BOOK REVIEWS

N. G. GAYLORD, Editor

Processing of Thermoplastic Materials. Edited by ERNEST C. BERNHARDT. Reinhold, New York, 1959. 720 pp. $18.00.

If a current illustration were needed of how a technical art becomes a branch of engineering, the recent history of extrusion in the plastics industry could hardly be improved upon. As recently as ten years ago, only the connoisseurs of obscure engineering science seemed aware that extrusion of melts could be considered rationally as a branch of fluid mechanics. Yet within this period, as the current volume sponsored by the Society of Plastics Engineers displays, there has appeared a substantial body of sound theory which has already had its impact on the working hypotheses that guide the practitioners of what is still largely an empirical engineering technique.

The distribution of subject matter by pages in this volume is perhaps slightly prophetic, being one-fifth theory, three-fifths applications, and one-fifth physical data pertinent to the flow of thermoplastics. Practice may not attain this ratio for some years yet, but the impetus to do so has been greatly increased by the appearance of this volume.

Fundamentals are treated by A. B. Metzner, discussing "Flow Behavior of Thermoplastics," J. M. McKelvey on "Heat Transfer and Thermodynamics," and D. J. Mohr on "Mixing and Dispersing." Metzner's chapter is a readable up-to-the-minute summary of the state of knowledge of non-Newtonian flow as pertaining to thermoplastics and offers a welcome guide to the newcomer to the bewildering diversity of the journal literature in this field. Perhaps because of its generally greater familiarity, McKelvey's chapter presents little that is new or specially slanted to the plastics engineer. It is nevertheless an adequate introduction to the concepts of heat transfer and heat generation by fluid friction. The chapter on "Mixing and Dispersing" by Mohr is an excellent presentation of new concepts in mixing of fluids in laminar flow, much of which has not previously been given in the detail here displayed. The ideas developed here will undoubtedly become the basis of much future work in the scientific study of laminar mixing and dispersing processes.

In the section on "Applications" one is impressed by the high degree of success with which the analysis of model fluid mechanical systems has been used in the design and understanding of the more complex practical machinery. Only for Newtonian fluids in an idealized single screw extruder without leakage is a rigorous theory at hand. Yet the functional forms of this theory have been extremely useful in correlating data on actual extruder performance and in suggesting design criteria and procedures. Paton, Squires, Darnell, and Cash contribute a long chapter on extrusion which contains much previously unpublished analysis on the flow of Newtonian fluids. Taking the same basic viewpoint as the publications in 1953 in *Industrial and Engineering Chemistry*, these authors have greatly elaborated it by correcting many misconceptions and clearing up many obscurities in previous discussions. Carley contributes an equally illuminating section on die design.

This chapter achieves a remarkable sense of unity in a very new engineering science, largely by ignoring the very real unknown factors that distinguish the Newtonian fluids discussed almost exclusively here from the highly temperature and pressure sensitive non-Newtonian polymer melts with which commercial extruders are concerned. As the authors state: "The biggest need at present is for usable methods of treating two-dimensional flow of non-Newtonian melts, including elastic effects."

Succeeding chapters on "Injection Molding" by Thayer, Mighton, Dahl, and Beyer; "Calendering" by Marshall; "Sheet Forming" by Platzer; "Forming of Hollow Articles" by Korach, and "Sealing and Welding" by Rouse and Hearst, are, if less satisfying esthetically, just as rewarding as intelligent descriptions of the state of the art with rational analyses of problems which have so far yielded to quantitative formulation.

The chapter on "Mixing and Dispersing Processes" by Beyer is a masterful presentation of the applications of Mohr's earlier analysis to actual equipment. In addition, hitherto unpublished work on the flow past the blade tip of a Banbury mixer is presented in what seems to be the first fundamental analysis of this device.

Perhaps of as much value as anything in the book is the section edited by Westover on "Processing Properties." Here are accumulated processing data on 63 commercial thermoplastic resins contributed by eleven manufacturers. Charts (with data points) of apparent viscosity versus apparent shear rate and temperature are extremely valuable to the processing engineer. The editors and contributors deserve hearty thanks for this beginning on the rational accumulation of basic data without which real engineering cannot begin.

This book is a required volume for anyone who hopes to gain some understanding of the fundamental principles of thermoplastics processing. In summarizing a vigorous development with real insight, it is also a mine of suggestions for further work in the field.

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Inorganic Fibres. C. Z. CARROLL-PORCZYSKI. Academic Press, New York, 1959. xii + 353 pp. $11.00.

The author prepared this book because "no comprehensive work has so far been published comprising all the modern fibrous inorganic materials, particularly concerning