Pre	Preface			xvii
Pa	rt 1 A	About R	ubber	1
1	Intr	oduction	I	
2	Brie	f Notes o	on Compounding Ingredients	5
	2.1	Acceler	cators	5
	2.2	Vulcani	izing Agents	6
	2.3	Activat	ors	6
	2.4	Antioxi	dants	6
	2.5	Fillers a	and Reinforcing Agents	6
	2.6	Retarde	ers	7
	2.7	Process	s Oils/Softeners	7
3	Son	e Hints	on Rubber Compounding Techniques	
4	Not	e on Rec	laimed Rubber	11
5	Rub	ber Con	tent in Products	12
6	Not	e on Col	oring of Rubbers	14
7	Tvp	ical Rub	ber Testing Methods	16
	7.1	Prelude		16
	7.2	Tests of	n Unvulcanized Rubber Stocks	17
		7.2.1	Plasticity	17
		7.2.2	Scorch Time and Rate of Cure	17
		7.2.3	Plasticity Retention Index	17
	7.3	Tests of	n Vulcanized Rubbers	17
		7.3.1	Hardness	17
		7.3.2	Tensile Test	18
		7.3.3	Resilience	19
		7.3.4	Specific Gravity	19
		7.3.5	Abrasion Resistance	19
		7.3.6	Spark Testing	19
		7.3.7	Accelerated Tests	20

		 7.3.8 Low Temperature Flexibility 7.3.9 Chemical Tests 7.3.9.1 Total Sulfur 7.3.9.2 Ash Content 7.3.9.3 Acetone Extract 7.3.9.4 Tests for Copper and Manganese 	20 21 21 21 21 21 22
Pa	rt2 F	ormulary	23
8	Thin	Coatings	25
	8.1	Introduction	25
	8.2	The Gray Coating of Hypalon	25
	8.3	The Black Coating of Neoprene	26
	8.4	Black Brushing	26
	8.5	Gray Brushing	27
9	Oil S	eals and ''0'' Rings	28
	9.1	Introduction	28
	9.2	Rotary Seal (Neoprene)—85°A	29
	9.3	"O" Ring (Neoprene)—60°A	29
	9.4	Rotary Seal (Nitrile)—60°A	30
	9.5	Rotary Seal (Nitrile)80°A	30
	9.6	Rotary Seal (Nitrile)—75°A	31
	9.7	"O" Rings (Nitrile)—65°A	31
	9.8	"O" Rings (Nitrile 1)—60°A	32
	9.9	"O" Rings (Nitrile 2)—60°A	32
	9.10	"O" Ring Compound	
		(Styrene-Butadiene Rubber, SBR)-55°A	33
	9.11	Rotary Seal (Natural Rubber)—85°A	33
	9.12	"O" Rings (Natural Rubber) for Pipe Couplings—60°A	A 34
	9.13	Rotary Seal (SBR)90°A	34
	9.14	Rotary Seal (Nitrile)75°A	35
	9.15	"O" Rings (Nitrile)60°A	35
	9.16	Rotary Seal (Blend of Nitrile/SBR)—75°A	36
	9.17	Rotary Seal (Neoprene)—85°A	36
	9.18	Rotary Seal (Neoprene)—95°A	37
	9.19	"O" Ring (Neoprene)—65°A	37
	9.20	Butyl Rubber Seal-75°A	38
	9.21	Bromobutyl Seal—70°A	38
	9.22	"O" Ring Thiokol (Polysulfide Rubber) for Airborne	
		Applications	39

		9.22.1 "O" Ring Thiokol—55°A	39
		9.22.2 'O'' Ring Thiokol—65°A	39
	9.23	Typical Nitrile Sealing Formulations for Airborne	
		Applications	40
	9.24	Rotary Seal (Hypalon)	40
		9.24.1 Rotary Seal (Hypalon)—85°A	40
		9.24.2 Rotary Seal (Hypalon)—70°A	41
	9.25	Rotary Seal (Nitrile/PVC Blend)—80°A	41
	9.26	"O" Ring (Nitrile/PVC Blend)—65°A	42
	9.27	Rotary Seal with Viton for Airborne Applications	42
	9.28	Nitrile Rubber Ebonite for Oil Resistant Products	43
10	Belting	gs — Transmission, Conveyor, and V-Belts	44
	10.1	Introduction	44
	10.2	V-Belt Inner Layer (Natural Rubber)	45
	10.3	Cord Friction Compound	45
	10.4	Latex-Based Solution for Cord Dipping	46
	10.5	Transmission Belting	46
	10.6	Conveyor Belt Cover Compound (Natural Rubber)	47
	10.7	Conveyor Belt Cover Compound (Flame Proof)	48
	10.8	Conveyor Belt Cover (Natural Rubber/SBR Blend)	49
	10.9	Oil Resistant Raw Edge V-Belt	50
11	Auto I	Rubber Components (Molded)	51
	11.1	Introduction	51
	11.2	Shock Absorber55°A	51
	11.3	Shock Absorber—65°A	52
	11.4	Shock Absorber 1—60°A	52
	11.5	Shock Absorber 2—60°A	53
	11.6	Stabilizer Bar Bush-60°A	53
	11.7	Stabilizer Bar Bush—67°A	54
	11.8	Adhesive Bonding Agent for Fabric Insertion Sheets	54
	11.9	Repair Cement for Automotive Belts	55
	11.10	Metal-Bonded Engine Mountings—45°A	55
	11.11	Tire Flaps—60°A	56
	11.12	Window Channel Extrusion for Cars (Natural Rubber)	57
	11.13	Window Channel Extrusion for Cars	
		(Styrene-Butadiene Rubber (SBR))	58
	11.14	Neoprene Dust Covers for the Auto Industry—58°A	59
	11.15	Automotive Tire Tubes—45°A	60
	11.16	Low Cost Butyl Tube	61

	11.17	Car Mat (Natural Rubber)70°A	61
	11.18	Bicvcle Tube	62
	11.19	Wind Screen Wiper for Automobiles	63
	11.20	Nitrile Rubber Gasket Molding for Automobiles	64
	11.21	Metal-Bonded Engine Mounting for	
		Automobiles — 50°A	
	11.22	Head Lamp Gasket for Automobiles	
		(Nonstaining)—55°A	
	11.23	Basic Formula for General-Purpose, Heat Resistant	
		Gasket (Natural Rubber Without Sulfur)60°A	
	11.24	Basic Formula for Oil Resistant Gasket from	
		Natural Rubber—65°A	
	11.25	General-Purpose Auto Rubber Bush	
12	Retrea	ading Rubber Compounds and Cements	68
	12.1	Introduction	68
	12.2	Tire Tread or Camel Back 1	68
	12.3	Tire Tread or Camel Back 2	69
	12.4	Tire Tread or Camel Back 3	69
	12.5	Tire Tread or Camel Back 4	70
	12.6	Tire Tread or Camel Back 5	71
	12.7	Tire Tread or Camel Back 6	72
	12.8	Under Tread Strips	72
	12.9	Cushion Gum Compound	73
	12.10	Vulcanizing Solution	73
13	Indust	trial Rubber Rollers	75
	13.1	Introduction	75
	13.2	Method	75
	13.3	Cylinder 38—Paper Mills	76
	13.4	Cylinder 44 (White)—Paper Mills	77
	13.5	Cylinder 55—Paper Mills	77
	13.6	Cylinder 65—Paper Mills	78
	13.7	Cylinder 56 (White)—Paper Mills	78
	13.8	Cylinder 75—Paper Mills	79
	13.9	Cylinder 60—Paper Mills	79
	13.10	Cylinder 80—Paper Mills	80
	13.11	Cylinder 92—Paper Mills	80
	13.12	Cylinder 96—Paper Mills	81
	13.13	Cylinder 995 — Semi-ebonite	81
	13.14	Cylinder for the Steel Industry (Natural Rubber)	82

CONTENTS

and the second second

	13.15	Cylinder A (Green) for Textile Mills	82
	13.16	Cylinder E—Textiles	83
	13.17	Cylinder G—Textiles	83
	13.18	Cylinder N55	84
	13.19	Cylinder N70	84
	13.20	Neoprene N75	85
	13.21	Cylinder N90	86
	13.22	Cylinder P72	87
	13.23	Printing Roll Nitrile Based (Oil Resistant Printing Roll)	88
	13.24	Cylinder "O" for the Textile Industry	88
	13.25	Cylinder B (Beige) for the Textile Industry	89
	13.26	Cylinder H (Green-Blue) for the Textile Industry	89
	13.27	Cylinder C (Red) for the Textile Industry	90
	13.28	Cylinder E (Yellow-Green) for the Textile Industry	90
	13.29	Cylinder F (Light Brown) for the Textile Industry	91
	13.30	Cylinder G (Light Green) for the Textile Industry	91
	13.31	Ethylene-Propylene Diene Monomer Roll for	
		15% Nitric Acid—Electroplating Service	92
	13.32	Neoprene Printing Roll-40-45°A	93
	13.33	Neoprene Hard Roll Compound (Nonblack)—85°A	94
	13.34	Hypalon Roll (Black)—85°A	95
	13.35	Hypalon Roll Compound (White)—98°A	96
	13.36	Rubber Roll for Tannery—60°A	96
	13.37	Rubber Roll for Tannery—80°A	97
14	Tank L	inings and Adhesives	98
	14.1	Introduction	98
	14.2	Rubber Lining of Digesters with Brick Lining for	
		Sulfuric Acid Conditions at 100°C	99
	14.3	Rubber Lining Drum Filters for Handling Sulfuric	
		Acid Slurry at 65°C	100
	14.4	Rubber Lining for Iron Ore Slurry (Wear Resistant)	100
	14.5	Adhesive Solution for the Abrasion/Wear Resistant	
		Lining Compound for Slurry Lines	101
	14.6	Rubber Lining for Wet Chlorine — Caustic Soda	
		Industry	101
		14.6.1 Base Laver (Semi-ebonite)	102
		14.6.2 Lining Layer (True Ebonite)	102
	14.7	Adhesive Dissolution to be Used on Cleaned Metal	
		Surfaces for Ebonite Lining	103
	14.8	Lining Formulations for Phosphoric Acid Storage	
		Tanks	

xi

CONTENTS

	14.8.1 Natural Rubber	104
	14.8.2 Neoprene Rubber	104
14.9	Cold Bond Adhesive Common for Natural, Neoprene,	
	Butyl, and Hypalon Rubber Sheets	105
14.10	Mixture of Solvents for Evaporation Makeup	105
14.11	Chlorine Resistant Compound Formulation Used in	
	Mercury Cells in the Caustic Soda Industry	106
14.12	Semi-ebonite Compound Formulation for Extrusion	
	of Profiles for Drum Filters	107
14.13	Formulation for Sulfuric Acid/Chlorine Solutions in	
	Drying Towers in the Caustic Soda Industry	108
14.14	Ebonite Based on Styrene Butadiene Rubber (SBR)	
	for Making Ebonite Distance Pieces and Internals for	
	the Chemical Industry	109
14.15	Ebonite Formulation Suitable for the Hot Water Curing	
	Method	110
14.16	Acid Resistant Strip Extrusion Compound Formulation	
	(Natural Rubber)	111
14.17	Acid and Ozone Resistant Strip Extrusion Compound	
	Formulation (Neoprene Rubber)	112
14.18	Nitric Acid Resistant Ethylene-Propylene Diene	
	Monomer (EPDM) Lining Formulation for the	
	Electroplating Industry	113
14.19	Bromobutyl Lining Formulation for the Ore/Sand	
	Beneficiation Industry	114
14.20	White Natural Rubber Compound Formula for Lining	
	of Equipments in Pigment Plants	115
14.21	White Neoprene Rubber Lining for Pigmentation	
0.175270	Plants	116
14.22	White Natural Rubber/Neoprene Blend for	10.00000000
	Pigmentation Plants	117
14.23	Chlorobutyl Adhesive Formulation for Use in Butyl	
	Lining Formulation	118
14.24	Adhesive for Patchwork in a Rubber-Lined Pipes	118
	14.24.1 Compound A	118
	14.24.2 Compound B	118
14.25	Butyl Rubber Lining for Acid Regeneration Duty	119
14.26	Flexible Cell Covers	119
	14.26.1 Ozone Resistant Neoprene Layer	120
	14.26.2 Wet Chlorine Resistant Layer	120

CONTENTS

	14.27	Butyl Rubber/EPDM Membrane for Use in Fishery	
		Tanks	121
	14.28	Low Temperature Curable Bromobutyl Lining for	
		Digesters in the Ore Industry	122
	14.29	Open Steam Curable Phosphoric Acid Resistant	
		Soft Natural Rubber Compound	123
		14.29.1 Master Batch	123
		14.29.2 Ultra Accelerator System	123
	14.30	Rubber Lining for 20% Hydrochloric Acid at 100°C	124
	14.31	Lining of Impellers in Phosphatic Fertilizer Plants	
		with Tip Velocities of 109-110 m/sec to withstand	
		Dust and Fumes of Phosphoric Acid	125
	14.32	Low Water Absorption Neoprene Lining Formulation	
		for Chlor-Alkali Plants	125
	14.33	Butyl Lining for Digester (Without Mineral Fillers)	126
	14.34	Lining for Road Tankers for 80% Phosphoric Acid	
		or 32% Hydrochloric Acid	127
15	Groov	ed Rubber Pads for Railways	128
	15.1	Introduction	128
16	Paddy	Dehusking Rolls	129
	161	Formulation Based on Natural Rubber	129
	10.1		14/
	16.2	Formulation Based on Carboxylated Nitrile Rubber	130
17	16.1 16.2 Footw	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components	12) 130 131
17	16.2 Footw 17.1	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear	12) 130 131 131
17	16.1 16.2 Footw 17.1 17.2	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear Black Heel for Footwear	12) 130 131 131 132
17	10.1 16.2 Footw 17.1 17.2 17.3	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear Black Heel for Footwear Brown Soling for Footwear	130 130 131 131 132 133
17	Footw 17.1 17.2 17.3 17.4	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear Black Heel for Footwear Brown Soling for Footwear Sponge with High Styrene Nitrile Rubber for Soling	130 130 131 131 132 133 134
17	Footw 17.1 17.2 17.3 17.4 17.5	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear Black Heel for Footwear Brown Soling for Footwear Sponge with High Styrene Nitrile Rubber for Soling Sponge Rubber Soling for Footwear (Natural Rubber)	129 130 131 131 132 133 134 134
17	Io.1 16.2 Footw 17.1 17.2 17.3 17.4 17.5 17.6	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear Black Heel for Footwear Brown Soling for Footwear Sponge with High Styrene Nitrile Rubber for Soling Sponge Rubber Soling for Footwear (Natural Rubber) Rubber Strap for Microcellular/Sponge Soling	129 130 131 131 132 133 134 134
17	10.1 16.2 Footw 17.1 17.2 17.3 17.4 17.5 17.6 Hoses	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear Black Heel for Footwear Brown Soling for Footwear Sponge with High Styrene Nitrile Rubber for Soling Sponge Rubber Soling for Footwear (Natural Rubber) Rubber Strap for Microcellular/Sponge Soling	129 130 131 131 132 133 134 134 134 135 136
17 18	10.1 16.2 Footw 17.1 17.2 17.3 17.4 17.5 17.6 Hoses 18.1	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear Black Heel for Footwear Brown Soling for Footwear Sponge with High Styrene Nitrile Rubber for Soling Sponge Rubber Soling for Footwear (Natural Rubber) Rubber Strap for Microcellular/Sponge Soling	129 130 131 131 132 133 134 134 135 136 136
17 18	10.1 16.2 Footw 17.1 17.2 17.3 17.4 17.5 17.6 Hoses 18.1 18.2	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear Black Heel for Footwear Brown Soling for Footwear Sponge with High Styrene Nitrile Rubber for Soling Sponge Rubber Soling for Footwear (Natural Rubber) Rubber Strap for Microcellular/Sponge Soling Introduction Nitrile Rubber Hose Outer	129 130 131 131 132 133 134 134 135 136 136 136
17 18	10.1 16.2 Footw 17.1 17.2 17.3 17.4 17.5 17.6 Hoses 18.1 18.2 18.3	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear Black Heel for Footwear Brown Soling for Footwear Sponge with High Styrene Nitrile Rubber for Soling Sponge Rubber Soling for Footwear (Natural Rubber) Rubber Strap for Microcellular/Sponge Soling Introduction Nitrile Rubber Hose Outer Nitrile Rubber Hose Inner	129 130 131 131 132 133 134 134 135 136 136 136 136
17 18 19	10.1 16.2 Footw 17.1 17.2 17.3 17.4 17.5 17.6 Hoses 18.1 18.2 18.3 Typica	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear Black Heel for Footwear Brown Soling for Footwear Sponge with High Styrene Nitrile Rubber for Soling Sponge Rubber Soling for Footwear (Natural Rubber) Rubber Strap for Microcellular/Sponge Soling Introduction Nitrile Rubber Hose Outer Nitrile Rubber Hose Inner al Ebonite Formulations	129 130 131 131 132 133 134 134 134 135 136 136 136 136 137 138
17 18 19	10.1 16.2 Footw 17.1 17.2 17.3 17.4 17.5 17.6 Hoses 18.1 18.2 18.3 Typica 19.1	Formulation Based on Carboxylated Nitrile Rubber ear Rubber Components Solid Rubber Soling for Footwear Black Heel for Footwear Brown Soling for Footwear Sponge with High Styrene Nitrile Rubber for Soling Sponge Rubber Soling for Footwear (Natural Rubber) Rubber Strap for Microcellular/Sponge Soling Introduction Nitrile Rubber Hose Outer Nitrile Rubber Hose Inner Al Ebonite Formulations Introduction	129 130 131 131 132 133 134 134 135 136 136 136 137 138 138

CONTENTS

20	Table Mats			
21	Rubber Erasers21.1Introduction21.2Pencil Eraser — Alternate I21.3Pencil Eraser — Alternate II21.4Ink Eraser — Alternate I21.5Ink Eraser — Alternate II21.6Eraser for Typewriter	141 141 142 142 143 144		
22	Natural Rubber (NR) Study Formulations — Factory Trials	145		
23	White Rubber Tiles	146		
24	Factory Trials of Neoprene Moldables 24.1 Introduction	147 147		
25	 Proofing Compounds for Clothing and Inflatables 25.1 Introduction 25.2 Frictioning Compound 25.3 Topping Compound 	149 149 149 149		
26	 Wear Resistant Rubber for the Mining Industry 26.1 Introduction 26.2 Typical Slurry Handling Compound40°A 26.3 Typical Chute and Launder Lining Compound—60°A 	150 150 151 151		
27	Neoprene Molded Corks 27.1 Introduction	152 152		
28	Low-Cost Chemical Resistant Canvass Reinforced Neoprene Rubber Sheets	153		
29	Battery Box	154		
30	Neoprene Washer for Water Taps	155		
31	Neoprene Inner Layer for Isocyanate Bonded Components			

Con	NTENTS			XV
32	Rubb	er Bond	ed Anvil for the Electronics Industry	157
33	Solid	Tires for	· Forklift Trucks	158
	33.1	Introduc	tion	158
34	Phar	maceutic	cal Bottle Closures	159
	34.1	Introduc	tion	159
Ap	pendic	es		161
Ap	pendix	1: Score	hing of Rubber — A Study Formula	163
Ap	pendix	2: Specif	fic Gravity and Volume Cost	164
Ap	pendix	3: Equiv	valent Chemical Names for Trade Names	165
Ap	pendix	4: Usefu	l Conversion Tables	169
	A4.1	Tensile S	Strength and Modulus	
		Convers	ions (Force/Area)	169
		A4.1.1	Tear Strength Conversions (Force/Width)	170
	A4.2	Tempera	ature Conversions	171
		A4.2.1	Celsius to Fahrenheit	171
		A4.2.2	Fahrenheit to Celsius	172
	A4.3	Other C	onversion Tables	173
		A4.3.1	Metric Weight Measures	173
		A4.3.2	Pounds to Kilograms	173
		A4.3.3	Ounces to Kilograms	174
		A4.3.4	Inches to Millimeters	174
		A4.3.5	Fractions to Decimals	175
Bib	liograp	hy		177