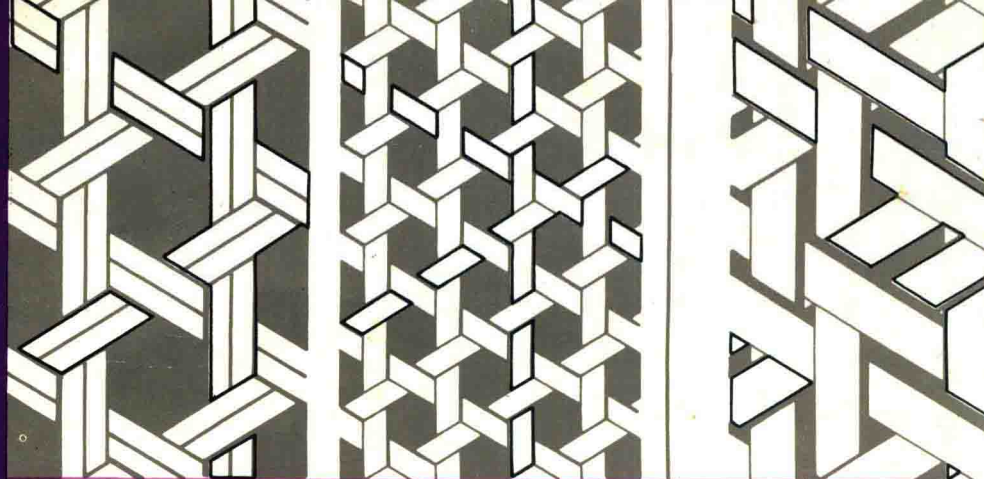




Edited by JARMILA ŠVÉDOVÁ

INDUSTRIAL TEXTILES

TEXTILE SCIENCE AND TECHNOLOGY 9

ELSEVIER

TEXTILE SCIENCE AND TECHNOLOGY 9

INDUSTRIAL TEXTILES

edited by
Jarmila Švédová

Linen Industry Research Institute, Šumperk, Czechoslovakia



ELSEVIER

Amsterdam Oxford New York Tokyo 1990

Published in co-edition with
SNTL — Publishers of Technical Literature

Distribution of this book is being handled by the following publishers

for the U.S.A. and Canada
ELSEVIER Science Publishing Co., Inc.
655 Avenue of the Americas
New York, N. Y. 10010

for the East European Countries, China, Northern Korea,
Cuba, Vietnam and Mongolia
SNTL — Publishers of Technical Literature
Spálená 51, 113 02 Praha 1, Czechoslovakia

for all remaining areas
ELSEVIER Science Publishers, B.V.
25 Sara Burgerhartstraat
P.O. Box 211, 1000 AE Amsterdam, The Netherlands

Library of Congress Cataloging-in-Publication Data

Industrial Textiles / edited by Jarmila Švédová.
p. cm. --(Textile science and technology; v. 9)
Includes bibliographical references.
ISBN 0-444-98754-1
1. Industrial fabrics. I. Švédová, Jarmila. II. Series.
TS1770 .I53I53 1990
677--dc20

90-32595
CIP

ISBN 0-444-98754-1 (vol. 9)
ISBN 0-444-41818-0 (series)

Copyright © SNTL — Publishers of Technical Literature 1990
Translation © Olga Steinerová 1990

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any other form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the copyright owner

Printed in Czechoslovakia

TEXTILE SCIENCE AND TECHNOLOGY 9

Industrial Textiles

TEXTILE SCIENCE AND TECHNOLOGY

- Volume 1 Open-end Spinning *by* V. Rohlena *et al.*
- Volume 2 Processing of Polyester Fibres *by* O. Pajgrt *and* B. Reichstädter
- Volume 3 Shuttleless Weaving Machines *by* O. Talavášek *and* V. Svatý
- Volume 4 Fluorescent Brightening Agents *by* R. Williamson
- Volume 5 Polypropylene Fibres — Science and Technology *by* M. Ahmed
- Volume 6 Production and Applications of Polypropylene Textiles *by*
O. Pajgrt *et al.*
- Volume 7 Absorbency *edited by* Pronoy K. Chatterjee
- Volume 8 Needle Punching Textile Technology *by* V. Mrština *and* F. Fejgl
- Volume 9 Industrial Textiles *edited by* J. Švédová

Contents

1. INTRODUCTION	13
2. SIGNIFICANCE AND CLASSIFICATION OF INDUSTRIAL TEXTILES	15
2.1 Canvas	18
2.2 Filter cloth	20
2.3 Textiles for the rubber and plastics industry	21
2.4 Industrial textiles for the leather industry	22
2.5 Geotextiles	22
2.6 Packing materials (coverstock)	22
2.7 Cordage	23
2.8 Belts, webbings and hoses	23
2.9 Various other industrial textiles	23
3. RAW MATERIALS USED IN THE PRODUCTION OF INDUSTRIAL TEXTILES	27
3.1 Natural fibres	27
3.1.1 Cotton	28
3.1.2 Flax	31
3.1.3 Hemp	32
3.1.4 Jute	32
3.1.5 Leaf fibres	33
3.1.6 Wool	33
3.1.7 Asbestos	35
3.1.8 Secondary textile raw materials	35
3.2 Man-made fibres	36
3.2.1 Inorganic man-made fibres	39
3.2.2 Organic man-made fibres	40
3.2.3 Some selected fibre structures	43
3.2.4 The properties of textile fibres	48
4. THE PRODUCTION OF INDUSTRIAL TEXTILES	68
4.1 The weaving technique	68
4.1.1 Yarn preparation for weaving	69
4.1.2 The weaving process	73
4.1.3 Finishing operations	81
4.2 The knitting technique	81
4.2.1 Warp knits	82

4.2.2	Stitchbondeds	84
4.2.3	Weft knits	85
4.2.4	Knit-woven fabrics	86
4.2.5	Machinery and equipment used in the production of industrial knits	87
4.2.6	Machines for material preparation for knitting or stitchbonding	87
4.2.7	Knitting machines	89
4.3	The nonwoven technique	96
4.3.1	The classification of nonwoven textiles	96
4.3.2	Nonwoven textiles produced on a dry (textile) route	97
4.3.3	The production of nonwovens on a wet (paper) route	102
4.3.4	Nonwovens made from polymer melt by the spunbonding method	103
4.3.5	Split film nonwovens	103
4.4	Finishing of industrial textiles	104
4.4.1	Equipment used to impregnate industrial textiles	104
4.4.2	Equipment used to coat industrial fabrics	106
4.4.3	Equipment for economically attractive finishing of industrial textiles	110
4.4.4	Special finishes	112
4.4.5	Fungicidal finishes	113
4.4.6	Water repellent finishes	115
4.4.7	Fire-reducing finishes	119
4.4.8	Combined finishes	125
4.4.9	Finishes applied by coating	126
4.4.10	Antistatic finishes	128
4.4.11	Increasing the resistance to the effects of weathering	131
4.4.12	Economically attractive finishes	135
4.5	Making-up of industrial fabrics	135
4.5.1	The distinguishing features of the making-up of industrial fabrics	135
4.5.2	The construction of ready-made products, preparation of block patterns, and styling	136
4.5.3	Production techniques used in making-up of industrial fabrics	137
5.	PROJECTING INDUSTRIAL TEXTILES	145
5.1	Computer-based textile design	147
5.2	Performance characteristics and performance value of textile fabrics	148
6.	PHYSICAL AND MECHANICAL TESTING OF INDUSTRIAL TEXTILES	152
6.1	The testing environment	152
6.1.1	The significance of moisture in the mechanical and physical testing of textiles	152
6.2	Conditioning	154
6.3	Testing split film tapes	155
6.3.1	Determining the thickness and width of flat tapes	155
6.3.2	Determining the fibrillation capacity of flat tapes	155
6.3.3	Determining the linear weight per filament in fibrillated tapes	156
6.4	Testing tyre cord yarns and the tyre cord-rubber system	156
6.4.1	Dynamic tests of tyre cord yarns	156
6.4.2	Static tests	157
6.4.3	Dynamic tests	157
6.5	Testing the ropes and cordage	161
6.5.1	Determining the rope diameter	161
6.5.2	Determining the rope lead	162
6.5.3	Determining the braiding factor of a rope	162

6.5.4	Determining the strength with load applied across the full cross section of the rope	163
6.5.5	Determining the strength with the load applied to individual yarns separated from the rope	164
6.6	Testing hoses	166
6.6.1	Overpressure test following transport pressure test	166
6.7	Testing textile fabrics	167
6.7.1	Taking and preparing samples	167
6.7.2	Determination of the dimensions and weight	167
6.7.3	Determination of the warp and weft sett in woven fabrics	172
6.7.4	Testing the tensile stresses	173
6.7.5	Testing under long-term horizontal stress application	180
6.7.6	Testing the fabric stiffness and elasticity	184
6.7.7	Frictional testing	185
6.7.8	Testing thread slippage in the seam	186
6.7.9	Testing the resistance to heat and cold	187
6.7.10	Testing the air permeability	190
6.7.11	Testing the effect of water	190
6.7.12	Determination of the dimensional changes in textile fabrics	194
6.7.13	Testing the weathering resistance of textile fabrics	195
6.7.14	Testing the fabric resistance to fungi and bacteria	197
6.7.15	Testing the textile filter materials	199
7.	CANVAS CLOTH AND COATED INDUSTRIAL TEXTILES	208
7.1	The particular properties required	208
7.2	Production of special types of industrial fabrics	209
7.2.1	Production of backing and coated textile fabrics	209
7.2.2	Production of woven fabrics	211
7.2.3	Setting of woven fabrics	213
7.2.4	Determination of the quality parameters of coated textiles	213
7.2.5	Ageing of coated fabrics	214
7.2.6	Canvas cloth made of spun yarns and provided with an air permeable finish	216
7.3	Final applications of industrial textiles	217
7.3.1	Inflated textile structures	218
7.3.2	Skeleton and suspended textile structures	220
7.3.3	Elastic containers and tanks	221
7.3.4	Carrier inserts for transport containers and trucks and railway wagons	224
7.3.5	Textile transport bags	224
7.3.6	Handling sheets	224
7.3.7	Elastic piping	225
7.3.8	Elastic weirs on water flows	227
8.	TEXTILES FOR THE RUBBER AND PLASTICS INDUSTRIES	228
8.1	A review of the types of fibres used	229
8.1.1	Steel fibres	229
8.2	Manufacture of cord yarns and fabrics	232
8.2.1	Finishes applied to cord yarns and fabrics	234
8.2.2	Adhesive systems	236
8.3	Comparison of the properties of various reinforcement materials used	240
8.4	Application of industrial textiles in individual rubber goods	243
8.4.1	Tyres	243
8.4.2	Transport conveyors	246

8.4.3 Driving belts	251
8.4.4 Other rubber goods	254
8.4.5 Conclusions	254
8.5 Textiles used in the plastics industry	255
8.6 Textiles used in the footwear industry	256
9. FILTER CLOTH	260
9.1 Theory of filtration	260
9.2 Woven filter cloth	260
9.2.1 Construction of woven filter cloth for wet filtration	260
9.2.2 Woven filter cloth made of conventional natural fibres	261
9.2.3 Woven filter cloth made of synthetic fibres	261
9.2.4 Woven filter cloth made of synthetic monofilament yarns	262
9.2.5 Shrinking of woven filter cloth	262
9.2.6 Calendering	263
9.2.7 Testing and designing of woven filter cloth	263
9.2.8 Various filter cloth applications	264
9.3 Nonwoven filter cloth	269
9.3.1 Needle-punched textiles for industrial filtration of air-gas mixtures	269
9.3.2 Nonwoven textiles used for the filtration of liquids	275
9.3.3 Nonwoven filter cloth designed for the filtration of atmospheric air	278
9.3.4 Electret filter cloth	279
10. GEOTEXTILES	281
10.1 The various types of geotextiles	282
10.2 The various geotextile applications	283
10.3 Some observations on the significance of geotextiles	289
11. CORDAGE	291
11.1 The classification of cordage products	291
11.2 Product properties	293
12. WRAPPING AND PACKING TEXTILES	296
12.1 Requirements imposed on wrapping and packing textiles	296
12.2 Classification of wrapping, packing and industrial jute-type woven fabrics by the raw material used	298
12.3 Classification of wrapping, packing and industrial jute-type textiles by the production technique used	299
12.3.1 Woven fabrics	299
12.3.2 Stitchbonded jute-type textiles	300
12.3.3 Spunbonded textiles	300
12.3.4 Knitted fabrics	300
13. NONWOVEN INDUSTRIAL TEXTILES	301
13.1 The range of nonwovens designed for industrial applications	301
13.1.1 Medical and sanitary applications	301
13.1.2 Industrial and atmospheric gas filtration applications	302
13.1.3 Liquid filtration applications	302
13.1.4 Clothing industry applications	302
13.1.5 Footwear applications	302

13.1.6	Upholstery applications	303
13.1.7	Thermal and sound insulation applications	303
13.1.8	Other industrial applications	303
14.	INDUSTRIAL TEXTILES MADE OF GLASS FIBRES	304
14.1	Glass fibres	304
14.2	Glass fibres in basic forms	304
14.2.1	Glass filament yarns	304
14.2.2	Glass staple fibres	305
14.2.3	Microfibres	305
14.2.4	Optical fibres	305
14.3	Technologies used in the production of glass fibres	305
14.4	Glass filament yarns	307
14.4.1	Type of glass	307
14.4.2	The thickness of elementary filament	308
14.4.3	Number of elementary filaments in the yarn	308
14.4.4	Lubrication	309
14.4.5	Yarn twist	309
14.5	The basic properties of glass fibres	309
14.5.1	Mechanical properties	310
14.5.2	Chemical resistance	311
14.5.3	Heat resistance	312
14.5.4	Electrical properties	313
14.5.5	Other properties	314
14.6	The various applications of different glass fibres and products	315
14.6.1	Glass filament yarn	315
14.6.2	Glass woven fabrics	317
14.6.3	Nonwoven glass fabrics	321
14.7	Prospective development in the glass fibre production	323
15.	INDUSTRIAL TAPES, NETS AND BRAIDS	324
15.1	Industrial tapes	324
15.1.1	Slide fastener tapes	325
15.1.2	Slide fastener straps	327
15.1.3	Insulating tapes for electrotechnical applications	328
15.1.4	Bookbinder's tapes	328
15.1.5	Labelling tapes	328
15.1.6	Border tapes	328
15.1.7	Elastic braids	329
15.1.8	Pleated lingerie ribbons	329
15.2	Industrial webbings	329
15.2.1	The manufacture of webbings	329
15.2.2	Spindle drive webbings	330
15.2.3	Print webbings	331
15.2.4	Webbings for automobile safety belts	332
15.2.5	Prosthesis webbing	333
15.3	Industrial nets	333
15.3.1	Knotted netting	335
15.3.2	Characteristic features of knotted netting	335
15.3.3	The production technique	336
15.4	Trimmed braids	339
15.4.1	Classification of braids	339

15.4.2	Production technique, braid properties and applications	339
15.5	Crocheted braids	343
15.5.1	Characteristic features of crocheted braids	344
15.5.2	The production technique, crocheted braid properties and applications	344
16.	OTHER INDUSTRIAL TEXTILES	347
16.1	Cotton-type industrial textiles	347
16.1.1	Quality requirements demanded by manufacturers, processors and users	348
16.2	Industrial textiles produced in the traditional silk weaving sector	350
16.2.1	The effect of the material structure	350
16.2.2	Product groups designed for individual application areas	351
16.3	Fire, irrigation and industrial hoses	356
16.4	Metallic wire screens and sieves	361
16.4.1	Rabitz-type fabrics	362
16.4.2	Filter-type fabrics	363
16.4.3	Metallic wire peeling cloth	363
16.4.4	Metallic wire endless belts	364
17.	PROSPECTIVE DEVELOPMENT OF INDUSTRIAL TEXTILES	365
REFERENCES		371
INDEX		378

TEXTILE SCIENCE AND TECHNOLOGY 9

Industrial Textiles

TEXTILE SCIENCE AND TECHNOLOGY

- Volume 1 Open-end Spinning *by* V. Rohlena *et al.*
- Volume 2 Processing of Polyester Fibres *by* O. Pajgrt *and* B. Reichstädter
- Volume 3 Shuttleless Weaving Machines *by* O. Talavášek *and* V. Svatý
- Volume 4 Fluorescent Brightening Agents *by* R. Williamson
- Volume 5 Polypropylene Fibres – Science and Technology *by* M. Ahmed
- Volume 6 Production and Applications of Polypropylene Textiles *by*
O. Pajgrt *et al.*
- Volume 7 Absorbency *edited by* Pronoy K. Chatterjee
- Volume 8 Needle Punching Textile Technology *by* V. Mrština *and* F. Fejgl
- Volume 9 Industrial Textiles *edited by* J. Švédová

TEXTILE SCIENCE AND TECHNOLOGY 9

INDUSTRIAL TEXTILES

edited by
Jarmila Švédová

Linen Industry Research Institute, Šumperk, Czechoslovakia



ELSEVIER

Amsterdam Oxford New York Tokyo 1990

Published in co-edition with
SNTL – Publishers of Technical Literature

Distribution of this book is being handled by the following publishers

for the U.S.A. and Canada
ELSEVIER Science Publishing Co., Inc.
655 Avenue of the Americas
New York, N. Y. 10010

for the East European Countries, China, Northern Korea,
Cuba, Vietnam and Mongolia
SNTL – Publishers of Technical Literature
Spálená 51, 113 02 Praha 1, Czechoslovakia

for all remaining areas
ELSEVIER Science Publishers, B.V.
25 Sara Burgerhartstraat
P.O. Box 211, 1000 AE Amsterdam, The Netherlands

Library of Congress Cataloging-in-Publication Data

Industrial Textiles / edited by Jarmila Švédová.

p. cm. --(Textile science and technology; v. 9)

Includes bibliographical references.

ISBN 0-444-98754-1

I. Industrial fabrics. I. Švédová, Jarmila. II. Series.

TS1770 .I53153 1990

677--dc20

90-32595

CIP

ISBN 0-444-98754-1 (vol. 9)

ISBN 0-444-41818-0 (series)

Copyright © SNTL – Publishers of Technical Literature 1990
Translation © Olga Steinerová 1990

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any other form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the copyright owner

Printed in Czechoslovakia

TEAM OF AUTHORS

Jarmila Švédová, Bohumil Brychta, Jiří Cach, Jiří Effenberger, Vladimír Hladík, Ladislav Holštejn, Miloslav Chvátal, Jaroslav Janiš, Jan Kádlec, František Krejčí, Stanislav Krmela, Václav Křivohlávek, Vlastimil Kühnel, Josef Morávek, Václav Mrština, Ivo Pokluda, Zdeněk Pospíšil, Jaroslav Richter, Jiří Salaba, Josef Schneeweiss, Ludvík Surý, Josef Tošovský, Hubert Uhmann, Alois Vágner, Jiří Zapletal, Pravoslav Zbořil, Karel Zelinka.

