Index

1,4-diazabicyclo [2,2,2] octane. See DABCO 2-oxazolidone, 18, 39 catalysts, 115 linkage, 101 modification of PIR foams with, 113

A

Acid rain, regulation of blowing agents due to. 8 Active hydrogen compounds, addition reaction of, 12 Addition reaction, 1, 11 thermal dissociation of compounds, 13 Advanced polyether polyols, 7 Airlite Foam SNB, 8, 103 Akzo Co., 17 Aliphatic isocyanates, 14 Aliphatic polyesters, preparation of, 22 Aliphaticity index, 106 Allophanate, 18 Alumina trihydrate. See ATH American Cyanamid Co., 18 Amide, 18 Amide-modified PIR foams, 116, 136 Amine-based polyether polyols, 22 Amine-emission catalysts, 37 Antioxidants, 46 classification of, 73 mechanisms of, 73 Appliances, 85 ARCO Chemical Corp., 17 Aromatic polyesters, preparation of, 23 Aromatic polyisocyanates, 9, 14 Aromatic polyol-modified PIR foams, 110 Aromatic secondary amines, use of as an antioxidant, 46

Asahi Chemical Industry Co., Ltd., 17
Ashida patent, 8, 102
ATH, use of as a noncalorific additive for
flame retardants, 46
Automotive interior foams, 37, 75
Azeotropes
halogen-containing, use of as a physical
blowing agent, 30
halogen-free, 8
use of as a physical blowing agent, 31

B

Barth, K., 6 Bayer AG, 17, 87, 101 Bayer, Otto, 5 Better-riding comfort foam. See viscoelastic foam **BHT. 73** use of as an antioxidant, 46 Biuret, 18 Blocked amines, 36 Blowing agents, 24 for integral skin flexible foams, 79 physical, 7 third generation, 8 use of in slabstock foam formation, 72 Blowing catalysts, 35 Boric acid, use of as a blowing agent, 26 Box foaming, 51 BTDA, 117 Bun cooling, 73 Bureau of Mines Flame Penetration Test, 104, Burn-through test, 129. See also Bureau of Mines Flame Penetration Test Butler Chimney test, 119, 132

С

C5-hydrocarbons, 85 advantages of halogen-free azeotropes over, 33 use of as a blowing agent, 8, 29, 112 Calcium carbonate, use of in flame retardants, 46 Carbodiimide, 18 catalysts, 39, 42 Carbodiimide-modified PIR foams, 118, 136 Carbon dioxide, 24 liquid, use of as a physical blowing agent, 29 Carbonyl group titration, antioxidant evaluation using, 74 Carboxyl-terminated polyester oligomer, 5 Carothers, W., 5 Caster oil, 23 Catalysts. See also specific types of catalysts 2-oxazolidone, 115 for isocyanate-based polymeric foams, 34 for polyether polyols, 20 kinetic activity studies using nonsolvent systems, 124 CCl₃F, use of as a blowing agent, 80 Cellular plastics, 1 CFC-11.7 use of as a blowing agent, 27 CFCs ban on, 66 (See also Kyoto Protocol; Montreal Protocol) use of as physical blowing agents, 27 Chain extenders, 43 Char-forming flame retardants, 45 Chemical blowing agents, 24 Chemical calculations, 56 Chemical frothing process, 56 Chlorofluorocarbon-11. See CFC-11 Chlorofluorocarbons. See CFCs Clay, use of in flame retardants, 46 Closed mold process for foam composites, 92 for rigid foams, 87 for skin flexible foams, 80 Cold molding, 74 Cold-molded flexible foams, 74 Colorants, 47 Combustion, mechanism of in foams, 44 Comfort index, 68 Compression recovery phenomena, 65 Compression set, 68 Compression-force deflection, 68 Compressive deformation characteristics, 69 Conch-Methane Service Ltd., 95

Condensation reaction, 1, 13 Continuous processes, for production of foam composites, 92 Conversion table (U.S. to SI), 57 CPT/MFT blend, use of as a physical blowing agent, 31 Crack prevention, 94 Crosslink density, reduction of by modifiers, 102Crosslinkers, 43 Cryogenic applications of PIR foams, 138 Cryogenic installation, 94 Cryogenic insulation, 91 Cup foaming, 49 Cushioning properties, 68 Cyclopentane. See C5-hydrocarbons Cyclotrimerization, 1, 13 catalysts, 38, 41 chemistry of, 120 kinetics of in nonsolvent systems, 124 kinetics of in solvent systems, 121, 123

D

DABCO, 7, 66 Danfunen NFPI, 110 Deformation characteristics, 68 Delayed action catalysts, 36 Dimerization, 12 Diols, low-molecular weight, 43 Diphenylmethane diisocyanate. *See* MDI Discoloration, 74 Draka-Petzetakis process, 70 DuPont, 5

E

E.I. DuPont de Nemours Co. See DuPont Elastomers, 22
Enolizable compounds, use of as blowing agents, 25
Environmental concerns, 8
Epoxides, 43
Epoxy/NCO, 114
Ergonomic foam. See viscoelastic foam
External mold release agents, 47

F

Farbenindustrie, 5 Fiber meshes, 81 Fibers, 22 Films, 22 Flame resistance of modified PIR foams, 104, 129

Flame retardants, 43 classification of, 44 Flammability of PIR foams, 128 Flexible facings, 84 Flexible foams, 7, 15, 21, 67. See also PUR foams; specific types of foams cell formation in. 35 flame retardants in, 43 historical development, 65 hysteresis curves. 67 integral skin, 79 molded, 74 polyether-based, use of surfactants in production of, 40 use of antioxidants in production of, 46 use of CFC-11 in the production of, 28 use of water as a blowing agent in the production of, 25 Foam composites, 91 structures of, 92 Foam cure, antioxidant determination after, 74 Foam density decreasing with use of antioxidants, 46 relationship of blowing agent boiling point and, 32 Foam mattresses, 75 use of VE foam for, 78 Foam scorching, 72 Foam sealants, 91 Foamed plastics, 1 Foamed urethane elastomers, 81 Foaming processes, 48. See also specific types of processes on-site, 87 Foaming profiles, 50 Foaming reaction, 6 Foaming systems, 47 Foams. See specific types of foams Fogging, 37, 74 Frothing technology, 9 chemical process, 56 conventional process, 52 frothing-in-place, 88 thermal process, 56 Frothing-in-place, 88 Full prepolymer foaming system, 48 Furan resin-modified PIR foams, 111

G

Gas generation, 24 Gashol tank floats, use of PIR foams as, 139 Gelation catalysts, 35 Global warming, 8 Glycol-modified PIR foams, 109 Graft copolyols, 7 Graft polyols, 20, 76. *See also* polymer polyols

H

Halogen-containing alkylene oxide-based polyols, 45 Halogen-containing azeotropes, use of as a blowing agent, 30 Halogen-free azeotropes advantages over C5-hydrocarbons, 33 use of as a blowing agent, 8, 31, 80, 113 HCFCs. 7 use of as blowing agents, 28 HCN generation, 133 Heat resistance of PIR foams, 104, 129 Helix mixers, 55 Hennecke-Planiblock process, 70 Hexafoam, 9 HFCEs, use of as blowing agents, 29 HFCs, use of as blowing agents, 28, 112 High resilience foams, 75 High-molecular-weight polyether polyols, 76 Hindered phenols, use of as an antioxidant, 46 Hodogaya Chemical, 110 Hoshino, T., 5 Hot molding, 74 Hot-molded flexible foams, 75 Humid aged compression set, 68 Hydantoin-containing polyol, 23 Hydrochlorofluorocarbons. See HCFCs Hydrofluorocarbon ethers. See HFCEs Hydrofluorocarbons. See HFCs Hydrogen compounds, active, 12 Hydrogen cyanide gas generation. See HCN generation Hydrophilic polyols, 45 Hydroxyl-terminated polyolefins, 18

I

I.G. Farbenindustrie A.G. See Farbenindustrie Imide, 18 Imide-modified PIR foams, 117, 136 Indentation load-deflection, 68 Indentation-force deflection, 68 Initiators for polyether polyols, 19 Integral skin flexible foams, 79 Internal mold release agents, 47 Isocyanate chemistry, reactions in, 11

Isocyanate production, phosgene-free methods, 9, 16 Isocyanate reactions, foams resulting from, 2 Isocyanate-based foams invention of, 5 preparation technologies, 47 use of flame retardants in, 44 Isocyanate-terminated quasi-prepolymers, 18 Isocyanurate foams, 18 urethane-modified, 9 Isocyanurate linkage, 101 Isocyanurate-modified urethane foams, 111 Isophorone diisocyanate, isocyanurate-modified, 18 Iwakura, Y., 5

K

Kacac, 117 Kogon's mechanism, 120 Kyoto Protocol, 8

L

Laminates, 84 Large-box foaming, 51 Liquid carbon dioxide frothing process, 56 use of as a blowing agent, 8 use of in formation of slabstock foams, 72 Liquid flame retardants, 45 Low-resiliency foam. *See* viscoelastic foam

М

Machine foaming, 51 Mannich polyols, 110 Maxfoam process, 70 MDI, 9, 15, 75 carbodiimide-modified, 18 physical properties of, 16 urethane-modified, 18 use of in PIR foams, 104 use of in viscoelastic foams, 77 Mesh-lining system, 94 Methylene chloride-hydrocarbon blends, use of as an alternative blowing agent, 34 Microcellular elastomers, 81 Microwave oven scorch test, 47 antioxidant evaluation using, 74 Mitsubishi Chemical Corp., 17 Mitsubishi Heavy Industries Co., Ltd., 95

Mitsui Toatsu Chemicals, Inc., 17 Modified polyisocyanates, 18 manufacturing of, 103 Mold release agents, 47 Molded foams, 67, 74 Molding, 52 Molina, Mario, 7, 66 Monomeric MDI, 15 Montreal Protocol, 66

N

N-pentane/methyl formate blend. See NPT/ MFT blend Nisshinbo Industries, Inc., 75 Nitrogen-containing polymers, HCN from, 135 Noncalorific additives, 46 Nonemission catalysts, 37 NPT/MFT blend, use of as a physical blowing agent, 31 Nylon 66, 5

0

ODP theory, 7 On-site foaming, 87 One-component, moisture-cure systems, 91 One-step foaming system, 48, 66 One-step process for flexible foam preparation, 6, 48, 65 Open cell formation, 50 Open mold process for rigid foams, 87 for skin flexible foams, 80 Oxazolidone catalysts, 39, 42 Oxazolidone-modified polyisocyanurate foams, use of epoxides in preparation of, 43 Oxidative carbonylation, 17 Ozone depletion potential of CFC, 7, 28

Р

Perfluorocarbons. See PFCs Petrochemical tanks, use of PIR foams in, 137 PFCs, use of as blowing agents, 29 PHD polyols, 7, 21 Phosgenation of aromatic amines, 9, 14 Phosphite, use of as an antioxidant, 46 Phosphorus esters, use of as flame retardants, 45

Physical blowing agents, 7, 24, 27, 66 use of in slabstock foam formation, 72 Pipelines, use of PIR foams in, 137 PIR foams, 28 2-oxazolidone modified, 113 amide-modified, 116 applications of, 136 aromatic polyol-modified, 110 blowing agents for, 111 carbodiimide-modified, 118 fire endurance of, 104 furan resin-modified, 111 glycol-modified, 109 imide-modified, 117 modification of by non-urethane linkages, 113 modified, 103 preparation of, 38, 101 properties of, 128 resole resin-modified, 110 secondary aromatic diamine-modified, 119 Plastic foams, 1 Plastic honeycomb, use of in production of vacuum insulation panels, 86 Poly-2-oxazolidone foams, use of epoxides in preparation of, 43 Polyalkylation, catalysts for, 20 Polyamide foam, 5 Polycarbonate polyols, 23 Polycyclotrimerization, 101 Polyester polyols, 18, 22 advantages of polyether polyols over, 20 Polyether polyols, 19, 76 amine-based, 22 catalysts for, 20 effect of the functionality of on fire endurance, 108 initiators for, 19 Polyether slabstock foam, 71 Polyether-polyol modified PIR foams, 104 Polyether-prepolymer-based foams, 7 Polyharnstoff dispersion polyols. See PHD polyols Polyisocyanates, 14, 76 aromatic, 9 gels, 91 modified, 18 Polyisocyanurate foams. See PIR foams Polymer polyols, 7, 20. See also graft polyols Polymer synthesis, 5 Polymeric foams, 1 HCN generated from, 135 isocyanate-based, catalysts for, 34 preparation of by polycyclotrimerization, 101

Polymeric materials, classification of, 1 Polymeric MDI, 15 Polyolefinic polyol, 23 Polyols, 18. See also specific polyols for urethane foams, 18 graft, 20 halogen-containing alkylene oxide-based, 45 hydrophilic, 45 polyether, 6 initiators for, 19 polymer, 20 polyoxyalkylene, 19 polypropylene ether, 19 polyurea dispersion, 21 Polyoxyalkylene polyols, 19 Polypropylene ether polyols, 7 Polytail, 23 Polytetramethylene either glycol. See PTMEG Polyurea dispersion polyols. See PUD polyols Polyureas, synthesis of, 5 Polyurethane foams. See PUR foams Polyurethanes, 1. See also urethanes preparation of using addition reaction, 11 Pour-in-place foaming, 52 Powder flame retardants, 45 Prepolymer process, 7 PTMEG, 21 PUD polyols, 21 PUR foams. See also flexible foams; rigid urethane foams; urethane foams classification of, 65 preparation of, 6 recycling of, 9

Q

Quasi-prepolymer foaming system, 48

R

Radical polymerization, 13 Radical scavenger flame retardants, 45 Reaction injection molding. *See* RIM Reactive flame retardants, 45 Reactive t-amines, 37 Reductive carbonylation, 16 Refrigerated showcases, 86 Refrigerated showcases, 86 Refrigerated trucks, 86 Reinforced RIM technology. *See* RRIM technology Reinforcing fibers, 91 Residential wall sidings, use of PIR foams in, 138 Resole resin-modified PIR foams, 110 Reticulated foam, 79 Rigid urethane foams. *See also* PUR foams molded, high-density, 87 production of, 82 use of flame retardants in, 43 RIM, 47 process for integral skin flexible foam production, 80 process for rigid foam production, 87 Rowland, Sherwood, 7, 66 RRIM technology, 47, 81

S

Sag factor, 68 Sandwich foaming, 52 Sandwich panels, 84 Sanshin Seinetsu Co., Ltd., 88 Scorching, 72 Secondary aromatic diamine-modified PIR foams, 119 Semi-prepolymers, 18 foaming system, 48 Semiflexible foams, 65, 78 Semirigid foams, 65 Shoe sole foam, 82 Silica, use of in flame retardants, 46 Silicon-containing compounds, smoke suppression by, 132 Silicone surfactants, 40, 43. See also surfactants Slabstock flexible urethane foam production, 48,69 Slabstock foaming, 51 Slabstock foams, 68 rigid, 82 soft/super-soft, 78 Slow-recovery foam. See viscoelastic foam Small-box foaming, 51 Smoke scavenger process, 131 Smoke suppression of PIR foams, 131 Soft slabstock foams, 78 Spray processes, for production of foam composites, 92 Spraying, 52, 87 Storage-stable, two-component, one-package systems, 88 Structural RIM, 81 Sulfonates, use of as flame retardants, 46 Super-soft slabstock foam, 78 Surfactants, 7, 40

Synthetic polymers, 5 Synwood, 92

T

TDI, 9, 14, 21, 65, 75 isocyanurate-modified, 18 manufacture of, 15 physical properties of, 16 use of in PIR foams, 104 use of in viscoelastic foams. 77 Telwest Recycling GmbH, 87 Temperature-sensitive foam. See viscoelastic foam Tertiary amine catalysts, 35 Tertiary amines, cyclotrimerization by, 120 Tetrahydrofuran. See THF Tetramethyl xylene diisocyanate. See TMXDI Thermal dissociation of addition compounds, 13 Thermal frothing process, 56 Thermally stable linkages, incorporation of in polymers for flame retardant purposes, 46 Thermax, 9 Thermo-activated amines, 36 Thermo-sensitive amines, 36 Thermoplastic foams, 1 Thermoplastic polyurethanes. See TPUs Thermosetting foams, 1 THF. 21 Thioether, use of as an antioxidant, 46 Third generation blowing agents, 8, 113 Thixotropic systems, 88 Tin catalysts, 38 TMXDI, 18 Tokyo Institute of Technology, 5 Toluene diisocyanate. See TDI TPUs, 22 Trimerization catalysts, 38 Triols effect of weight ratio of on fire endurance, 106 low-molecular weight, 43 Tumbler friability test, 132 Two-step process for flexible foam preparation, 6, 66

U

UN/FCCC, 8 United Nations Framework Convention on Climate Change. See UN/FCCC

Index

Urea-modified PIR foams, 136 Urethane catalysts, 38 Urethane foam mattresses, 75 use of VE foam for, 78 Urethane foams. See also PUR foams catalysts used in the preparation of, 35 classification of, 66 colorants in, 47 gas generation reaction for, 24 HCN generation vs. percent nitrogen in, 135 isocyanurate-modified, 111 polyols for, 18 use of flame retardants in, 43 Urethane linkage, 101 Urethane-modified isocyanurate foams, 9 Urethane-modified PIR foams, 136 Urethane-modified polyisocyanurate foams, 104 Urethanes, 18 characterization of, 1 fire hazards of, 8

V

Vacuum insulation panels, 86 Vegetable oils, hydroxyl-containing, 18 Verifoam process, 70 Viscoelastic foam, 77 VOCs, regulation of blowing agents due to, 8 Volatile organic compounds. *See* VOCs

W

Wall panels, use of PIR foams in, 138 Water use of as a blowing agent, 8, 24, 46, 76, 80 advantages and disadvantages, 111 use of in formation of slabstock foams, 72 Wood substitutes, 91

Ζ

Zaunbrecher, K., 6 Zero ODP blowing agents, blends of, 34