

CONTENTS AND SUBJECT INDEX

INTRODUCTION

OIL SHALE RETORTING	3
Gas Combustion	4
Multiprocessing Zones in Kiln	4
Multistage Thermal Processes	12
Isolation of Retort Zone to Utilize Flue Gases	15
Increased Residence Time in Retort Zone	16
Recycle Gas Bypasses Combustion Zone	16
Preheat Requirements for Optimum Operation	20
External Indirect Gas Heat Exchange	23
Control of Fines	28
Multistage Retort Process	30
Mixtures of Rich and Lean Oil Shale	33
Feed Segregation and Shale Oil Recycle	34
Retorting Total Oil Shale	36
Recovery and Conversion of Shale Oil Mist	38
Rotatable Grate	39
Tunnel Oven with Separate Compartments	40
Artificially Induced Condensation Nuclei	41
Addition of Coke	42
Retorting and Coking in Single Vessel	43
Externally Heated Flue Gas for Temperature Control	43
Hydrogen Produced as By-Product	45
Inert Gas Used in Place of Hydrogen	46
Continuous Fluidized Process	47
Catalytic Oxidation	50
Heat Recovery	51
Controlled Retort Atmosphere	55
Solid Heat Transfer Media	57
Special Pellets and Steam Stripping	57
Special Pellets and Precoking Stage	66
Heated Spent Oil Shale	66
Recycle of Pellets	70
Ball Heater-Equilibrators System	75
Inert Ball Heater	78
Heat Supplied by Pyrolysis Products	79
Heated Solids for Attrition and Heat Transfer	81

Control of Entrained Solids	81
Finely Divided Heat Carrier	83
Finely Granular Carrier	84
Horizontal Retort	90
Removal of Ash Prior to Retorting	93
In-Ground Processes	97
Solution Mining to Form Cavern	97
Laterally Expanding Permeabilization	103
Fracturing Using a Pair of Well Boreholes	108
Nuclear Detonation	109
Carbon Dioxide as Heat Carrier	110
Perforated Pipe	112
Halogenated Organic Compounds	113
Other Processes	114
Diluent Soaking Followed by Gradual Heating	114
Noncombustive Process Using Superheated Steam	115
Traveling Grate Shale Retorting	118
Agglomeration of Fines in Traveling Grate Process	121
Electrothermal Pyrolysis	122
Controlled Nuclear Reactor	125
Sonic Energy Induced Separations	125
Pipeline Transportation and Recovery	126
Mining of Deep Thick Oil Shale Deposits	127
Laser Beam Heating	127
OIL SHALE REFINING PROCESSES	131
Hydrogenation	131
Activated Carbon-Alkali Metal Catalyst	131
Hydrotorting Using Hydrogen and Water	134
Hydrotorting Using Synthesis Gas and Water Injection	139
Use of Coarse and Fine Catalysts	140
Impregnation of Shale with Gasoline	140
Solvent Treating Before Hydrogenation to Prevent Plugging	141
Conservation and Reuse of Hydrogen	142
Other Processes	143
Screw Conveyor Process	143
Combined Retort and Cracking Process	146
Simultaneous Separation and Cracking	149
Simultaneous Retorting and Hydrogenation	149
Pyrolysis and Hydrogenation in Single Reaction Zone	150
Heat Transfer Balls and Controlled Cracking	151
Zeolite Catalysts	157
Pour Point Depressant	157
Visbreaking in Presence of Hydrogen for Pour Point Reduction	158
Thermal Treatment to Reduce Pour Point	161
Treatment of Raw Oil with HCl	162
TAR SANDS SEPARATION PROCESSES	165
Hot Water Processes	166
Hot Alkaline Polyphosphate Solution	166
Treatment with Inorganic Phosphates and Alkylene Oxide Surfactants	167
Recovery of Oil from Middlings Layer	169
Coker Naphtha Diluent	172
Gaseous Hydrocarbons as Flotation Aids	173
Controlled Amounts of Fine Sand in Intermediate Layer	175
Calcium Carbonate as pH Controller	178
Reduction of Solids Using Secondary Froth Wash Technique	180
Addition of Tar Sand Oil to Slurry	183
Water Washing and the Use of Fluid Bed Combustion Chamber	184

Thermal Dehydration of Emulsion	185
Dehydration Using Heated Dry Bitumen	186
Micellar Dispersions for In Situ Treatment	187
Water-External Micellar Dispersions	188
Oil-External Micellar Dispersions	189
Centrifugal Separation	189
Continuous Extraction in Centrifugal Separator	190
Cyclone Settling Zone Prior to Centrifuging	192
Two-Stage Separation System	194
Integration of Extraction Processing Streams	197
Introduction of Water Immediately Below Emulsion Layer	199
Multicell Processing Apparatus	200
Hot Water-Clarification Processes	205
Clarification of Middlings Water	205
Freeze-Thaw Separation Technique	207
Treatment of Discharge Water with Gaseous Effluent	209
Acrylic Acid Polymers as Flocculants	212
Tailings Disposal System	213
Frothing Treatment of Middlings Stream	213
⌘ Cold Water Processes ⌘	214
Addition of Kerosene and Recycled Oil	214
Alkali Metal Silicate Treatment	217
Aqueous Extraction Using Seawater	218
Utilization of Methane as Flotation Gas	220
Addition of Granulated Carriers During Mixing	222
Vacuum Separation Technique	222
Use of Shearing-Mixing Zone to Obtain Bitumen-Rich Sand	222
Hydrogenation of Emulsion	224
Hydraulic Cyclone	225
Sound Wave Induced Separation	226
Mechanical Separation Technique	226
Other Processes	226
Extraction Apparatus with Endless Perforate Conveyor	226
Use of Soluble Oils	231
Addition of Hydrocarbon Diluent	232
Use of Propane	233
⌘ Solvent Extraction ⌘	235
Sonic Energy	236
Solvent Addition with High Energy Shear Treatment	237
Screen Separation	239
Freezing Technique Employing Propylene	239
Centrifugal Separation	239
In Situ Process Employing Gamma Radiation	239
Substituted Nitrobenzenes in Water Flooding	241
Alkali Metal Hydroxides and Amine for Water Flooding	242
pH-Sensitive Aqueous Surfactant Solutions	243
TAR SANDS RETORTING AND REFINING PROCESSES	245
Retorting and Coking	245
Simultaneous Separation and Cracking	245
Internal Combustion Retorting	246
Recycle of Hot Decoked Feed Solids	250
Compacted Tar Sands	250
Compaction and Retorting	251
Slurry Process	255
Retorting and Coking Process with Hot Sand Recycle	256
Coking a Mixture of Tar Sand and Froth Product	259
Fluid Coking Processes	259
Removal of Suspended Material by Filtration	262

Hydrogenation	263
Upflow Liquid Phase Hydrogenation System	263
Hydrofining Process	266
Hydrogenated Thermal Tar as Hydrogen Donor-Diluent	269
Jet Fuels	270
Two-Stage Deasphalting Process Using Controlled Solvent-Feed	271
RECOVERY OF METAL VALUES	275
Aluminum	275
Soda Ash-Caustic Soda Treatment for Cell-Grade Alumina	275
Alumina Trihydrate as Seed	278
Controlled Pyrolysis to Prevent Formation of Insoluble Oxides	281
Leaching Technique	282
Pyrolytic Extractive Fluid and Chelate	283
Sodium Aluminate	286
Sodium Aluminate—Critical Roasting Temperature	287
Recovery of Alumina	289
Vanadium	291
Lime Treatment Prior to Leaching	291
Hydrometallurgical Treatment and Anion Exchange Resin	294
Carbonation Technique to Control pH	296
Sulfur Dioxide	298
Zirconium	299
COMPANY INDEX	302
INVENTOR INDEX	303
U.S. PATENT NUMBER INDEX	306