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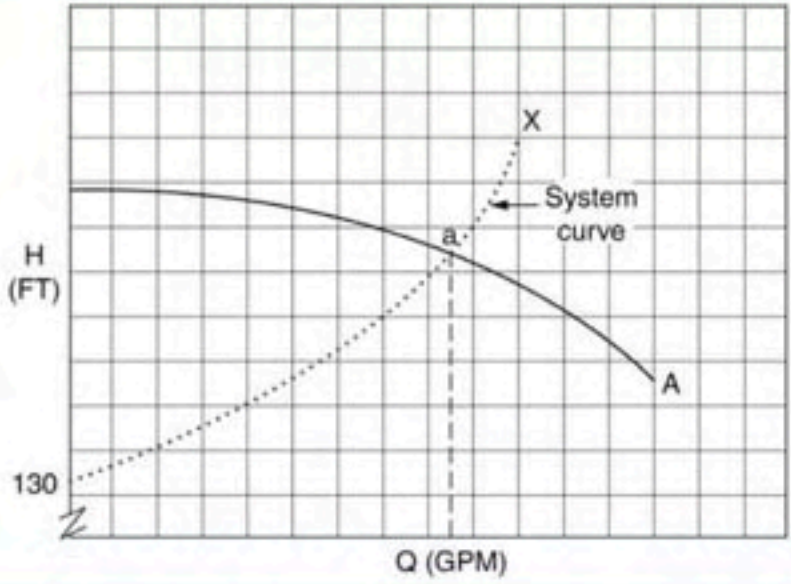
Pump Characteristics and Applications

Second Edition



Michael Volk, P.E.

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Second Edition

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Taylor & Francis
Taylor & Francis Group

Boca Raton London New York Singapore

A CRC title, part of the Taylor & Francis imprint, a member of the Taylor & Francis Group, the academic division of T&F Informa plc.

Published in 2005 by
CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

Printed in the United States of America on acid-free paper
10 9 8 7 6 5 4 3

International Standard Book Number-10: 0-82472-755-X (Hardcover)
International Standard Book Number-13: 978-0-82472-755-0 (Hardcover)

Library of Congress Cataloging-in-Publication Data

Catalog record is available from the Library of Congress

T&F informa
Taylor & Francis Group
is the Academic Division of T&F Informa plc.

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Preface to the Second Edition

Thankfully, the laws of physics have not changed since the first edition of this book was written in 1996. Therefore, virtually everything about pump selection, sizing, system analysis, and other aspects of pump hydraulics remains unchanged from the first edition. There have, however, been a number of innovations in the world of pumps, which are introduced in this second edition. This edition also expands the material on many components of typical pump installations that were only briefly covered in the first edition, if at all. Some of the most important new or expanded topics covered in this second edition include:

- *Chapter 1* — Several new types of positive displacement (P.D.) pumps are introduced, while the information on other types of P.D. pumps has been expanded.
- *Chapter 2* — Important new topics in this chapter include NPSH analysis for closed systems, expansion of the discussion on NPSH margin, and system head curve development for existing systems and for parallel pumping systems.
- *Chapter 3* — In the world of software, 9 years is an eternity, and so the entire section of this chapter covering software used to design and analyze pump piping systems has been completely rewritten. A new CD is included with the second edition of the book, demonstrating one such software tool, including solving some of the problems covered in the book.

- *Chapter 4* — Entire new sections of this chapter have been added to provide in-depth coverage of two very important and relevant topics: pump couplings and electric motors. Additionally, several types of centrifugal pumps that were not included in the first edition are covered in this chapter.
- *Chapter 5* — This chapter has an entire new section on O-rings used in pumps, as well as additional information about sealless pumps.
- *Chapter 6* — Two major additions to the book are included in this chapter. The first is an in-depth discussion of variable-frequency drives. Second, this chapter includes a section covering pump life-cycle cost, an innovative approach to the study of the cost of pumping equipment that looks way beyond the capital cost of the pump.
- *Chapter 7* — This chapter has added in-depth discussion of metallic corrosion in pumps, as well as discourse on elastomers commonly used in pumps for sealing components.
- *Chapter 8* — New topics covered in this chapter include ten methods to prevent low flow damage in pumps, and a much more detailed discussion of vibration, including a detailed vibration troubleshooting chart.

About the Author

Michael W. Volk, P.E., is President of Volk & Associates, Inc., Oakland, California, www.volkassociates.com, a consulting company specializing in pumps and pump systems. Volk's services include pump training seminars; pump equipment evaluation, troubleshooting, and field testing; expert witness for pump litigation; witnessing of pump shop tests; pump market research; and acquisition and divestiture consultation and brokerage. A member of the American Society of Mechanical Engineers (ASME), and a registered professional engineer, Volk received the B.S. degree (1973) in mechanical engineering from the University of Illinois, Urbana, and the M.S. degree (1976) in mechanical engineering and the M.S. degree (1980) in management science from the University of Southern California, Los Angeles. He may be contacted at mike@volkassociates.com.

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Introduction to Pumps

I. WHAT IS A PUMP?

Simply stated, a pump is a machine used to move liquid through a piping system and to raise the pressure of the liquid. A pump can be further defined as a machine that uses several energy transformations to increase the pressure of a liquid. The centrifugal pump shown in Figure 1.1 illustrates this definition. The energy input into the pump is typically the energy source used to power the driver. Most commonly, this is electricity used to power an electric motor. Alternative forms of energy used to power the driver include high-pressure steam to drive a steam turbine, fuel oil to power a diesel engine, high-pressure hydraulic fluid to power a hydraulic motor, and compressed air to drive an air motor. Regardless of the driver type for a centrifugal pump, the input energy is converted in the driver to a rotating mechanical energy, consisting of the driver output shaft, operating at a certain speed, and transmitting a certain torque, or horsepower.

The remaining energy transformations take place inside the pump itself. The rotating pump shaft is attached to the pump impeller (see Figure 1.4). The rotating impeller causes the liquid that has entered the pump to increase in velocity. This is the second energy transformation in the pump, where the input power is used to raise the kinetic energy of the liquid. Kinetic energy is a function of mass and velocity. Raising a liquid's velocity increases its kinetic energy.

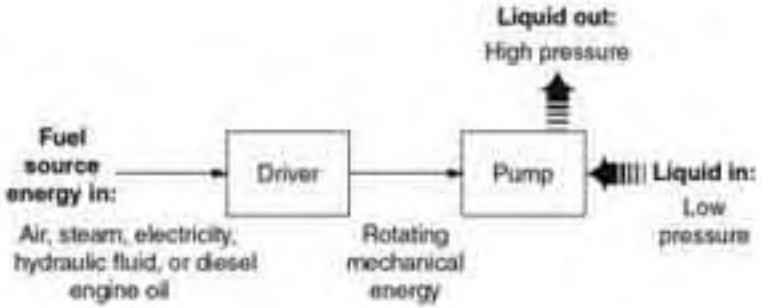

Figure 1.1 A centrifugal pump uses several energy transformations to raise the pressure of a liquid.

After the liquid leaves the impeller, but before exiting the pump, the final transformation of energy occurs in a *diffusion* process. An expansion of the flow area causes the liquid's velocity to decrease to more than when it entered the pump, but well below its maximum velocity at the impeller tip. This diffusion transforms some of the velocity energy to pressure energy.

II. WHY INCREASE A LIQUID'S PRESSURE?

There are actually three distinct reasons for raising the pressure of a liquid with a pump, plus another related factor:

1. *Static elevation*. A liquid's pressure must be increased to raise the liquid from one elevation to a higher elevation. This might be necessary, for example, to move liquid from one floor of a building to a higher floor, or to pump liquid up a hill.
2. *Friction*. It is necessary to increase the pressure of a liquid to move the liquid through a piping system and overcome frictional losses. Liquid moving through a system of pipes, valves, and fittings experiences frictional losses along the way. These losses vary with the geometry and material of the pipe, valves, and fittings, with the viscosity and density of the liquid, and with the flow rate.

Mechanical Engineering

about the book . . .

This hands-on reference/text offers a practical introduction to pumps and provides the tools necessary to select, size, operate, and maintain pumps properly—highlighting the interrelatedness of pump engineering from system and piping design to installation and startup.

Classifying pumps into major categories of centrifugal and positive displacement, **Pump Characteristics and Applications, Second Edition** presents the fundamentals of pump and pump system hydraulics; discusses pump selection and system design; explains the latest developments in pump technology; examines computer software for system design and pump selection and includes a demonstration CD-ROM that illustrates how software can facilitate the sizing and analysis of pumps and piping systems; and furnishes an appendix detailing the major pump suppliers.

This updated second edition expands on many subjects introduced in the first edition and also provides new in-depth discussion of pump couplings, o-rings, motors, variable frequency drives, pump life-cycle cost, corrosion, and pump minimum flow.

Written by an acclaimed expert in the field, **Pump Characteristics and Applications, Second Edition** is an invaluable day-to-day reference for mechanical, civil, chemical, industrial, design, plant, project, and systems engineers; engineering supervisors; maintenance technicians; and plant operators. It is also an excellent text for upper-level undergraduate and graduate students in departments of mechanical engineering, mechanical engineering technology, or engineering technology.

about the author . . .

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Printed in the United States of America

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