

Table of Contents

1. Objectives	1
1.1 Purpose	1
1.1.1 Filtration	1
1.1.2 Stabilisation	2
1.1.3 Cold Sterilisation	2
1.2 Major Processes	3
2. Required Performance	5
2.1 Outline of Process Requirements	5
2.2 Nature and Loadings of Solids in Beer Filters	7
2.3 Loading on Beer Stabilisation Processes	11
2.4 Loading on Cold Sterilisation Processes	13
3. Filtration using Filter-aids	15
3.1 Introduction	15
3.1.1 Background	15
3.1.2 Filtration Equipment	16
3.1.3 Design Considerations	17
3.2 Filter-aids	18
3.2.1 Types	18
3.2.2 Kieselguhr	18
3.2.3 Perlite	20
3.2.4 Cellulose	21
3.2.5 Impact on Beer Quality	22
3.2.6 Impact on Process Performance	23
3.3 Principles of Operation	24
3.3.1 Mechanisms of Solids Removal	24
3.3.2 Filter-aid Characterisation	27
3.3.3 Process Model	31
3.4 Powder Handling and Slurrying	35
3.4.1 Powder Packaging	35
3.4.2 Powder Conveying	35
3.4.3 Slurrying	36
3.5 Pre-coating Procedures	39
3.5.1 First Pre-coat	39
3.5.2 Second Pre-coat	40
3.5.3 Quantities	42

3.6	Body-feed	43
	3.6.1 Types	43
	3.6.2 Grades	43
	3.6.3 Mixing Grades	44
	3.6.4 Quantity	44
	3.6.5 Dosing Systems	46
3.7	Filter Performance	47
	3.7.1 Total Suspended Solids in Feed	47
	3.7.2 The Size and Nature of Beer Solids	49
	3.7.3 Un-filtered Beer Solids	52
	3.7.4 Filtered Beer Solids	52
	3.7.5 Filter Cake	53
	3.7.6 Microbiological Content	53
3.8	Quality Control	54
	3.8.1 Beer Haze	54
	3.8.2 Oxygen Pick-up	55
	3.8.3 Microbiological Content	57
	3.8.4 Beer Losses Caused by Beer Handling in the Filter Cellar	57
4.	Filtration Equipment	59
4.1	General Factors	59
	4.1.1 Design Basis	59
	4.1.2 Operation	62
	4.1.3 Process Hygiene, Cleaning and Disinfection	66
	4.1.4 Process Failure and Troubleshooting	67
	4.1.5 Power Consumption	68
	4.1.6 Operator Safety	68
4.2	Candle Filters	70
	4.2.1 General Description	70
	4.2.2 Operation	72
	4.2.3 Process Hygiene, Cleaning and Disinfection	74
	4.2.4 Water Consumption	74
	4.2.5 Maintenance	74
	4.2.6 Process Failure and Troubleshooting	75
	4.2.7 Operator Safety	75
4.3	Plate and Frame Filters	76
	4.3.1 General Description	76
	4.3.2 Operation	78
	4.3.3 Process Hygiene, Cleaning and Disinfection	80
	4.3.4 Water Consumption	80
	4.3.5 Maintenance	81
	4.3.6 Process Failure and Troubleshooting	81
	4.3.7 Operator Safety	82
4.4	Horizontal Leaf Filters	83
	4.4.1 General Description	83
	4.4.2 Operation	85

4.4.3	Process Hygiene, Cleaning and Disinfection	87
4.4.4	Water Consumption	87
4.4.5	Power Consumption	88
4.4.6	Maintenance	88
4.4.7	Process Failure and Troubleshooting	88
4.4.8	Operator Safety	89
4.5	Recent Developments	90
4.5.1	Automation	90
4.5.2	Control of Filter-aid Addition	90
4.5.3	Recycling Filter-aids	91
4.5.4	New Filter-aids	91
4.5.5	Crossflow Filtration	92
5.	Stabilisation in Filter	93
5.1	Introduction	93
5.1.1	Background to Haze Formation and Stabilisation	93
5.1.2	Colloidal Haze Formation	93
5.1.3	Control of Haze	95
5.1.4	Systems Currently in Use	95
5.1.5	Disposal	96
5.1.6	Operator Safety	96
5.1.7	Control of Oxygen Pick-up	96
5.1.8	Water Consumption	96
5.1.9	Impact on Beer Quality	96
5.2	PV PP with Main Beer Filtration	97
5.2.1	Principles of Operation	97
5.2.2	Procedure	97
5.2.3	Process Engineering	97
5.2.4	Process and Quality Control	99
5.3	Regenerable PVPP Systems	101
5.3.1	Principles of Operation	101
5.3.2	Procedure	101
5.3.3	Process Engineering	101
5.3.4	Process Operation	102
5.3.5	Process and Quality Control	108
5.3.6	Process Hygiene, Cleaning and Disinfection	108
5.3.7	Water Consumption	108
5.4	PVPP Impregnated Filter Sheets	110
5.4.1	General Description	110
5.4.2	Procedure	110
5.5	Silica Gels with Main Beer Filtration	112
5.5.1	Range of Amorphous Silicas	112
5.5.2	Principles of Operation	112
5.5.3	Procedures	113
5.5.4	Operation	116
5.5.5	Process and Quality Control	116
5.5.6	Process Hygiene, Cleaning and Disinfection	116

6.	Cold Sterilisation	117
6.1	Introduction	117
	6.1.1 Background	117
	6.1.2 Equipment	117
6.2	Principles of Operation	118
	6.2.1 Mechanisms of Sterilisation	118
	6.2.2 Process Variables	120
	6.2.3 Regeneration	121
6.3	Cartridge Filters	122
	6.3.1 Materials for Filter Media	122
	6.3.2 Cartridge Construction	122
	6.3.3 Design Basis	126
	6.3.4 Control	130
	6.3.5 Process Hygiene, Handling and Disinfection	131
	6.3.6 Maintenance	136
	6.3.7 Operational Failure and Troubleshooting	136
	6.3.8 Operator Safety	137
6.4	Sheet Filters	138
	6.4.1 Types Available	138
	6.4.2 Materials for Filter Media	139
	6.4.3 Design Basis	140
	6.4.4 Control	141
	6.4.5 Process Hygiene, Cleaning and Disinfection	143
	6.4.6 Maintenance	143
	6.4.7 Operational Failure and Troubleshooting	144
	6.4.8 Operator Safety	144
7.	Safety	145
7.1	Suppliers Obligations	145
7.2	Risks from Typical Filtration Materials	146
	7.2.1 General	146
	7.2.2 Kieselguhr, Crystalline Silica	146
	7.2.3 Perlite	147
	7.2.4 Cellulose.....	148
	7.2.5 PVPP	148
	7.2.6 Silica Gel.....	148
	Appendices	149
	A.1 Design Bases for Filtration Equipment	149
	A.2 Effects of Filtration on Hop Derived Flavours	155