

Table of Contents

1.	Objectives	1
1.1	Nature of malt	1
1.2	Brewers'expectations	4
1.3	Others'expectations	5
1.3.1	Distillers	5
1.3.2	Bakers	5
1.3.3	Food manufacturers	5
2.	The overall process	7
2.1	Malt production	7
2.2	Materials	9
2.2.1	Barley to malt	9
2.2.2	Utilities.....	10
2.3	Production costs.....	11
3.	Raw materials	13
3.1	Cereal structure and composition	13
3.1.1	Malting barley	13
3.1.2	Wheat, maize, rice and sorghum	15
3.1.3	Composition	17
3.2	Quality parameters of malting barley	22
4.	The processes	23
4.1	Malting	23
4.1.1	Physiological principles of the production of barley malt	23
4.1.2	Summary of the process	24
4.1.3	Steeping	24
4.1.4	Germination	37
4.1.5	Kilning	48
4.2	Speciality and coloured malts	68
4.3	Grain drying and storage	77

5. Equipment	83
5.1 History of development	83
5.1.1 Introduction	83
5.1.2 Steeping	83
5.1.3 Germination	87
5.1.4 Kilning	90
5.1.5 Conclusions	94
5.2 Production cycle	96
5.2.1 Barley reception, cleaning, drying, storage and hygiene	96
5.2.2 Steeping	110
5.2.3 Germination	113
5.2.4 Kilning	114
5.2.5 Auxiliaries of kilning, energy recovery equipment	119
5.3 Heating cycle	131
5.3.1 Combustion of fuels	131
5.3.2 Heating systems and heat recovery	133
5.3.3 Combined heat and power (CHP)	137
6. Quality management and control	141
6.1 Meeting malt quality specifications	141
6.2 Control points by process step	143
6.3 Engineering breakdowns	145
6.3.1 Barley silos	145
6.3.2 Malt Silos	145
6.3.3 Steeping	146
6.3.4 Germination	146
6.3.5 Kilning	146
6.3.6 Sensitivities of various malting systems	147
6.3.7 Preventative maintenance	147
7. Safety considerations	149
7.1 Product safety.....	149
7.1.1 Mycotoxins	149
7.1.2 Other contaminants	155
7.1.3 Control of volatile nitrosamines (NDMA) during kilning	156
7.1.4 Hygiene and control of vermin in the malting plant	158
7.2 Personnel safety	172
7.2.1 Dust and the risk and prevention of explosions	172
7.2.2 Safe working practices	176

8. Trouble-shooting	179
8.1 Problems with malt quality and performance	179
Appendices	185
Appendix A.1 Glossary of Kilning terms	185
Appendix A.2 Definitions of brewing malt parameters	187
Appendix A.3 Methods of analysis	195
A.3.1 ASBC Methods of analysis	196
A.3.2 EBC Methods of analysis	200
A.3.3 IOB Methods of analysis	203
A.3.4 Mebak Methods of analysis	205
Appendix A.4 National organisations	211
Appendix A.5 Research and development needs	215
Appendix A.6 Malting varieties	217
Appendix A.7 Bibliography	219
Appendix A.8 Physical changes during malting	221
Appendix A.9 Psychrometric chart	223