

Preface

Polyethylene is, by a wide margin, the largest volume synthetic polymer made by mankind. As of this writing, about 77 million metric tons are produced annually and the growth rate is expected to continue at about 5% per year into the foreseeable future. Within the three minutes or so it takes to read this preface, over 400 tons of polyethylene will have been manufactured. It is produced in various forms on 6 continents and its applications are ubiquitous in daily life, from the trash bag you placed on the curb this morning to Uncle Fred's artificial hip.

This book is primarily intended as an introductory text for chemists, engineers and students who wish to gain an understanding of the fundamentals of the commercially important polymers and copolymers of ethylene. The reader is assumed to have had a modicum of training in chemistry but little prior knowledge about polyethylene. I also intend it to be useful as a complement to courses on polymer chemistry. This book will answer essential questions such as:

- What are the types of polyethylene and how do they differ?
- What catalysts are used to produce polyethylene and how do they function?
- What is the role of cocatalysts in polyethylene production?
- What processes are used in the manufacture of polyethylene?
- What is the fate of polyethylene after its useful life is over?

Jargon used in industrial polyethylene technology can be bewildering to newcomers. This text will educate readers on terminology in common use in the industry and demystify the chemistry of catalysts and cocatalysts employed in the manufacture of polyethylene. I have employed several techniques to make the text user friendly. A thorough glossary is included in the appendix. The glossary not only provides definitions of acronyms and abbreviations, but also concisely defines terms commonly used in discussions of production and properties

of polyethylene. An extensive index with liberal cross-referencing enables the reader to find a topic quickly.

Chapter 1 is used to review the history of polyethylene, to survey quintessential features and nomenclatures for this versatile polymer and to introduce transition metal catalysts (the most important catalysts for industrial polyethylene). Free radical polymerization of ethylene and organic peroxide initiators are discussed in Chapter 2. Also in Chapter 2, hazards of organic peroxides and high pressure processes are briefly addressed. Transition metal catalysts are essential to production of nearly three quarters of all polyethylene manufactured and are described in Chapters 3, 5 and 6. Metal alkyl cocatalysts used with transition metal catalysts and their potentially hazardous reactivity with air and water are reviewed in Chapter 4. Chapter 7 gives an overview of processes used in manufacture of polyethylene and contrasts the wide range of operating conditions characteristic of each process. Chapter 8 surveys downstream aspects of polyethylene (additives, rheology, environmental issues, etc.). However, topics in Chapter 8 are complex and extensive subjects unto themselves and detailed discussions are beyond the scope of an introductory text.

I must take this opportunity to express my appreciation to friends and associates who made constructive suggestions on the content of this book. Thanks to Drs. James C. Stevens and Rajen Patel (of The Dow Chemical Company in Freeport, TX) for their comments on the product descriptions and single-site catalysts. Dr. Roswell (Rick) E. King III (of Ciba, now part of BASF, in Tarrytown, NY) and Dr. Brian Goodall reviewed portions of the text and provided recommendations for improvement. Dr. Malcolm J. Kaus of ExxonMobil directed me to several outstanding literature discussions on catalyst and process technologies and kindly provided a reprint of a conference paper on the ExxonMobil high pressure process for polyethylene. Dr. James Strickler (of Albemarle Corporation in Baton Rouge, LA) helped with valuable suggestions about the chapter on metal alkyls. I am indebted to Drs. Balaji B. Singh and Clifford Lee of Chemical Marketing Resources, Inc. (Webster, TX) who shared information on markets and fabrication methods. Drs. Bill Beaulieu and Max McDaniel (of Chevron Phillips) reviewed information on "Phillips Catalysts" and instructed me on the intricacies of these mysterious catalysts. People mentioned above made suggestions that I found very helpful and tried to meld into the text. However, any residual errors are solely my responsibility. Finally, I would like to thank my publisher Martin Scrivener for the invitation to write this book and for his help in getting it published.

In closing, I would be remiss if I did not acknowledge my former colleagues at Texas Alkyls, Inc. (now Akzo Nobel) with whom I toiled for more than 30 years producing and marketing the metal alkyls that are so crucial to the polyolefins

industry. The experiences and knowledge acquired during those years contributed mightily to the foundations for this book. However, my former coworkers at Texas Alkyls shall remain anonymous, for the list would be far too long.

I hope the reader will find the text informative on the fundamental aspects of industrial polyethylene.

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