HANSER

The Complete Part Design Handbook

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For Injection Molding of Thermoplastics

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Preface

This handbook was written for the injection molding product designer who has a limited knowledge of engineering polymers. It is a guide for the designer to decide which resin and design geometries to use for the design of plastic parts. It can also offer knowledgeable advice for resin and machine selection and processing parameters. Manufacturer and end user satisfaction is the ultimate goal.

This book is an indispensable, all inclusive, reference guide that can be used by any plastic product designer. There is no need to search through many books and catalogs for needed information. New illustrations, graphs and equations have been included to provide additional clarity for complex ideas. The equations have been verified to ensure correctness and not just copied from another source. Thousands of hours of research and cross referencing have gone into the completion of this work. In addition, more than 35 years of the "hands-on" experience of a plastics expert have been incorporated in this handbook.

The following topics are covered:

Chapter 1 **Plastic Materials Selection Guide:** Includes an introduction to plastic materials, the beginning of plastics, classification of polymer families. Each resin is discussed by its basic chemistry, properties, processing characteristics, advantages, disadvantages and limitations, typical applications and several product illustrations. Thermoplastic materials (35 generic families), thermoplastic elastomer materials (8 generic families), liquid injection molding of silicone, thermoset materials (16 generic families).

Chapter 2 **Engineering Product Design:** Starts with the introduction to structural product design principles, mechanical strength properties of thermoplastics. Centroid, section area, moment of inertia equations and tables. Beam deflection analysis methods. Structure analysis of beams, columns, flat circular plates, and torsion.

Chapter 3 **Structural Design for Thermoplastics:** Discusses the product wall thickness, structural rib design, sharp corners, bosses, threads, undercuts, integral life hinges, pin hinges. Encapsulation of inserts, types of metal inserts and anchorage, and electrical lead inserts.

Chapter 4 **Thermoplastic Gearing Design:** An introduction to and classification of gears. Standard spur, helical, bevel, and worm gears; properties required for thermoplastic molded spur gears, mounting gears on metal shafts, tolerances and mold shrinkage of gears. Plastic spur and helical gearing technology design, strength, horsepower rating, equations, tables, analysis examples and gear specification illustrations.

Chapter 5 **Plastic Journal Bearing Design:** An introduction to types of materials for journal bearings. Theory and design for lubrication. Design principles, performances, dimensions, clearances, molding effects, PV limits and surface finishing. Self-lubricated thermoplastic bearings. Equations, tables, and analysis examples.

Chapter 6 **Thermoplastic Spring Design:** Introduces cantilever beam spring design, applications, and analysis examples. Locating, fixing clip, flexible hinges, and torsional spring applications. Belleville spring washers' equations, tables, and analysis examples.

Chapter 7 **Thermoplastic Pressure Vessel Design:** Discusses thin- and thick-walled pressure vessels' basic principles, equations, tables, analysis examples, design guidelines, applications, and pressure vessel regulations.

Chapter 8 **Thermoplastic Assembly Methods:** Joining two or more components together: assembly method is selected based on product design geometry, size, end use requirements, thermoplastic material characteristics, automatic or manual assembly operation, and manufacturing costs. Each assembly method provides a description, process sequence, advantages and limitations, typical applications, equipment, product joint design, and its variations.

Chapter 9 **Thermoplastic Effects on Design:** Starts discussing the polymer melt behavior, reinforcement, degradation, moisture characteristics, mold shrinkage and critical properties. The molding process effects caused by molding cycle, melt/mold temperature, injection pressure and speed, etc. on product design dimensions, surface finishing, weld line strength and impact resistance and other molding problems.

Chapter 10 **Thermoplastic Injection Mold Design:** Provides an introduction of injection molds, classification and effects on product design. Types of steels, chemical composition, effects of alloying, heat treatment, properties and characteristics. Types of steels used for mold bases and mold components. Cavity surfaces finish procedures and specifications. Types of injection mold designs. Cold runners (two- and three-plate molds, interchangeable mold inserts and vertical insert encapsulation mold). Hot runner molds (internally and externally heated, insulated). Mold design system and other considerations, such as number of cavities, parting line, ejection, cooling, cold runner, gating, venting, cavity inserts sidewall strength, support pillars, molded parts tolerances, mold designer check list, general specifications for mold construction are covered.

Chapter 11 **Performance Testing of Thermoplastics:** It introduces various tests to which thermoplastic polymers are subjected, describes their properties (statistical analysis), such as mechanical, thermal, chemical resistance, rheometer melt viscosity, soldering heat resistance, electrical, flammability, smoke generation, weathering and micro-organism resistance. Test description, procedures, apparatus, test specimen and conditioning, and their significance are discussed here.

Chapter 12 **Thermoplastic Product Cost Analysis:** It discusses molding process variables and capital equipment cost. Three cost analysis methods are used to estimate the molded product user's price.