

Contents

1	The polysaccharides: sources and structures	1
1.1	An overview on polysaccharides	1
1.1.1	The building units	2
1.1.2	The building linkages	6
1.1.3	Polysaccharide shapes	13
1.2	Polysaccharides: biopolymers from renewable sources	17
1.2.1	Polysaccharides from plants	17
1.2.2	Marine polysaccharides	26
1.2.3	Microbial polysaccharides	32
1.2.4	Polysaccharides from animals	44
1.3	Syntheses and modifications of polysaccharides	46
1.3.1	Chemical and enzymatic techniques	47
1.3.2	Genetic engineering and advanced methodologies	60
1.4	Secondary and tertiary structure of polysaccharides in solutions and gels	63
1.4.1	Chains in solution	63
1.4.2	Order versus disorder: the gels	83
1.4.3	Liquid crystals	94
1.4.4	Experimental techniques for the investigation of higher order structures	99
	References	118
2	Industrial applications of polysaccharides	134
2.1	Polysaccharides as specialty chemicals	134
2.1.1	Polysaccharides in foods: function versus gum used	135
2.1.2	Pharmaceutical and medical applications	138
2.1.3	Polysaccharides for biotechnology, separatory products and laboratory aids	141
2.1.4	Other fields of industrial applications	143
2.2	Rheology in industrial research	150
	References	156
3	Rheology	162
3.1	Introduction	162
3.2	Basic concepts: tensional and deformation states	164
3.2.1	Tensional state	165
3.2.2	Deformation state	168
3.3	Basic principles for constitutive equations	170

3.4	Constitutive equations and rheological characterization	172
3.5	Kinematic classification of flows	176
3.5.1	Shear flows	176
3.5.2	Elongational flows	184
3.5.3	Complex flows	188
3.6	Shear flow behavior	190
3.7	Elongational flow behavior	211
3.8	Rheological models	214
3.8.1	Generalized Newtonian fluids	216
3.8.2	Thixotropy and viscoelasticity	219
3.8.3	Linear viscoelastic models	223
3.8.4	General linear viscoelastic model	229
3.8.5	Corotational models	230
3.8.6	Molecular models	235
	References	247
4	Rheology of polysaccharide systems	250
4.1	Introduction	250
4.2	Dilute solutions	253
4.2.1	Steady shear viscosity	255
4.2.2	Normal stresses	260
4.2.3	Dynamic viscoelastic moduli	262
4.2.4	Modeling the shear dependence of η	263
4.3	Infinite dilution	267
4.3.1	Intrinsic viscosity	267
4.3.2	Determining $[\eta]$ from experimental data	269
4.3.3	Empirical correlations for $[\eta]_0$	273
4.3.4	$[\eta]_0$ and molecular models	281
4.3.5	Modeling the shear dependence of $[\eta]$	288
4.3.6	Intrinsic viscoelastic quantities	296
4.4	Temperature dependence of dilute solutions	307
4.4.1	Temperature dependence of shear viscosity	307
4.4.2	Temperature dependence of $[\eta]_0$	309
4.4.3	Temperature dependence of the viscoelastic quantities: the method of reduced variables	311
4.5	From dilute to concentrated solutions	312
4.6	Concentrated solutions	324
4.6.1	Steady shear viscosity	324
4.6.2	Normal stresses	338
4.6.3	Time-dependent properties	341
4.6.4	Dynamic properties	351
4.7	From solutions to gels	373
4.8	Gels	393
4.8.1	Dynamic properties	394
4.8.2	Transient properties	423

4.8.3	Steady flow behavior	436
4.9	Mixed gels	438
4.10	Liquid crystals	447
4.10.1	Phenomenological aspects	452
4.10.2	Models for interpretation and correlation	457
4.11	Polysaccharides in real systems	460
	References	477
5	Rheometry	495
5.1	Introduction	495
5.2	Qualitative rheometry	498
5.2.1	The falling-ball viscometer	499
5.2.2	Consistency cups (orifice viscometers)	500
5.2.3	The Brookfield viscometer	501
5.2.4	The Stormer-Krebs viscometer	502
5.2.5	Penetrometers	503
5.2.6	Viscographs and amylographs	503
5.3	Quantitative rheometry	504
5.4	Capillary rheometry	507
5.5	Sources of error in capillary rheometry	515
5.6	Rotational rheometers	522
5.6.1	Cone-and-plate viscometers	524
5.6.2	Plate-and-plate viscometers	526
5.6.3	Coaxial cylinder viscometers	528
5.7	Sources of errors in rotational rheometry	539
5.8	Dynamic tests	551
5.9	Sources of error in dynamic tests	558
5.10	Extensional rheometry	560
5.11	A brief survey of capillary and rotational instruments	570
5.11.1	Capillary viscometers	571
5.11.2	Rotational rheometers	571
	References	577
	Appendix A: review of elementary matrix, vector and tensor algebra	579
	Appendix B: derivation of the rate of deformation tensor	587
	Appendix C: the Criminale-Ericksen-Filbey (or CEF) equation	588
	Appendix D: correlation between relaxation modulus and material functions	589
	Index	591