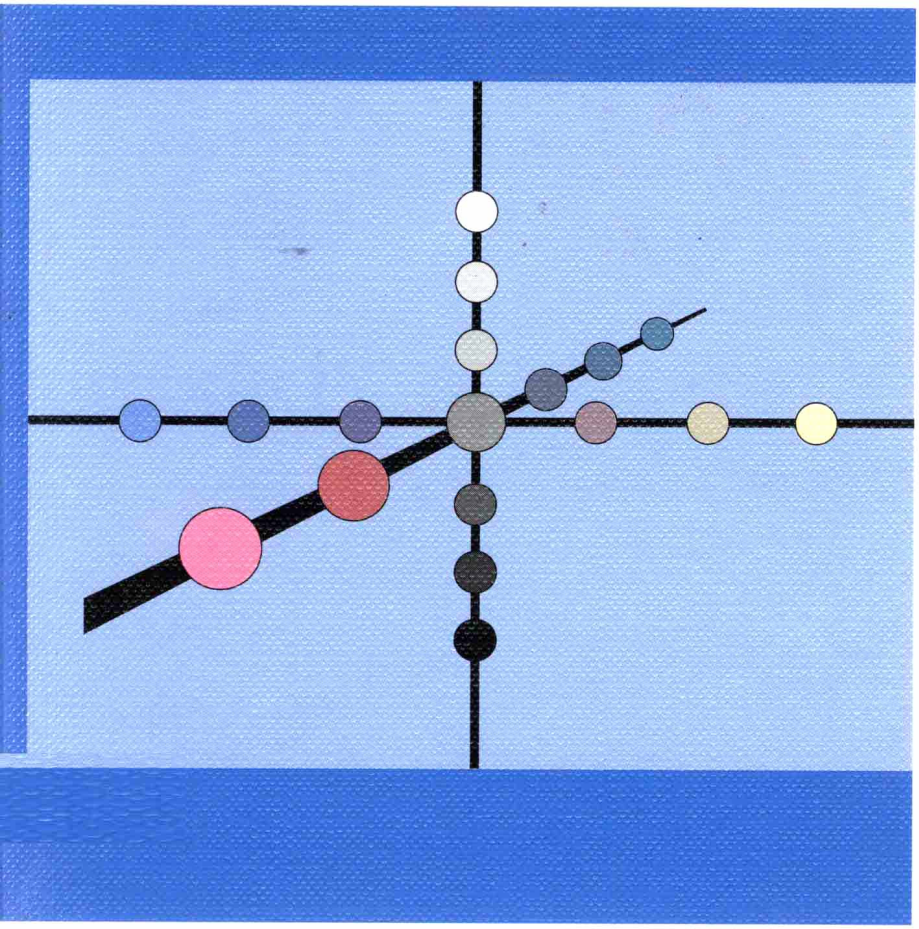
Hans G. Völz

Industrial Color Testing

Fundamentals and Techniques



VCH

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Industrial Color Testing

Fundamentals and Techniques

Translated by Ben Teague

VCH

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Preface to the English Edition

The English version of my book is appearing just four years after the successful German edition entitled *Industrielle Farbprüfung*. It is closely based on the German text. Revisions have been necessary in only a few passages to correct errors and update (and sometimes expand) the literature citations. Furthermore, equations that are essential for theoretical understanding and practical application have been enclosed in boxes for emphasis.

New material in the colorimetric part includes the CIELAB 92 color-difference system (Section 2.3.3) and the RAL Design color-order system (Section 2.3.4). A greatly simplified and clearer description has been given for the proposition (important in the determination of tinting strength) that equality of the CIE tristimulus values Y in lightness matching implies equality of the Kubelka-Munk functions, that is, that $\Delta Y = \Delta F_Y = 0$ (Sections 4.6.4 and 4.7.1). In connection with tests of significance, it is shown how the error of preparation can be separated into specific error components (Section 6.3.3). To aid the understanding of confidence levels in relation to acceptability, an explanatory paragraph has been inserted in Section 6.5.3, and the same chapter has been expanded by the new Section 6.5.4, "Acceptability and Test Errors."

The index of standards (Appendix 1) is completely new. Organized through keywords, it lists standards of the International Organization for Standardization (ISO), the European Committee for Standardization (CEN), and several national standards bodies: the American Society for Testing and Materials (ASTM), the British Standards Institution (BSI), the Association Française de Normalisation (AFNOR), the Japanese Industrial Standards (JIS), and the Deutsches Institut für Normung (DIN). An important role in the preparation of this table was again performed by Mr. E. Fritzsche of DIN, Berlin, to whom I would like to express my gratitude.

I am also grateful to my colleague and successor, Dr. H. Heine, Krefeld, for his generous assistance, to Mr. Ben Teague for a sympathetic translation, and to Mrs. Karin Sora of VCH Publishers for her helpful collaboration.

July 1994 Hans G. Völz

Preface

This book is directed chiefly to all technical personnel who are involved with pigments and dyes, whether as manufacturers, converters, or consumers. It is often not enough to be familiar with the procedure used in a test; more must be known about the quantity being measured and the way in which it varies as a function of other parameters – in brief, about its physicochemical habit, which is embedded in the well-known fields of chemistry and physics. This is especially important when test methods are to be rationalized; rationalization requires computers, and all computer use is based on applied mathematics. Effective rationalization is possible only when the mathematical and physical background of the quantities being measured is kept fully in view. The lack of suitable worked-out examples to illustrate test methods often creates difficulties in practice as well. This book should help close the gap by providing at least one practical example for each of the test methods described.

The book should, however, also offer some utility to the scientist engaged in research and development work on pigments and dyes. Discussion of principles makes up a substantial part of the text, and many suggestions and hints are included to further the scientist's work. On the other hand, anyone working in research or development but lacking a knowledge of both the principles and the state of the art will scarcely be in a position to advance the colorimetric properties of these substances.

A third audience – so the author hopes – will find the book beneficial: university lecturers and students in the natural sciences. The study of colorimetry in the testing of coloring material is a perfect example of the interdisciplinary effect of chemistry, physical chemistry, physics, theoretical physics, mathematics, and cybernetics (informatics). It goes without saying that one must understand the principles of each discipline before one can understand their interaction. There is, however, another point: The integrative components of the knowledge assembled in this book are hardly taught (if at all) in our universities and colleges of technology – colorimetry and Kubelka-Munk theory being just two examples. Even beyond the field of coloring materials, both these bodies of knowledge have significant roles to play in many other technical areas, and it is hard to comprehend that people with university-level diplomas even today are entering the colorant manufacturing and converting industries without ever having come in contact with either topic.

In choosing the contents of this book from the disciplines named, the author has adopted a standard that he considers trustworthy, one that has continually

aided him in distinguishing key topics from less important ones: He wanted to write the book he wishes had been available when he entered the field of pigment testing. Naturally, such a wish is a bit of a fantasy, for it is only now that this book could be written in its present form. Some three-quarters of the test methods described here did not even exist then. The same holds, in modified form, for the principles; while certain branches of knowledge had already been developed 30 years ago, they were not yet relevant for our field – the statistical analysis of color coordinates is one of many topics that might be mentioned. Finally, the introduction of the computer in colorimetric testing has led to major changes in recent years.

To avert misunderstandings, some special points relating to text selection should be stated in advance. The title of the book should be read as referring to the colorimetric examination of pigments and dyes *in media*; thus, all tests not carried out in mixtures with a lacquer, paint, plastic, or other coating are excluded (e.g., on textile fibers or in printing inks). The chapter on "Colorimetry" has been kept short even though it threatened to grow into another whole volume. In other words, this book does not wish to be mistaken for a textbook on colorimetry. The only aspects of that field that are covered are topics essential for the context of the book. Similarly, one will search in vain for instructions on color formulation and correction calculations. These operations do not come under the heading of pigment and dye testing, even if they must be preceded by testing. Similarly, the application of Mie theory in the determination of particle-size distributions is not covered, for it is based not on colorimetric methods but on general spectroscopic methods.

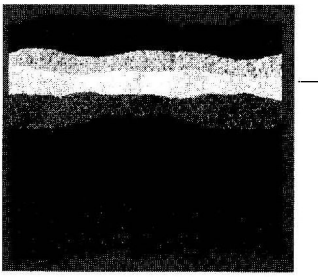
In Chapter 2, on the other hand, a comparatively large proportion has been devoted to the statistical analysis of color coordinates. The reasons for this are that these applications are relatively novel in practice and that key topics such as acceptability (tolerances) are related to them. New in Chapter 3 are the four-flux equations for specular substrates, which may prove to be of interest in the future. Chapter 4 offers – for the first time, as far as the author is aware – a theoretical mathematical justification for the universal practice of treating wide-band measurements (e.g., reflectometer values) or color coordinates (e.g., CIE tristimulus values) as spectral values in Kubelka-Munk analysis and of matching not the tristimulus values but their Kubelka-Munk functions. In Chapter 5, instructions are given for extending Mie calculations to the particle-size distribution of anisometric (i.e., bladed or rod-shaped) pigments.

While the text was in preparation, a number of colleagues expressed willingness to read it and offer vital suggestions and corrections. The entire text was read by Dr. H. Heine (Krefeld-Uerdingen), Dr. S. Keifer (Krefeld-Uerdingen), and A. van Leendert (Krefeld). The following experts made themselves available to read portions of the text: Dr. L. Gall (Ludwigshafen), Dr. W. Herbst (Frankfurt-Höchst), Prof. G. Kämpf (Leverkusen), Prof. J. Krochmann (Berlin), Dr. H. Pauli (Basel), Dr. K. Sommer (Krefeld-Uerdingen), Dr. J. Spille (Leverkusen), Dr. J. Thiemann (Leverkusen), Dr. J. Wiese (Krefeld-Uerdingen), and Dr. K. Witt (Berlin). Mrs. E. Lechner and Mr. E. Fritzsche of DIN, Berlin, have prepared the exemplary listing of the standards cited. The author would

like to take this opportunity to thank all these colleagues for their helpfulness and their valuable advice and suggestions.

I am grateful to Bayer AG for its continuing interest and assistance in the writing of this book, and to VCH Publishers for its intelligent collaboration and valuable advice.

Krefeld, November 29, 1989 Hans G. Völz



Buxbaum, G. (ed.)

Industrial Inorganic Pigments

1993. XIII, 281 pages with 92 figures and 56 tables.
Hardcover. DM 188.00. ISBN 3-527-28624-1

The authors, who are renowned experts in their field, ensure a concise, up-to-date presentation of the chemistry, production, properties, applications and economic importance of industrial inorganic pigments.

This book is neither a list of commercially available products nor a compilation of company product specifications but instead provides the knowledge required for the optimal selection and use of inorganic pigments. It will prove to be an indispensable guide to all chemists, material scientists and practitioners in pigment-related fields.

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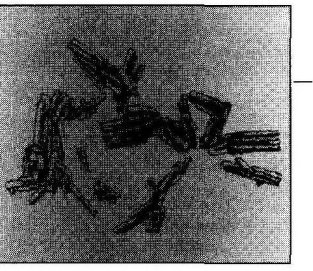

Herbst, W. /Hunger, K.

Industrial Organic Pigments

Production, Properties, Applications

1992. XIV, 630 pages with 95 figures, 6 in color and 38 tables.
Hardcover. DM 296.00. ISBN 3-527-28161-4

Currently the most comprehensive source of information on synthetic organic pigments! It treats all aspects of applications of organic pigments from chemical and physical viewpoints. Relevant test methods are covered, and toxicological and ecological properties are outlined. Readers will find the book exceptionally useful as it considers the synthesis, properties and applications of organic pigments commercially available on the world market. They will appreciate the fact that standardized methods allow test results to be compared throughout the book.

From reviews of the German Edition:

"The volume can be recommended unreservedly to industrial and academic practitioners concerned in any way with the technological aspects of organic pigments. Presentation throughout is of the highest quality and the volume must now become the standard reference text in this important area of coloring matters."

Dyes and Pigments

"This wide-ranging reference work can be warmly recommended ..."

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Contents

Part I

Principles

1 Introduction

1.1 Coloring Materials

This book deals with color-imparting substances and the color phenomena which they produce. The general term for all coloring substances is "coloring materials";* and includes, in particular, pigments and dyes.

Pigments are substances consisting of particles that are practically insoluble in the application medium. They are used chiefly as coloring materials but can also be employed for other properties in special applications (e.g., anti-corrosion or magnetic pigments). The demarcation between pigments and fillers was formerly somewhat problematic as it cannot be stated in terms of a limiting refractive index. However they can be differentiated according to their application. In contrast to pigments, a filler is not employed to impart color but to impart certain technical properties to the coating or to increase the volume of the coating material. Such a convention does not rule out the possibility that certain substances can find use as both pigments and fillers. However, there is a large group of substances that act as pigments in the great majority of cases (e.g., TiO_2 is never used as a filler). When we speak of pigments, we are referring to this group. This statement also applies to the present book.

Pigments can be classified according to a variety of criteria; here we generally follow the standard scheme and speak of two classes:
- Inorganic pigments
- Organic pigments

The next step in classification is according to their origin:
- Natural pigments
- Synthetic pigments

Economically, synthetic pigments are very much more significant than natural pigments, and they will therefore be our exclusive focus in the following classification.

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* For standards see "Coloring Materials, Terms" in Appendix 1.