

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

their industrial application." The book consists of nineteen chapters—five on glass fibers, three on blown and leached fibers, five on asbestos, five on wire and metallized fibers, and one on inorganic fiber paper. While published in the United States, the book was apparently written in the U. K., as the English spellings of words, i.e., fibre and colour, are used. The book is heavily illustrated with commercial art.

Inorganic Fibres is not a text or reference book, as one can judge from the following paragraph taken from the chapter (page 85) on "Glass Reinforced Plastics," which would have particular interest to readers of the *Journal of Applied Polymer Science*:

"Household Equipment. In this field plastics are well established. Buttons, combs, toothbrushes, and electric light switches and fittings have been used for many years in every home. Today, the glass-fibre-reinforced industry has reached a stage when it can look forward confidently to a rapidly expanding market for its many varied products. It is practically impossible to enumerate each item in which glass-reinforced plastics are used since additions to the long list are made practically everyday. Glass-reinforced bath tubs are yet another example of these new products which have great potentialities (See Figure 32)." (There is a photograph of a pretty girl *holding* a bath tub.) "Already established in house trailers and caravans, these are entering into competition with the standard enamelled steel or cast-iron bath. A 54-in. plastic bath weighs only 19 lb. Other advantages favouring its sales are prices that are 10 to 20 per cent less than those for conventional types, quick warm up of the tub, attractive appearance, resistance to chipping and easy cleaning with a damp cloth."

A watchful editor should have caught this with an easy movement of his blue pencil.

Where is the comprehensive work of the author? Unfortunately in the case of his chapter with the inviting title, "Asbestos in the Electrical Industry," he has written only 6 pages, one of which consists of a bibliography of twenty patent references and three others not mentioned in the text but suggested for further study. How does he handle his twenty patent references in such a short space, considering that he also has three photographs? Here it is, in one sentence (page 210):

"Great Progress has already been made in the selection and treatment of asbestos for electrical applications¹⁻²⁰ and today asbestos impregnated with modern insulating resins will withstand the most arduous conditions encountered in electrical engineering practice."

This smacks sorely of the Sunday Supplement.

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Industrial Fatty Acids and Their Applications.

E. SCOTT PATTISON, Ed. Reinhold, New York, 1959. 230 pp. \$7.00.

This little book consists of sixteen chapters, each written by a representative of a fatty acid producer or user, equipment manufacturer, or research organization. As often happens with such compilations, some discussions are excellent and others leave much to be desired. As the title implies, the subject matter covers the uses of commercial fatty acids. The fact that such products are impure mixtures is perhaps responsible for the rather abbreviated and general discussions of fatty acid chemistry. Chapter 6 on the "General Chemical Reactions" is a well organized summary of typical reactions which fatty acids can undergo. The sole references at the end of this chapter to five other texts is an indication of the cursory treatment, however. Other chapters on vinyl esters and "Surface-Active Derivatives" have excellent bibliographies, including selected literature references through 1957. Pages 163 through 175 seem unnecessarily repetitive of the more extensive discussion of surface-active derivatives found in the preceding chapter. Chapter 10 is particularly inadequate in its sketchy coverage of applications in the rubber industry considering the statistics on page 2 which show an average consumption in this field of 10% of total production. The statement on page 9 that linseed, castor, corn, and fish oil fatty acids are not "substantial articles of commerce" seems questionable when apparently 22 million pounds were produced in 1957. Several fatty acid producers make available excellent charts showing the composition of a wide variety of commercial products; a much better selection could have been made than the one reproduced on page 6. While illustrations always make a book more attractive, the caption underneath the photograph on page 39 is uninformative if not downright puzzling. Statements on page 96 to the effect that alkyd production using direct esterification of fatty acids rather than alcoholysis of oils is "simpler and shorter," "kettle capacity is increased," is less "variable" and not "subject to seasonal and geographical variation" are highly questionable if not actually incorrect. There is no discussion of utilization of fatty acids in wax technology, no mention of emulsification by *in situ* soap formation, and no appreciation of the role of fatty acids in pigment wetting. The index is inadequate.

This book is of limited value as a technical reference work but it does provide a quick, easily read perspective of the fatty acid industry.

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