Index

A

Absolute density, 120
Academia, 17
Acentric factor, 11
  aromatics, 52
  definition, 33
  estimation, 80–82, 115–116
  pure hydrocarbons, prediction, 64–66
Activation energy, 346
Activity coefficients
  mixtures, 254–255
  calculation, 257–261
Albahri et al. method, 137
Alcohols, octane number, 139
Alkanes
  boiling point, 58–59
  critical compressibility factor, 64
  critical temperature, 50
  entropy of fusion, 262
  liquid thermal conductivity, 343–344
  surface tension, 361
  vapor pressure, 306
n-Alkyl, critical pressure, 52
Alkylbenzene
  entropy of fusion, 262
  vapor pressure, 307
Analytical instruments, 96–98
ANFOR M 15-023, 10
Aniline point, 11
  definition, 35
  petroleum fractions, 137
Antoine coefficients, 310
Antoine equation, 305–306
API degree, 21
API gravity, 11
  crude oils, 156
  definition, 32
  petroleum fractions, 93
  prediction, pure hydrocarbons, 58–60
API methods, 124–126
  critical temperature and pressure, prediction, 60
  critical volume, prediciton, 63
  molecular weight prediction, 56
API RP 42, 37, 56
API Technical Data Book-Petroleum Refining, 15
Aromatics, 4–5
Arrhenius-type equation, 346
Asphalt, 10
Asphaltene, 373–378
  inhibitor, 377–378
  precipitation, 375, 377, 379
    solid-liquid equilibrium, 385–388
    temperature and pressure effects, 381
Association parameter, 347
ASTM, definitions of terms, 397–400
ASTM D 56, 133
ASTM D 86–90, 92, 100–106, 108, 110, 113–115, 118, 131, 134, 140, 144, 313–314
ASTM D 88, 23
ASTM D 92, 34, 133
ASTM D 93, 34, 133–134, 144
ASTM D 97, 135, 144
ASTM D 129, 99
ASTM D 189, 141, 144
ASTM D 240, 144
ASTM D 287, 93
ASTM D 323, 33, 144
ASTM D 341, 70, 338
ASTM D 357, 34, 139
ASTM D 445, 100, 144, 338
ASTM D 446, 338
ASTM D 524, 144, 141
ASTM D 611, 35, 137, 144
ASTM D 613, 138
ASTM D 908, 34, 139
ASTM D 976, 138
ASTM D 1018, 99
ASTM D 1160, 92, 100–101, 106, 108, 110, 114, 144
ASTM D 1218, 94, 144
ASTM D 1262, 99
ASTM D 1266, 99, 144
ASTM D 1298, 93
ASTM D 1319, 144
ASTM D 1322, 142
ASTM D 1368, 99
ASTM D 1500, 144
ASTM D 1548, 99
ASTM D 1552, 99
ASTM D 1747, 95
ASTM D 2007, 96
ASTM D 2267, 10
ASTM D 2270, 122–124
ASTM D 2386, 136, 144
ASTM D 2500, 135, 144
ASTM D 2501, 36
ASTM D 2502, 56
ASTM D 2503, 94
ASTM D 2533, 133
ASTM D 2549, 97
ASTM D 2700, 144
ASTM D 2717–95, 144
ASTM D 2759, 127
ASTM D 2887, 12, 89–90, 100, 104–105, 110, 144
ASTM D 2890, 320–321
ASTM D 2892, 144, 154
ASTM D 2983, 144
ASTM D 3178, 99
ASTM D 3179, 99
ASTM D 3228, 99
ASTM D 3238, 121, 126
ASTM D 3343, 99, 128, 130
ASTM D 3431, 99
ASTM D 3710, 90
ASTM D 4045, 99
ASTM D 4052, 93, 144
ASTM D 4124, 96
ASTM D 4530, 141
ASTM D 4737, 144
ASTM D 4953, 131
ASTM D 5296, 94
ASTM D 5985, 135
ASTM method, 128
  molecular weight prediction, 56
Atmospheric critical pressure, heavy hydrocarbons, 51
Autoignition temperature, definition, 34
Avogadro number, 24

B

Benedict-Webb-Rubin equation of state, modified, 214, 217–220
Benzene, 4–5
  vapor pressure, 313
Binary interaction parameter, 209–210, 269–270
Binary systems, freezing-melting diagram, 285
Block and Bird correlation, 359
Boiling point, 11
  n-alkanes, 58–59
  definition, 31
  elevation, 282–284
  heavy hydrocarbons, 50, 52
  hydrocarbon-plus fractions, 173
  petroleum fractions, 88–93
  prediction, pure hydrocarbons, 58–59
  reduced, 251
  sub- or superatmospheric pressures, 106–107
  true, 89
Boiling points
  average, 100–101
  range, 88
Boiling range fractions, narrow versus wide, 112–119
Boltzman constant, 24
Bubble point, calculations, 370–371
Bubble point curve, 201
Bubble point pressure, 223, 367
Bubble point temperature, 368
Bulk parameters, petroleum fractions, 114
Butane, equilibrium ratios, 274–275

C

Capillary pressure, 357
Carbon
  prediction in petroleum fractions, 127
  see also SCN groups
Carbon number range approach, petroleum fractions, 186
Carbon residue, petroleum fractions, 141–142
Carbon-to-hydrogen weight ratio, 11
  definition, 36
Carnahan-Starling equation of state, 214–215
Cavett method, 61
Cementation factor, 351
Cetane number, petroleum fractions, 137–138

Copyright © 2007 by ASTM International

CH weight ratio, pure hydrocarbons, prediction, 68–69
Chapman-Enskog equation, 346
Chapman-Enskog theory, 339
Characterization method, evaluation criteria, 75–76
Chemical potential, mixtures, 254–255
Chen correlation, 323
Chen-Othmer correlation, 347
Chromatography, 96–98
Chueh-Prausnitz relation, 210
Chung's model, 386
Clapeyron equation, 252, 307–309
Clausius-Clapeyron equation, 252
Cloud point
  calculation, 382–385
  petroleum fractions, 135–136
Coal liquid fractions, heat of vaporization, 324
Coefficient of thermal expansion, 236
Colloidal model, 375–376
Composition, units, 21–22
Compressibility factor, 203, 215–221, 289
Consistency test, predicted physical properties, 71, 73
Continuous mixture characterization approach, petroleum fractions, 187–189
Correlation index, 122–124
Corresponding states principle, 215
COSTALD correlation, 224
Cracking, 7
Cricondentherm temperature, 202
Critical compressibility factor
  definition, 32
  prediction, pure hydrocarbons, 63–64
Critical constants, definition, 32–33
Critical density, definition, 32
Critical point, 200
Critical pressure, 11
  n-alkyl, 52
  definition, 32
  estimation, 78–80
  heavy hydrocarbons, 52–53
  PNA hydrocarbons, 52
  prediction, pure hydrocarbons, 60–62
Critical properties
  coal liquids, 62
  estimation, 115–116
  internal consistency, 51
Critical temperature, 11
  n-alkanes, 50
  definition, 32
  estimation, 78–80
  heavy hydrocarbons, 52–53
  influence, 13–14
  prediction, pure hydrocarbons, 60–62
Critical viscosity, 334
Critical volume, 11
  estimation, 79
  prediction, pure hydrocarbons, 62–63
Crude oils, 5–7
  API gravity, 156
  asphaltene content, 374–378, 387–388
  assays, 154, 156–159
  cloud point temperature, 383–384
  composition and properties, 6–7
  from atmospheric separator, 7
  lumping scheme, 186
  nomenclature, 152–153
  products and composition, 9
  properties calculation, 189–191
  resin content, 374–375, 387–388
  single carbon number groups, characteristics, 161–163
  sulfur content estimation, 191–192
  vapor pressure, 313–315
  viscosity, 338
Cryoscopy, 94
C_{6+} fraction,subitem refractive index, 180
C_{7+} fraction
  carbon number range approach, 186
  comparison of distribution models, 179–180
  probability density functions, 370
C_8 hydrocarbons, properties, 48
Cubic equations of state, 204–210, 319
  application to mixtures, 209–210
  other types, 208–209
  Peng-Robinson equation, 205–206, 208
  Redlich and Kwong equation, 205, 226–227
  Soave modification of Redlich and Kwong equation, 205, 208
  solution, 206–207
  unified form, 206
  van der Waal equation, 204–205
  volume translation, 207–208
Cycloalkanes, 4

D

Daubert's method, 103–106
Deasphalted oils, 378
Decane, equilibrium ratios, 282
Defined fraction, 114
Defined mixtures, 114–115
Definition of basic properties, 31
Degrees of freedom, 199
Density, 11, 300–305
  definition, 31
  gases, 300
  liquid petroleum fractions, 223–224
  liquids, 300–304
  petroleum fractions, 93
  pure hydrocarbons, prediction, 66
  solids, 304–305
  units, 20–21
Dew point, 201–202
  calculations, 371–372
Diesel fuel, characteristics, 143
Diffusion coefficients, 12, 345–351
  measurement in reservoir fluids, 354–356
  multicomponent systems, 350
  order of magnitude, 346
  porous media, 350–351
  units, 23–24
Diffusivity, 12
  relation to refractive index parameter, 353
Dipole forces, 45
Dipole moments, 375
Distillation, simulated, by gas chromatography, petroleum fractions, 89–91
Distillation curves, 11
  interconversion, 101–108
    at reduced pressures, 106–108
    summary chart, 109
  petroleum fractions, 88–93
  prediction, 108–111
  at reduced pressures, petroleum fractions, 92–93
  sub- or superatmospheric pressures, 108
Double-bond equivalent, 45
Dry gas, 6

E

Edmister method, 65
Elemental analysis, petroleum ractions, 98–99
EN 238, 10
End point, 88
Energy, units, 22
Enthalpy, 12, 315–318
  calculation diagram, 318
  ideal gas, constants, 246–247
  two petroleum fractions, 316–317
Enthalpy departure, 317
Enthalpy of vaporization, 322
  versus temperature, 323
Entropy, 234
  ideal gas, constants, 246–247
Entropy departure, 237
  hard-sphere fluids, 286–287
Entropy of vaporization, 252
Equations of state, 199–204
  corresponding state correlations, 215–221
  fugacity coefficient calculation, 255–256
  ideal gas law, 203
  intermolecular forces, 202–203
  real gasses, 203–204
  refractive index based, 225–227
  velocity of sound based, 286–287
  see also Cubic equations of state; Noncubic equations of state
Equilibrium flash vaporization, petroleum fractions, 91–92
Equilibrium ratios, 12, 14, 269–276
Ethane
  compressibility factor, 289
  equilibrium ratios, 272
  saturation curves, 209
Ethers, octane number, 139
Excess property, 249
Exponential model, hydrocarbon-plus fractions, 165–167
Extensive property, 198–199
Eyring rate theory, 347

F

Fenske Equation, 14
Flame ionization detector, 90
Flammability range, definition, 34
Flash calculations, 368–370
Flash point, 11
  definition, 34
  petroleum fractions, 133–135
Fluid properties, use of sound velocity, 284–292
Fluidity, relation to refractive index parameter, 352
Fluids
  Newtonian and non-Newtonian, 331
  wettability, 358
Force, units, 19
Fractured reservoirs, idealized, 391
Free-volume theory, 347
Freezing point, 259–260
  definition, 34
  depression, 281–283
  petroleum fractions, 136–137
  prediction, pure hydrocarbons, 68–70
  saturated liquid and solid properties, 304
  temperature, 200

Fugacity, 187–188, 237–238, 253, 382–383
asphaltene, 386
calculation from Lewis rule, 256
coefficient, mixtures, 254–255
liquids, 268
mixtures, 254–255
pure gases and liquids, 256–257, 268
of solids, 261–263
Fugacity coefficients, 12, 238
calculation from equations of state, 255–256
Fusion curve, 200
Fusion line, 251

G

Gamma density function, molar distribution, 168–169
Gamma distribution model, 167–170
Gas chromatography, 96–97
simulated distillation, petroleum fractions, 89–91
Gas condensate system
C_{7+} fraction characteristics, 171
pseudocritical properties, 160–161
SCN group prediction, 166–167
Gas constant, 22, 24
Gas injection projects, 390–391
Gas mixtures
properties, 120
viscosity, 335
Gas phase, 200
Gas solubility, in liquids, 266–269
see also Vapor-liquid equilibria
Gas-to-liquid ratio, 337–338
Gas-to-oil ratio, 368–370
units, 24
Gases
density, 300
diffusivity
at high pressures, 348–350
low pressures, 346–347
thermal conductivity, 339–342
Gasoline, characteristics, 143
Gaussian quadrature approach, splitting, 185–186
Gel permeation chromatography, 94
Generalized correlation, 215
Generalized distribution model, 170–184
boiling point, 178
calculation of average properties, 175–177
subfractions, 177–178
C_{6+} fraction, 180
C_{7+} fractions, 179–180
model evaluations, 178–180
prediction using bulk properties, 181–184
probability density function, 174–175
specific gravity, 179
versatile correlation, 170–174
Gibbs energy, 263
binary system, 263–264
excess, 257–258
Gibbs free energy, 12, 235
Gilliland method, 347
Glaso's correlation, 338
Glossary, ASTM definitions, 397–400
Goossens correlation, 57–58
Goossens method, 127–128
Grouping, 184

H

Hall-Yarborough method, 63
Hammerschmidt equation, modified, 390
Hard-sphere fluids, entropy departure, 286–287
Hard-sphere potential, 202
Heat capacity, 12, 235
estimation from refractive index, 321–322
ideal gas, constants, 246–247
mixture, 250
thermodynamic properties, 319–321
Heat capacity coefficients, 320
Heat capacity ratio, 235
Heat of combustion, 12, 324–326
Heat of formation, 12
Heat of fusion, 201, 259–261
Heat of mixing, 249
Heat of reaction, 12
Heat of sublimation, 314
Heat of vaporization, 12, 201, 252, 321–324
at boiling point, 323
Heating value, 25, 324–326
Heats of phase changes, 321–324
Heavy hydrocarbons
API gravity and viscosity, 59–60
atmospheric critical pressure, 51
boiling point, 50, 52
constants, 50–51, 54
critical pressure, 52–53
critical temperature, 52–53
prediction of properties, 50–54
refractive index and viscosity, 44
Heavy petroleum fractions
enthalpy, 316
molecular weight and composition, 116
Helmholtz free energy, 235
Henry's constant, 267, 269
Henry's law, 266–269
Heptane, equilibrium ratios, 279
Hexane
equilibrium ratios, 278
vapor pressure, 311
n-Hexatriacontane
acentric factor, 65
critical properties, 64
High performance liquid chromatography, 97
High-shrinkage crude oil, 6
Hoffman correlation, 271–272
Hydrate inhibitors, 389–390
Hydrates, formation, 388–390
Hydrocarbon-plus fractions, 153, 164–184
boiling point and specific gravity prediction, 173
calculation of average properties, 175–177
exponential model, 165–167
gamma distribution model, 167–170
general characteristics, 164–165
generalized distribution model, 170–184
molar distribution, 167, 172–173
molecular weight variation, 165
prediction of PDF, 173–174
probability density functions, 164–165
subfractions, calculation of average properties, 177–178
Hydrocarbons, 3–5
groups, 3
liquid specific gravity, temperature effect, 301
pure, *see* Pure hydrocarbons
research octane number, 140
Hydrodynamic theory, 347
Hydrogen, prediction in petroleum fractions, 127
Hydrogen sulfide, equilibrium ratios, 283

I

Ideal gas
mixture, heat capacity, 244
thermodynamic properties, 241–247
Ideal gas law, 203, 209
In-situ alteration, 2
Infrared spectroscopy, 97
Intensive property, 198–199
Interfacial tension, *see* Surface/interfacial tension
Intermolecular forces, 43, 202–203
Internal energy, 199
IP 2/98, 144
IP 12, 144
IP 13/94, 144
IP 14/94, 144
IP 15, 135, 144
IP 16, 136, 144
IP 34/97, 144
IP 57, 142
IP 61, 99
IP 69/94, 144
IP 71/97, 144
IP 107, 99, 144
IP 123/99, 144
IP 156/95, 144
IP 196/97, 144
IP 218, 138
IP 219, 135, 144
IP 236, 144
IP 365, 93, 144
IP 370/85, 144
IP 380/98, 144
IP 402, 131
IP 406/99, 144
ISO 2049, 144
ISO 2185, 144
ISO 2192, 144
ISO 2592, 34
ISO 2719, 144
ISO 2909, 123
ISO 2977, 144
ISO 3007, 144
ISO 3013, 144
ISO 3014, 142
ISO 3015, 135, 144
ISO 3016, 135, 144
ISO 3104, 100, 144
ISO 3405, 144
ISO 3837, 144
ISO 4262, 144
ISO 4264, 144
ISO 5163, 144
ISO 6615, 144
ISO 6616, 144
ISO 6743/0, 10
ISO 8708, 144
ISO 12185, 93
Isofugacity equations, 383
Isoparaffins, 3
Isothermal compressibility, 236

J

Jenkins-Walsh method, 128–129
Jet fuel
characteristics, 143
enthalpy, 318

Jossi's correlation, 337
Joule-Thomson coefficient, 236

K

Kay's mixing rule, 220, 372
Kesler-Lee method, 79, 81
Kinematic viscosity, 331, 337
  definition, 33–34
  estimation, 118–119
  prediction, pure hydrocarbons, 70–73
  units, 23
Korsten method, 65, 81
Kreglweski-Kay correlation, 372
Kuwait crude oil, characterization, 190

L

Lee-Kesler correlation, 239
Lee-Kesler method, 56, 60–61, 64–65, 80–81
Length, units, 18
Lennard-Jones model, 202
Lennard-Jones parameters, velocity of sound data, 288–289
Lewis rule, fugacity calculation, 256
Linden method, 137
Liquid chromatography, 90, 97
Liquid density
  effect of pressure, 223–225
  pressure effect, 302
  temperature effect, 303
Liquid mixtures, properties, 119–120
Liquids
  density, 300–304
  diffusivity
    at high pressures, 348–350
    at low pressure, 347–348
  fugacity, 268
    calculation, 256–257
  gas solubility, 266–269
  heat capacity values, 319
  thermal conductivity, 342–345
  viscosity, 335–338
  see also Vapor-liquid equilibria
London forces, 45
Lubricants, 9–10
Lumping scheme, 184
  petroleum fractions, 186–187

M

Margule equation, 261
Mass, units, 18
Mass flow rates, units, 20
Mass spectrometry, 98
Maturation, 2
Maxwell's equations, 235
Melting point, 11
  definition, 34
  prediction, pure hydrocarbons, 68–70
  pressure effect, 253–254
Metals, in petroleum fractions, 99
Methane
  compressibility factor, 289
  equilibrium ratios, 271
  hydrate formation, 388
  P-H diagram, 263–264
  speed of sound in, 286
Micellar model, 375–376
Miller equation, 306
Mixtures
  phase equilibria, 254–263
    activity coefficients, 254–255, 257–261
    criteria, 263–265
    fugacity and fugacity coefficients, 254–257
    fugacity of solids, 261–263
  property change due to mixing, 249–251
  thermodynamic properties, 247–251
Molar density, units, 20–21
Molar distribution, gamma density function, 168–169
Molar refraction, 47, 225
Molar volume, 259–260
  units, 20
Molecular types, characterization parameters, 121–124
Molecular weight, 11
  comparison of distribution models, 178
  definition, 31
  estimation, 115–116
    evaluation of methods, 76–77
  petroleum fractions, 93–94
  prediction, pure hydrocarbons, 55–58
  units, 19
Moles, units, 19
Motor octane number, 34–35, 138
Multicomponent systems, diffusion coefficients, 350
Multisolid-phase model, 378, 382–385

N

n-d-M method, 126–127
Naphthalene, solubility, 277–278
Naphthas, 9
  GC chromatograph, 91
  research octane number, 140
Naphthenes, 4
Natural gas
  hydrate formation, 388
  pseudocritical properties, 160–161
  sulfur in, 5
  wet and dry, 6
Near-critical oils, 6
Newton-Raphson method, 380
Newton's law of viscosity, 331
NF M 07–048, 136
NF T 60–162, 10
NF T 60–101, 93
Nitrogen, prediction in petroleum fractions, 129–130
Nomenclature, 1
Nonane, equilibrium ratios, 281
Noncubic equations of state, 210–215
  Carnahan-Starling equation of state, 214–215
  modified Benedict-Webb-Rubin equation of state, 214, 217–220
  SAFT, 215
  second virial coefficients, 211–212
  truncated virial, 212–213
  virial equation of state, 210–214
Nonfuel petroleum products, 9–10
Nonhydrocarbon systems, extension of correlations, 54–55
Nonpolar molecules, potential energy, 45–46
Nonwetting fluid, 357
Numerical constants, 24

O

Octane
  equilibrium ratios, 280
  liquid heat capacity, 291
Octane number
  definition, 34–35
  petroleum fractions, 138–141
Oil, speed of sound in, 286
Oil field, 2
Oil reserves, 2
Oil wells
  history, 2
  number of, 3
Oils, enhanced recovery, 390–391
Olefins, 4
Oleum, 1

P

P-T diagrams, 372–373
Packing fraction, 214
Parachor, 358–359
Paraffins, 3–4
  content and research octane number, 141
  properties, 48
Partial molar properties, mixtures, 248–249
Partial specific property, 248
Pedersen exponential distribution model, 167
Peng-Robinson equation of state, 205–206, 208
  velocity of sound data, 289–292
Pentane, equilibrium ratios, 276–277
Percent average absolute deviation, 75
Petroleum, formation theories, 2
Petroleum blends, volume, 251
Petroleum cuts, 8
Petroleum fluids
  nature of, 1–3
  characterization, importance, 12–15
Petroleum fractions, 7–10, 87–146
  acentric factor, estimation, 115–116
  aniline point, 137
  average boiling point, 100–101
  boiling point and composition, 121
  boiling point and distillation curves, 88–93
  bulk parameters, 114
  carbon and hydrogen prediction, 127
  carbon number range approach, 186
  carbon residue, 141–142
  cetane number, 137–138
  cloud point, 135–136
  composition, 11
  compositional analysis, 95–99
  continuous mixture characterization approach, 187–189
  critical properties, estimation, 115–116
  defined mixtures, 114–115
  density
    estimation, 117
    specific gravity, and API gravity, 93
  diesel index, 137–138
  distillation
    at reduced pressures, 92–93
    columns, 8
    curve prediction, 108–111
  elemental analysis, 98–99
  elemental composition prediction, 127–130
  equilibrium flash vaporization, 91–92
  flash point, 133–135

freezing point, 136–137
gas mixtures, properties, 120
Gaussian quadrature approach, 185–186
ideal gas properties, 243–244
interconversion of distillation data, 101–108
kinematic viscosity, estimation, 118–119
laboratory data analysis, 145–146
liquid mixtures, properties, 119–120
lumping scheme, 186–187
matrix of pseudocomponents, 111–112
method of pseudocomponent, 114–115
minimum laboratory data, 143–145
molecular type prediction, 121–124
molecular weight, 93–94
molecular weight estimation, 76
narrow versus wide boiling range fractions, 112–114
nomenclature, 87
octane number, 138–141
olefin-free, 115
PNA analysis, 98
PNA composition, prediction, 120–127
pour point, 135–136
predictive method development, 145–146
pseudocritical properties, estimation, 115–116
Rackett equation, 223
refractive index, 94–95
estimation, 117
Reid vapor pressure, 131–133
simulated distillation by gas chromatography, 89–91
smoke point, 142
specific gravity, estimation, 117
splitting scheme, 184–186
sulfur and nitrogen prediction, 129–130
surface/interfacial tension, 359–360
thermodynamic properties, general approach, 298–300
true boiling point, 89
types of composition, 96
undefined mixtures, 114
vapor pressure, 312–314
viscosity, 99–100
using refractive index, 338
V/*L* ratio and volatility index, 133
Winn nomogram, 74
Petroleum processing, 17
Petroleum production, 17
Petroleum products
nonfuel, 9–10
quality, 143
vapor pressure, 313–314
Petroleum waxes, 10
Phase equilibrium, 365–393
asphaltene, precipitation, solid-liquid equilibrium, 385–388
enhanced oil recovery, 390–391
mixtures, 254–263
activity coefficients, 254–255, 257–261
criteria, 263–265
fugacity and fugacity coefficient, 254–257
fugacity of solids, 261–263
nomenclature, 365–366
pure components, 251–254
types of calculations, 366–367
vapor-solid equilibrium, 388–390
viscosity, 367–373
see also Vapor-liquid-solid equilibrium-solid precipitation
Phase rule, 199
Physical properties, 10–12
Planck constant, 24
PNA analysis, 98
PNA composition, prediction, 120–127
PNA three-pseudocomponent model, 115
Polarizability, 47
Porous media, diffusion coefficients, 350–351
Potential energy, nonpolar molecules, 45–46
Potential energy function, 202
Potential energy relation, two-parameter, 46, 48
Pour point, 11
petroleum fractions, 135–136
Poynting correction, 257
Prandtl number, 339
Pressure
triple point, 199
units, 19
Propane
compressibility factor, 289
equilibrium ratios, 273
The Properties of Gases and Liquids, 16
Properties of Oils and Natural Gases, 16
Pseudocomponent method, 320
Pseudocomponent technique, 112
Pseudocomponents
generation from Gaussian quadrature method, 185–186
matrix, 111–112
Pseudocritical properties, 12, 32
gas condensate, 160–161
natural gas, 160–161
Pseudoization, 184
Psuedocomponents, 13
Pure components, vapor pressure, 305–306
Pure compounds
critical thermal conductivity, 241
liquid thermal conductivity, 343
vapor pressure, coefficients, 308–309
viscosity coefficients, 333–334
Pure gases, fugacity, 268
calculation, 256–257
Pure hydrocarbons, 30–83
acentric factor, prediction, 64–65, 81
boiling point, prediction, 58–59
CH weight ratio, prediction, 68–69
characterization, 45–55
parameters, 48–50
criteria for evaluation of characterization method, 75–76
critical temperature and pressure, prediction, 60–62
critical volume, prediction, 62–63
data sources, 36–37
definition of properties, 31–36
density, prediction, 66
estimation of critical properties, 77–81
extension of correlations to nonhydrocarbon systems, 54–55
freezing/melting point, prediction, 68–70
generalized correlation for properties, 45–48
heavy, properties, 37, 44–45
kinematic viscosity, prediction, pure hydrocarbons, 70–73
molecular weight prediction, 55–58
nomenclature, 30
prediction of properties, recommended methods, 83
properties, 37–43
refractive index, prediction, 66–68
secondary properties, 41–43
specific gravity/API gravity prediction, 58–60
Winn nomogram, 73–75
see also Heavy Hydrocarbons
PVT relations, 199–202
critical point, 46
intermolecular forces, 202–203
nomenclature, 197–198
Rackett equation, 222–225

Q

Quadratic mixing rule, 209

R

Rachford-Rice method, 368
Rackett equation, 222–225, 301
pressure effect on liquid density, 223–225
pure component saturated liquids, 222–223
Rackett parameter, 222
Raoult's law, 188, 265–267
Real gases, equations of state, 203–204
Redlich-Kister expansion, 257
Redlich-Kwong equation of state, 46, 205, 226–227, 300
velocity of sound data, 289–292
Refining processes, 7
Refractive index, 11
basis for equations of state, 225–227
C_{6+} fraction, 180
definition, 32
estimation, 117
heat capacity estimation from, 321–322
heavy hydrocarbons, 44
parameter
relation to fluidity, 352
relation to diffusivity, 353
petroleum fractions, 94–95
pure hydrocarbons, prediction, 66–68
Refractivity intercept, 11
definition, 35
Reid vapor pressure, 11, 33, 131–133
Reidel method, 63
Relative volatility, 14
effect of error, 14
Research octane number, 34–35, 138
Reservoir fluids, 2, 5–7
composition and properties, 6–7
C_{7+} fractions, characteristics, 163–164
definition, 5
diffusion coefficients measurement, 354–356
flash calculation, 369
laboratory data, 153–155
lumping scheme, 186
nomenclature, 152–153
properties calculation, 189–191
single carbon number groups, characteristics, 161–163
types and characteristics, 6
Residual enthalpy, 237
Residual Gibbs energy, 237–238
Residual heat capacity, 238
Resins, 374–375
Retention time, 90
Retrograde condensation, 202
Riazi-Daubert correlations, 58, 78–80
Riazi-Daubert methods, 55–57, 58–60, 62, 102–103, 124–126
Riazi-Faghri method, 341, 343

Riazi method, 127
Riedel equation, 313, 323
Riedel method, 342

S

SAFT model, 386
Saturation curves, ethane, 209
Saturation pressure, thermodynamic properties, 251– 254
Saybolt viscosity, 35
Scatchard-Hildebrand relation, 258, 261
Schmidt number, 345
SCN groups
  characteristics, 161
  exponential model, 165–167
  molecular weight boundaries, 168
Self-diffusion coefficient, 345
Sensitivity of fuel, 138
Separation by solvents, 96
Shear stress, 331
Shift parameter, 208
SI units, 18
Size exclusion chromatography, 93–94
Smoke point, petroleum fractions, 142
Solid-liquid equilibrium, 385–388
Solid solubility, 276–281
Solid solution model, 378, 380–382
Solids
  density, 304–305
  fugacity calculation, 261–263
  vapor pressure, 314–316
Solubility, 259–260
Solubility parameter, units, 24
Solvents, 9
Soreide correlation, 58
Sound velocity
  equations of state based on, 286–287
  Lennard-Jones and van der Waals parameters, 288–289
  prediction of fluid properties, 284–292
  RK and PR EOS parameters, 289–292
  virial coefficients, 287–288
Specific energy, units, 22
Specific gravity, 11
  comparison of distribution models, 178–179
  definition, 31
  estimation, 117
  hydrocarbon-plus fractions, 173
  hydrocarbons, temperature effect, 301
  petroleum fractions, 93
  prediction, pure hydrocarbons, 58–60
  units, 21
Specific volume, units, 20
Spectrometric methods, 98
Speed of light in vacuum, 24
Splitting scheme, petroleum fractions, 184–186
Square-Well potential, 202
Standing-Katz chart, 215–216
Stiel-Thodos method, 341
Stokes-Einstein equation, 349
Sublimation, 314
Sublimation curve, 200
Sublimation line, 251
Sublimation pressure, 315
Sulfur
  crude oil content, 191–192
  in natural gas, 5
  prediction in petroleum fractions, 129–130
Supercritical fluid, 200
Surface/interfacial tension, 12, 356–361
  predictive methods, 358–361
  theory and definition, 356–358
  units, 24

T

Temperature
  triple point, 199
  units, 19, 19–20
Tensiometer, 357
Thermal conductivity, 12, 339–345
  critical, 341
  gases, 339–342
  liquids, 342–345
  versus temperature, 340
  units, 23
Thermal conductivity detector, 90
Thermodynamic properties, 232–292
  boiling point, elevation, 282–284
  calculation for real mixtures, 263
  density, 300–305
  departure functions, 236–237
  enthalpy, 316–318
  freezing point depression, 281–283
  fugacity, 237–238
  generalized correlations, 238–241
  heat capacity, 319–321
  heat of combustion, 324–326
  heat of vaporization, 321–324
  heats of phase changes, 321–324
  ideal gases, 241–247
  measurable, 235–236
  mixtures, 247–251
  nomenclature, 232–234
  property estimation, 238
  residual properties, 236–237
  saturation pressure, 251–254
  solid-liquid equilibria, 276–281
  summary of recommended methods, 326
  use of sound velocity, 284–292
  vapor-liquid equilibria, 265–276
Thermodynamic property, 199
Time, units, 18–19
Toluene, effect on asphaltene precipitation, 377–378
Tortuosity, 350–351
Transport properties, 329–362
  diffusion coefficients, 345–351
  diffusivity at low pressures
    gases, 346–347
    liquids, 347–348
  diffusivity of gases and liquids at high pressures, 348–350
  interrelationship, 351–354
  measurement of diffusion coefficients in reservoir fluids, 354–356
  nomenclature, 329–330
  surface/interfacial tension, 356–361
  thermal conductivity, 339–345
  viscosity, 331–338
Triple point pressure, 199
Triple point temperature, 199
Trouton's rule, 322
True boiling point, distillation curve, 182
True critical properties, 372–373
Tsonopoulos correlations, 62
Two petroleum fractions, enthalpy, 316–317
Twu method, 61–62, 80

U

Units
  composition, 21–22
  conversion, 25
  density, 20–21
  diffusion coefficients, 23–24
  energy, 22
  force, 19
  fundamental, 18
  gas-to-oil ratio, 24
  importance and types, 17–18
  kinematic viscosity, 23
  length, 18
  mass, 18
  mass flow rates, 20
  molar density, 20–21
  molecular weight, 19
  moles, 19
  prefixes, 18
  pressure, 19
  rates and amounts of oil and gas, 24–25
  solubility parameter, 24
  specific energy, 22
  specific gravity, 21
  surface tension, 24
  temperature, 19–20
  thermal conductivity, 23
  time, 18–19
  viscosity, 23
  volume, 20
  volumetric flow rates, 20
UOP characterization factor, 13

V

Van der Waal equation, 204–205
Van der Waals parameters, velocity of sound data, 289
Van Laar model, 257–258
Vapor, 200
Vapor-liquid equilibria, 251–253, 265–276
  equilibrium ratios, 269–276
  formation of relations, 265–266
  Raoult's law, 265–266
  solubility of gases in liquids, 266–269
Vapor-liquid equilibrium calculations, 367–373
  bubble and dew point calculations, 370–372
  gas-to-oil ratio, 368–370
  P-T Diagrams, 372–373
Vapor liquid ratio, volatility index and, 133
Vapor-liquid-solid equilibrium-solid precipitation, 373–385
  heavy compounds, 373–378
  wax precipitation
    multisolid-phase model, 382–385
    solid solution model, 378, 380–382
Vapor pressure, 11, 200, 305–316
  Antoine coefficients, 310
  definition, 33
  petroleum fractions, 312–314
  predictive methods, 306–312
  pure components, 305–306
  pure compounds, coefficients, 308–309
  solids, 314–316
Vapor pressure method, 94
Vapor-solid equilibrium, 388–390
Vignes method, 347
Virial coefficients, velocity of sound data, 287–288

Virial equation of state, 210–214
  truncated, 240
Viscosity, 12, 331–338
  gases, 331–335
  heavy hydrocarbons, 44
  liquids, 335–338
  petroleum fractions, 99–100
  pressure effect, 334
  versus temperature, 332
  units, 23
Viscosity-blending index, 337
Viscosity coefficients, pure liquid compounds, 336–337
Viscosity gravity constant, 11
  definition, 35–36
Viscosity index, 122–124
Viscosity-temperature relation, 72
Volatility, properties related to, 131–135
Volatility index, and vapor liquid ratio, 133
Volume, units, 20
Volume translation, cubic equations of state, 207–208
Volumetric flow rates, units, 20

W

Walsh-Mortimer method, 137
Water
  ideal gas heat capacity, 242–243
  vapor pressure, 312
Watson characterization factor, 320
Watson *K*, 11, 13, 323
  definition, 35
Wax appearance temperature, 378, 382
Wax precipitation
  multisolid-phase model, 382–385
  solid solution model, 378, 380–382
Waxes, 373
Wet gas, 6
Wetting liquid, 357
Wilke-Chang method, 347
Wilson correlation, 273
Winn method, 137
Winn-Mobil method, 62
Winn nomogram, 73–75
Won model, 380

X

Xylene, vapor pressure, 311