflection in a new edition.

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*Published by Statistika, Moscow, 1974.