

Contents

Introduction		
Section I	Coal Processing and Conversion	1
	Coal-based processes evaluated in Germany	3
	Coal research: momentum builds in Germany, U.K.	7
	Slagging gasifier aims for SNG market	11
	Solvent-refined coal keeps flue gas clean	13
	Coal cleaning readies for wider sulfur-removal role	15
Section II	Fertilizer	19
	Melt granulator featured in low-energy fertilizer route	21
	Potash flotation method handles variable feed	23
	Phosphoric acid purification: comparing the process choices	26
	Enter: sulfur-coated urea, a slow-release fertilizer	29
Section III	Foods, Flavors and Fragrances	31
	Fermentation process turns whey into valuable protein	33
	Current developments in fermentation	35
	<i>l</i> -Menthol synthesis employs cheap, available feedstocks	50
	Protein from methanol	52
	A better way to make protein from whey	54
Section IV	Inorganic Chemicals	57
	Ammonia from coal	59
	Ammonia from coal: a technical/economic review	63
	Hydrogen recovery unit ups NH ₃ -plant efficiency	66
	New feeds and processes perk ammonia production	69
	New solvent cuts cost of carbon monoxide recovery	73
	Chloralkali plants win by teaming technology	76
	New ion-exchange membrane stars in chloralkali plant	78
	Recovering chlorine from HCl	81
	Nitric acid route recovers more heat from tailgas	83
	Strong-nitric acid process features low utility costs	85
	Recovery of active silica cuts costs of cryolite route	87
	Soda ash plant exploits mineral-laden brine	89
	Coal converts SO ₂ to S	91
	Selective oxidation in sulfuric and nitric acid plants: current practices	93

VI CONTENTS

Section V	Metallurgical Processes	101
	Alumina producers look to alternate raw materials	103
	Continuous copper-smelting process uses single vessel	105
	Cu/U ore-leaching route cuts pollution, trims costs	108
	High-carbon ferrochrome route slashes power use	110
	Iron-ore concentration process unlocks low-grade reserves	112
	Direct iron reduction: the role widens for natural-gas alternatives	115
	Sponge-iron process combines flexibility, low costs	118
	Metals from Mn nodules	120
	Nickels reduced directly in rotary converter	122
	New technology tries to tap tungsten trove	124
Section VI	Organic Chemicals	127
	Combined ammonia/urea process trims operating, capital costs	129
	New processes will feed on mixed-butenes glut	132
	Caprolactam without any ammonium sulfate byproduct	135
	Caprolactam from toluene—without ammonium sulfate	137
	Choosing the optimum CO ₂ -removal system	139
	Diaminomaleonitrile makers push product's potential	145
	Efficient, nonpolluting ethylbenzene process	147
	Ethylene and its coproducts: the new economics	149
	Ethylene diamine route eases pollution worries	162
	Fermentation achieves new high in flexibility	164
	Molten salt process yields chlorinated hydrocarbons	167
	New route to hydroquinone	169
	Belgians tap PA wastes for Maleic anhydride	171
	Methanation routes ready	173
	<i>n</i> -Paraffins extraction	175
	Low air-feedrate cuts phthalic anhydride costs	177
	Pressure-swing adsorption: geared for small-volume users	179
	New processes win the spotlight at ACS centennial meeting	182
	Propylene oxide routes are ready to take off	186
	Low-pressure oxo process features rhodium catalyst	188
Section VII	Petroleum Processes	191
	Demetallization seeks a heavier refinery role	193
	Process provides option for nonleaded-gas makers	196
	New additive gives boost to unleaded fuel in Europe	199
	Molecular sieves star in gasoline-upgrading route	202
	Resid conversion route	204
Section VIII	Plastics and Elastomers	207
	Artificial-latex route boasts foamfree stripping technique	209
	Continuous peroxyester route to make its commercial debut	211
	New routes tackle tough plastics-recycling jobs	213
	New catalyst streamlines HD-polyethylene route	216
	LDPE goes low pressure	218
	Water-dispersed polyolefins recovered as microfine powder	221
Section IX	Solid Waste Processes	223

	Flash pyrolysis turns refuse into fuel oil	225
	Sludge pyrolysis schemes now head for tryouts	227
Section X	Tar Sands, Shale Oil Processes	229
	Giant oil-sands plant comes onstream	231
	Shale oil—process choices	234
	Soviet oil-shale processes offered for U.S. licensing	237
Section XI	Uranium Processing and Enrichment	239
	Uranium enrichment methods detailed at meeting	241
	Uranium processing update	243
	Recovering uranium from wet-process phosphoric acid	245
Section XII	Waste Gas Treatment/Recovery Process	247
	Cleaning up Claus offgas	249
	Coke-oven offgas yields fuel, chemicals byproducts	251
	Flue-gas desulfurization produces salable gypsum	253
	Japan's NO _x cleanup routes	255
	System curbs nitrogen in plant-effluent streams	257
	New SO ₂ -cleanup contenders	260
	Limestone + magnesium: a new SO ₂ control team	262
	Removal of SO ₂ from industrial waste gases	264
Section XIII	Wastewater Treatment/Recovery Processes	273
	New extraction process wins acetic acid from waste streams	275
	Choosing a process for chloride removal	277
	Wastewater cleanup processes tackle inorganic pollutants	285
	Mercury cleanup routes—I	288
	Mercury cleanup routes—II	290
	Water treatment system cuts organics	292
	Photo-processing facility achieves zero discharge	294
	Wastewater reclamation system ups productivity, cuts water use	296
	Finns make saltpeter from wastewater	299
	Swedes recover zinc from rayon wastes	301
Section XIV	Wood, Pulp and Paper	303
	Bagasse now becomes a newsprint source, too	305
	ClO ₂ generator cuts byproduct sulfuric acid	308
	Fir-Bark Conversion Route	310
	Pulp-bleaching process cuts costs, time, effluent	312
	Pulping/bleaching scheme boosts yields, cuts waste	314
	Salt-recovery process allows reuse of pulp-bleaching effluent	316
	How to get water out of lignite, wood and peat	318
Section XV	Miscellaneous	321
	Non-caustic refining of edible oils and fatty acids	323
	Beneficiated-ilmenite process recycles HCl leach liquor	325
	Tobacco supplement seeks to catch fire in Britain	327
	Hydroprocessing for white oils	329

VIII CONTENTS

Award Winning Processes	333
1973—	
Proteins from hydrocarbons	335
New catalytic route to acrylamide	341
Gas-phase, high-density polyethylene process	343
1975—	
Complete combustion of CO in cracking process	345
Integrated use of oxygen in pulp and papermaking	351
Shortened route to pure nickel	353
Arc-plasma dissociation of zircon	355
1977—	
Low-pressure oxo process yields a better product mix	357
Nitrogen trifluoride by direct synthesis	363
Winning more from heavy oils	365
Better path to ethylbenzene	366
Carbon monoxide from lean gases	368

Contents

Introduction		v
Section I COAL PROCESSING AND CONVERSION		
Coal technology reigns at AIChE gathering		3
Synthetic gas and chemicals from coal: economic appraisals		6
Hygas at the crossroads		10
Entrained-bed coal gasifiers handle double throughput		14
Methanol from coal: cost projections to 1990		16
Guide to coal-cleaning methods		21
Coal combustor retrofits to gas- and oil-fired boilers		24
Methane from coal aided by use of potassium catalyst		26
Better fluid-bed units ready to make debuts		29
Section II INORGANIC CHEMICALS		
<i>Ammonia Manufacture</i>		
Tightening the loop in ammonia manufacture		35
Argon recovery: Aid to ammonia economics		37
Improved reactor design for ammonia synthesis		39
Grander process changes eyed by ammonia makers		41
<i>Hydrogen Production</i>		
Hollow fibers recover hydrogen		42
Hydrogen routes' future is keyed to economics		44
Metal hydrides selectively remove H ₂ from gas streams		47
Progress on the hydrogen front		49
<i>Other Chemicals</i>		
Catalytic purification of diaphragm-cell caustic		50
Membrane cells a hit with chlorine producers		52
Concentrating nitric acid by surpassing an azeotrope		55
Improved titanium dioxide process keeps plant alive		57
Phosphoric acid process proven for large-capacity plants		59

Section III METALLURGICAL PROCESSES

Plasma process is ready for metals recovery	63
Oil gasification is teamed with iron-ore reduction	66
Refining precious metals	68
Simplified zinc process does not generate SO ₂	70
Aluminum: Energy diet pays off	73
↙ New smelting methods aim to get the lead out	76
↙ Search is on for clean ways to produce nonferrous metals: Part I: Copper	78
↙ Search is on for clean ways to produce nonferrous metals: Part II: Nickel, zinc and lead	82
Copper routes assessed in economics report	85

Section IV ORGANIC CHEMICALS

Ethanol

Low-energy processes vie for ethanol-plant market	89
New ethanol route wears low-energy label	92
Wood-to-ethanol methods edge closer to fruition	93
Battelle maps ways to pare ethanol costs	96
Ethanol from wood	98

Other Organics

Bright future for CO feed	101
Supercritical fluids try for CPI applications	104
New technology sparks ethylene glycol debate	107
Phthalic anhydride made with less energy	110
Ethylene from ethanol: The economics are improved	112
Will butane replace benzene as a feedstock for maleic anhydride?	114
Aniline: phenol feed chosen	117
Separating paraffin isomers using chromatography	119
New catalyst revises dimethylaniline production	122
Nitrobenzene via an adiabatic reaction	124
Formic acid from CO-containing gases	126
Ethylene: Feedstocks and their impact on by-products	129

Section V PETROLEUM PROCESSES

General Processes

Gas oil becomes feedstock for SNG plant	135
Partial oxidation in comeback	137
Gasoline or olefins from an alcohol feed	140
Polygas spells relief from alkylation ills	143
Feedstock flexibility: Cracking butanes for ethylene	145
Hydrocracking without catalysis upgrades heavy oil	148
Membranes separate gas	150
New lease on life for enhanced oil recovery	152

Rerefining Used Oil

Rerefining waste oil	155
Bright prospects loom for used-oil rerefiners	158
Oil re-refining route is set for two plants	161

Section VI PLASTICS AND ELASTOMERS

New catalyst cuts polypropylene costs and energy requirements	165
British route to polymer hinges on bacteria	167
Plastics producers search for paths to linear LDPE	168
New catalyst controls LLDPE's particle geometry	171

Section VII TAR SANDS AND SHALE OIL PROCESSES

Oil recovery is higher in new tar-sands route	175
Oil shale commercialization: The risks and the potential	177
Improved routes for making jet fuels from shale oil	182
New ways to process oil shale	185

Section VIII WASTE GAS TREATMENT/RECOVERY PROCESSES

Sulfur Removal

Flue-gas desulfurization produces salable gypsum	191
Dry scrubbing looms large in SO ₂ cleanup plans	193
Fluid-bed gets the nod	195
Citrate solution absorbs SO ₂	198
H ₂ S reduces SO ₂ to desulfurize flue gas	200
Treating hydrogen sulfide: When Claus is not enough	202

NO_x Removal

NO _x controls: Many new systems undergo trials	205
Catalytic burning tries for NO _x control jobs	209

Other Processes

Breakthroughs ahead for cleaning hot gases?	212
Cost-saving process recovers CO ₂ from power-plant fluegas	215

Section IX WASTEWATER TREATMENT/RECOVERY PROCESSES

Waste treatment boosted by bacterial additions	219
Biological phosphorus removal	221
Biological, mechanical methods compete for wastewater-cleanup job	223
Activated carbon removes pesticides from wastewater	226
Big waste-treatment job for water hyacinths	228
New ways to destroy PCBs	231
Rapid oxidation destroys organics in wastewater	234
Waste treatment with hydrogen peroxide	236
Process gives new life to contaminated sulfuric acid	240
Anaerobic treatment of industrial wastewaters	242

Section X SOLID WASTE DISPOSAL

Waste-sludge treatment in the CPI	251
Waste disposal with an energy bonus	266
Sludge drying—one way to waste-reduction	268
The cost of shredding municipal solid waste	271
Petrochemicals from waste: Recycling PET bottles	273
Firms avidly seek new hazardous-waste treatment routes	275
Pyrolysis process converts waste polymers to fuel oils	279

Section XI WOOD, PULP AND PAPER

Anthraquinone pulping of wood	283
Wood: An ancient fuel provides energy for modern times	285
Pulping process reduces water pollution	288
High-grade lignin schemes edge closer to reality	290

Section XII *CHEMICAL ENGINEERING's* KIRKPATRICK AWARDS

1979 Kirkpatrick Chemical Engineering Achievement Awards	295
1981 Kirkpatrick Chemical Engineering Achievement Awards	311

Index	323
--------------	------------