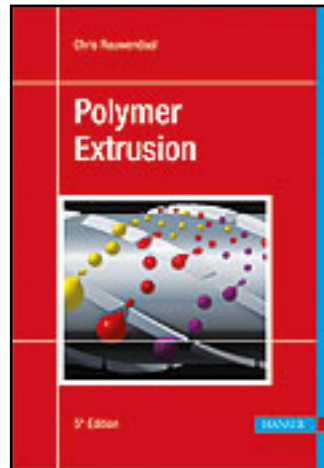




Stichwortverzeichnis

Chris Rauwendaal

Polymer Extrusion

ISBN (Buch): 978-1-56990-516-6

For further information and order see

<http://www.hanser-fachbuch.de/978-1-56990-516-6>

or contact your bookseller.

Index

Numeric

4-mode Giesekus model 891

A

abrasive wear 787
absorptivity 170
AC drive systems 49
– adjustable frequency drive 49
– adjustable transmission ratio drive 49
actual energy requirement 34
actual stock temperatures, and degradation 811
adiabatic temperature 401
adjustable frequency drives 49, 51
adjustable groove depth 299
adjustable grooved feed extruder 297
adjustable transmission ratio drive 49
air entrapment
– solutions to 834
analytical solution 862
analytical techniques 862
angle of repose 193
apex area 730
Archimedean solids transport 269
arching 268
arching or bridging in hopper flow 260
area draw ratio (ADR) 672
AutoCAD™ 878
autogenous process 78
automatic gel detection methods 839
automatic reset 123, 124
autoscreen 74
average flow velocity in the thin section 660
Avogadro's number 158
axial mixing (backmixing) 483, 484

B

backmixing (axial mixing) 483, 484
– prevention 488
“back relieving” the land 658
balance by channel height 659

Banbury type mixer 871, 885
– modeling 871
– simulating 873
barrel temperature measurement 100
barrier flight extruder screws 569
– patent history 569
Barr screw 575
basic guidelines in profile design 654
batch extruders 2
BEM simulation 611
Bessel functions 725
best straight line (BSL) 93
bimetallic barrels 67
Bingham model 213
Biot number 167, 424
blister ring 587, 618
blown film extrusion 676
BMK mixer *see* SMV mixer
Boltzmann constant 169
boundary element method (BEM) 610, 653, 872
breakdown force 470
breaker plate 72
Brinkman number 164, 638
Brownian motion 469
brushless DC drives 55
BT mixer 585
buckling 515
bulk density 191, 193
bypass vented extruder 559

C

calibrator 692
– external calibrators 693
– internal calibrator 693
– slide calibrator 692
– Technoform process 694
– vacuum calibrator 692
CAMPUS, Computer Aided Material Preselection 249
cantilever 515
capacitance measurement 112
Capillary (or Weber) number 874
capillary rheometer 223
– melt index tester 223

- capillary transducers 89
 - Carreau model 213
 - cascade devolatilization 562
 - Cauchy's equation 150
 - cavity transfer mixing (CTM) 620
 - chain drives 50
 - change-over 23
 - time 23
 - channel depth 537
 - characterization of the mixture 442
 - chemical degradation 805
 - Chris Rauwendaal Dispersive (CRD) 908
 - Chung 5
 - classification of polymer extruders 14
 - classification of twin screw extruders 25
 - clearance 70, 350
 - closely intermeshing co-rotating (CICO) twin screw extruder 701
 - closely intermeshing counter-rotating extruder (CICT) 702, 720
 - closely self-wiping co-rotating extruders (CSCO) 705
 - coalescence 479
 - coat hanger die 664, 666
 - coaxial twin screw (CTS) extruder 743
 - coefficient of cohesion 193
 - coefficient of friction 195, 290
 - of the bulk material 194
 - coefficient of variation (COV) 464
 - coextrusion 686
 - color concentrates (CC) 614
 - color measurement 116
 - commercial twin screw machinery 749
 - common screw materials 70
 - european equivalents 70
 - comparison of various temperature sensors 98
 - comparison, type of thrust bearings 65
 - compatibilizers 480
 - compression characteristics of bulk materials 194
 - compression mold filling simulation 868
 - compression ratio (X_c) 518, 536
 - computer aided engineering 3
 - computer simulation 610
 - melting theories 332
 - conservation of energy 864
 - conservation of mass 864
 - conservation of momentum 864
 - "constant torque" characteristic 60
 - constructing a timeline 765
 - contiguous solids melting (CSM) 304, 333
 - continuous extruders 2, 13, 28
 - disk extruders 28
 - controllers, factory-tuned and non-adjustable parameters 139
 - controller transfer curve (power input curve) 122
 - control volume approach (CVA) 870
 - conventional extruders 23
 - conventional multi-flighted screw 568
 - conveying mechanism 33
 - conveying process, self-wiping extruders 713
 - co-rotating extruders, screw geometry 708
 - corrosive wear 788
 - Couette flow 169 *see* drag flow
 - Couette shear rate 405, 520, 594
 - Coulomb friction 260
 - crammer feeders 68, 258
 - CRD (Chris Rauwendaal Dispersive mixing) barrier screw 581
 - CRD fluted mixer 586, 603, 613, 614
 - critical screw speed 400
 - critical tensile deformation rate range 675
 - critical Weber (Capillary) number 475
 - cross-channel flow 361
 - crosshead die 669
 - crosslinking 1
 - cross-sectional mixing 483
 - CT mixer 621
 - cumulative residence time distribution (CRTD) 904
 - curved plate model 277
 - cylindrical coordinate system (CCS) 413
- D**
- data acquisition systems (DAS) 769
 - DC brush motor 776
 - dead spots 675
 - degradation 245
 - polymer 624, 626
 - reducing 819
 - del Pilar Noriega 5
 - design parameters for spiral mandrel die 679
 - determinant, det 211
 - developing melt temperatures 390
 - devolatilization 175, 180, 435, 554
 - continuous 745
 - efficiency 830
 - particulate polymer 180
 - polymer melts 181
 - devolatilizing extruder screws 553
 - diameter draw ratio (DDR) 672
 - diaphragms 92
 - die 72
 - die assembly 72
 - die drool *see* die lip build-up
 - die flow instabilities 431
 - die flow problems 843
 - die forming zone 419
 - die geometry, effect on flow distribution 680
 - diehead pressure 87, 419
 - dielectric heating 171
 - die lip build-up 845
 - dies, film and sheet 663
 - die swell *see* extrudate swell

- die temperature adjustment 665
 - differences in screw design 753
 - differential thermal analysis (DTA) 247
 - dilatant fluid 205
 - dimensional analysis 161
 - dimensionless numbers 161, 163
 - dimensionless throughput 364
 - dimensionless viscosity 423
 - discharge screw (crammer feed) 778
 - discolored specks 846
 - in the raw material 837
 - discontinuous extruders 2, 13
 - disk extruder *see* screwless extruder
 - diskpack extruder 31
 - spiral disk extruder 31
 - stepped disk extruder 28
 - dispersed solids melting (DSM) 304, 333, 617
 - Dispersive/Distributive Static Mixer (DDSM) 911
 - CRD mixing technology 463
 - dispersive mixers 604, 618
 - dispersive mixing 469
 - elements 584
 - liquid-liquid systems 471
 - distributive mixers 623
 - distributive mixing 441, 619
 - double wave mixing screw 601, 622
 - down channel velocity 863
 - drag flow 202
 - of power law fluids 374
 - rate 635
 - term 43
 - drag induced solids conveying 270
 - draw ratio balance (DRB) 673
 - draw resonance 434, 823
 - Dray and Lawrence screw 578
 - Dray fluted mixing section 587
 - drop rupture 467
 - drum extruder 30
 - DSM process *see* dispersed solids melting theory
 - dual output temperature controllers 128
 - dual reciprocity boundary element method (DRM) 874
 - dual sensor temperature control 125
 - Dulmage mixing section 619
 - dynamic analysis 231
 - dynamic process model 141
 - dynamic testing of pressure transducers 94, 95
- E**
- effective angle of friction, β_e 199
 - effective yield locus (EYL) 198
 - Egan mixing section 587
 - E-gels 839
 - Ehring model 213
 - elastic encapsulation 691
 - elastic melt extruder 35
 - elastomers 1
 - electric friction clutch drive 50
 - electric heating 75
 - electric resistance heaters 75
 - electronic data acquisition systems (DAS) 625
 - electronic integrator 123
 - Ellis model 213
 - elongation 203
 - elongational deformation 203
 - elongational flows
 - shear-free flows 871
 - elongational viscosity 205
 - empirical identifications technique 142
 - deterministic functions 142
 - stochastic (random) identification functions 142
 - energy balance equation 151, 242
 - energy consumption 23
 - energy efficiency for pressure generation 34, 43
 - Energy Transfer (ET) screws 622, 893
 - entropy 155, 157
 - equation of continuity 149
 - equation of motion *see* momentum balance equation
 - equilibrium melt temperature *see* fully developed melt temperature
 - equivalent spherical diameter (esd) 200
 - Esde 22
 - E-speck 846
 - Euler equation 150
 - extended mandrel 674
 - extensional flow mixer (EFM) 602
 - extensive mixing 441
 - external coefficient of friction 194
 - extrudate swell *see* die swell
 - extrudate thickness, measure 110
 - extruder 1
 - barrel 64
 - cooling 77
 - extruder drive 49
 - AC motor drive systems 49
 - DC motor drive systems 49
 - hydraulic drives 49
 - extruder screw 13, 70
 - functions 626
 - extruder screw for rubber
 - EVK screw (Wener & Pfeiderer) 20
 - Pirelli rubber extruder screw 19
 - Plastiscrow 19
 - QSM Extruder 20
 - Transfermix 20
 - extruders without gear reducer 23
 - extrusion instabilities 820
 - solutions to 833

F

Farrel continuous mixer (FCM) 742
 feedback ratio 436
 feed block dies 686
 feed-controlled extrusion 7
 feed hopper 68
 feed port design 65
 feedstock properties 767
 feed throat 64
 F-H relationship *see* Flory-Huggins relationship
 fibrillation 482
 Fick's law 175
 filtration systems 74
 finite element analysis (FEM) 653, 800
 finite element fluid dynamics analysis package,
 FIDAP 872, 892
 first law of thermodynamics 151, 153
 fishtail die 663
 five-layer blown film coextrusion dies 687
 flash devolatilization 182
 flat plate model 275
 flat plate system (FPS) 208, 877
 flat slanted flight flanks
 – trapezoidal flight geometry 279
 flat three-plate model 734
 flex lip adjustment 664
 flight flank 347
 flight geometries 514, 539
 flood feeding 7, 302, 831
 Flory-Huggins (F-H) relationship 177
 Flow Analysis Network (FAN) 869
 flow behavior of polymer melt 653
 flow distribution 682
 flow function 270
 flow number 610
 – distribution 881
 flow patterns 699
 flow rate 43, 265, 415
 fluoropolymers 673
 flux vector (FV) 52
 form factor 54
 Fortran program 363, 493
 Fourier number 168, 310
 Fourier's law of heat transfer 152, 160, 176
 four-motor CMG torque drive 22
 four-screw extruder 26
 Frequon 173
 frictional heat 67
 – generation 282, 290
 frictional properties, polymer 196
 friction, attributions 195
 fully developed melt temperature *see* equilibrium
 melt temperature
 functional instabilities 828
 funnel flow 260
 funneling 268

G

Gaussian elimination 865
 gear pump extruder 27
 gear reducer 23
 gel 836, 837, 839
 – content 836
 – crosslinked 840
 – defects with discoloration 838
 gelation 836
 general characteristics of the standard extruder 549
 Generalized Newtonian Fluids (GNF) 870
 geometrical encapsulation 691
 geometrical relationships 257
 geometry, extruder screw 255 *see* single stage
 – feed section of screw 13
 – metering section (pump section) 13
 – transition section (compression section) 13
 Gibbs free energy 159
 gloss 853
 gloss, quantitative measurement 115
 GMP, good manufacturing practices 625
 G-process 676
 Graetz number 166, 638
 gravity flow 261, 266
 grooved barrel sections 66, 284, 288
 grooved feed extruder 296
 grooves, number 682
 grooves, wear 286

H

hardfacing or hardsurfacing 794
 hardfacing techniques 644
 – laser hardfacing 646
 – metal inert gas (MIG) welding 646
 – oxyacetylene welding 644
 – plasma transfer arc (PTA) welding 645
 – tungsten inert gas (TIG) welding 645
 haze 853
 – and luminous transmittance of transparent plastics,
 measurement 115
 HDPE 39
 – melt extruded, properties 39
 – solid-state extruded, properties 39
 heating extruders 75
 – electric heating 75
 – fluid heating 75
 – steam heating 75
 heat transfer 160
 – conductive heat transfer 160
 – convective heat transfer 161
 helix angle 532, 538, 578, 594, 683
 Henry's law 177
 Henry's law constant 177
 high-frequency instabilities 821
 high-pressure extrusion 669

high speed co-rotating twin screw extruders, compared
to low speed twin screw extruders 698
high-speed extrusion 22
high-speed single screw extruders (HS-SSE) 22, 23
high stress region, HSR 602
high-viscosity polymers 23
Hi-mixer 463
history of polymer extrusion 6
homopolymers 245
horseshoe die 667
hot-stage microscopy (HSM), to characterize
gels 840
hydraulic drive
– hydrostatic drive 55
hygroscopic resins 564
hysteresis 93, 118
– curve 118

I

improper screw geometry 509
increase in the screw diameter 802
induction time 245
infrared (IR) heating 171
infrared (IR) melt temperature measurement 106
infrared (IR) sensors 98
infrared thermometer 768
Ingen Housz barrier screw 581
initial scale of segregation 832
inner melt removal (IMR) 744
instrumentation 85, 86
insufficient melting capacity 829
insufficient mixing capacity of the screw 831
integrator 123
interface distortion 690
intermeshing co-rotating extruders 701
intermeshing twin screw extruder (TSE) 304, 862
internal coefficient of friction 194
ion-nitriding 67
iron-constantan thermocouple (TC) 98
ISG mixer 461
ITX 5

J

Janssen model 481

K

K-BKZ model 884
Kelvin model 871
Kenics mixer 462
Kennaway 19
Kim screw 579
kinematic viscosity 167
Kirchhoff's law 170

L

laminar mixing (laminar flow) 457
land length 657, 673
leakage 722
leakage flow 350
LeRoy/Maddock mixer 585
light microscope 772
linear low-density polyethylene, LLDPE 546
linear variable differential transformer (LVDT) 110
lines in extruded product 851
liquid crystalline polymers (LCPs) 853
lobal mixing 603
low-frequency instabilities 826

M

machinery, wear 780
Maddock mixing section 585
Maddock or LeRoy dispersive mixing section 905
magneto-strictive ultrasound transducer 112
Maillefer extruder screw 572, 573
mass balance equation 149
mass flow (hopper flow) 260
material consumed in the change-over 24
mathematical modeling 610
maximum melting efficiency 571
maximum normal stress 512
maximum shear stress 513
maximum stress 511
Maxwell model 871
“MC3” and “MC4” screw 576
mechanical adjustable speed (MAS) 50
mechanical adjustment of the die flow channel 655
mechanical degradation 804
mechanical specific energy consumption 23
medical devices, molecular degradation 630
medical extrusion 624
– automation 625
– good manufacturing practices (GMP) 625
– requirements 625
medical tubing 672
melt conveying of isothermal fluids 342
melt conveying or pumping problems 830
melt conveying theory of Newtonian fluids 440
melt fracture 432, 822, 843, 844
melt index (MI) 223
melting mechanism, for diskpack
– dissipative melt mixing (DMM) 34
– drag melt removal (DMR) 34
melting models 326
melting point 245
melting rate for a non-zero clearance 534
melting theory for temperature-dependent fluids
319
melting zone (plasticizing zone) 103

melt pressure 86, 87
 melt pressure control systems 141
 melt temperature 22
 – distribution 627
 – parameters 407
 – variations 628
 membrane stretching model during blow molding and thermoforming 869
 mesh editing procedure
 – dynamic mesh generator 868
 mesh generation scheme 869
 mesh superposition technique (MST) 896
 metallic filter medium 73
 metallocenes 546
 metal-to-metal wear 789
 mettalic filter medium
 – relative performance comparison 73
 microwave heating 173
 minimum set of instrumentation 85
 mixing 441
 – element 584
 – of immiscible fluids in a twin screw extruder 482
 – zone in the extruder 442
 modeling, linear control system 130
 molecular weight (MW) 624
 – reductions 624
 momentum 150
 – convection of momentum 150
 momentum balance equation 150
 moving boundaries 861
 – moving free boundaries 861
 – moving solid boundaries 861
 multi-flighted screw geometry 568
 multiflux mixer 460
 multi-manifold external-combining dies 688
 multi-manifold internal combining dies 686
 multi-manifold sheet die 688
 multi-screw extruder 878
 multi-vent devolatilization 561

N

Nahme number 321, 324
 – also Griffith number 167
 Newtonian flow rate equation 528
 Newtonian fluids 205, 210, 343, 367
 Newton-Raphson method 542
 nitriding 67
 – gas nitriding 67
 – liquid bath nitriding 67
 noise level 23
 non-intermeshing twin screw extruders 730
 – are counter-rotating (NOCT extruders) 730
 non-Newtonian and non-isothermal, polymer melt 316
 non-Newtonian fluid 205, 210
 non-return valve (NRV) 615

nuclear radiation sensors 113
 numerical techniques 864
 – boundary element method (BEM) 867
 – finite difference method (FDM) 865
 – finite element method (FEM) 866
 Nusselt number 166

O

objective of an extrusion die 654
 offset 121, 124
 one-dimensional flow analysis 356
 one-dimensional power law analysis 525
 on-off controller 133
 on-off control of temperature 117, 118
 on-off differential 118
 optical properties 853
 optimize the channel depth and helix angle 521
 optimizing output 519
 optimum channel depth 519
 optimum channel depth H^* 542
 optimum helix angle ϕ^* 541
 optimum screw geometry for melt conveying 519
 oxidative degradation 806

P

“pancake” coextrusion die 687
 parallel flights 532
 parallel plate analysis with moving barrel 411
 particles
 – broken solids 201
 – granules 201
 – pellets 201
 – powders 201
 – semi-free-flowing granules 201
 particle size 200
 Peclet number NP_e 166, 389, 439
 PET powder 564
 Petrov-Galerkin technique 882
 P-gels 839
 piezoelectric pressure transducers 90, 93
 piezoelectric ultrasonic transducer 112
 piezo-resistive pressure transducers 91
 piezo-resistive transducer 88
 pineapple mixer 620
 pin mixing section 619
 pipe dies 668
 piping 260
 Planck constant 169
 Planck’s law of radiation 169
 planetary roller extruder 25
 plasticating 548, 551, 562
 plasticating extrusion 2
 plasticating instabilities 829
 plasticating zone *see* melting zone

plug flow 203
 – zone 261
 plugging 536
 pneumatic pressure transducers 90
 Poiseuille equation 187
 Poiseuille flow 169
 Poisson ratio 244
 polymer degradation 803
 polymer density ρ 236
 polymer processing aids (PPA) 843
 polymers 1, 2, 219
 – elastomers 1
 – thermoplastics 1
 – thermosets 1
 polypropylene 23
 polystyrene 23
 polytetrafluoroethylene (PTFE)
 – extrusion of 37
 portable data collectors (PDCs) 769
 portable machine analyzers (PMAs) 769
 positive displacement 699
 positive displacement devices 27 *see* gear pump
 extruder
 Potente 5
 power consumption (z) 43, 353, 391, 540
 – in the melting zone 330
 – measurement 108
 power conversion unit (PCU) 776
 power factor 108
 power law equation 209, 212, 216
 power law fluid 356, 588
 power law index 209, 529
 power law model 870, 872
 power law of Ostwald and de Waele *see* power law
 equation
 Prandtl number 167
 pressure differential (ΔP) 512
 pressure distribution 262
 pressure drop 465, 596, 601
 pressure flow 202
 pressure flow rate through a triangle 735
 pressure flow term 43
 pressure transducers 88, 89, 90, 91, 92
 – selection 93
 problem-solving process 763
 process model 137, 138
 process monitoring, of wear 850
 process reaction curve
 – response curve 128
 process transfer curve 122
 ProEngineer™ 878
 profile dies 684
 profile extrusion 684
 profiling 691
 profitability of an extrusion operation 23
 properties of the bulk material 191

proportional band 119, 120, 123
 proportional control 123
 proportional controller 119, 123
 proportional plus integral (PI) controllers 124
 proportional plus integral plus derivative (PID) control
 system 124
 – PID controller 136
 P-speck 846
 Pulsar mixer 622
 Pulsar mixing section 622
 pumping efficiency in diskpack extruder 42
 pump ratio (X_p) 555
 pushrod transducer 88
 pyrometer 768

R

Rabinowitsch and Weissenberg, fluid relationship 213
 Rabinowitsch correction 222
 Rabinowitsch equation 213
 radial clearance 543, 544
 radiation, absorption 113
 radio frequency heating *see* dielectric heating
 ram extruder
 – multi-ram extruder 41
 random fluctuations in instability 827
 rapid flow 260
 rate of solids melting 863
 Rayleigh disturbances 472
 reaction-curve method 138
 rear valving 559
 rearward devolatilization 560
 rebuilding extruder barrels 646
 rebuilding extrusion equipment 642
 reducer 59
 reducing gel formation in the extruder 840
 reduction in noise level 23
 residence time 23, 24, 449
 – distribution functions (RTD) 455, 466, 485, 807
 resistance temperature (RT) curve 97
 resistive temperature sensors
 – conductive-type temperature (RTD) 97
 – semiconductor type 97
 resonance frequency 516
 Reynolds number 163
 rheological models 887
 rheological properties 191
 rheometer 220
 – capillary rheometer 220
 – cone and plate rheometer 227
 – slit die rheometer 228
 rheopectic 219
 rhomboid mixing section 902
 roller die 21
 rotating drum devolatilizer (RDD) 564
 rotational speed, measure 109

RPVC extrusion 837
 rubber elasticity, theory 157
 rubber extruders 17
 – cold feed 18
 – hot feed 18

S

sag at the end of the screw 514
 Saxton mixer 619, 620
 Saxton mixing section 609
 scale-up 635, 641
 – factors 639
 – method 635
 scanning and sorting (S & S) system 847
 screen
 – autoscreen system 74
 screens 72 *see* metallic filter medium
 screw beat 825
 screw binding 797
 – problems 802
 screw extruders
 – multi screw 13
 – single screw 13
 screw frequency instabilities 825
 screw geometry 540
 screwless extruders 28
 – drum extruder 30
 screw, outside diameter (O.D.) 849
 screw shank, rear vacuum seal round 69
 screw wear 849
 second law of thermodynamics 156
 Secor's model for devolatilization in co-rotating twin screw extruders 745
 self-tuning temperature controllers 140
 self-wiping co-rotating twin screw extruders 705
 setpoint 119, 121, 133
 shark skin 431, 821
 shear 202
 – rate 203
 – strain 204
 – – rate 870
 – strength 197
 – stress 43
 – viscosity 204
 sheet extrusion 853
 shish-kebab crystal morphology 238
 short extruder 829
 short residence times 24
 simple conveying screws 629
 simple proportional controller 123
 simulating a mixing process 868
 simulating polymer processes 861
 simulation 873, 912
 single screw extruders (SSE) 22
 single screw extrusion 22
 single screw residence time distribution (RTD) 487
 single stage 13
 sinh law 213
 six-step variable voltage inverter 52
 slenderness ratio 513
 slide-plate screen changers 73
 slot flank angle 610
 slot geometry 609
 slotted mixing sections 620
 slow fluctuations in instability 827
 slow frictional flow 260
 SMV mixer *see* BMK mixer
 solids conveying 6, 192, 537, 562
 – angle θ 272, 277
 – instabilities 829
 – rate 286, 637
 – zone 258
 solids draining screw (SDS) 744
 solid-state extrusion 38
 – direct solid-state 38
 – hydrostatic 38
 spatial finite difference formulation 869
 specifications on pressure transducers 93
 specific energy consumption (SEC) 23, 301, 542, 850
 specific enthalpy 241
 specific extruder throughput (SET) 850
 specific heat 239
 spherulitic crystal morphology 238
 spiral disk extruder 31
 spiral mandrel die 671, 676, 678
 square feed hoppers 68
 square pitch extruder screw 509
 standardize evaluation and testing of temperature sensors 105
 standard or conventional extruder screw 23, 549
 Staromix mixer 621
 starve feeding 303, 831
 state-of-the art techniques 862
 static coefficient of friction 194
 static mixers, geometry 460
 static mixer, simulation 910
 static mixing 459
 stationary screw, barrel rotates, assumption 411
 statistical process control (SPC) 625
 statistical rated life of a thrust bearing, formula 62
 Stefan-Boltzmann law 169
 stock temperature measurement 102
 – flush-mounted temperature sensor 104
 – straight immersion temperature sensor 104
 Stokes drag force 479
 strain distribution functions (SDF) 455
 strain gauge transducer 88
 strain-induced crystallization 159
 strain rates, and degradation 811
 Strata-blend mixer 623
 super-extrusion 843, 844

T

Tadmor melting model 326
 taper angle 674
 T-die 663
 Technoform process 694
 temperature 86
 temperature controller 126
 – analog 126
 – digital 126
 temperature control system 116
 – closed loop 116
 – feedback 116
 temperature measurement 96
 – radiation pyrometers 97
 – resistive temperature sensors 97
 – thermocouple temperature sensors 97
 temperature profiles 367, 420
 test methods for P-gels 839
 test methods for wear 782
 The Madison Group 610
 thermal analysis techniques 775
 thermal barrier 65
 thermal characteristics of the system 128
 thermal characterization 247
 thermal conductivity 234, 235
 thermal degradation 803
 thermal diffusivity 167, 242
 thermal homogenization 467
 thermal optical analysis (TOA) 248
 thermal properties 191, 233
 thermal stability 23
 – of a polymer 246
 thermal time distribution 467
 thermistors 97
 thermochromic materials 774
 – for temperature related problems 773
 thermochromic powders 774
 thermocouple (TC) temperature sensors 97–99
 thermodynamics 153
 thermoelectric effect 97
 thermoelectric transducers 97
 thermogravimetric analyzer (TGA) 247
 thermomechanical analysis (TMA) 248
 thermoplastics 1
 thermosets 1
 thixotropic 219
 three-dimensional BEM package 610
 three-dimensional finite element simulation, FIDAP™ 885
 three-dimensional models 861
 three-dimensional simulation 885
 three-phase full wave rectifier 54
 three-stage extruder screw 562
 throttle ratio, ratio between pressure flow to drag flow 43, 353

thrust bearing assembly 61
 time constant of the closed-loop system 132
 timeline, leading up to problem 765
 time-proportioning power controller 126
 tipstreaming 477
 torque 510
 torque (T) 207
 torsional braid analysis (TBA) 248
 total flight width (pw) 544
 total process control 140
 total strain 453
 tracking tracer ink 872
 transfer function for a reverse-acting controller 119
 transparency 853
 troubleshooting 763
 – feeding system 778
 – heating and cooling system 778
 – machine-related problems 776
 – tools 768
 Troubleshooting the Extrusion Process, book 763
 true proportional power controller
 – current proportioning controller 126
 – phase-angle-fired proportional controller 127
 true total extrusion process control 141
 tubing 671
 – dies 668
 Turbo-Screw™ 620, 906
 Twente Mixing Ring (TMR) 621
 twin ram extruder 41
 twin screw devolatilization systems 561
 twin screw extruder (TSE) 22, 24, 895
 – advantages over single screw extruders 697
 – characteristics 699
 two-dimensional BEM analysis 610
 two-dimensional flow analysis 361
 two-dimensional power law analysis 525
 two-stage devolatilizing extruder screw 554
 types of mixing motion
 – convective motion 441
 – molecular diffusion 441
 – turbulent motion 441

U

ultrahigh molecular weight polyethylene (UHMWPE)
 – extrusion of 37
 ultrasonic transducers 112
 ultrasonic transit time (“Laufzeit”) 113
 ultrasonic vibration 843, 844
 ultrasound transmission time (UTT) 105
 understanding of the extrusion process 764
 uniformity 690
 Union Carbide (UC) mixing section 585

V

vacuum feed hopper 69
 variable decreasing pitch (VDP) 19
 variable depth mixers 622
 variable pitch extruder screw 550
 variable reducing pitch (VRP) screw 551
 velocity patterns 699
 velocity profiles 379, 420, 715
 – for a Newtonian fluid 42
 vented extruders 16
 – with axial adjustment capability of the screw 559
 vernier screw mechanism 50
 viscoelastic fluids 653
 viscometric flow 210
 viscosity, and pressure 214
 viscosity, and temperature 214
 viscous dissipation 390
 viscous encapsulation 691, 889, 891
 viscous flow *see* rapid flow
 viscous heat generation 168
 viscous heating 800
 Voight model 871
 volumetric melt conveying rate for a Newtonian fluid 519

W

wall draw ratio (WDR) 672
 wear
 – abrasive 787
 – causes of wear 787
 – corrosive 788
 – five mechanisms of wear 781
 – grooves 286
 – machinery 780
 – metal-to-metal 789
 – monitoring 850
 – screw 849
 – test methods 782
 weighted average total strain (WATS) 455
 weld lines in product 852
 whirling 516
 Wien's law 169
 Williams-Landel-Ferry (WLF) equation 216
 wire coating 881

X

Xanthos 4

Z

zero-meter screw 551
 Ziegler-Nichols method 137