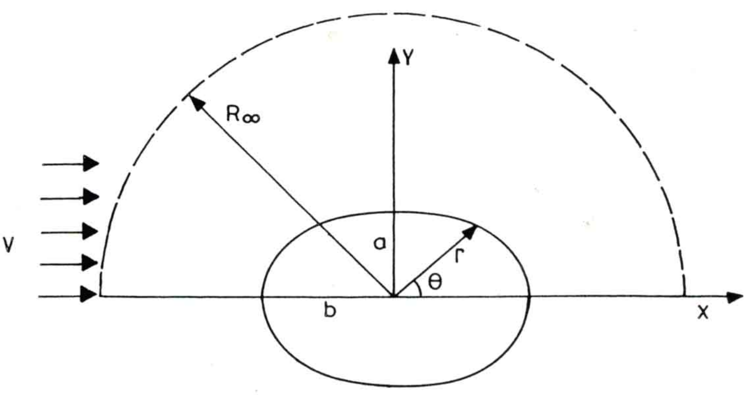
HANDBOOK OF APPLIED POLYMER PROCESSING TECHNOLOGY



EDITED BY

NICHOLAS P. CHEREMISINOFF
PAUL N. CHEREMISINOFF

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EDITED BY

NICHOLAS P. CHEREMISINOFF
Consultant and Technical D[illegible]
Donets Oblast, Ukraine

PAUL N. CHEREMISINOFF
Consultant
Hasbrouck Heights, New Jersey

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Clemson, South Carolina

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Preface

Polymer processability and processing procedures have evolved into one of the most extensively investigated areas of polymer science over the past decade. The reason for this intense interest is that polymer suppliers have had to learn the difficult and costly lesson that product design in terms of performance in the marketplace often depends on the processing characteristics of the raw material in parts manufacturing operations. Not only must product design take into account end-use performance properties such as adhesion, weather and ozone resistance, chemical resistance, durability, flexural modulus, sealing performance, vibration damping, and a multitude of other end-user requirements, but it must also consider the efficiency of polymer processing operations. Furthermore, many end-use performance properties are a strong function of the processing and rheological characteristics of the elastomer or plastic. A practical example is the manufacture of automotive trunk seals from EPDM. Aesthetics qualities (e.g., surface smoothness, glossiness) that are performance criteria for the consumer depend on such properties as melt fracture and swell. In this example, the extrusion performance of the elastomer plays a critical role in end-performance criteria, as well as extrusion conditions (temperature, pressure, rate), compounding formulation, vulcanization conditions, and the compositional and molecular structure of the elastomer. One cannot simply design a polymeric product with certain end-user performance criteria as targets without addressing the processing steps and characteristics of the polymer along with its active and filler compounding ingredients.

This handbook has been prepared as an industry reference on applied and advanced techniques in polymer processing. It provides some fundamental discussion of rheological properties and concepts but is largely written by experts attempting to develop more rigorous guidance in processability. The handbook contains twenty-seven chapters on advanced subjects of industry concern, and in many discussions the relationships between polymer structural and molecular characteristics are explored in relation to processing properties. The work represents the efforts of a large group of international practitioners. Contributors are to be considered responsible for the statements in their respective chapters. The editors wish to extend deep gratitude to these contributors for their time and effort in the preparation of their treatise and to Marcel Dekker, Inc., for the fine production of this volume.

Nicholas P. Cheremisinoff, Ph.D.
Paul N. Cheremisinoff, P.E.

Contributors

S. Blackburn Interdisciplinary Research Centre (IRC) in Materials for High Performance Applications and School of Chemical Engineering, University of Birmingham, Edgbaston, Birmingham, United Kingdom

R. P. Chhabra School of Chemical Engineering and Industrial Chemistry, University of New South Wales, Sydney, New South Wales, Australia

A. Y. Coran Polymer Blending and Compounds Center, Institute of Polymer Engineering, University of Akron, Akron, Ohio

D. De Kee Department of Chemical Engineering, University of Sherbrooke, Sherbrooke, Quebec, Canada

A. P. De Weijer Department of Analytical Chemistry, University of Nijmegen, Nijmegen, The Netherlands

Mikael Epstein Department of Chemical Technology, Technical Research Center of Finland, Tampere, Finland

Junji Furukawa Aichi Institute of Technology, Toyota, Japan

K. J. Ganzeveld Department of Chemical Engineering, University of Groningen, The Netherlands

W. A. Gifford Extrusion Dies, Inc., Chippewa Falls, Wisconsin

Toyohiko Gondoh Department of Industrial Chemistry, Kurume National College of Technology, Kurume City, Japan

Markku T. Heino Department of Chemical Engineering, Helsinki University of Technology, Espoo, Finland

H. M. Heuvel Akzo Nobel Central Research Laboratories Arnhem, Arnhem, The Netherlands

Lee-May Huang Department of Chemical Engineering, National Tsing Hua University, Hsinchu, Taiwan, Republic of China

Hiroaki Imura Department of Materials Science and Engineering, Yamagata University, Yonezawa, Yamagata, Japan

Léon P. B. M. Janssen Department of Chemical Engineering, University of Groningen, Groningen, The Netherlands

B. Jiang Polymer Physics Laboratory, Changchun Institute of Applied Chemistry, Changchun, People's Republic of China

Jyoti P. Jog Chemical Engineering Division, National Chemical Laboratory, Pune, India

Takeshi Kitano Department of Polymer Engineering, National Institute of Materials and Chemical Research, Tsukuba, Ibaraki, Japan

Shinya Kitoh Pharmaceutical Laboratories, Lion Corporation, Odawara, Kanagawa, Japan

Antonin Klásek Department of Environmental Chemistry and Technology, Technical University of Brno, Zlin, Czech Republic

Tsuneo Koike Research and Development Laboratory, Yuka Shell Epoxy Co., Ltd., Yokkaichi-city, Mie, Japan

Keisuke Kurita Department of Industrial Chemistry, Seikei University, Masushino, Tokya, Japan

A. V. Kurnoskin Laboratory of Coordination Chemistry of Transition Elements, Kurnakov Institute of General and Inorganic Chemistry, Russian Academy of Sciences, Moscow, Russia

Yuri S. Lipatov Institute of Macromolecular Chemistry, National Academy of Sciences of Ukraine, Kiev, Ukraine

Ta-Jo Liu Department of Chemical Engineering, National Tsing Hua University, Hsinchu, Taiwan, Republic of China

Y. Liu Department of Chemical Engineering, Hebei University of Technology, Tianjin, People's Republic of China

Y. Luo Radiation Chemistry Laboratory, Changchun Institute of Applied Chemistry, Changchun, People's Republic of China

Mamoru Mishima Sumitomo Heavy Industries, Ltd., Osaka City, Japan

Kinjiro Miyagawa Department of Clinical Nutrition, Suzuka University of Medical Science and Technology, Suzuka, Mie, Japan

Tetsuo Mori Department of Industrial Chemistry, Kurume National College of Technology, Kurume City, Japan

Tony Moussa Department of Chemical Engineering, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia

Yasuhiro Murakami Department of Chemical Engineering, Kyushu University, Fukuoka City, Japan

Haruyuki Nishimi Sumitomo Heavy Industries, Ltd., Toyo City, Japan

Jacobus W. M. Noordermeer Department of Research and Application Technology, DSM Elastomers B.V., Sittard, The Netherlands

Ikuko Ogawa Faculty of Education, Kagawa University, Takamatsu, Japan

D. Rodrigue Department of Chemical Engineering, University of Sherbrooke, Sherbrooke, Quebec, Canada

U. V. Shenoy Department of Chemical Engineering, Indian Institute of Technology, Powai, Bombay, India

George P. Simon Department of Materials Engineering, Monash University, Clayton, Victoria, Australia

Dana Škabrahová Department of Mathematics, Technical University of Brno, Zlin, Czech Republic

Shinichi Suto Department of Materials Science and Engineering, Yamagata University, Yonezawa, Yamagata, Japan

H. Tai Department of Chemical Engineering, Hebei University of Technology, Tianjin, People's Republic of China

K. C. Tam Division of Manufacturing Engineering, School of Mechanical and Production Engineering, Nanyang Technological University, Singapore

Carlos Tiu Department of Chemical Engineering, Monash University, Clayton, Victoria, Australia

Michiharu Toh Department of Industrial Chemistry, Kurume National College of Technology, Kurume City, Japan

Douglas E. Turek Ventures and Central Research, The Dow Chemical Company, Midland, Michigan

Tommi P. Vainio Department of Chemical Engineering, Helsinki University of Technology, Espoo, Finland

Mathias M. Wilms Department of Research and Applications Technology, DSM Elastomers B.V., Sittard, The Netherlands

R. J. Yan Polymer Materials Laboratory, Changchun Institute of Applied Chemistry, Changchun, People's Republic of China

Hideki Yamano Faculty of Education, Kagawa University, Takamatsu, Japan

Shoichiro Yano Department of Composite Materials, National Institute of Materials and Chemical Research, Tsukuba, Ibaraki, Japan

L. Zhang Department of Chemical Engineering, Hebei University of Technology, Tianjin, People's Republic of China

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Contents

1

Hydrodynamics of Nonspherical Particles in Non-Newtonian Fluids

R. P. Chhabra
School of Chemical Engineering and Industrial Chemistry, University of New South Wales, Sydney, New South Wales, Australia

I. INTRODUCTION

The relative motion between solid particles and a viscous liquid occurs in a variety of operations carried out in chemical, polymer, food, and allied industries. For instance, it is often necessary to estimate the force needed to move a solid object through a liquid, or conversely, the force that a moving liquid exerts on a solid as the fluid flows past it. Many processes for the separation of particles of various sizes, shapes, and densities depend on their behavior when subjected to the action of a moving fluid. Notwithstanding the importance of the detailed kinematics of flow, it is readily recognized that the variable of central interest in all such applications is the free-falling velocity as a function of the properties of the liquid medium (density, viscosity), of the particles (size, shape, and density), and of the operating conditions (size of the apparatus compared to that of the particle, whether the liquid is undergoing any motion, etc.). For the simplest case of the settling of the particle under the influence of the earth's gravitational field in a vast expanse of quiescent viscous medium, the functional relationship between the settling velocity and the pertinent variables is conveniently expressed in terms of the usual dimensionless groups such as Reynolds number and drag coefficient for spherical particles, whereas additional shape factors are needed to quantify the settling behavior of nonspherical particles. Further complications arise depending on whether the shape of the particle is regular or irregular.