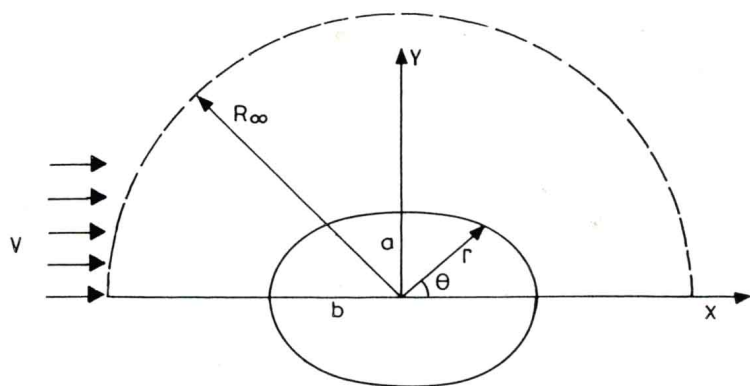


HANDBOOK OF APPLIED POLYMER PROCESSING TECHNOLOGY



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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.

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Hydrodynamics of Nonspherical Particles in Non-Newtonian Fluids

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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.