
PREFACE

TO THE THIRD EDITION

It is difficult to follow in the footsteps of Igor J. Karassik, whose vision and leadership played a major role in the concept of a handbook on pumps that is broad enough to encompass all aspects of the subject—from the theory of operation through design and application to the multitude of tasks for which pumps of all types and sizes are employed. That vision was realized in the first edition of the *Pump Handbook*, which appeared a quarter-century ago, with the capable and dedicated co-authorship of William C. Krutzsch, Warren H. Fraser, and Joseph P. Messina. Acceptance of this work globally soon led these distinguished pump engineers to assemble a second edition that not only contained updated material but also presented all numerical quantities in terms of the SI system of units in addition to the commonly used United States customary system of units.

Worldwide developments in pump theory, design and applications have continued to emerge, and these have begun to affect the outlook of pump engineers and users to such an extent that a third edition has become overdue. Pumps have continued to grow in size, speed, and energy level, revealing new problems that are being addressed by innovative materials and mechanical and hydraulic design approaches. Environmental pressures have increased, and these can and are being responded to by the creative attention of pump engineers and users. After all, the engineer is trained to solve problems, employing techniques that reflect knowledge of physical phenomena in the world around us. All of this has led the current authors to respond by adding new sections and by revising most of the others as would be appropriate in addressing these developments. Specifically the following changes should be noted.

Centrifugal pump theory, in the rewritten Section 2.1, proceeds from the basic governing fluid mechanics to the rationale that underlies the fundamental geometry and performance of these machines—while maintaining the concrete illustrations of design examples. A new subsection on high-energy pumps is included.

An update has been made to Section 2.2.1 on major components of centrifugal pumps.

Section 2.3.1 on centrifugal pump general performance characteristics has been updated.

The emerging technology of magnetic bearings is presented in the new Section 2.2.6.

Section 2.2.7, is a new treatment of sealless centrifugal pumps that includes both the canned-motor and magnetically-coupled types.

Chapter 3 on displacement pumps has been reorganized and includes updates of the sections on both reciprocating and rotary positive displacement pumps.

A new Section 4.1 on jet pump theory begins the chapter on jet pumps and deals with liquids and gases for the motive and secondary flows as well as the basics of design optimization.

Chapter 5 on materials of construction, including the Sections 5.1 and 5.2 on metallic and nonmetallic materials respectively, has been completely rewritten and updated.

Chapter 6 on pump drivers has been updated, Section 6.1.1 on electric motors and Section 6.2.2 on adjustable-speed electric drives having been substantially rewritten.

In Chapter 9 on pump services, most of the applications sections have been updated, including those for fire pumps (Section 9.4) and pumps for steam power plants (9.5), pulp and paper (9.8), mining (9.10), metering (9.15), pumped storage (9.13), and nuclear services (9.14).

Section 9.11 on marine applications has been rewritten.

Sections 9.16.1 on hydraulic transport of solids and 9.16.2 on centrifugal slurry pumps are completely new and include several examples.

A new section on aerospace pumps has been added, which includes Sections 9.19.1 on aircraft fuel pumps and 9.19.2 on liquid rocket propellant pumps.

Section 9.20 on handling hazardous liquids is new.

Chapters 10 on intakes and suction piping, 11 on selecting and purchasing pumps and 12 on installation, operation, and maintenance have been updated.

We recognize that further developments are going on apace and that more could have been done. *Computational fluid dynamics* (CFD) and finite-element structural and rotor-dynamic analysis techniques, as well as the revolution in information management and utilization, already promise to profoundly transform pump design, application, and operational practice—and indeed all other areas of engineering endeavor. Nevertheless, we offer this third edition of the *Pump Handbook* as a practical tool for the present day. In this sense, we hope that it will fulfill the vision of the authors of prior editions while at the same time serving as a stepping stone to the future world of pumping.

PAUL COOPER

PREFACE

TO THE SECOND EDITION

Once more, the dubious honor of writing a preface has been bestowed upon me by my three co-editors. And while they are perfectly willing to share the pluses and minuses of collective editorship, they refused to engage in collective “prefaceship,” if I may be allowed to coin a word. At best, they reserved for themselves the right of looking over my shoulder and criticizing the spirit of levity with which I chose to approach the task for which they had unanimously volunteered me. I should add parenthetically that the preface of the first edition (which you can read on the following pages) is actually my fourth draft; the first three were judged too irreverent by my co-editors. (I have preserved these first three drafts for whoever inherits my collection of unpublished material.)

Assuming that my co-editors are more charitable this time, or alternately that our publisher is pressed for time, what follows (if not what precedes) will appear more or less as written.

First of all, we would like to assure the readers of this second edition of the *Pump Handbook* that it is not merely a slightly warmed-over version of the first edition, with such errata as we have spotted corrected and with a few insignificant changes and additions. Actually, the task of rewriting and editing the material in a form that would correspond to what was planned for this second edition proved to be a monumental, not to say awesome, undertaking.

To begin with, in concert with the publishers, it was decided that all data given here would appear in both USCS and SI units. This was not as simple a task as it may appear, for the reason that “absolute” pure SI units do not lend themselves well to the scale of numbers generally encountered in industrial processes. To give but one example, the pascal, which is the SI unit of pressure, corresponds to 0.000145 lb/in^2 , and even the kilopascal is only 0.145 lb/in^2 . Although this might be a reasonably satisfactory unit for scientific work, the case is hardly such for centrifugal pumps used in everyday life.

This led us to choose what might be called a modified set of SI units, all as explained in “SI Units—A Commentary,” on page xxi. Even conveying this desirable concept of a practical set of SI units to the authors of various sections proved to be somewhat difficult.

As a result, we have permitted these authors some leeway in their specific choice, understanding full well that what is desirable in one industry may differ from the preferred choice in another.

We decided that a number of sections and subsections in the first edition could benefit by being significantly expanded. This, for instance, is the case with the following:

- 2.2.1 "Centrifugal Pumps: Major Components"
- 2.3.1 "Centrifugal Pumps: General Performance Characteristics"
- 2.4 "Centrifugal Pump Priming"
- 8.1 "General Characteristics of Pumping Systems and System-Head Curves"
- 8.4 "Pump Noise"
- 9.4 "Fire Pumps"
- 9.15.1 "Nuclear Electric Generation"
- 9.17.1 "Hydraulic Transport of Solids"
- 10.1 "Intakes, Suction Piping, and Strainers"
- Appendix "Technical Data"

At the same time, we felt that some material originally included in the subsection "Centrifugal Pumps: Major Components" should be excised from there and treated in greater depth separately.

This expanded coverage includes the following:

- 2.2.2 "Centrifugal Pump Packing"
- 2.2.3 "Centrifugal Pump Mechanical Seals"
- 2.2.4 "Centrifugal Pump Injection-Type Shaft Seals"
- 2.2.5 "Centrifugal Pump Oil Film Journal Bearings"

Finally, a large amount of subject matter has been added to the second edition:

- 2.3.2 "Centrifugal Pump Hydraulic Performance and Diagnostics"
- 2.3.3 "Centrifugal Pump Mechanical Performance, Instrumentation, and Diagnostics"
- 2.3.4 "Centrifugal Pump Minimum Flow Control Systems"
- 3.3 "Diaphragm Pumps"
- 3.6 "Displacement Pump Performance, Instrumentation, and Diagnostics"
- 3.7 "Displacement Pump Flow Control"
- 5.2 "Materials of Construction of Nonmetallic Pumps"
- 6.3.2 "Magnetic Drives"
- 6.3.3 "Hydraulic Pump and Motor Power Transmission Systems"
- 9.15.2 "Nuclear Pump Seismic Qualifications"
- 9.17.3 "Construction of Solids-Handling Displacement Pumps"
- 9.18 "Oil Wells"
- 9.19 "Cryogenic Liquefied Gas Service"
- 9.20 "Water Pressure Booster Systems"
- 10.2 "Intake Modeling"

In brief, the editors have attempted to increase the usefulness of this handbook. The extent to which we have achieved this objective, we will leave to the judgment of our readers.

PREFACE

TO THE FIRST EDITION

Considering that I had written the prefaces of the three books published so far under my name, my colleagues thought it both polite and expedient to suggest that I prepare the preface to this handbook, coedited by the four of us. Except for the writing of the opening paragraph of an article, a preface is the most difficult assignment that I know. Certainly the preface to a handbook should do more than describe minutely and in proper order the material that is contained therein.

Yet I submit that the saying “a book should not be judged by its cover” should be expanded by adding “and not by its preface.” If the reader will accept this disclaimer, I can proceed.

As will be stated in Section 1, “Introduction and Classification of Pumps,” it can rightly be claimed that no machine and very few tools have had as long a history in the service of man as the pump, or have filled as broad a need in his life. Every process which underlies our modern civilization involves the transfer of liquids from one level of pressure or static energy to another. Pumps have played an essential role in our life ever since the dawn of civilization.

Thus it is that a constantly growing number of technical personnel is in need of information that will help them in either designing, selecting, operating, or maintaining pumping equipment. There has never been a dearth of excellent books and articles on the subject of pumps. But the editors and the publisher felt that a need existed for a handbook on pumps that would present this information in a compact and authoritative form. The format of a handbook permits a selection of the most versatile group of contributors, each an expert on his particular subject, each with a background of experience that makes him particularly knowledgeable in the area assigned to him.

This handbook deals first with the theory, construction details, and performance characteristics of all the major types of pumps—centrifugal pumps, power pumps, steam pumps, screw and rotary pumps, jet pumps, and many of their variants. It deals with prime movers, couplings, controls, valves, and the instruments used in pumping systems.

It treats in detail the systems in which pumps operate and the characteristics of these systems. And because of the many services in which pumps have to be applied, a total of 21 different services—ranging from water supply to steam power plants, construction, marine applications, and refrigeration to metering and solids pumping—are examined and described in detail, again by a specialist in each case.

Finally, the handbook provides information on the selection, purchasing, installation, operation, testing, and maintenance of pumps. An appendix provides a variety of technical data useful to anyone dealing with pumping equipment.

We are greatly indebted to the men who supplied the individual sections that make up this handbook. We hope that our common task will have produced a handbook that will help its user to make a better and more economical pump installation than he or she would have done without it, to install equipment that will perform more satisfactorily and for longer uninterrupted periods, and when trouble occurs, to diagnose it quickly and accurately. If this handbook does all this, the contributors, its editors, and its publisher will be pleased and satisfied.

No doubt a few readers will look for subject matter that they will not find in this handbook. Into the making of decisions on what to include and what to leave out must always enter an element of personal opinion; therefore we will feel some responsibility for their disappointment. But we submit that it was quite impossible to include even everything we had wanted to cover. As to our possible sins of commission, they are obviously unknown to us at this writing. We can only promise that we shall correct them if an opportunity is afforded to us.

IGOR J. KARASSIK