

book reviews

Progress in Modelling of Polymer Processing: Recent Developments

A. I. Isayev (Ed.)

Carl Hanser Verlag, Munich, 1991,
312 pp., £51.00,
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This multi-author book is aimed at those involved in research and development of polymer processing. Its purpose is to present and review recent advances in some of the major polymer processing operations. Altogether, 16 leading researchers have contributed to nine chapters covering extrusion, die flow, thermoforming, blow moulding and injection moulding of plastics and rubbers. A total of 680 references are provided to bring the reader up-to-date with the latest literature in the various subjects.

In Chapter 1, the editor provides a brief overview of modelling of polymer processing. This is entirely descriptive and outlines the stages in the development of the theory in the various polymer processing sectors. It is a useful introduction to the subject for the non-specialist reader and an extensive reading list is provided to complement the contents of the subsequent chapters.

Chapters 2-4 look at the computer simulation of flow in extruders. In Chapter 2, the advantages and difficulties of applying the concept of inverse formulation to flow through extruder dies are discussed. The principle of inverse formulation is first described and its application in other fields is reviewed. Its utilization in the area of heat conduction and pressure loss in extrusion dies is then illustrated. Unfortunately the treatment of each subject is rather cursory and there is no attempt to show how the analysis may be applied to a real situation or to indicate what accuracy may be expected from the predictions. Chapter 3 considers flow simulation in twin-screw extruders and Chapter 4 analyses the transport processes in this type of equipment. These are useful contributions which should be of interest to the practising engineer. In Chapter 4, extensive numerical results are presented to illustrate the effects of the process variables.

Chapter 5 deals with free surface moulding in the form of thermoforming and blow moulding. The primary interest is simulation using finite element analysis but the chapter is a very valuable overview of the complex subject of thermal forming of sheet materials. Many

of the techniques illustrated will have broader applicability to the newer forming technologies such as injection blow moulding.

The remainder of the book deals with injection moulding in relation to thermoplastics (Chapter 6), rubbers (Chapter 7) and flow within mould cavities (Chapter 8). The final chapter describes an interactive data acquisition system for injection moulding. Many industrialists will nowadays be familiar with software such as MOLDFLOW and these chapters provide an insight to the basis of such programs.

Overall the book can be regarded as a useful addition to the literature. It is not comprehensive nor has there been an attempt to rationalize the modelling approaches for the processes considered. Also, the authors have not made any real attempt to simplify the analytical procedures to the point where they could be used by practising engineers or designers. Nevertheless the book provides a valuable state-of-the-art starting point for those embarking on modelling of polymer processing. Extensive references are provided for further reading and in relation to modern prices, the book represents quite good value for money.

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Design Formulas for Plastics Engineers

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Hanser, Munich, 1991,
144 pp., £17.00,
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This book aims to summarize useful formulae for the plastics engineer involved in designing machines and dies for polymer processing. Since much of this design is usually done with computer programs, a knowledge is needed of the fundamental equations on which computer models are based if programs are to be written or developed. The book covers rheology (viscous shear flow and viscoelasticity), thermodynamic properties, heat transfer, designing plastics parts, extrusion dies and screws and injection moulding. The formulae are introduced and defined with concise text and numerical examples given with worked solutions. There are also numerous schematic graphs of typical behaviour.

It is difficult to know what readership would best be served by this book. Because of the natural brevity of the text, it is unlikely to be used by people who are not already familiar with the principles and concepts involved. As a teaching text it is far too concise, and because the aim is to present formulae suitable for use in computer models there is little attempt to simplify them to bring out their physical significance. Of course the stated aim is to help design engineers to write computer programs. However, care must be exercised to ensure that the equations used are in an appropriate form. For instance, the power law for non-Newtonian viscosity uses shear rate as a function of shear stress raised to a power n , i.e. shear rate is plotted as the ordinate and shear stress as the abscissa. Thus the power law exponent n used here is the inverse of that often used. For low density polyethylene, for instance, the power law index is quoted here as 2.57, whereas it is commonly taken to be about 0.39 when shear rate is the abscissa. This also has an effect on the Rabinowitsch correction and although the alternative form is quoted in the text, mistakes could easily be made.

The chapter on viscoelastic behaviour relies heavily on schematic graphs which might be difficult to apply without the appropriate data. A more serious omission is any mention of loss tangent in the section on dynamic loading. Although storage and loss moduli are often sufficient, sometimes the only data available from polymer manufacturers are plots of loss factor against frequency or temperature. In the section on heat transfer there is a good summary of dimensionless groups which are defined both in symbols and in words. The chapter on designing plastics parts is of necessity brief since the potential applications are too diverse for a thorough treatment. Extrusion equations are given for flow in several channel geometries and for the solids conveying and melting regions of the screw. Perhaps because of the book's emphasis on machine design, the overall performance equations for extruder output (drag flow minus pressure flow) are not given. In the section on injection moulding the clamping force equation appears in an unduly complicated form and again there is little attempt to simplify difficult formulae, so that the reader must follow the argument in the given form in order to apply the equations easily.