

McGraw-Hill **HANDBOOKS**

SLURRY SYSTEMS HANDBOOK



- Examines hydraulics of slurry flows
- Details equipment used in making and processing slurries
- Covers ASME codes

BAHA ABULNAGA

SLURRY SYSTEMS HANDBOOK

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Mazdak International, Inc.

McGRAW-HILL

New York Chicago San Francisco Lisbon London Madrid

Mexico City Milan New Delhi San Juan Seoul

Singapore Sydney Toronto

Cataloging-in-Publication Data is on file with the Library of Congress.

McGraw-Hill



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1 2 3 4 5 7 8 9 0 DOC/DOC 0 7 6 5 4 3 2

ISBN 0-07-137508-2

The sponsoring editor for this book was Larry S. Hager and the production supervisor was Sherri Souffrance. It was set in Times Roman by Ampersand Graphics, Ltd.

Printed and bound by R. R. Donnelley and Sons, Co.



This book was printed on recycled, acid-free paper containing a minimum of 50% recycled de-inked fiber.

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SLURRY SYSTEMS HANDBOOK

*In memory of my father, Dr. Sayed Abul Naga,
and in dedication to my mother, Dr. Hiam Aboul Hussein,
who devoted their lives to comparative literature
as authors and translators. May their efforts contribute
to a better understanding among mankind.
And to my children Sayed and Alexander
for filling my life with joy and happiness.*

PREFACE

The science of slurry hydraulics started to flourish in the 1950s with simple tests on pumping sand and coal at moderate concentrations. It has evolved gradually to encompass the pumping of pastes in the food and process industries, mixtures of coal and oil as a new fuel, and numerous mixtures of minerals and water. Because of the diversity of minerals pumped, the wide range in sizes [$43\text{ }\mu\text{m}$ (mesh 325) to 51 mm (2 in)], and the various physical and chemical properties of the materials, the engineering of slurry systems requires various empirical and mathematical models. The engineering of slurry systems and the design of pipelines is therefore fairly complex. This handbook targets the practicing consultant engineer, the maintenance superintendent, and the economist. Numerous solved problems and simplified computer programs have been included to guide the reader.

The structure of the book is essentially in two parts. The first six chapters form the first part of the book and focus on the hydraulics of slurry systems. Chapter 1 is a general introduction on the preparation of slurry, the classification of soils, the siltation of dams, and the history of slurry pipelines. Chapter 2 focuses on water as a carrier of solids. Chapter 3 progresses with the mechanics of mixing solids and liquids and the principles of rheology. Chapter 4 presents the various models of heterogeneous flows of settling slurries, whereas Chapter 5 concentrates on non-Newtonian flows. Due to the importance of open channel flows in the design of long-distance tailings systems or slurry plants, Chapter 6 was dedicated to a better understanding of these complex flows, which are seldom mentioned in books on slurry. In Part II, the book focuses on components of slurry systems and their economic aspects. In Chapter 7, the important equipment of slurry processing plants is presented, including grinding circuits, flotation cells, agitators, mixers, and thickeners. Chapter 8 presents the guidelines for the design of centrifugal slurry pumps, and methods of correction of their performance. Chapter 9 reviews the continuous improvements of positive displacement slurry pumps in their different forms, such as plunger, diaphragm, or lockhopper pumps. As slurry causes wear and corrosion, aspects of the selection of metals and rubbers is presented in Chapter 10. To guide the reader to the various aspects of the design of slurry pipelines, Chapter 11 presents practical cases such as coal, phosphate, limestone, and copper concentrate pipelines. This review of historical data is followed by a review of standards of the American Society of Mechanical Engineers and the American Petroleum Institute, as they are extremely useful tools for the design and monitoring of pipelines. Finally, as the big unknown is too often cost, Chapter 12 closes the book by offering guidelines for a complete feasibility study for a tailings disposal system or a slurry pipeline.

The author wishes to thank the staff of Mazdak International Inc, particularly Ms. Mary Edwards for providing typing services with great dedication over a period of two years. The author particularly wishes to thank Fluor Daniel Wright Engineers for allowing him to use their excellent library in Vancouver, Canada. The author wishes to thank his former colleagues in a colorful career, particularly Mr. K. Burgess, C.P.Eng. of Warman International; Mr. A. Majorkwicz, K. Major, and Mr. Peter Wells of Hatch & Associates; Mr. I. Hanks, P.Eng. and W. McRae of Bateman Engineering; Mr. R. Burmeister

H. Basmajian, and Dr. C. Shook, consultants; Mr. C. Hunker, P.Eng, V. Bryant, D. Bartlett, and W. Li, P.Eng. of Fluor Daniel; and Mr. A. Oak, P.Eng. of AMEC for allowing him to work on very challenging assignments in Australia and South and North America. The author wishes to thank the following firms for their contributions in the form of figures and data to this handbook: The Metso Group (formerly the companies Nordberg and Svedala), Red Valves, Geho Pumps (Weir Pumps), Mobile Pulley and Machine Works, Inc., Wirth Pumps, Hayward Gordon, Mazdak International Inc., the BHR Group, and GIW/KSB Pumps.

The author is grateful to the various publishers and associations who allowed him to reproduce valuable materials in the book.

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PART ONE

**HYDRAULICS OF
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