Contents

Foreword Authors Abbreviatio	xi xiii nsxv						
Chapter 1	Introduction1						
	Acknowledgments						
Chapter 2	From Wood to Paper: A General View of the Papermaking Process						
	2.1 From the Papyrus Era to Modern Times: A Brief History of Making Paper						
	 2.3 Paper Structure and Composition						
	2.5Synthetic Polymers: Everywhere in Papermaking Process						
	2.6 Paper Testing: A Difficult Task 35 References 39						
Chapter 3	The Fate of Paper Chemicals at the Wet End						
	3.1 Friends and Foes at the Wet End 51 3.2 Polymers in Heterogeneous Systems 53 3.2.1 Polyelectrolyte Interactions in a Continuous Phase 55 3.2.2 Polyelectrolyte Adsorption at an Interface 56 3.2.3 The Polymer Retention Mechanism 58 3.2.4 Polymer Particles Retained on Cellulose Fibers 61 3.2.5 Colloidal Titration 62						
	3.3 Retention Aids 63 3.3.1 Electrophoretic Mobility 64 3.3.2 Fiber Flocculation Mechanisms 65 3.3.3 Paper Chemicals as Retention Aids 67 3.3.1 Nonionic Flocculants 68 3.3.2 Aluminum Compounds as Retention Aids 70 3.3.3 Anionic Retention Aids 71						

			3.3.3.4	Cationic Polymers as Retention Aids	72		
	ЪĆ		3.3.3.5	Amphoteric Retention Aids	78		
	Refe	rences	••••••		85		
Chapter 4	Temporary Wet-Strength Resins						
	4.1 A Look at the Paper Wet-Strength Concept						
	4.2	The S	ynthesis of	Temporary Wet-Strength Resins: General Chemistry	100		
		4.2.1	Strong E	Bonds and Weak Bonds in Organic Chemistry	100		
		4.2.2	The Bac	kbone Structure for Carriers of Aldehyde Groups	104		
			4.2.2.1	Backbone with Aldehyde Functionality Bonded			
				through Strong Bonds	105		
			4.2.2.2	Carriers of Aldehyde Group through a Weaker Bond			
				(Hemiacetal or Amidol)	111		
	4.3	The Sy	ynthesis of	Polyacrylamide	113		
		4.3.1	Cationic	Polyacrylamide through Free Radical			
			Copolyr	nerization	113		
		4.3.2	Acrylam	ide Copolymers with a "Diluter"	118		
		4.3.3	Polyacry	lamide Molecular Weight	120		
		4.3.4	Polymer	Blends as TWSR	120		
	4.4	Polyal	dehyde Co	polymers from Polyacrylamide	121		
		4.4.1	Glyoxala	ation of Polyacrylamide	121		
		4.4.2	The Gly	oxalated Polyacrylamide Stability	125		
	4.5 Paper Wet Strength and Its Decay						
	Refe	References					
Chapter 5	Wet-Strength Resins						
	5.1	Prepol	ymer Synt	hesis	139		
		5.1.1	Prepoly	ners with a Hetero-Atom in the Backbone	139		
			5.1.1.1	Urea-Formaldehyde Resins	139		
			5.1.1.2	Melamine-Formaldehyde Resins	141		
			5.1.1.3	Polyamines and Polyethylene Imines	142		
			5.1.1.4	Polyamidoamine	146		
			5.1.1.5	Polyamidoamine Esters	151		
			5.1.1.6	Polysaccharides	152		
			5.1.1.7	Polyisocyanates	155		
			5.1.1.8	Polycarboxylic Acids	161		
			5.1.1.9	Polyethers	163		
		5.1.2	Backbon	e with Carbon–Carbon Bonds Only	164		
			5.1.2.1	Homopolymers as Wet-Strength Resins	164		
			5.1.2.2	Copolymers as Wet-Strength Resins	168		
		5.1.3	Polymer	-Analogous Reactions	171		
		5.1.4	Polymer	Latexes	176		
	5.2	Ionic C	Charge Ad	dition	178		
		5.2.1	Anionic	Groups	179		
		5.2.2	Cationic	Groups	179		
		5.2.3	PAE Res	ins Synthesis: The Epichlorohydrin Ability to Add			
			Cationic	Charges	182		
		5.2.4	The Svn	thesis of PAE-Type Resin without Epichlorohydrin as			
			Raw Ma	terial	184		

5.3	Polyar	midoamine Epichlorohydrin Polymers as Wet-Strength Resins	185
	5.3.1	Chemical Structure of PAE Resins	186
	5.3.2	Molecular Weight	187
	5.3.3	Resin Stability and Shelf Life	189
	5.3.4	By-Products (DCP and CPD) and How to Lower Their	
		Concentration	193
		5.3.4.1 WSR with Low AOX by Adjusting the Synthesis	
		Parameters	194
		5.3.4.2 The Reduction of the Concentration of DCP and CF	νD
		by Their Hydrolysis	195
		5.3.4.3 Producing WSR with Reduced AOX via Physical	
		Processes	196
		5.3.4.4 Epichlorohydrin-Free Resins as Paper	
		Wet-Strengthening Agents	196
5.4	WSR I	Made from Blends	197
	5.4.1	Blends of Resins with Similar Chemistry and No Synergetic	
		Effect	197
	5.4.2	Synergetic Effects Provided by Blends of Resins with	
		Different Chemistries	198
5.5	Paper	Wet-Strengthening Mechanisms	201
	5.5.1	The Strength of Wet and Dry Paper	201
	5.5.2	WSR Retention Mechanism	
	5.5.3	Diverging Views on the Wet-Strength Mechanism	
		5.5.3.1 Are Cellulose Fibers Involved in New Covalent Bor	ıd
		Formation?	210
		5.5.3.2 To What Extent Does Hydrogen Bonding Explain th	ne
		Paper Wet Strength?	214
		5.5.3.3 What Would a Protective Mechanism Look Like?	216
5.6	Paper	Repulpability	219
	5.6.1	Fighting the Chemicals that Yield Permanent Wet Strength	220
	5.6.2	The Repulping Mechanism	221
	5.6.3	Repulpable Paper	
	5.6.4	Improved Recycled Fibers	
Refe	rences		224

Chapter 6	Dry-Strength Resins			
	6.1	Involve	ement of Chemicals in the Dry Strength Mechanism of Paper	241
	6.2	Anioni	c Dry-Strength Additives	245
	6.3	Cation	Cationic Dry-Strength Additives	
		6.3.1	Cationic Starch as a Dry-Strength Additive	248
		6.3.2	Cationic Polyvinyl Alcohol as Dry-Strength Additive	250
		6.3.3	Cationic Polyacrylamide as a Dry-Strength Resin	251
		6.3.4	Blends of Cationic Resins as Dry-Strength Additives	252
		6.3.5	Polyamine	
		6.3.6	Cationic Latexes as Dry-Strength Additives	254
	6.4 Amphoteric Dry-Strength Resins			
	6.5	Blends	of Anionic and Cationic Resins	
	References			260

Chapter 7	Internal Sizing Agents				
	7.1	The Chemistry of Alum in the Papermaking Processes	268		
	7.2	Rosin is Back on the Cellulose Fibers	271		
		7.2.1 Exploring the Organic Chemistry of Rosin: Rosin Derivatives			
		as Sizing Agents	272		
		7.2.1.1 Reactions at Double Bonds	272		
		7.2.1.2 Reactions at Carboxyl Group	273		
		7.2.1.3 Rosin Neutralization	274		
		7.2.2 Anionic Rosin Size	274		
		7.2.3 Cationic Rosin Dispersions and Amphoteric Stabilizers	276		
		7.2.4 Rosin Sizing Mechanism	276		
		7.2.5 Technological Consequences of the Rosin Sizing Mechanism	279		
		7.2.6 Other Carboxylic Acids as Sizing Agents	280		
	7.3	Reactive Internal Size (1): Alkyl Ketene Dimer	282		
		7.3.1 AKD Synthesis	282		
		7.3.2 The Emulsification of AKD	283		
		7.3.2.1 Stabilizers for AKD Emulsion	283		
		7.3.2.2 AKD Dispersion with Higher Solids Content	285		
		7.3.2.3 AKD Emulsion Stability	286		
		7.3.3 AKD Retention	287		
		7.3.4 AKD Sizing Mechanism	289		
		7.3.4.1 Investigating the Formation of Covalent Bond			
		between AKD and Cellulose	290		
		7.3.4.2 Alternative Suggestions for an AKD Sizing			
		Mechanism	294		
	7.4	Reactive Internal Size (2): Akenyl Succinic Anhydride	297		
		7.4.1 The Synthesis of ASA-Type Compounds	298		
		7.4.2 ASA Emulsification	300		
		7.4.3 Effects of ASA Hydrolysis on Its Application	302		
		7.4.4 ASA Sizing Mechanism	304		
	7.5	Other Chemical Compounds Able to Fit the General Concept for an			
		Internal Sizing Agent.	307		
		7.5.1 Other "Potentially Reactive" Compounds as Internal Sizing			
		Additives	307		
		7.5.2 Other Nonreactive Compounds as Internal Sizing Agents	311		
	Refe	erences	316		
Chapter 8	Crep	ping Adhesives and Softeners	327		
	Q 1	Craning Adhesives	270		
	0.1 0.1	Composition of Craning Adhesives	220		
	0.2	8.2.1 Adhesives for the Vankae Dryer	220		
		0.2.1 Addresives for the failkee Dryer	330		

	8.2.1.1	Nonreactive Creping Adhesives	330
	8.2.1.2	Reactive Self-Cross-Linkable Creping Adhesives	332
	8.2.1.3	Creping Adhesives with a Cross-Linker	333
	8.2.1.4	How to Control the Cross-Linking Reaction on the	
		Yankee Dryer	336
8.2.2	Modifie	rs	337
8.2.3	Release	Aids	339

Contents

	8.3	Debon	ders/Soft	eners		
		8.3.1	Softene	rs Retention and Softening Mechanism		
		8.3.2	Paper S	oftness Evaluation		
		8.3.3	Chemic	al Structure of Softeners/Debonders		
	Refe	rences				
Chapter 9	Cher	Chemicals for the Treatment of Paper Surface				
	9.1	Surfac	e Sizing A	Agents	352	
		9.1.1	Starches	s for Size-Press Solutions		
		9.1.2	Nonread	ctive Surface Sizing Agents		
			9.1.2.1	Emulsions of Nonreactive Small Molecules		
				as Sizing Materials	358	
			9.1.2.2	Surface Size Obtained through Emulsion		
				Polymerization		
			9.1.2.3	Surface Treatment for Oil-Resistant Paper		
		9.1.3	"Reactiv	ve" Surface Sizing Agents		
			9.1.3.1	Anionic Water-Soluble Polymers		
			9.1.3.2	Dispersions of Nonreactive Sizing Agents Stabilize	d	
				with Reactive Sizing Agents	374	
			9.1.3.3	Internal Sizing Agents for Surface Treatment		
			9.1.3.4	Surface Sizing Mechanism		
		9.1.4	Effect o	f the Defoamer		
	9.2	Surfac	e Strength	n Agents		
	9.3	Porosit	ty Builder	۶		
	9.4	Polymers in Paper Coatings		er Coatings	390	
		9.4.1	Natural	and Synthetic Binders		
		9.4.2	Binder I	Migration	393	
		9.4.3	Hydropl	nobic and Cross-Linked Binders		
		9.4.4	Coating	Hydrophobicity and Its Repulpability		
		9.4.5	Coating	Surface Properties	396	
	Refer	ences		-	398	
Index					411	