

Contents

Preface	xi
Authors	xiii
Acknowledgements	xvii
Symbols and Abbreviations	xix
Table of Chemical Elements	xxiii
Units Conversion Table	xxv
General References	xxix
1 Petroleum, Oil Shale and Natural Asphalts	1
1.1 Petroleum 1 - 1.2 Oil shale 23 - 1.3 Tar sands (Bituminous or oil sands) 29 - 1.4 Natural asphalts 32 - 1.5 Literature 35	
2 Petroleum Refinery Processes and Petroleum Products	37
2.1 Introduction 37 - 2.2 Petroleum fractionation (distillation) 38 - 2.3 Conversion of petroleum fractions 44 - 2.4 Purification of petroleum fractions 55 - 2.5 Extraction of components and blending techniques 60 - 2.6 Gases 60 - 2.7 Motor fuels 61 - 2.8 Heating and illuminating oils 65 - 2.9 Lubricants 67 - 2.10 Other oils 71 - 2.11 Petroleum waxes and petroleum asphalts 73 - 2.12 Oil wastes 74 - 2.13 Petroleum products for petrochemicals 74 - 2.14 Synthetic petroleum products 76 - 2.15 Statistics 76	
3 Tar and Pitch	79
3.1 Definition and sources of tar 79 - 3.2 Composition and properties 82 - 3.3 Primary distillation of coal tar 84 - 3.4 Tar products 87 - 3.5 Statistics 102 - 3.6 Literature 105	
4 Natural Gas	107
4.1 Definition and history 107 - 4.2 Origin and occurrence of natural gas 108 - 4.3 Other sources of natural gas 109 - 4.4 Discovery and development of natural gas fields 110 - 4.5 Transmission, distribution and storage of natural gas 115 - 4.6 Combustion of natural gas 118 - 4.7 Present and future uses of natural gas 119 - 4.8 World production of natural gas 121 - 4.9 Literature 122	

5	Hydrocarbons	123
	5.1 Introduction 123 - 5.2 Saturated aliphatic hydrocarbons 134 - 5.3 Ethylene $\text{CH}_2=\text{CH}_2$ 140 - 5.4 Other mono-olefins 144 - 5.5 Buta-1,-3-diene $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$ 149 - 5.6 Isoprene $\text{CH}_2=\text{C}(\text{CH}_3)-\text{CH}=\text{CH}_2$ 153 - 5.7 Acetylene $\text{HC}=\text{CH}$ 155 - 5.8 Alicyclic hydrocarbons 159 - 5.9 Benzene 164 - 5.10 Toluene 169 - 5.11 Xylenes and other saturated alkylbenzenes 172 - 5.12 Styrene $\text{C}_6\text{H}_5\text{CH}=\text{CH}_2$ 178 - 5.13 Diphenyl $\text{C}_6\text{H}_5-\text{C}_6\text{H}_5$ and terphenyls, $\text{C}_6\text{H}_5-\text{C}_6\text{H}_4-\text{C}_6\text{H}_5$ 181 - 5.14 Polynuclear hydrocarbons 182 - 5.15 Literature 189	
6	Chlorinated Hydrocarbons	191
	6.1 Introduction 191 - 6.2 Chlorine derivatives of saturated aliphatic hydrocarbons 198 - 6.3 Vinyl chloride, $\text{CHCl}=\text{CH}_2$ 205 - 6.4 Other chlorine derivatives of unsaturated aliphatic hydrocarbons 207 - 6.5 Hexachlorocyclohexane $\text{C}_6\text{H}_6\text{Cl}_6$ (BHC, Benzene hexachloride) 212 - 6.6 Chlorinated derivatives of aromatic hydrocarbons 213 - 6.7 Statistics 218 - 6.8 Literature 221	
7	Organic Fluorine, Bromine and Iodine Compounds	223
	7.1 Introduction 223 - 7.2 Organic fluorine compounds 223 - 7.3 Organic bromine compounds 254 - 7.4 Organic iodine compounds 261 - 7.5 Literature 263	
8	Alcohols and Phenols	265
	8.1 Introduction 265 - 8.2 Methanol CH_3OH 273 - 8.3 Ethanol $\text{CH}_3\text{CH}_2\text{OH}$ 276 - 8.4 Other monohydric aliphatic alcohols 280 - 8.5 Polyhydric aliphatic alcohols 292 - 8.6 Alicyclic and araliphatic alcohols 303 - 8.7 Phenol 305 - 8.8 Cresols and Naphthols 310 - 8.9 Literature 326	
9	Ethers and Oxides	329
	9.1 Introduction 329 - 9.2 Diethyl ether $\text{C}_2\text{H}_5-\text{O}-\text{C}_2\text{H}_5$ 333 - 9.3 Other dialkyl ethers 333 - 9.4 Polyalkylene glycols 336 - 9.5 Aromatic ethers 340 - 9.6 Ethylene oxide 342 - 9.7 Other cyclic ethers 345 - 9.8 Literature 352	
10	Aldehydes and Acetals	353
	10.1 Aldehydes 353 - 10.2 Formaldehyde: $\text{H}-\text{CH}=\text{O}$ 358 - 10.3 Acetaldehyde: $\text{CH}_3-\text{CH}=\text{O}$ 359 - 10.4 Other aldehydes 361 - 10.5 Acetals 370 - 10.6 Statistics 374 - 10.7 Literature 375	
11	Ketones, Ketens and Quinones	377
	11.1 Introduction 377 - 11.2 Ketones 377 - 11.3 Ketens 395 - 11.4 Quinones 401 - 11.5 Literature 413	
12	Carboxylic Acids and Their Salts	415
	12.1 Introduction 415 - 12.2 Formic acid $\text{H}-\text{COOH}$ 420 - 12.3 Acetic acid CH_3-COOH 422 - 12.4 Other aliphatic monocarboxylic acids 425 - 12.5 Aliphatic dicarboxylic acids 430 - 12.6 Hydroxycarboxylic acids and lactones 438 - 12.7 Aromatic carboxylic acids 445 - 12.8 Literature 457	
13	Carboxylic Acid Anhydrides and Halides, Organic Peroxides and Peracids	459
	13.1 Carboxylic acid anhydrides 459 - 13.2 Acid halides 471 - 13.3 Organic peroxides and peracids 476 - 13.4 Literature 482	
14	Esters	485
	14.1 Introduction 485 - 14.2 Esters of aliphatic monocarboxylic acids 490 - 14.3 Esters of aliphatic dicarboxylic acids 495 - 14.4 Esters of oxycarboxylic acids 497 - 14.5 Esters of aromatic carboxylic acids 499 - 14.6 Esters of mineral acids 503 - 14.7 Statistics 505 - 14.8 Literature 506	

15	Organic Nitrogen Compounds	507
	15.1 Introduction 507 - 15.2 Aliphatic amines and their salts 508 - 15.3 Aniline and anilinium chloride (Aniline hydrochloride) 517 - 15.4 Other aromatic amines 518 - 15.5 Carboxylic acid amides, imides and lactams 523 - 15.6 Imines 531 - 15.7 Nitriles and isocyanides 532 - 15.8 Organic isocyanates 542 - 15.9 Urethans 544 - 15.10 Aliphatic nitro compounds 546 - 15.11 Aromatic nitro and nitroso compounds 549 - 15.12 Heterocyclic compounds containing one or more nitrogen atoms in the ring 556 - 15.13 Statistics 563 - 15.14 Literature 567	
16	Organic Sulphur Compounds	569
	16.1 Introduction 569 - 16.2 Mercaptans (Thiols) 572 - 16.3 Sulphides (Thioethers) and disulphides 582 - 16.4 Sulphones and sulphoxides 584 - 16.5 Sulphonic acids of benzene and substituted benzenes 587 - 16.6 Sulphonic acids of naphthalene and substituted naphthalenes 595 - 16.7 Anthraquinonesulphonic acids 608 - 16.8 Sulphonyl chlorides and sulphonamides 611 - 16.9 Thiocyanates and isothiocyanates 616 - 16.10 Dithiocarbamates and related compounds 618 - 16.11 Heterocyclic sulphur compounds 623 - 16.12 Literature 627	
17	Organometallic Compounds	629
	17.1 Introduction 629 - 17.2 Historical background: applications of organometallic compounds 629 - 17.3 Properties of organometallic compounds 630 - 17.4 Organo derivatives of the alkali metals 634 - 17.5 Organo derivatives of the group II elements 637 - 17.6 Organo derivatives of group III elements 642 - 17.7 Organo derivatives of group IV elements 646 - 17.8 Organo derivatives of group V elements 654 - 17.9 Organo derivatives of transition metals 655 - 17.10 Literature 658	
18	Organic Dyes	661
	18.1 Introduction 661 - 18.2 The colouration process 669 - 18.3 Azo dyes 677 - 18.4 Anthraquinone dyes 689 - 18.5 Indigoid and thioindigoid dyes 695 - 18.6 Triarylmethane dyes 698 - 18.7 Miscellaneous dyes 700 - 18.8 Reactive dyes 703 - 18.9 Statistics 707 - 18.10 Literature 708	
19	Explosives	709
	19.1 Introduction 709 - 19.2 Assessment of explosives 709 - 19.3 Initiatory explosives 712 - 19.4 Secondary explosives 715 - 19.5 High explosive compositions 723 - 19.6 Detonators and fuses 725 - 19.7 Production and applications of explosives 728 - 19.8 Pyrotechnics 731 - 19.9 Propellants 736 - 19.10 Literature 743	
20	Industrial Organic Solvents	745
	20.1 Introduction 745 - 20.2 Solvency power 745 - 20.3 Survey of some important solvents 747 - 20.4 Use of solvents 758 - 20.5 Solvent recovery 762 - 20.6 Safety with solvents 764 - 20.7 Statistics 765 - 20.8 Literature 765	
	Index	767