# Contents

Contributors
Preface
Acknowledgements

## 1 Paper and paperboard – raw materials, processing and properties
Daven Chamberlain and Mark J. Kirwan

1.1 Introduction – quantities, pack types and uses

1.2 Choice of raw materials and manufacture of paper and paperboard
   1.2.1 Introduction to raw materials and processing
   1.2.2 Sources of fibre
   1.2.3 Fibre separation from wood (pulping)
   1.2.4 Whitening (bleaching)
   1.2.5 Recovered fibre
   1.2.6 Other raw materials
   1.2.7 Processing of fibre at the paper mill
   1.2.8 Manufacture on the paper or paperboard machine
   1.2.9 Finishing

1.3 Packaging papers and paperboards
   1.3.1 Introduction
   1.3.2 Tissues
   1.3.3 Greaseproof
   1.3.4 Glassine
   1.3.5 Vegetable parchment
   1.3.6 Label paper
   1.3.7 Bag papers
   1.3.8 Sack kraft
   1.3.9 Impregnated papers
   1.3.10 Laminating papers
   1.3.11 Solid bleached board (SBB)
   1.3.12 Solid unbleached board (SUB)
   1.3.13 Folding boxboard (FBB)
   1.3.14 White-lined chipboard (WLC)

1.4 Packaging requirements

1.5 Technical requirements of paper and paperboard for packaging
   1.5.1 Requirements of appearance and performance
   1.5.2 Appearance properties
   1.5.3 Performance properties

1.6 Specifications and quality standards

1.7 Conversion factors for substance (basis weight) and thickness measurements

References
## Environmental and resource management issues

Daven Chamberlain and Mark J. Kirwan

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Introduction</td>
<td>51</td>
</tr>
<tr>
<td>2.2 Sustainable development</td>
<td>53</td>
</tr>
<tr>
<td>2.3 Forestry</td>
<td>54</td>
</tr>
<tr>
<td>2.4 Environmental impact of manufacture and use of paper and paperboard</td>
<td>61</td>
</tr>
<tr>
<td>2.4.1 Issues giving rise to environmental concern</td>
<td>61</td>
</tr>
<tr>
<td>2.4.2 Energy</td>
<td>62</td>
</tr>
<tr>
<td>2.4.3 Water</td>
<td>66</td>
</tr>
<tr>
<td>2.4.4 Chemicals</td>
<td>67</td>
</tr>
<tr>
<td>2.4.5 Transport</td>
<td>68</td>
</tr>
<tr>
<td>2.4.6 Manufacturing emissions to air, water and solid waste</td>
<td>68</td>
</tr>
<tr>
<td>2.5 Used packaging in the environment</td>
<td>73</td>
</tr>
<tr>
<td>2.5.1 Introduction</td>
<td>73</td>
</tr>
<tr>
<td>2.5.2 Waste minimisation</td>
<td>74</td>
</tr>
<tr>
<td>2.5.3 Waste management options</td>
<td>74</td>
</tr>
<tr>
<td>2.6 Life cycle assessment</td>
<td>79</td>
</tr>
<tr>
<td>2.7 Carbon footprint</td>
<td>81</td>
</tr>
<tr>
<td>2.7.1 Carbon sequestration in forests</td>
<td>81</td>
</tr>
<tr>
<td>2.7.2 Carbon stored in forest products</td>
<td>82</td>
</tr>
<tr>
<td>2.7.3 Greenhouse gas emissions from forest product manufacturing facilities</td>
<td>82</td>
</tr>
<tr>
<td>2.7.4 Greenhouse gas emissions associated with producing fibre</td>
<td>83</td>
</tr>
<tr>
<td>2.7.5 Greenhouse gas emissions associated with producing other raw materials/fuels</td>
<td>83</td>
</tr>
<tr>
<td>2.7.6 Greenhouse gas emissions associated with purchased electricity, steam and heat, and hot and cold water</td>
<td>83</td>
</tr>
<tr>
<td>2.7.7 Transport-related greenhouse gas emissions</td>
<td>83</td>
</tr>
<tr>
<td>2.7.8 Emissions associated with product use</td>
<td>83</td>
</tr>
<tr>
<td>2.7.9 Emissions associated with product end of life</td>
<td>83</td>
</tr>
<tr>
<td>2.7.10 Avoided emissions and offsets</td>
<td>83</td>
</tr>
<tr>
<td>2.8 Conclusion</td>
<td>84</td>
</tr>
<tr>
<td>References</td>
<td>86</td>
</tr>
</tbody>
</table>

## Paper-based flexible packaging

Jonathan Fowle and Mark J. Kirwan

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Introduction</td>
<td>91</td>
</tr>
<tr>
<td>3.2 Packaging needs which are met by paper-based flexible packaging</td>
<td>94</td>
</tr>
<tr>
<td>3.2.1 Printing</td>
<td>94</td>
</tr>
<tr>
<td>3.2.2 Provision of a sealing system</td>
<td>95</td>
</tr>
<tr>
<td>3.2.3 Provision of barrier properties</td>
<td>95</td>
</tr>
<tr>
<td>3.3 Manufacture of paper-based flexible packaging</td>
<td>99</td>
</tr>
<tr>
<td>3.3.1 Printing and varnishing</td>
<td>99</td>
</tr>
<tr>
<td>3.3.2 Coating</td>
<td>100</td>
</tr>
<tr>
<td>3.3.3 Lamination</td>
<td>105</td>
</tr>
</tbody>
</table>
4 Paper labels
Michael Fairley

4.1 Introduction

4.2 Types of labels
   4.2.1 Glue-applied paper labels
   4.2.2 Pressure-sensitive labels
   4.2.3 In-mould labels
   4.2.4 Plastic shrink-sleeve labels
   4.2.5 Stretch-sleeve labels
   4.2.6 Wrap-around film labels
   4.2.7 Other labelling techniques

4.3 Label adhesives
   4.3.1 Adhesive types
   4.3.2 Label adhesive performance

4.4 Factors in the selection of labels

4.5 Nature and function of labels
   4.5.1 Primary labels
   4.5.2 Secondary labels
   4.5.3 Logistics labels
   4.5.4 Special application or purpose labels
   4.5.5 Smart, smart-active and smart-intelligent labels
   4.5.6 Functional labels
   4.5.7 Recent developments

4.6 Label printing and production
   4.6.1 Letterpress printing
   4.6.2 Flexography
   4.6.3 Lithography
   4.6.4 Gravure
   4.6.5 Screen process
   4.6.6 Hot-foil blocking/stamping process
   4.6.7 Variable information printing (VIP), electronically originated
   4.6.8 Digital printing
4.7 Print finishing techniques 156
   4.7.1 Lacquering 156
   4.7.2 Bronzing 156
   4.7.3 Embossing 156
4.8 Label finishing 156
   4.8.1 Introduction 156
   4.8.2 Straight cutting 157
   4.8.3 Die-cutting 157
   4.8.4 Handling and storage 159
4.9 Label application, labelling and overprinting 159
   4.9.1 Introduction 159
   4.9.2 Glue-applied label applicators 160
   4.9.3 Self-adhesive label applicators 160
   4.9.4 Shrink-sleeve label applicators 161
   4.9.5 Stretch-sleeve label applicators 162
   4.9.6 In-mould label applicators 162
   4.9.7 Modular label applicators 163
4.10 Label legislation, regulations and standards 163
   4.10.1 Acts of Parliament 163
   4.10.2 EC regulations and directives 163
   4.10.3 Standards 164
4.11 Specifications, quality control and testing 164
   4.11.1 Introduction 164
   4.11.2 Testing methods for self-adhesive labels 165
   4.11.3 Testing methods for wet-glue labels 165
4.12 Waste and environmental issues 167
Websites 168

5 Paper bags 169
Smith Anderson Group Ltd, Fife, UK, and Welton Bibby &
Baron Ltd, Radstock, Somerset, UK

5.1 Introduction 169
   5.1.1 Paper bags and the environment 170
5.2 Types of paper bags and their uses 170
   5.2.1 Types of paper bag 170
   5.2.2 Flat and satchel 170
   5.2.3 Strip window bags 172
   5.2.4 Self-opening satchel bags (SOS bags) 172
   5.2.5 SOS carrier bags with or without handles 174
5.3 Types of paper used 175
   5.3.1 Kraft paper – the basic grades 175
   5.3.2 Grease-resistant and greaseproof papers 176
   5.3.3 Vacuum dust bag papers 176
   5.3.4 Paper for medical use and
       sterilisation bags 176
   5.3.5 Wet-strength kraft 176
   5.3.6 Recycled kraft 176
   5.3.7 Coated papers 176
5.3.8 Laminations 177
5.3.9 Speciality papers 177
5.3.10 Weights of paper 177
5.4 Principles of manufacture 177
5.4.1 Glue-seal bags 177
5.4.2 Heat-seal bags 178
5.4.3 Printing on bag-making machines 178
5.4.4 Additional processes on bag-making machines 178
5.4.5 Additional operations after bag making 179
5.5 Performance testing 179
5.5.1 Paper 179
5.5.2 Paper bags 179
5.6 Printing methods and inks 180
5.6.1 Printing methods 180
5.6.2 Inks 181
5.7 Conclusion 181
5.7.1 Development of the paper bag industry 181
5.7.2 The future 181
Reference 182
Websites 182

6 Composite cans 183
Catherine Romaine Henderson

6.1 Introduction 183
6.2 Composite can (container) 185
6.2.1 Definition 185
6.2.2 Manufacturing methods 185
6.3 Historical background 187
6.4 Early applications 189
6.5 Applications today by market segmentation 189
6.6 Designs available 190
6.6.1 Shape 190
6.6.2 Size 190
6.6.3 Consumer preferences 190
6.6.4 Clubstore/institutional 190
6.6.5 Other features 191
6.6.6 Opening/closing systems 191
6.7 Materials and methods of construction 194
6.7.1 The liner 195
6.7.2 The paperboard body 196
6.7.3 Labels 197
6.7.4 Nitrogen flushing 197
6.8 Printing and labelling options 197
6.8.1 Introduction 197
6.8.2 Flexographic 197
6.8.3 Rotogravure 198
6.8.4 Lithography (litho/offset) printing 199
6.8.5 Labelling options 199
<table>
<thead>
<tr>
<th>6.9</th>
<th>Environment and waste management issues</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.9.1</td>
<td>Introduction</td>
<td>200</td>
</tr>
<tr>
<td>6.9.2</td>
<td>Local recycling considerations</td>
<td>200</td>
</tr>
<tr>
<td>6.10</td>
<td>Future trends in design and application</td>
<td>200</td>
</tr>
<tr>
<td>6.10.1</td>
<td>Introduction</td>
<td>200</td>
</tr>
<tr>
<td>6.10.2</td>
<td>Increase barrier performance of paper-bottom canisters</td>
<td>201</td>
</tr>
<tr>
<td>6.10.3</td>
<td>Totally repulpable can</td>
<td>201</td>
</tr>
<tr>
<td>6.10.4</td>
<td>Non-paper-backed liner</td>
<td>201</td>
</tr>
<tr>
<td>6.10.5</td>
<td>Film label</td>
<td>201</td>
</tr>
<tr>
<td>6.10.6</td>
<td>Killer paper</td>
<td>201</td>
</tr>
<tr>
<td>6.11</td>
<td>Glossary of composite can-related terms</td>
<td>201</td>
</tr>
<tr>
<td>References</td>
<td>203</td>
<td></td>
</tr>
<tr>
<td>Websites</td>
<td>203</td>
<td></td>
</tr>
</tbody>
</table>

7 Fibre drums
Fibrestar Drums Ltd., Cheshire, UK

| 7.1 | Introduction | 205 |
| 7.2 | Raw material | 207 |
| 7.3 | Production | 208 |
| 7.3.1 | Sidewall | 208 |
| 7.3.2 | Drum base | 210 |
| 7.3.3 | Lid | 210 |
| 7.4 | Performance | 212 |
| 7.5 | Decoration, stacking and handling | 214 |
| 7.6 | Waste management | 215 |
| 7.7 | Summary of the advantages of fibre drums | 215 |
| 7.8 | Specifications and standards | 216 |
| References | 216 |
| Websites | 216 |

8 Multiwall paper sacks
Mondi Industrial Bags, Vienna, Austria

| 8.1 | Introduction | 217 |
| 8.2 | Sack designs | 218 |
| 8.2.1 | Types of sacks | 218 |
| 8.2.2 | Valve design | 223 |
| 8.2.3 | Sewn closures | 225 |
| 8.3 | Sack materials | 226 |
| 8.3.1 | Sack body material | 226 |
| 8.3.2 | Ancillary materials | 230 |
| 8.4 | Testing and test methods | 232 |
| 8.4.1 | Sack materials | 232 |
| 8.4.2 | Sack testing | 235 |
| 8.5 | Weighing, filling and closing systems | 237 |
| 8.5.1 | Open mouth sacks | 238 |
| 8.5.2 | Valve sacks | 241 |
8.5.3 Sack identification 245
8.5.4 Sack flattening and shaping 247
8.5.5 Baling systems 247
8.6 Standards and manufacturing tolerances 248
8.6.1 Standards 248
8.6.2 Manufacturing tolerances 248
8.7 Environmental position 250
References 251
Useful contacts 251
Websites 251

9 Rigid boxes 253
Michael Jukes

9.1 Overview 253
9.2 Rigid box styles (design freedom) 254
9.3 Markets for rigid boxes 256
9.4 Materials 256
9.4.1 Board and paper 256
9.4.2 Adhesives 257
9.4.3 Print 257
9.5 Design principles 257
9.6 Material preparation 258
9.7 Construction 259
9.7.1 Four-drawer box 261
9.8 Conclusion 263
References 263
Websites 263

10 Folding cartons 265
Mark J. Kirwan

10.1 Introduction 265
10.2 Paperboard used to make folding cartons 267
10.3 Carton design 268
10.3.1 Surface design 268
10.3.2 Structural design 269
10.4 Manufacture of folding cartons 277
10.4.1 Printing 277
10.4.2 Cutting and creasing 280
10.4.3 Creasing and folding 287
10.4.4 Embossing 292
10.4.5 Hot-foil stamping 293
10.4.6 Gluing 294
10.4.7 Specialist conversion operations 295
10.5 Packaging operation 296
10.5.1 Speed and efficiency 296
10.5.2 Side seam-glued cartons 297
10.5.3 Erection of flat carton blanks 298
11 Corrugated fibreboard packaging

Arnoud Dekker

11.1 Introduction
11.1.1 Overview
11.1.2 Structure of corrugated fibreboard
11.1.3 Types of corrugated fibreboard packaging
11.1.4 History of corrugated fibreboard

11.2 Functions
11.2.1 Overview functions
11.2.2 Corrugated fibreboard packaging production
11.2.3 Packing lines
11.2.4 Palletisation and logistic chain
11.2.5 Communication
11.2.6 Retail-ready
11.2.7 Product safety
11.2.8 Recycling and sustainability

11.3 Board properties and test methods
11.3.1 Overview of board properties and test methods
11.3.2 Box tests
11.3.3 Pallet tests
11.3.4 Predictions

11.4 Manufacturing
11.4.1 Overview
11.4.2 Paper production
11.4.3 Corrugated board production
11.4.4 Corrugated fibreboard converting
11.4.5 Corrugated fibreboard printing
11.4.6 Customer packing lines
11.4.7 Good manufacturing practice

11.5 Corrugated fibreboard and sustainability
11.5.1 Sustainable sourcing of raw materials
11.5.2 Sustainable production
11.5.3 Sustainable packaging design
11.5.4 Sustainable supply chain

References
Websites
Suggested further reading
12  Solid board packaging  
Mark J. Kirwan  
12.1 Overview 341  
12.2 Pack design 342  
12.3 Applications 345  
12.3.1 Horticultural produce 345  
12.3.2 Meat and poultry 346  
12.3.3 Fish 346  
12.3.4 Beer (glass bottles and cans) 346  
12.3.5 Dairy products 346  
12.3.6 Footwear 346  
12.3.7 Laundry 346  
12.3.8 Engineering 346  
12.3.9 Export packaging 347  
12.3.10 Luxury packaging 347  
12.3.11 Slip sheets 347  
12.3.12 Partitions (divisions, fitments and pads) 348  
12.3.13 Recycling boxes 350  
12.3.14 Bag-in-box liquid containers 350  
12.3.15 Shelf-ready packaging 350  
12.4 Materials 350  
12.5 Water and water-vapour resistance 350  
12.6 Printing and conversion 351  
12.6.1 Printing 351  
12.6.2 Cutting and creasing 352  
12.7 Packaging operation 352  
12.8 Waste management 352  
12.9 Good manufacturing practice 352  
Reference 352  
Websites 352  

13  Paperboard-based liquid packaging  
Mark J. Kirwan  
13.1 Introduction 353  
13.2 Packaging materials 357  
13.2.1 Paperboard 357  
13.2.2 Barriers and heat-sealing layers 358  
13.3 Printing and converting 360  
13.3.1 Reel-to-reel converting for reel-fed form, fill, seal packaging 360  
13.3.2 Reel-to-sheet converting for supplying printed carton blanks for packing 361  
13.3.3 Sheet-fed for bag-in-box 361  
13.4 Carton designs 361  
13.4.1 Gable top 362  
13.4.2 Pyramid shape 362  
13.4.3 Brick shape 363