

Colorants and auxiliaries

ORGANIC CHEMISTRY AND APPLICATION PROPERTIES

Second Edition

Volume 1 – Colorants

Edited by John Shore

Formerly of BTTG/Shirley and ICI Dyes (now DyStar), Manchester, UK

2002

Society of Dyers and Colourists

Copyright © 2002 Society of Dyers and Colourists. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means without the prior permission of the copyright owners.

Published by the Society of Dyers and Colourists, PO Box 244, Perkin House, 82 Grattan Road, Bradford, West Yorkshire BD1 2JB, England, on behalf of the Dyers' Company Publications Trust.

This book was produced under the auspices of the Dyers' Company Publications Trust. The Trust was instituted by the Worshipful Company of Dyers of the City of London in 1971 to encourage the publication of textbooks and other aids to learning in the science and technology of colour and coloration and related fields. The Society of Dyers and Colourists acts as trustee to the fund.

Typeset by the Society of Dyers and Colourists and printed by Hobbs The Printers, Hampshire, UK.

ISBN 0 901956 77 5

Contributors

John Shore

Formerly of BTTG/Shirley and ICI Dyes (now DyStar), Manchester, UK

David Patterson

Formerly senior lecturer, Department of Colour Chemistry and Dyeing, University of Leeds, UK

Geoff Hallas

Formerly senior lecturer, Department of Colour Chemistry and Dyeing, University of Leeds, UK

Contents

Preface		ix
CHAPTER 1	Classification and general properties of colorants	1
1.1	Introduction	1
1.2	Development of colorant classification systems	2
1.3	Colour Index classification	4
1.4	Chemical classes of colorants	5
1.5	Colour and chemical structure	14
1.6	Application ranges of dyes and pigments	18
1.7	Colorants and the environment	33
	References	42
CHAPTER 2	Organic and inorganic pigments; solvent dyes	45
2.1	Pigments	45
2.2	Dyes converted into pigments	48
2.3	Azo pigments	53
2.4	Phthalocyanine pigments	67
2.5	Quinacridone pigments	71
2.6	Isoindolinone pigments	73
2.7	Dioxazine pigments	73
2.8	Diketopyrrolopyrrole pigments	73
2.9	Fluorescent pigments	74
2.10	Inorganic pigments	75
2.11	How pigments act as colorants	82
2.12	Solvent dyes	86
2.13	Conclusion	86
	References	87
	Bibliography	88
CHAPTER 3	Dye structure and application properties	89
3.1	Dye characteristics and chemical structure	89
3.2	Dyeability of fibres in relation to dye structure	116
3.3	Application properties and chemical structure	134
	References	176

CHAPTER 4	Chemistry of azo colorants	180
4.1	Introduction	180
4.2	Mechanism of diazotisation and coupling	180
4.3	Diazo components and diazotisation methods	182
4.4	Preparation and use of coupling components	186
4.5	Structure of azo dyes	193
4.6	Preparation and importance of naphthalene intermediates	196
4.7	Schematic representation of coupling	204
4.8	Sulphonated azo dyes	204
4.9	Unsulphonated monoazo dyes	211
4.10	Basic azo dyes	218
4.11	Azoic diazo and coupling components	220
4.12	Stabilised diazonium salts and azoic compositions	223
4.13	Azo pigments produced by final coupling	225
4.14	Implications of new technology in diazotisation and coupling	227
	References	228
CHAPTER 5	Chemistry and properties of metal-complex and mordant dyes	231
5.1	Introduction	231
5.2	Fundamental concepts	233
5.3	Electronic structure of transition-metal ions	235
5.4	Structural characteristics necessary for complex formation	240
5.5	Preparation of metal-complex colorants	248
5.6	Isomerism in metal-complex dyes	260
5.7	Stability of metal-complex dyes	261
5.8	Chromium-related problems in the mordant dyeing of wool	268
	References	277
CHAPTER 6	Chemistry of anthraquinonoid, polycyclic and miscellaneous colorants	280
6.1	Anthraquinone acid, disperse, basic and reactive dyes	280
6.2	Polycyclic vat dyes	294
6.3	Indigoid and thioindigoid dyes	316
6.4	Sulphur and thiazole dyes	321
6.5	Diarylmethane and triarylmethane dyes	327
6.6	Miscellaneous colorants	344
	References	353

CHAPTER 7	Chemistry of reactive dyes	356
7.1	Introduction	356
7.2	Reactive systems	358
7.3	Monofunctional systems	361
7.4	Bifunctional systems	385
7.5	Chromogens in reactive dyes	400
7.6	Stability of dye–fibre bonds	410
7.7	Reactive dyes on wool	415
7.8	Reactive dyes on silk	420
7.9	Reactive dyes on nylon	424
7.10	Novel reactive dyeing processes	426
	References	440

Preface to Volume 1

This Second Edition of a textbook first published in 1990 forms part of a series on colour and coloration technology initiated by the Textbooks Committee of the Society of Dyers and Colourists under the aegis of the Dyers' Company Publications Trust Management Committee, which administers the trust fund generously provided by the Worshipful Company of Dyers.

The initial objective of this series of books has been to establish a coherent body of explanatory information on the principles and application technology of relevance for students preparing to take the Associateship examinations of the Society. This particular book has been directed specifically to the subject areas covered by Section A of Paper B: the organic chemistry and application of dyes and pigments and of the auxiliaries used with them in textile coloration processes. However, many qualified chemists and colourists interested in the properties of colorants and their auxiliaries have found the First Edition useful as a work of reference. For several reasons it has been convenient to divide the material into two separate volumes: 1. Colorants, 2. Auxiliaries. Although fluorescent brighteners share some features in common with colorants, they have been treated as auxiliary products in this book.

This first volume of the book is concentrated on the chemical characteristics of dyes and pigments, with emphasis on attempts to interpret their colouring and fastness properties in terms of the essential structural features of colorant molecules. This Second Edition has been extensively updated and greater attention has also been given to factors associated with the potential impact of colorants and their metabolites on the environment. All chapters have been affected by these changes, but the concluding chapter on reactive dyes contains more new material than the others. Rationalisation of the global dyemaking industry during the 1990s means that many of the traditional commercial names of dyes and pigments have disappeared. For this reason Part 2 of the Colorants Index has been eliminated and colorants have been specified almost always by their CI Generic Names. The fundamental value of the unique *Colour Index International* to colorant makers and users is recognised worldwide.

Chapters 4 and 7 in the First Edition were written by Vivian Stead and Chapter 5 by Frank Jones. Sadly, Frank died in 1989 and Vivian in 1996, but my co-authors and myself would like to record our tribute for the major contributions to this volume by our former friends and colleagues. We have tried to preserve their original style intact during the necessary updating process. Our grateful thanks are due to John Holmes and Catherine Whitehouse for their patient copy editing and to the publications staff of the Society, especially Carol Davies, who have prepared all the material in this new edition for publication.

JOHN SHORE

Chapters in Volume 2

Chapter 8 Functions and properties of dyeing and printing auxiliaries

Chapter 9 The chemistry and properties of surfactants

Chapter 10 Classification of dyeing and printing auxiliaries by function

Chapter 11 Fluorescent brightening agents

Chapter 12 Auxiliaries associated with main dye classes