

Contents

1	Introduction and definitions	10
1.1	Components of lacquers _____	10
1.2	Deposition of paints _____	12
2	Processable condition	13
2.1	Liquid state – solutions and dispersions _____	13
2.1.1	Viscosity _____	13
2.1.2	Solvents _____	17
2.2	Aqueous solutions _____	21
2.3	Aqueous dispersions: suspensions and emulsions _____	24
2.4	Methods of stabilisation of dispersions _____	24
2.4.1	Electrostatic stabilisation _____	24
2.4.2	Steric stabilisation _____	24
2.5	Production of dispersions _____	25
2.6	Viscosity of aqueous dispersions _____	25
2.7	Non-aqueous dispersions _____	26
2.8	Aerosols _____	27
2.9	Viscosity and solid content for application _____	28
2.10	VOC regulations _____	28
2.11	Reduction of solvent content _____	31
2.12	High-solids _____	31
2.13	Water-based systems _____	32
2.14	100 % systems _____	33
3	Dispersing and mixing	34
3.1	Dispersing pigments and fillers _____	34
3.1.1	Dispersing units _____	37
3.1.2	Pigment pastes _____	39
3.1.3	Powder coatings _____	40
3.1.4	Dispersing of effect substances _____	40
3.2	Mixing processes _____	40
3.2.1	Stirring processes _____	40
3.2.2	Modular manufacturing concepts _____	41
3.3	Storage _____	41
3.3.1	Flocculation _____	41
3.3.2	Settling _____	42
3.3.3	Change in viscosity _____	43
3.3.4	pH value change _____	44
3.3.5	Prevention of skinning _____	45
3.3.6	Preservation of aqueous coating materials _____	45

4	Application	47
4.1	Substrates _____	47
4.2	Application methods _____	48
4.2.1	Dip coating _____	48
4.2.2	Flooding, casting _____	50
4.2.3	Doctor blading _____	51
4.2.4	Spraying _____	51
4.2.5	Rolling _____	52
4.3	Wetting _____	52
4.3.1	Surface tension, surface free energy _____	52
4.3.2	Spreading _____	55
4.3.3	Influences on wetting _____	57
5	Characteristics defined by the application process	58
5.1	Levelling _____	58
5.1.1	Orange peel effect _____	58
5.1.2	Bénard cells _____	59
5.1.3	Influence of viscosity _____	59
5.1.4	Levelling additives _____	60
5.2	Sagging _____	62
5.2.1	Application technology _____	62
5.2.2	Rheology _____	63
5.3	Edge receding _____	66
5.4	Gloss _____	66
5.5	Appearance _____	69
5.6	Fullness _____	69
5.7	Recoatibility _____	70
5.8	Craters _____	70
5.9	Deairation/bubbles _____	71
6	Film formation	72
6.1	Physical drying _____	72
6.1.1	Physical drying of solvent containing coating materials _____	72
6.1.2	Physical drying of coating materials containing water _____	78
6.1.3	Film formation with aqueous dispersions _____	79
6.1.4	Film formation with non-aqueous dispersions _____	83
6.2	Chemical film formation (cross-linking) _____	84
6.2.1	Prerequisites for cross-linking _____	84
6.2.2	Structure of cross-linked molecules _____	86
6.3	Structure-property relationships in coating materials _____	89
6.3.1	Molecular structure of polymers _____	89
6.3.2	Melting point and T_g _____	90
6.3.3	Influences on the glass transition temperature _____	94
6.4	Physical description of polymer networks _____	96
6.4.1	Mechanical properties of networks _____	97
6.4.2	Degree of cross-linking _____	98
6.4.3	Interpenetrating networks _____	98
6.4.4	Cross-linking with aqueous binders _____	99

Contents

6.5	Important cross-linking reactions and their application _____	99
6.5.1	Molar mass and molar mass distribution _____	100
6.5.2	Classification of cross-linking reactions _____	100
6.5.3	Condensation reactions _____	103
6.5.4	Addition reactions _____	115
6.5.5	Polymerisation reactions _____	123
7	Colour and effects	136
7.1	Colour _____	136
7.2	Absorption and scattering _____	142
7.3	Inorganic and organic pigments _____	148
7.3.1	Inorganic pigments _____	148
7.3.2	Organic pigments _____	150
7.4	Dispersion of pigments _____	153
7.5	Pigment concentration _____	154
7.6	Effect pigments and effect formation _____	156
7.6.1	Aluminium pigments _____	156
7.6.2	Interference pigments _____	162
8	Performance characteristics of paints	165
8.1	Hardness and flexibility _____	165
8.1.1	Spatial extent of the molecular networks _____	167
8.2	Mechanical resistance _____	170
8.3	Adhesion _____	172
8.3.1	Adhesion tests _____	173
8.3.2	Pretreatment _____	174
8.3.3	Interlayer adhesion _____	176
8.4	Resistance to solvents and chemicals _____	176
8.5	Corrosion protection properties _____	180
8.5.1	Fundamentals of corrosion _____	180
8.5.2	Anti-corrosion coatings _____	184
8.6	Weather resistance _____	186
8.6.1	Exposure to UV radiation _____	186
8.6.2	Light stabilisers _____	191
8.6.3	Temperature resistance _____	195
9	Test planning and error analysis	198
10	Recent developments in coating chemistry	201
10.1	Effect pigments _____	201
10.2	Functional coatings: self-healing _____	202
10.2.1	Self-healing through encapsulation of reactive components _____	203
10.2.2	Self-healing through (reversible) physical or chemical cross-linking of polymers _____	205
10.3	Functional coatings: self-cleaning _____	205
10.3.1	Lotus effect _____	205
10.3.2	Superhydrophilic coatings and photocatalysis _____	207
10.4	Anti-fog coatings/hydrophilic coatings _____	208

10.5	Anti-fouling coatings _____	209
10.5.1	Active anti-fouling coatings _____	209
10.5.2	Hydrophobic, release-promoting coatings _____	210
10.5.3	Hydrophilic, adhesion-preventing surfaces _____	212
10.5.4	Newer trends in anti-fouling coatings _____	213
10.6	Liquid-infused coatings – SLIPS _____	214
10.7	Biodegradable coatings and coating materials made from renewable raw materials _____	216
10.7.1	Oils _____	217
10.7.2	Cellulose and starch _____	219
10.7.3	Lignin _____	220
10.7.4	Proteins _____	223
11	Looking ahead	225
12	References	227
	Authors	240
	Index	241