J.C. WILLIAMS and T. ALLEN
EDITORS

HANDBOOK OF POWDER TECHNOLOGY

Volume 7

R.D. NELSON

DISPERSING POWDERS IN LIQUIDS

ELSEVIER

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DISPERSING POWDERS IN LIQUIDS

HANDBOOK OF POWDER TECHNOLOGY

Edited by J.C. WILLIAMS
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The Handbook presents, in convenient form, existing knowledge in all specialized areas of Powder Technology.

Information that can be used for the design of industrial processes involving the production, handling and processing of particulate materials so far did not exist in a form in which it is readily accessible to design engineers. Scientists responsible for characterizing particulate materials, specifying the requirements of industrial processes, operating plants, or setting up quality-control tests all have similar problems in their fact-finding missions through the scattered and scanty literature. The aim of this handbook is to remedy this deficiency by providing a series of thematic volumes on various aspects of powder technology. Each volume is written as a monograph and can be used independently of other volumes.

Emphasis is placed on setting out the basic concepts of the subject and discussing their applications to the design, selection and operation of equipment of an industrial scale. To ensure timely publication, each volume will be published as soon as the material has been delivered by the authors.

Vol. 1. Particle Size Enlargement (C.E. Capes)
Vol. 2. Fundamentals of Gas-Particle Flow (G. Rudinger)
Vol. 3. Solid-Gas Separation (L. Svarovsky)
Vol. 4. Dust Explosions (P. Field)
Vol. 5. Solid-Liquid Separation Processes and Technology (L. Svarovsky)
Vol. 6. The Packing of Particles (D.J. Cumberland and R.J. Crawford)
Vol. 7. Dispersing Powders in Liquids (R.D. Nelson)

Further volumes are in preparation
(For further information on Volumes 1-6 see p. 243 of this volume.)

Dedication

This book is a memorial tribute to my colleagues and companions in research and development from 1976 to 1981 at Du Pont's Colored Pigments Research Center at 256 Vanderpool Street in Newark, New Jersey – particularly the senior scientists, who provided a professional atmosphere and pleasant community within which I learned much about dispersing powders in liquids:

Gerald H. Aldridge
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Ronald L. Sweet
Robert F. White

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- T. Allen and H. L. Jackson for permission to use their unpublished data.
- Catherine Bloecker Nelson, who patiently endured my distraction.

Disclaimers

While I have attempted to provide reliable descriptions of commercial products, I cannot guarantee that they are correct. You should contact surfactant suppliers for up-to-date information, and you should do sufficient testing to ensure that the surfactant you select is suitable for your particular application. There was space for only a few examples from the wide variety of commercially available surfactants. You should not imply any product endorsement or recommendation for a specific application simply because it is mentioned here, and you are encouraged to consider products and to contact manufacturers beyond those few included here.

Although numerous omissions, typographical errors, and things that were just plain wrong have already been corrected, I am sure that some remain. You should check two independent sources to verify any equations and information that you plan to use as a basis for actions or decisions.

Preface

THE TOPIC UNDER DISCUSSION

A slurry (often called a dispersion) consists of small particles suspended in a liquid. Since most untreated particles tend to stick together when they collide, the preparation of a stable dispersion requires that we add dispersants to prevent agglomeration. Through this book I hope to help you understand the factors that cause agglomeration and dispersion in a slurry and to provide some guidance for selecting and optimizing the dosage of a surfactant that will produce a stable dispersion of a specific powder in a specific liquid.

The field of surface science has become very active in the past ten years. Several major new classes of surfactants have been introduced into commercial use. Many new instruments have been developed to monitor low concentrations of surfactants in the slurry environment. Improved process control techniques now allow close control of slurry properties, giving improved process operability and better products.

For the past five years I have taught slurry technology and powder dispersion courses to students who were either engineers recently graduated from college or managers recently transferred to plants that handle slurries. No book suitable for such a course was available, so I developed a set of course notes to supplement the lectures. When Terence Allen asked me to write a volume for the "Handbook of Powder Technology", I welcomed the twin opportunities of improving my notes and reaching a wider audience. I hope you enjoy the presentation.

A FEW WORDS ABOUT MYSELF

After earning degrees in chemistry from Colby College and Princeton University, I spent two years as a post-doctoral fellow with the U. S. National Bureau of Standards. For eight years I professed physical and analytical chemistry at Middlebury College, Brown University, and West Virginia University (where I also earned a degree in Chemical Engineering). I then joined the Du Pont company to practice chemical engineering. For eight years I provided technical support to the manufacture of colored pigments. Since 1982 I have been a company-wide consultant in the field of slurry technology, obtaining from within and outside the company the information, materials, equipment, and expert advice required to solve slurry problems.

QUESTIONS ADDRESSED BY THIS TEXT

The chapters answer the following questions at an introductory level and prepare you to understand the concepts and terminology found in the primary technical literature. The first chapter discusses the goals and organization of the book in more detail.

Chapter 1. What problems arise in industrial processes due to the presence of particles in liquids or their interaction with liquids? What resources are available to provide training, information, discussion, or personal assistance in solving such problems?

Chapter 2. What do the various structures found in clumps of particles look like? What terms are commonly used to describe them?

Chapter 3. How are atomic-level forces related to the attractions and repulsions among particles? How do the various contributions to particle interaction depend on slurry composition?

Chapter 4. What are the major chemical classes of particles, liquids, and surfactants. What are the molecular structures of typical commercial surfactants? What sorts of chain length distributions and chemical mixes are present in industrial surfactants?

Chapter 5. How is interfacial energy accounted for in thermodynamic formulas? What factors affect adsorption from solution onto a surface?

Chapter 6. How is the rate of flocculation of charged particles related to solution composition? What factors affect micelle formation and steric stabilization?

Chapter 7. What steps should be followed in selecting, testing, and optimizing the dose of a dispersant?

Chapter 8. What tests are available for characterizing the degree of dispersion? What instruments can be used to analyze the chemicals in the bulk and in the solid-liquid interface of a slurry?

TABLE OF CONTENTS

1. INTRODUCTION

2. PARTICLE STRUCTURE

3. PARTICLE PHYSICS