

Textile Printing

Second Edition

Edited by Leslie W C Miles

Formerly Lecturer in Textile Chemistry, Department of Textiles, University of Manchester Institute of Science and Technology, Manchester, UK

1994

Society of Dyers and Colourists

Copyright © 1994 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, its Textbooks Committee being the Trust's technical subcommittee.

Typeset by the Society of Dyers and Colourists and printed by The Alden Press, Oxford.

ISBN 0 901956 57 0

Contents

Contributors	viii	
Prefaces	ix	
CHAPTER 1	Traditional methods	
	by Leslie W C Miles	1
1.1	A historical perspective	1
1.2	Surface printing methods	8
1.3	Engraved-roller printing	11
CHAPTER 2	Screen printing	
	by Christopher J Hawkyard	18
2.1	Introduction	18
2.2	Hand screen and semi-automatic screen printing	20
2.3	Fully automatic flat-screen printing	24
2.4	Rotary-screen printing	31
2.5	Design aspects	37
2.6	Computer-aided design	40
2.7	Screen production	43
2.8	The fundamental mechanism of screen printing	53
2.9	Nontextile applications of screen printing	54
CHAPTER 3	Transfer printing	
	by Ian D Rattee	58
3.1	Introduction	58
3.2	Sublimation transfer	60
3.3	Melt and film release transfer	87
3.4	Wet transfer printing	95
CHAPTER 4	Carpet and yarn printing	
	by Timothy L Dawson	99
4.1	Historical development of carpet printing	99
4.2	Yarn printing (space dyeing)	102
4.3	Carpet printing	103
4.4	Printing of carpet tiles	114

- 4.5 Treatments before and after printing 115
- 4.6 Physical factors affecting the quality of printed carpets 118
- 4.7 Selection of dyes and chemicals for printing nylon carpets 126
- 4.8 Printing of carpets tufted from fibres other than nylon 135

CHAPTER 5 Direct print coloration 139
 by Heinz Gutjahr and Robert R Koch

- 5.1 Introduction 139
- 5.2 Pigment printing 140
- 5.3 Cellulosic fibres 153
- 5.4 Polyester fibres 172
- 5.5 Cellulose acetate fibres 176
- 5.6 Acrylic fibres 178
- 5.7 Polyamide fibres 181
- 5.8 Protein fibres 183
- 5.9 Polyester/cellulose fibre blends 187

CHAPTER 6 Discharge, resist and special styles 196
 by Clifford Berry and John G Ferguson

- 6.1 Introduction and definitions 196
- 6.2 Discharge printing 197
- 6.3 Application procedures in discharge printing 206
- 6.4 Resist printing 217
- 6.5 Special styles 230

CHAPTER 7 The production and properties of printing pastes 240
 by Leslie W C Miles

- 7.1 The requirements 240
- 7.2 Thickeners 241
- 7.3 Raw materials: polysaccharides 245
- 7.4 Viscous emulsions 255
- 7.5 Viscous foams 257
- 7.6 Synthetic-polymer thickeners 257
- 7.7 Print paste rheology 260
- 7.8 Print paste production 272
- 7.9 Colour shop organisation 273

CHAPTER 8	Fixation and aftertreatment processes	
	by Leslie W C Miles	275
8.1	Introduction	275
8.2	Pigment prints	275
8.3	Steamers	276
8.4	Miscellaneous techniques	291
8.5	Washing-off processes	292
8.6	Washing-off equipment	296

Contributors

Clifford Berry

Formerly marketing manager (textile dyestuffs), Hoechst UK Ltd, Halifax, UK

Timothy L Dawson

Honorary research fellow, UMIST, Manchester UK

John G Ferguson

Textile dyestuffs manager, Hoechst UK Ltd, Halifax, UK

Heinz Gutjahr

Formerly chemist, Dyestuff Marketing, Bayer AG, Leverkusen, Germany

Christoper J Hawkyard

Lecturer in polymer and fibre science, UMIST, Manchester, UK

Robert R Koch

Head of Textile Printing Department, Bayer AG, Leverkusen, Germany

Leslie W C Miles

Formerly lecturer in textile chemistry, UMIST, Manchester, UK

Ian D Rattee

Research director, Wace Screen (a division of Wace UK Ltd), Wakefield, UK and former professor of colour chemistry, University of Leeds, Leeds, UK

From the preface to the First Edition

Textile printing is probably best described as an industrial art, having a long history and an assured future. It has become more dependent on the sciences than it was, but will always be a multidisciplinary activity, requiring more than a knowledge of science and technology.

The need for a textbook has been evident for some years, as the techniques, substrates and colorants in use have changed so dramatically since the admirable *Principles and practice of calico printing*, by Knecht and Fothergill, was last revised in 1952. The present work is intended to provide the information and understanding required by students preparing for the Associateship examinations of the Society of Dyers and Colourists. Many others, we hope, will also find it of value.

For those readers with practical, rather than academic, objectives, perhaps looking for answers to specific technical questions, a warning may be necessary. In a short book on such a substantial subject, some generalisations are inevitable but dangerous. Successful printing depends not only on using the appropriate materials and techniques, but also on the coordination of many individuals' skills. Printing machines have been compared to musical instruments, in that the results obtained depend on who is playing. In any printworks, the difficult patterns are given to the best printers, but even the best printer has to work within the limitations of his equipment and his supporting team.

Before describing current techniques, a brief discussion of the historical development of textile printing may be helpful. The English term 'printing' was coined in the 18th century and is derived from a Latin word meaning pressing, the word 'impression' being similarly derived. At that time printing was normally achieved by the use of wood blocks, with raised printing surfaces, which required pressure to obtain good contact between the fabric and the colour on the block.

Wood blocks were certainly used for printing illustrations in books at around 1400, and on linen hangings at about the same time. In China, they had been used in the 10th century. Stencil printing of playing cards was established in around 1440, and engraved-copper-plate printing was used in Venice in 1450. Techniques used on paper were naturally tried on fabrics, but often required long processes of trial and error before they could be successfully adapted.

Techniques of resist dyeing, mordant printing and painting had been developed in the East at a much earlier period. Herodotus wrote of the painting of garments in the 5th century BC, a dye that was probably indigo being used. In fact, it was the enormous demand for colourful hand-painted cotton fabrics, imported from India in the 17th century, that stimulated the inventiveness and drive of the

European pioneers. By 1842 some 90% of British prints were produced on machines, rather than by hand block and, at about that time, 60% of the cotton fabric produced was printed. The pioneer printers of Europe not only developed the machinery and mastered the art of using suitable thickeners, but were also innovators of the factory system.

LESLIE MILES

Preface to the Second Edition

The 1981 edition was widely welcomed and became a standard textbook. But it was clear that a second edition was required and we have taken the opportunity to effect some significant updating. The whole book has been updated and I hope that it will prove to be of lasting value, to students and the industry around the world.

The near demise of roller printing since 1981 prompted the replacement of the first chapter, which was a very thorough account of this technique, by one on the historical development and the traditional methods of printing. Screen printing is certainly the dominant method at the present time, but block printing and roller printing are still of some significance and of technical interest. I am pleased that we have included both this time. The other development that we have reflected is the substantial use of computer-aided design (CAD) and of computers in screen production in printing processes. The extension to jet printing, with its potential of very quick response, is not yet beyond the development stage – for flat fabrics – but may be important for a future editor.

My thanks are gratefully recorded to all the authors, especially Ian Rattee who has provided invaluable expertise on transfer printing (originally dealt with by the late Frank Jones). I wish to acknowledge the assistance of Paul Dinsdale (the Society's editor) and Carol Davies for her expert typesetting and layout. Jean Macqueen has improved the text significantly and provided the index, for which I am indebted. I am also grateful for all those individuals and organisations who granted permission to reproduce illustrations, as signified in the figure captions.

LESLIE MILES