CONTENTS

		Page
Intro	xv	
1.	Base oils from petroleum	1
1.	1.1 Introduction	1
	1.2 Base oil Composition	2
	1.3 Products and specifications	6
	1.4 Conventional base oil manufacturing methods	13
	1.5 Modern catalytic processes	25
	1.6 Future developments	30
	References	31
2.	Synthetic base fluids	32
	2.1 Introduction	32
	2.2 Polyalphaolefins	33
	2.3 Alkylated aromatics	37
	2.4 Polybutenes	39
	2.5 Synthetic esters	40
	2.6 Polyalkylene glycols	51
	2.7 Phosphate esters	58
	References	60
3.	Detergents/ dispersants	62
	3.1 Introduction	62
	3.2 Detergents	63
	3.3 Dispersants	72
	3.4 Other lubricants	77
	3.5 Performance evaluation	78
	References	80
	Further reading	80
4.	Oxidative degradation and stabilisation of mineral oil based lubricants	83
	4.1 Introduction	83
	4.2 Autoxidation of hydrocarbons	83
	4.3 Oxidation stability of base oils	93
	4.4 Inhibition of oxidative degradation of lubricants	94
	4.5 Application of antioxidants	109
	4.6 Future antioxidant technology	120
	Acknowledgements References	121 122
5.	Viscosity index improvers and thickeners	124
	5.1 Introduction	124
	5.2 Overview of VI improver Chemistry	125
	5.3 Chemistry and manufacture of commercial VI improvers	126
	5.4 Function and properties	135
	5.5 Performance	149
	5.6 prognosis for future developments	155
	References	156
6.	Miscellaneous additives	160
	6.1 Friction modifiers	160

	6.2	Pour point depressants	165
	6.3	Demulsifiers and antifoams	168
	6.4	Corrosion inhibitors	170
	Refere	ences	173
7.	The fo	174	
	7.1	Introduction	174
	7.2	What type of lubricant is wanted?	174
	7.3	Why there are so many types of lubricant	175
	7.4	Multifunctional lubricants	176
	7.5	Definition of lubricant performance	178
	7.6	Lubricant formulation – the physical phase	186
8.	Indust	196	
	8.1	Introduction	196
	8.2	Bearing lubricants	198
	8.3	Compressor lubricants	205
	8.4	Hydraulic lubricants (fluids)	208
	8.5	Industrial gear lubricants	211
	8.6	Turbine lubricants	212
	8.7	Metalworking lubricants	213
	8.8	Specialities	220
	Refere	ences	221
9.	Aviati	ion lubricants	223
	9.1	Introduction	223
	9.2	Lubrication of rotary engines	224
	9.3	Lubrication of conventional aircraft piston engines	225
	9.4	Lubrication of aircraft turbine engines	227
	9.5	Aircraft hydraulic fluids	231
	9.6	Helicopter gearboxes	232
	9.7	Undercarriage lubrication	233
	9.8	Airframe lubrication	233
	9.9	Safety aspects of aircraft lubrication	234
	9.10	Space lubrications	235
	Refere	ences	236
10.	Marin	ne lubricants	237
	10.1	Introduction	237
	10.2	Marine diesel engines	237
	10.3	Fuel oil	240
	10.4	Base oils	243
	10.5	Additives	243
	10.6	Properties and formulation of marine lubricants	245
	10.7	System oils	246
	10.8	Cylinder oils	247
	10.9	Trunk piston engine oils	251
		Used oil analysis	251
	Refere	ences	253
11.		cating grease	255
	11.1	Introduction	255
	11.2	Structure and Properties	256
	11.3	chemistry	259
	11.4	Applications	265
	11.5	Future developments	266
	11.6	Conclusions	267 267
	References		

12.	Extreme-pressure and anti-wear additives		269
	12.1	Introduction	269
	12.2	Anti-wear additives	272
	12.3	Extreme –pressure additives	274
	12.4	Mechanisms of action of anti-wear and EP additives	277
	12.5	Application of different classes of additive	279
	12.6	Future developments	280
	References		281
13.	Lubricants and their environmental impact		282
	13.1	Introduction	282
	13.2	Collection of waste lubricant	283
	13.3	Treatment of collected lubricant	284
	13.4	Re-refined base oil quality	286
	13.5	Health and safety aspects of re-refined base oils	287
	13.6	Environmental considerations of waste lubricant	289
	13.7	Environmental impact of 'consumed' lubricant	291
	13.8	Biodegradation tests for oils	292
	13.9	Future trends	297
	References		298
	Furthe	298	
Index			299