

Table of contents

TABLE OF CONTENTS

CHAPTER 1

WOOD FIBERS	1
1.1 Key Terms	2
1.2 Introduction	3
1.3 Trees	3
1.4 Fibers	4
1.5 Review Questions	6

CHAPTER 2

PULP MILL OVERVIEW	8
2.1 Key Terms	9
2.2 Introduction to Pulping Methods	11
2.2.1 Mechanical Pulping	11
2.2.2 Semi-chemical Pulping	11
2.2.3 Chemical Pulping	12
2.3 Pulp Processing	14
2.4 Chemical Recovery	16
2.5 Summary	17
2.6 Review Questions	18

CHAPTER 3

WOOD PREPARATION	19
3.1 Key Terms	20
3.2 Introduction	22

3.3 Receiving and Storing Wood	22
3.4 Debarking	23
3.5 Chipping	25
3.6 Chip Storage	27
3.7 Chip Screening	28
3.8 Review Questions	30

CHAPTER 4

KRAFT PULPING	31
4.1 Key Terms	32
4.2 Introduction	34
4.3 Pulping Chemistry	34
4.4 Process and Equipment	35
4.5 Pulp Defiberizing and Deknotting	39
4.6 Brownstock Washing	40
4.7 Pulp Screening	43
4.8 Summary	45
4.9 Review Questions	46

CHAPTER 5

CHEMICAL RECOVERY	47
5.1 Key Terms	48
5.2 Introduction	51
5.3 Brownstock Washing	52
5.4 Black Liquor Evaporation	53
5.5 Recovery Furnace/Boiler	55
5.6 Chemical Recovery	56
5.7 By-Products	58
5.8 Conclusions	58
5.9 Liquor Testing	59
5.10 Review Questions	60

CHAPTER 6

MECHANICAL AND CHEMI-MECHANICAL PULPING62

6.1 Key Terms63

6.2 Introduction to Mechanical and Chemi-mechanical Pulping Processes65

6.3 Mechanical Pulping: The Stone Groundwood Pulping Processes67

6.4 Mechanical Pulping: Refiner-mechanical Pulping Processes68

6.5 Chemi-mechanical and Semi-chemical Pulping72

6.6 Summary75

6.7 Review Questions75

CHAPTER 7

PULP BLEACHING77

7.1 Key Terms78

7.2 Introduction80

7.3 Chemical Pulp Delignification and Bleaching81

7.3.1 Oxygen Delignification81

7.3.2 Common Bleaching Stages and Sequences81

7.3.3 Bleaching Equipment84

7.3.4 Bleaching Chemicals84

7.3.5 Increasing Brightness During Bleaching85

7.3.6 Bleach Plant Filtrate Flow85

7.3.7 Bleached Pulp Quality85

7.3.8 Pulp Strength86

7.3.9 Pulp Cleanliness86

7.3.10 Pulp Yield86

7.3.11 Evolving Bleach Sequences86

7.4 Mechanical Pulp Bleaching87

7.5 Bleaching and the Environment87

7.5.1 Chlorinated Organic Compounds and AOX88

7.5.2 U.S. Environmental Protection Agency (EPA) Cluster Rule88

7.6 Summary89

7.7 Review Questions	89
7.8 Bibliography	90
CHAPTER 8	
PAPER RECYCLING	91
8.1 Key Terms	92
8.2 Introduction	94
8.3 Types of Wastepaper	94
8.4 Wastepaper Procurement	95
8.5 Contaminants in Wastepaper	95
8.6 Repulping	96
8.7 Cleaning and Screening	98
8.8 Deinking - Flotation and Washing	100
8.9 Bleaching and Brightening	103
8.10 Waste Disposal	103
8.11 Conclusion	104
8.12 Review Questions	104
ANSWER KEY TO REVIEW QUESTIONS	106
SUBJECT INDEX	116
CHEMICAL RECOVERY	117
9.1 Key Terms	117
9.2 Introduction	117
9.3 Brownstock Washlog	117
9.4 Black Liquor Evaporation	117
9.5 Recovery Furnace	117
9.6 Chemical Recovery	117
9.7 By-Products	117
9.8 Conclusion	117
9.9 Lignin	117
9.10 U.S. Environmental Protection Agency (EPA) Cluster Rulemaking	117
9.11 Summary	117

A

Acetate acrylic latex, 111

Acidic paper, 41

Acidic papermaking, 40, 43

Acrylate gums, 112

Acrylic latex, 111

Additives, 23, 34, 36

coating, 111

functional, 35, 36

process, 35, 36, 42

wet-end, 45

Air-flotation drying, 123

Air-knife coaters, 121

Air-knife metering, 121

Air-padded headbox, 11, 74

AKD. See Alkyl Ketene Dimer

Alginate, 112

Alkaline papermaking, 39, 40

Alkalis for pH adjustment, 113

Alkenyl succinic anhydride, 34, 40

Alkyl ketene dimer, 34, 40

Alum, 34, 43

Aluminum sulfate. See Alum

Ammonium hydroxide, 113

Ammonium zirconium carbonate, 112

Anionic, 34

Anionic charges

in dispersant solution, 112

Applicator-roll coaters, 118

Applicators

coating, 117

ASA. See Alkenyl Succinic Anhydride

AZC. See Ammonium Zirconium Carbonate

B

Backflushing, 27

Bacterial growth

in paper machines, 45

Balance tube, 73

Bales, 5, 23, 24

Barrier coating. See Functional coating

Base paper surface

nonuniformity, 103

Basestock

and sheet smoothness, 104

Basis weight, 8, 20, 49, 50, 56

Uniformity, on cylinder machines, 83

Basis weight valve, 9, 20, 28

Batch pulper, 20

Bent-blade metering, 120

Beveled-blade metering, 120

Binder migration, 109, 122

Binders, 99, 105, 109

casein, 109

protein, 109

Biocides. See Slimicides

Blade

in metering size press, 86

Blade coaters, 118

Blades*as metering elements, 119**in metering size press, 94***Blend chest, 8, 20, 26****Blending***of stock, 25***Boiler, 73****Boilouts, 45****Breast roll, 50, 64****Brightness, 34, 99, 104***and pigmented coating, 101**of calcium carbonate, 106**with optical brighteners, 113**with polyvinyl alcohol, 110***Broke, 20, 30****Broke handling, 30****Broke repulper, 30****Bugs, 45****Bulk, 34, 73, 105***reduction by pressing, 14***C**

Calcined clay, 104, 106**Calcium carbonate, 34, 39, 40, 99, 106***ground, 107**precipitated, 35, 37, 106, 107***Calcium stearate, 112****Calender stack, 87****Calendering, 2, 15, 16, 34, 73, 86***hard-nip, 73**shoe-nip, 74**soft-nip, 16, 74***Caliper, 38, 73****Carboxy methyl cellulose, 112, 113****Casein, 105****Casein binders, 109****Cationic, 34****Cationic polymers, 106****Cationicstarch, 34, 41, 43****Centrifugal cleaner, 2, 10, 20, 29***for broke, 30***Clay, 34***calcined, 104, 106**delaminated, 34, 37, 99, 106**kaolin, 91, 99, 106***Cleaners****Centrifugal, 2, 10, 20, 29****Cleanliness***and additives, 46**of paper machine, 46***Clothing, 73***machine, 51***Cluster press. See Tri-nip press****CMC. See Carboxy Methyl Cellulose****Coater***replaced by metering size press, 95***Coater unit operations, 115****Coaters***air-knife, 121**applicator-roll, 118*

blade, 118

flooded-nip, 118

gate-roll, 116

low-angle jet, 119

post-metering, 117, 118

short-dwell, 118

transfer-roll, 116

Coating, 99

functional, 101

pigment, 101

pigmented, in metering size press, 95

Coating additives, 111

Coating applicators, 117

Coating formulation, 104

Coating kitchen, 99, 113

Coating layer

thickness, 102

Coating preparation system, 113

Coating recipe, 114

Coating recirculation rate, 114

Coating structure, 105, 106

Coatings

pigments used in, 42

size press, 116

Colloidal phenomenon, 34, 46

Color, 41

Condensate, 2, 15, 73, 83

Configurations

press section, 80

size press, 85, 93

Conical refiners, 20, 25

Consistency, 2, 6, 20, 23, 50

after dryers, 15, 83

after flat boxes, 62

after forming section, 12

after press section, 14, 79

after shoe press, 79

at couch, 63

at fan pump, 28

at size press, 15

headbox, 11

in forming section, 77

in pulpers, 24

in stock prep, 26

screening, 27

sheet, 74

Consistency control, 25

Consistency transmitters, 25

Containment hood, 85

Contaminants, 10

removed by cleaners, 28

removed by screening, 10, 26

Continuous pulper, 20, 24

Copolymers, 105

Cost

water removal, pressing vs. drying, 80

Couch roll, 50, 60, 62, 73

Cross-direction (CD), 50

Cross-direction Profile

at headbox, 58

Cross-machine direction (CD), 61

Crown

of calender rolls, 87

Cylinder former, 50, 64

Cylinder machine, 64

D

Deaeration, 2, 10, 30

Deculator, 20

Deflaker, 20

Deflocculation, 50, 51, 57

Defoamers, 34, 42, 44, 45, 46, 113

Delaminated clay, 34, 37, 99, 106

Detackifiers, 42, 45, 46

Dilution control, 11, 50, 58

Disk refiners, 20, 25

Dispersants, 46, 112

Dispersing agents, 46

Donkin, Brian, 60

Double-felting, 73, 80

Drainage, 50, 61

on fourdrinier, 13

on twin-wire machine, 13

on wire, 59

Dry end, 2, 14, 50, 73, 76

Dry parts (Pigment), 105

Dry strength, 41

Dryer cans, 15, 83

Dryer fabric, 83

Dryer hood, 85

Dryers, 2, 15, 73

infrared, 123

on cylinder machines, 84

single-tier, 74, 84

two-tier, 75, 83

Drying, 73, 76

air-flotation, 123

Drying coated pPapers, 122

Dry-strength agents, 36

Dwell time, 117, 118

in coating, 115

Dyes, 36, 41, 46, 112

emulsions, 34

retention aids shipped as, 44

sizing agents added as, 46

extraction plate

in continuous pulper, 24

F

Fan pump, 2, 9, 20, 28

Felts

press, 14, 76

Fiber alignment

on cylinder machines, 65

Fibrils, 20, 25

Fillers, 21, 34, 36, 37

Film split patterning, 91, 94, 99, 115, 117, 118

Fines, 21, 25, 50

First-pass retention, 44

Flakes, 21, 24, 31

Flat boxes, 50, 62

Flexography, 99

Flocs, 2, 9, 11, 50, 56, 61

Flooded-nip coater, 118

Flow controller, 26

Flow rate, 7, 8

Foam, 113

on paper machine, 44

Foil units, 50, 61

Foils

vacuum, 52

Forces

exerted in press, 78

Formation, 9, 50, 61

on cylinder machines, 83

Formers, 2, 73

cylinder, 50, 64

gap, 51, 66

hybrid, 66

top-wire, 52, 66

twin-wire, 13, 65

Forming, 51

multi-ply fourdrinier, 63

Forming board, 51

Forming fabric, 64

Forming roll, 51

on twin-wire machine, 65

Forming section, 9, 13, 64

Forming wire, 11, 12, 13, 52, 64

Fourdrinier, 2, 13, 51, 64

Fourdriniers

multiple, 64

Free-drainage zone, 51, 66

Free-jet applicator, 119

Functional additives, 35, 36

Functional coating, 101

Furnish, 2, 21

G

Gap formers, 51, 66

Gate-roll coaters, 116

Gate-roll size press, 94

GCC. See Ground Calcium Carbonate

Gloss, 73, 99, 105

increased by plastic pigments, 108

with pigmented coating, 101

Gravure, 99

Ground calcium carbonate, 107

H

Hard-nip calendering, 73

Hardwood, 2, 7

Headbox, 3, 9, 11, 51, 54

air-padded, 11, 56

Hydraulic, 11, 51, 56

rectifier-roll, 51, 56

secondary, 64

stratified, 52, 63

Headbox manifold, 3, 11

Heat recovery system*in dryer hood, 85***High-density chest, 21, 23****High-density tower, 5****High-molecular-weight polymers, 44****Holdout, 91, 99, 102***with pigmented coating, 101***Hood***containment, 85**dryer, 85***Hybrid formers, 66****Hydration, 21****Hydraulic headbox, 11, 51, 56****Hydraulic manifold, 55****Hydrophilic, 62, 73, 83**

I

Index of refraction*with titanium dioxide, 107***Infrared dryers, 123****Ink receptivity, 104****Insolubilizers, 112****Integrated mill, 5, 23****Internal sizing, 92**

J

Jet, 51, 61**Jordan refiners, 25****Jumbo roll, 16**

K

Kaolin clay, 91, 99, 106**Kilonewtons per meter, 78****Kraft pulp, 21**

L

Latex, 113*acetate acrylic, 111**acrylic, 111**polyvinyl acetate, 110**styrene-acrylate, 111**styrene-butadiene, 110***Limestone, 106****Linerboard***white, pigmented, 95***Loadings***press, 77***Long-chain polymers, 41, 43****Low-angle jet coaters, 119****Low-density chest, 21, 23****Lubricants, 112**

M

Machine chest, 8, 21, 27**Machine clothing, 51****Machine direction (MD), 61****Maintenance shutdowns, 17**

Manifold

- headbox, 3*
- hydraulic, 55*
- tapered, 54*

Metering elements, 119

- in coating, 117*

Metering size press, 15, 86, 91, 94, 99, 117

Microbiocides, 113

Migration of binder, 122

Morphology, pigment, 105

Mottle

- reduced with pigmented coating, 101*

Multiple fourdriniers, 64

Multi-ply cylinder machine, 64

Multi-ply fourdrinier forming, 63

N

Nip, 73

- calender, 86*
- coating applicator roll, 118*
- in shoe press, 79*
- in size press, 15*
- press, 14, 77, 78*
- size press, 93*
- time in press, 78*

Nip rejection, 93

Nonintegrated mill, 5, 23

Nonuniformity

- base paper surface, 103*

O

Octopus. See Hydraulic Manifold

Office papers

- surface-sized, 95*

Offset pond, 94

Offset printing, 91, 99

Opacity, 35, 38, 91, 99, 104

- with titanium dioxide, 107*

Optical brighteners, 113

P

Packaging papers

- surface-sized, 95*

PAM. See Polyacrylamide

Paper machine, 48

- flow diagram of, 44*
- invention of, 53*

Parent roll, 16, 73, 87

PCC. See Precipitated Calcium Carbonate

Ph, 36, 113

Phosphates

- as dispersants, 112*

Pickup, 100

- of starch in size press, 63*

Pickup, size or coating, 91

Pickup, sizing, 93

Pigment coating, 101

Pigment formulations, 105

Pigments, 36, 41, 46, 100, 101, 104, 113

Plastic, 108

Pitch, 45, 46

Plastic pigments, 108

Plies

in multi-ply product, 63

Polyacrylamide, 43

Polyethylene emulsion, 112

Polymers, 35

cationic, 106

high-molecular-weight, 44

long-chain, 41, 43

short-chain, as dispersants, 112

soy protein, 110, 114

synthetic, as plastic pigments, 108

Polystyrene, 108

Polyurethane blanket

in shoe press, 79

Polyvinyl acetate, 105

Polyvinyl acetate latex, 110

Polyvinyl alcohol, 110

Pond turbulence, 93

Post-metering coaters, 117, 118

Pounds per linear inch, 78

Precipitated calcium carbonate, 35, 37, 106,

107

Preservatives, 113

Press

roll, 74

shoe, 74, 7

straight-through, 80, 81

tri-nip, 81

Press fabrics, 14, 73, 82

Press felts, 14, 76, 82

Press forces, 78

Press loadings, 77

Press nip, 14, 77

Press section, 14

Press section configurations, 80

Pressing, 3, 74, 76

Pressure attenuator, 51, 57

Pressure screens, 3, 10, 11, 51

Print quality

improved with pigment coating, 101

Process additives, 35, 36, 42

Protein binders, 109

Pulp, 3, 5

virgin, 4

Pulper, 3, 5, 21, 23

batch, 20, 23

continuous, 20, 23, 24

R

Recipe

coating, 114

Recirculation rate

coating, 114

Rectifier rolls, 11

Rectifier-roll headbox, 51, 56

Reel, 3, 16, 74, 87

Refiner plates, 25

Refiners

- conical, 20, 25*
- disk, 20, 25*
- Jordan, 25*
- refining, 3, 7, 21, 24*

Repulper. See Pulper

- for broke, 30*

Repulping, 5

Retention, 35

- first-pass, 44*
- of fillers, 37*

Retention aids, 35, 42, 43

- functioning of, 45*

Rewetting, 74, 76

Rewinding, 17

Rheology modifiers, 112

Rods, as metering elements, 120

Roll press, 74

Rosette, 37

Rosin size, 35

S

Savealls, 21, 31

SBR. See Styrene-Butadiene Latex

Screen baskets, 10, 26

Screening, 10, 21

- before headbox, 30*

Screens

- Pressure, 3, 10, 51*

Secondary headbox, 64

Separator, 74

Sheet consistency, 74

Sheet uniformity

- at headbox, 57*

Shoe press, 74, 7

Shoe-nip calendering, 74

Short-chain polymers

- as dispersants, 112*

Short-dwell coater, 118

Silo, 21

Single-tier dryers, 74, 84

Siphon, 15, 75, 83

Size

- rosin, 35*

Size press, 3, 15, 74, 85, 91, 92, 100, 115

- gate-roll, 94*

- metering, 15, 86, 91, 94, 99, 117*

Size press coatings, 116

Size press configurations, 62, 93

Sizing, 35, 36, 40, 62, 91, 100

- and defoamer, 44*

- internal, 92*

Surface, 92

- tub, 92*

Sizing agents, 45, 46

Slice, 3, 11, 51, 57

Slice adjustment rods, 57

Slice screw adjusters, 11

Slimicides, 35, 42, 45, 46

Slitters, 3, 74, 84

Slot Size*for screening, 26***Slurry, 6, 24****Slusher. See Pulper****Smoothness***improved with coating, 102**of coated sheet, 104***Sodium hydroxide, 113****Sodium polyacrylates***as dispersant, 112***Soft-nip calenders, 16, 74****Softwood, 3, 7****Solids, percent, 91, 100***of sizing, 93***Soy protein, 105***as binder, 109***Soy protein polymers, 110, 114****Spool, 16****Starch, 15, 41, 85, 92, 105, 109, 113***cationic, 34, 43***Steam pressure***in dryers, 83***Stickies, 35, 42, 45****Stock, 51****Stock activity, 52, 65****Stock approach system, 23****Stock blending, 25****Stock prep, 3, 6, 22, 23, 52****Stock preparation. See Stock prep****Straight-through press, 80, 81****Stratified headbox, 52, 62****Stuffbox, 4, 9, 22, 28****Styrene acrylic, 108****Styrene-acrylate latex, 111****Styrene-butadiene latex, 105, 110****Supercalendering, 74****Surface contour, affected by coating, 121****Surface sizing, 15, 92****Surface-driven winder, 87****Surface-pigmented newsprint, 95****Synthetic polymers, 108****T**

Talc, 35, 45, 46**Tapered manifold, 52, 54****Thick stock screening, 26****Thick stock system, 4, 6, 7, 22, 23****Thickness***coating layer, 102***Thin stock system, 4, 6, 9, 22, 23****Tint, 41****TiO₂. See Titanium Dioxide****Titanium dioxide, 35, 39, 100, 104, 107****Top-wire formers, 52, 66****Transfer-roll coaters, 116****Transmitters***consistency, 25***Tri-nip press, 81****Tub sizing, 92****Turnup, 4, 16, 87**

Twin-wire formers, 4, 13, 83

Two-drum winder, 87

Two-sidedness, 65

Two-tier dryers, 75, 83

U

Uhle box, 4, 14

V

Vacuum

in foil units, 61

Vacuum foil boxes, 62

Vacuum foils, 52

Variable-speed stock pump, 9, 26, 28

Vinyl acrylic copolymers, 105

Virgin pulp, 4

Viscosity, 91, 100

W

Water removal

cost, pressing vs. drying, 80

Water vapor

removal from dryers, 84

Wet-end, 4, 52, 53, 75, 91, 100

Wet strength, 41

Wet-end additives, 45

Wet-end chemistry, 36

Wet-strength agents, 36

White water, 9, 22, 31, 91, 100

used in pulpers, 24

Winder, 17, 75

surface-driven, 87

two-drum, 87

Wire, 11, 12, 13, 52, 64