Paste Flow and Extrusion

By J. Benbow and J. Bridgwater, Oxford Series on Advanced Manufacturing, Oxford, 1993, 153 pp. (hard cover), $56.50.

This is a well produced and attractive slim book covering a topic of industrial importance. Paste flow and extrusion are involved in the manufacture of lead pencils, toothpaste, foodstuffs, catalyst's supports—such as monoliths—animal feedstocks, health care products and a host of pharmaceutical processes. The material covered is largely based on work by the two authors, and it is conveyed with a minimum of fuss, economically with no unnecessary information. If anything, the reader might get the feeling that the authors are holding back—a rare feat—in an effort to keep the level uniform.

The book is structured as follows. After the customary Introduction, there is an overview of paste extrusion and related processes, including methods of size enlargement. Chapter 3 focuses on types of extruders: rotary, ram, and screw. Chapter 4 is the most "theoretical" on fundamentals of paste flow (a bit of rheology here). Chapter 5 concerns laboratory evaluation methods, a quite practical chapter, and Chapter 6 with paste formulation. Chapter 7 deals with flow defects and phase migration—an area dear to polymer processing types involved in melt fracture and related issues, whereas Chapters 8 and 9 deal with die design and screw extruders (again both areas closely paralleled by polymer processing). Chapters 10 and 11 conclude the presentation with an overview and worked examples, respectively. The very last chapter places the book squarely in the category of a know-how book.

Nevertheless, a sense of research needs manages to come through and ideas for PhD topics abound (for example in Chapter 7). A few comments regarding overall placement of the area in a broader context might help. Even though this topic could be imagined as a natural continuation of concentrated suspensions—as currently practiced in the U.S. and U.K. fluid mechanical communities, it is clear that things in this area did develop in a very much independent fashion. Do not search for tensors in this work; in fact, a chemical engineering undergraduate should be able to follow most of it. Nor is it connected with physics of granular media, a topic enjoying somewhat of a resurgence within the physics community. In fact, the flavor that comes across is somewhat akin to that of polymer processing, as the topic was just starting to find its way into texts with J. M. McKelvey and others; polymer types will recognize some of the names in the bibliography and feel very much at home in the chapters dealing with extrusion.

Other connections are not hard to imagine, and research needs are not hard to grasp. Some are obvious; very little is known about dry and wet mixing. High shear mixing, breaking agglomerates, is also in need of more fundamental work. Surface fracture and all the instabilities resulting from extrusion seem to be of a descriptive level and behind what one might find in the fluid mechanics and polymer literature (e.g., M. M. Denn, *Annual Reviews of Fluids Mechanics*, **22**, 13, 1990). Rheology, and all the processing that goes along with it, die design et al. suggest fertile areas for work as well.

In short, this is a pithy book that will undoubtedly help its intended industrial audience and sparkle the imagination of academic researchers.

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Scaleup and Design of Industrial Mixing Processes

By Gary B. Tatterson, McGraw Hill, New York, 312 pp., 1994, $56.

Gary Tatterson is well known to the international mixing community through his attendance at Engineering Foundation conferences since the 1970s and at the AIChE meetings, and through his earlier book titled *Fluid Mixing and Gas Dispersion in Agitated Tanks*. In the Preface to this book, he names 24 industrialists in the U.S. and 13 academics from the U.S., Japan and Europe, whom he thanks for advice and opinions that have helped guide it. Two academics have been given further recognition: Richard Calabrese has had a dimensionless group named after him and John Smith, an impeller. However, what all of these people know is that Gary has a wicked and outrageous sense of humor; I think this explains this book which is a bit of a spoof.

The book has five chapters. The first deals with Basic Processing Concepts (51 pages), which has very few equations with only those for drop size being considered in any detail. It is here that the Calabrese number is introduced to account for the effect of viscosity on Sauter mean drop size (just defined here as mean drop size d_p). Without the correction for viscosity, the equations published by Calabrese and others give $d_p/D \alpha\, We_I^{-0.6}$ where We_I and D are the impeller Weber number and diameter, respectively. This relationship is then rearranged here to give $d_p \alpha (\epsilon_T)^{-0.6}$ for both stirred vessels and static mixers where ϵ_T is the specific energy dissipation rate or power per unit mass. No explanations are given as to how these equations are derived. Of course, they come from the application of Kolmogoroff's theory by which turbulent stresses causing breakup are derived and these are then balanced in the low viscosity case by interfacial tension. Kolmogoroff's theory, however, when applied correctly, gives $d_p \alpha (\epsilon_T)^{-0.4}$. Unfortunately, these equations are used frequently throughout the book.

Chapter 1 also introduces the "Smith impeller" (similar to the Chemineer CD6 or the Scaba 6SRGT). Though the impeller is strongly recommended, quantitative data (for example, its power number, flow number, or gassed power characteristics) are not given on any of the three occasions discussed.

Each chapter contains personal nuggets of wisdom or key points, many