Introduction to Industrial Polyethylene
Properties, Catalysts, Processes

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Introduction to Industrial Polyethylene
Contents

Preface ix
List of Tables xiii
List of Figures xv

Chapter 1 Introduction to Polymers of Ethylene 1
  1.1 Genesis of Polyethylene 1
  1.2 Basic Description of Polyethylene 2
  1.3 Types and Nomenclature of Polyethylenes 7
  1.4 Molecular Weight of Polyethylenes 15
  1.5 Transition Metal Catalysts for Ethylene Polymerization 20

Chapter 2 Free Radical Polymerization of Ethylene 23
  2.1 Introduction 23
  2.2 Free Radical Polymerization of Ethylene 24
  2.3 Organic Peroxide Initiators 29

Chapter 3 Ziegler-Natta Catalysts 33
  3.1 A Brief History of Ziegler-Natta Catalysts 33
  3.2 Definitions and Nomenclature 35
  3.3 Characteristics of Ziegler-Natta Catalysts 36
  3.4 Early Commercial Ziegler-Natta Catalysts 38
  3.5 Supported Ziegler-Natta Catalysts 39
  3.6 Prepolymerized Ziegler-Natta Catalysts 40
  3.7 Mechanism of Ziegler-Natta Polymerization 40
Chapter 4 Metal Alkyls in Polyethylene Catalyst Systems 45
  4.1 Introduction 45
  4.2 Aluminum Alkyls in Ziegler-Natta Catalysts 46
    4.2.1 Reducing Agent for the Transition Metal 49
    4.2.2 Alkylating Agent for Creation of Active Centers 49
    4.2.3 Scavenger of Catalyst Poisons 50
    4.2.4 Chain Transfer Agent 50
  4.3 Magnesium Alkyls in Ziegler-Natta Catalysts 50
    4.3.1 \( R_2Mg \) for Production of Supports 52
    4.3.2 \( R_2Mg \) as Reducing Agent 52
  4.4 Lithium Alkyls 53
  4.5 Organoboron Compounds 55
  4.6 Zinc Alkyls 56
  4.7 Safety and Handling of Metal Alkyls 57

Chapter 5 Chromium Catalysts 61
  5.1 Chromium Catalysts Supported on Metal Oxides 61
  5.2 Basic Chemistry of Phillips Catalysts 62
  5.3 Generations of Phillips Catalysts 65
  5.4 Union Carbide Chromium Catalysts 67
  5.5 Mechanism of Polymerization with Supported Chromium Catalysts 68

Chapter 6 Single Site Catalysts 71
  6.1 Introduction 71
  6.2 Metallocene Single Site Catalysts 72
    6.2.1 Non-metallocene Single Site Catalysts 74
  6.3 Cocatalysts for Single Site Catalysts 76
    6.3.1 Methylaluminoxanes 77
    6.3.2 Arylboranes 80
    6.3.3 Other Cocatalysts for Single Site Catalysts 81
  6.4 Mechanism of Polymerization with Single Site Catalysts 82
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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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List of Tables

Chapter 1 Introduction to Polymers of Ethylene
Table 1.1 IUPAC names of selected polymers and copolymers of ethylene 12
Table 1.2 Classification of selected polyethylenes 15
Table 1.3 Polyethylene catalysts containing transition metals 22

Chapter 2 Free Radical Polymerization of Ethylene
Table 2.1 Key organic peroxide initiators for LDPE 31

Chapter 4 Metal Alkyls in Polyethylene Catalyst Systems
Table 4.1 Comparative cost of selected trialkylaluminum compounds 48

Chapter 5 Chromium Catalysts
Table 5.1 Generations of Phillips catalysts 65

Chapter 6 Single Site Catalysts
Table 6.1 Contrasting characteristics of single-site and Ziegler-Natta catalysts 72

Chapter 7 An Overview of Industrial Polyethylene Processes
Table 7.1 Features of key industrial polyethylene processes 86
Table 7.2 Typical operating features of autoclave processes for LDPE 91
Table 7.3 Typical operating features of tubular processes for LDPE 91
Table 7.4 Typical operating features of slurry/suspension processes for LLDPE and HDPE 93