Zbigniew K. Walczak

Processes of Fiber Formation

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Zbigniew K. Walczak

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PREFACE

More than twenty years have passed since the publication of my first book on the subject of fiber formation. Nonetheless, time has its own right. Though throughout the last twenty-five years the fundamental research activity in the field was low worldwide, some progress was made, and thus a presentation of the current status appears to be necessary.

It is almost a paradox that on the one hand, the fiber formation process has passed its centennial birthday, while on the other hand, in some circles, it continues to be considered a craft. In this book I intend to show that fiber formation is a multidisciplinary, complex, often difficult to comprehend **science**. The fiber formation presented here is based on the systematics published in my first book, on numerous important publications concerning different unit processes involved, as well as on my own research conducted over some thirty years. By taking the broadest possible view, a sort of a "frontal attack", it was possible to develop the ways of full description of the fiber formation process. The outcome of the process has been made also predictable *in principle*. The reservation *in principle* means that the outcome of a process may be predicted on the basis of laboratory analytical data and process parameters within a relatively narrow range of conditions. Obtaining full predictability requires additional fundamental research on the behavior of viscoelastic spectra, and on development of new, solid fundamentals of polymer crystallization kinetics, especially of the kinetics of crystal growth.

It can not be neglected to underscore that fiber formation is treated here as one process with three different variants: formation from melt and formation from solution either by the wet or by the dry method. In essence, the difference between the formation from melt and solution differs only by one additional aspect: the presence of a solvent, and this is insufficient to treat it as a separate process. The plural form, processes, relates to the many "unit processes" involved in the formation of a fiber. For this reason, the subject of fiber formation is treated generally as formation from the melt. The additional unit processes pertinent to the formation from solution are treated in a separate chapter which describes the additional complications.

Fiber formation consists of a number of physical processes with nonlinear behaviors occurring and influencing each other simultaneously. In some cases, still another chemical process may be involved. Several disciplines are involved, many different experimental techniques. For these reasons, some of the introductory chapters on raw material properties, rheology, or certain parts of the engineering aspects may appear to some readers as unnecessary, too elementary, or outright boring. Nonetheless, people educated in various disciplines enter into this field, and to facilitate access to the subject, such a broad range of background subjects had to be covered.

Many of my own findings and solutions concerning some of the most vital aspects of fiber formation are presented here for the first time. A book form gives

a better stage to present a complex, systemic approach and a mutual confirmation of the different techniques, results, and conclusions. Since, in my view, a theory without corroboration is useless, every original solution presented here has been confirmed experimentally numerous times and under various conditions. And here is the need and place to express my greatest appreciation and gratitude to those with whom I was lucky to work during different periods on the experimental parts of the endeavors: Ms. Janet B. Fryzel, Mr. Nolan Smith, and Mr. Alan C. Smith. Some of the experimental tasks were very demanding for accuracy, some, like program debugging, were trying to the patience — nonetheless, execution of every task was really admirable.

All the parts involving aerodynamics could not have been written without the generous consultations, or rather teachings, of Professor Juliusz Lukasiewicz, Jr. chief of von Karmàn Gas Dynamics Facility, Arnold Engineering Development Center, Tullahoma, Tennessee and later of Carlton University, Ottawa, Ontario.

I owe special gratitude to Mr. Rainer Typke for his learned and generous help at the time when my computer broke down and needed the hardware to be replaced, the new operating systems introduced. His help saved many of my older programs, and much time and frustration.

An expression of deep appreciation and thanks I direct to my daughter Agatha C. Walczak-Typke for the editing and proof reading of this book, despite the heavy load of her own work; a Dixie style: *Thank you. Thank you. Thank you.*

And last, though not least, I would like to express my long standing and great appreciation to my wife Krystyna for her patience over the time of our togetherness lost to this book. Instead of a display of dissatisfaction, she was generous enough to apply her artistry to design the cover for this book.

I owe a special *thank you* to all of the publishers who granted me their permission for copying material from other publications. Also, some of the illustrations have been made available by the authors and my gratitude is extended to them, though, sorry to say, many of them are already deceased.

Zbigniew K. Walczak

Barcelona, 2001.

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