POLYMER HANDBOOK

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Physical Constants of Poly(acrylonitrile)*

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A. TABLES OF PHYSICAL CONSTANTS

TABLE 1. CRYSTALLINITY/CRYSTALLIZATION BEHAVIOR

Property	Value	Remarks	Refs.
Crystallographic data	See table	With molecular modelling calculations of PAN	1
Unit cell dimensions[a]	See also corresponding chapter of this Handbook	References are made to unit cell parameter, crystal system, density, melting point, heat of fusion	

Tacticity	Axis a (Å)	b (Å)	c (Å)	System	Refs.
Syndio	5.99	5.99	–	Hexagonal	2
Syndio	21.18	11.60	5.1	Orthorhombic	3
Syndio	10.6	11.60	5.04	Orthorhombic	4
Syndio	10.2	6.10	5.10	Orthorhombic	5
Syndio	10.55	5.8	5.08	Orthorhombic	6
Syndio	21.0	11.9	5.04	Orthorhombic	7
Syndio	10.7	12.1	5.1	Orthorhombic	8
Iso	4.74	4.74	2.55	Tetragonal	9

Property	Value	Remarks	Refs.
Crystallinity (%)	See table	Samples: gel spun PAN-fibers. The role of macromolecular entanglements is discussed	
Crystal size L_{100} (Å)	See table		10

Molecular weight $\bar{M}_w$ (g/mol)	Draw ratio (fiber)	Crystallinity (%)	Crystal size L_{100} (Å)
6×10^4	2.0–7.0	18.5–32.0	43.5–66.0
12×10^6	2.0–6.0	27.5–39.5	45.5–78.0

Property	Value	Remarks	Refs.
	See Ref.	Degree of PAN-crystallinity as a function of crystallite thickness and polymer tacticity	11

*Based on a similar table in the third edition, by W. Fester, Hoechst AG, FR Germany.

Property	Value	Remarks	Refs.
Crystallization temperature T_c[b] (°C)	95–100	Determined in propylene carbonate	12,13
	153.6	Crystallization from PAN/H_2O – melt under pressure	14
Density (g/cm^3)	1.15–1.18	Sample: flakes and films	12,16,17
	1.17–1.19	Sample: fiber	18
Orientation factor	See Ref.	Sample: stretched films X-ray diffraction studies Chain-orientation factors were measured by IR-dichroism.	15

[a]The reported unit cell dimensions, especially the c-dimension along the chain axis, can only be regarded as estimated because of the diffuse meridian and polar reflections in the X-ray diffraction studies.
[b]The dissolution and crystallization temperatures given here are obtained from a free radical poly(acrylonitrile). They are sensitive to chain irregularities in the polymer. Samples of poly(acrylonitrile) obtained from different sources show marked differences in the dissolution and crystallization temperatures, although they have similar IR-spectra, X-ray diffraction patterns and densities.

TABLE 2. ELECTRIC AND ELECTRONIC PROPERTIES

Property	Value	Remarks	Refs.
Dielectric Constant			
ε	4.2–6.5 (60–10^6 Hz)	Sample: film	19,20
ε_{RT}	5.68 ± 0.84 (293 K)	Sample: film	
ε_{He}	3.29 ± 0.17 (3.8 K)	Temperature dependence: Arrhenius type behavior	21
ε ($T > 373$ K)	See Ref.	Sample: discs from powder Variation of ε with temperature at various frequencies	22,23
Dissipation factor			
$\tan\delta = \frac{\varepsilon''}{\varepsilon'}$	0.033–0.113 (60–10^6 Hz)	Sample: film (ε'', ε' loss and storage dielectric constants)	19,20
	See Ref.	Comparison of the mechanical and dielectric values of tan δ as function of temperature (10^2 Hz)	24
tanδ ($T > 373$ K)	See Ref.	Sample: discs from powder Variation of tan δ with temperature at various frequencies	22
Piezoelectric constants			
Driver constant d_{31} (C/N)	1.5×10^{-12}		
Generator constant g_{31} (V m/N)	30.8×10^{-3}		17,25
McGinnies parameter χ	0.963		
Conductivity (S/cm)	4.8×10^{-14} (293 K)	Sample: film (sandwich)	
	8.4×10^{-12} (373 K)	Data from the current–voltage characteristics at various temperatures	26,31
Radiation induced conductivity	See Ref.	Sample: film (40 μm) sandwich	27
Dipole moments in solution	See corresponding chapter of this Handbook		
Magnetic susceptibility (e m n/g)	See Ref.	Sample: PAN-foam	28
Photoelectric properties	See Ref.	Sample: thin film (plasma-polymerized)	29
Photocurrent (A/cm^2)			
Electronic properties			
Ionization potential (eV)	8.2	Sample: thin film (plasma-polymerized)	30
Electron affinity (eV)	3.9		
Surface work function (eV)	5.8		

TABLE 3. FIBER PROPERTIES

Property	Conventional acrylic fibers (≥ 85% AN)[a] (Refs. 18, 32–36)	PAN-fiber Dralon T (100% AN) (Ref. 35)	High strength acrylic fibers[b] (Refs. 38,39)	Acrylic fibers from isotactic PAN[c] (Ref. 40)
Fiber fineness (dtex)	0.6–19.0	3.3–17.0	1.0–4.0	
Density (g/cm^3)	1.14–1.19	1.17–1.19		
Tenacity [21°C/65% RH] (cN/dtex)	1.8–4.5	3.5–6.0	10–20	8.0–20.0
Tenacity [wet/dry ratio] (%)	75–95	80–100		
Elongation ε [21°C/65% RH] (%)	30–60	25–40	7–10	
Elongation [wet/dry ratio] (%)	100–120	≈ 100		
Initial modulus [(Elongation $\varepsilon \to 0$)] (cN/dtex)	30–100	95–160	140–270	
Modulus in hot water [90°C] (cN/dtex)	1.0–5.5 (Ref. 37)			15.0–21.0
Relative knot tenacity (%)	70–90	≈ 70	4.5–6.5 (cN/dtex)	
Relative loop tenacity (%)	30–80	≈ 60		

[a]The properties of acrylic fibers manufactured by conventional processes of wet or dry spinning are dependent on spinning conditions and the monomer content in the polymer itself. Some trade names of acrylic fibers: Acrilan, Cashmilon, Courtelle, Dolan, Dralon, Euracryl, Leacryl.
[b]Polyacrylonitrile fibers with high tensile strength are prepared under special conditions: Use of polyacrylonitriles with high molecular weight ($\bar{M}_w > 5.0 \times 10^5$ g/mol), wet or dryjet/wet spinning and forming a fiber with a gel structure, afterwards stretching to high degrees (draw ratios 15–30).
[c]Fibers are made from polyacrylonitriles with highly isotactic content (mm > 0.40). They are prepared by anionic polymerization with a special catalyst.

TABLE 4. FURTHER PROPERTIES OF ACRYLIC FIBERS

Property	Value[a]	Remarks	Refs.
Elastic recovery [$(1-\varepsilon_r/\varepsilon) \times 100$] (%)		*Effects of acids and alkalis*	36,42
$\varepsilon = 2.0\%$	90–95	Good to excellent resistance to mineral acids,	
$\varepsilon = 5.0\%$	50–90	fair to good resistance to weak alkali, and	
		moderate resistance to strong cold solutions of alkali	
Torsion modulus (cN/dtex)	10–17		
Fiber shrinkage [in water, 95°C] (%)		*Effects of bleaches and solvents*	
Drawn fiber	14–22	Good resistance to strong bleaches and common solvents;	
Thermoset fiber	≈ 1.0	Unaffected by dry cleaning solvents;	
Water absorption [(21°C/65% RH)] (%)	1.0–1.5	Can be bleached with sodium chlorite	
Water retention (%)	4.0–12.0[b]	*Resistance to mildew, aging, sunlight, abrasion*	41
Glass transition temperature (°C)		Not attacked by mildew;	
Dry	85–95	Good resistance to aging, sunlight and abrasion	
Wet	50–60		
Melting/decomposition temperature (°C)	250–320		
Heat resistance in air (°C)	140		
Fire limiting oxygen index (LOI) (°C)	18		

[a] Refs. 18, 21–36. [b] Ref. 41.

TABLE 5. OPTICAL PROPERTIES

Property	Value	Remarks	Refs.
Birefringence[a]			
$\Delta_n = n_\parallel - n_\perp$	−0.005	Sample: PAN-fiber	32
	−0.0017 (skin)	Sample: PAN-fiber (kidney-shaped)	44
	−0.0047 (core)		
Refractive index			
n_d^{25}	1.158		45
$n_\parallel$	1.50–1.53	Sample: PAN-fiber	19,32,44
$n_\perp$	1.51–1.53		
	See also corresponding chapter of this Handbook		
Refractive index increments	See Ref.	Measured and calculated for different solvents	46
	See also corresponding chapter of this Handbook	($\lambda = 546$ nm)	
Polarizability			
$P_\parallel$	0.0735		
$P_\perp$	0.074		
Optical anisotropy in solution	See corresponding chapter of this Handbook		44

[a]$n_\perp$ and $n_\parallel$ are refractive indices measured with incident light having the vibration vector perpendicular and parallel to the fiber axis, respectively.

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TABLE 6. POLYMERIZATION: KINETIC AND THERMODYNAMIC DATA

Property	Value	Remarks	Ref.
Heat of polymerization (KJ/mol)	− 72.4 ± 2.2		43
Rate constants of free radical polymerization (propagation, termination and transfer constants)	See corresponding chapter of this Handbook		
Heats and entropies of polymerization	See corresponding chapter of this Handbook		
Activation energies of polymerization	See corresponding chapter of this Handbook		
Activation enthalpies and entropies of stereo-control in free radical polymerization	See corresponding chapter of this Handbook		
Stereoregularity[a]	See table		

Polymerization	$[\eta]_{DMF}$ (dl/g)	$\bar{M}_{V(DMSO)}$ (g/mol)	Triad tacticity (%)† Iso	Hetero	Syndio	Refs.
Radical	1.97−6.87		25−29	47−51	22−27	47
Anionic	2.17−2.26		30−31	43−46	23−27	47,48
Anionic		5.3×10^4	26.7	48.8	24,524	40
Anionic		0.2×10^4−5.1×10^6	47−72	21−36	10−20	49,50,51
Urea clathrate						
UV-irradiation	0.22−1.56		56−71	22−32	7−12	52
γ-irradiation (post)	0.79−3.05		69−87	10−23	3−8	48
γ-irradiation (in source)	1.81−4.96		48−65	25−36	9−16	53

† Tacticity of PAN was determined by ^{1}H-NMR, ^{2}H-NMR and ^{13}C-NMR, computing the spectra, and by decoupling techniques.

Property	Value	Remarks	Ref.
Spectral data[a]			
Nuclear magnetic resonance spectrum			
^{1}H-NMR, ^{2}H-NMR	See Refs.	Configuration of PAN	54−58
^{13}C-NMR	See Refs.	Stereoregularity of PAN	48,53,59−61
Solid-state NMR	See Refs.	Chain conformation and phase structure of PAN	62−64
Infrared spectrum	See Refs.		65−72

[a] Stereoregularity and spectral data were properly provided with separate generic terms..

TABLE 7. SOLUBILITY/SOLUTION PROPERTIES

Property	Value	Remarks	Refs.
Solvents	Dimethylformamide, dimethyl sulfoxide, dimethylacetamide, ethylene carbonate, propylene carbonate, malononitrile, succinonitrile, adiponitrile, γ-butyrolactone, conc. sulfuric and nitric acid, conc. salt solutions: LiBr, NaCNS, $ZnCl_2$;	See also corresponding chapter of this Handbook Solvents and Nonsolvents	73,74
Solubility			
Hildebrand parameter δ_2 $[J/cm^3]^{1/2}$	31.5 (exp.); ~26.0 (estim.) See also corresponding chapter of this Handbook	Estimated values from empirical formulae of Hildebrand/Scott and Askadskii	75
Dissolution of highly isotactic PAN	See Ref.	Solution temperature as function of isotacticity and molecular weight	76
Intrinsic viscosity (η)			77,78
Solvent dependence	See Ref.	Data and factors which convert [η]-values from one solvent into another	79

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Property	Value	Remarks	Ref.
Temperature dependence	See table		

Solvent	T (°C)	Huggins' coefficients	$-(\mathrm{d}\ \ln[\eta]/\mathrm{d}T)$
N,N-Dimethyl-formamide	25 35	34 33	0.14–0.19
N,N-Dimethylacetamide			0.27
Dimethyl sulfoxide			0.08
60% HNO_3			0.05
γ-Butyrolactone			0.14 0.13–0.17
Hydroxyacetonitrile acetonitrile			0.07

Property	Value	Remarks	Ref.
Viscosity–molecular weight relationship	See corresponding chapter in this Handbook	Mark–Houwink–Sakurada equation	
Dilute solution properties			
Unperturbed dimensions of linear chain molecules	See corresponding chapter in this Handbook		
Partial specific volume	See corresponding chapter in this Handbook		
Huggins and Schulz–Blaschke coefficients		See corresponding chapter in this Handbook	
Sedimentation and diffusion coefficients	See corresponding chapter in this Handbook		
Parameters of isotactic PAN	See Ref.	Effects of stereoregularity on Mark–Houwink–Sakurada equation for different solvents, further on the radius of gyration $\langle S^2\rangle$, the second virial coefficient A_2 and the conformation parameter	80
Parameters of ultrahigh molecular weight PAN	See Ref.	Dependence of molecular weight on radius of gyration $\langle S^2\rangle$, second virial coefficient A_2 and intrinsic viscosity $[\eta]$	81
Viscosity and related parameters	See Ref.	η-values, activation parameters of viscous flow, voluminosity and shape factor at different temperatures (Solvent: DMF)	82
Flexibility parameter (λ) (Theta conditions)	7.20–7.68	Solvent: DMF λ is defined by Kratky–Porod for random-coiled polymers	83
Dissolution temperature[a] (°C)	125–130	In propylene carbonate	12,13

[a] The dissolution and crystallization temperatures given here are obtained from a free radical poly(acrylonitrile). They are sensitive to chain irregularities in the polymer. Samples of poly(acrylonitrile) obtained from different sources show marked differences in the dissolution and crystallization temperatures, although they have similar IR-spectra, X-ray diffraction patterns and densities.

TABLE 8. SPECIAL SOLID STATE PROPERTIES

Property	Value	Remarks	Refs.
Gas permeability (P) $\left[\frac{\mathrm{g \times cm}}{\mathrm{cm^2 \times s \times bar}}\right]$			
O_2 (film, 25°C) (film, 25°C/65% RH)	2.15×10^{-15} $150–195 \times 10^{-15}$	Relationship between published and CGS permeability units	84,85,86
CO_2 (film, 25°C)	11.8×10^{-15}	$1\,\frac{\mathrm{g \times cm}}{\mathrm{s \times cm^2 \times bar}} = \frac{298.82}{M}\,\frac{\mathrm{cm^3(STP) \times cm}}{\mathrm{s \times cm^2 \times cmHg}}$	
H_2O (film, 25°C)	18.4×10^{-10}	Where M is the molecular weight of the penetrant gas	
Polymer surface energy δ (m N/m)	58.8 49.9/54.1	Calculated from cohesion parameters and refractometric data	87 88
Critical surface tension γ_c (dyn/cm)	See corresponding chapter of this Handbook		
Vickers microhardness H_V (kg/mm^2)	11–24	H_V is a function of load L ($L = 20–60$ g) Sample: film	89

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TABLE 9. THERMAL AND THERMODYNAMIC DATA

Property	Value	Remarks	Refs.
Heat capacity C_P Enthalpy function $H_T - H_O$ Entropy function $S_T - S_O$	See table See also corresponding chapter of this Handbook	C_P-data based on measurements in the solid state Enthalpy and entropy functions are calculated	90

T (K)	C_P (J/mol/K)	$H_T - H_O$ (J/mol)	$S_T - S_O$ (J/mol/K)
50	13.77	244.7	7.546
100	30.23	1388	22.73
150	40.44	3167	37.02
200	49.77	5410	49.87
250	58.48	8101	61.84
300	68.84	11277	73.40
350	80.83	15012	84.89
370	86.18	16681	89.53

Property	Value	Remarks	Refs.
Heat capacity C_P ($T > T_g$)	See Ref.	Calculated heat capacity data for states above the Glass transition temperature	91
Specific heat of combustion Δh_c (KJ/g)	30.6 (expt.) 31.5 (calc.)	Δh_c is related to other parameters, such as oxygen index and char residue	92
Thermal decomposition temperature[a] (°C)	250–310		33
Initial decomposition temperature (°C)	248		
Exotherm decomposition range (°C)	238–299	Data from DSC and thermogravimetry analysis	93
Heat of oligomerization ΔH (J/g)	530.9		
	See Ref.	Ranges of decomposition and activation energies for the thermal degradation in air and nitrogen	94
Thermal decomposition activation energies and products	See also corresponding chapter of this Handbook		
Glass transition temperature T_g (°C)	85–104	Various data cited in the 3/e of Polymer Handbook	95
	110	Sample: film Method: fluorescence probe technique	96
	65/105	Existence of two transition temperatures in thermomechanical analysis	97
	See Ref.	Effects of solvents and thermal treatment on T_g	97
	See Ref. See also corresponding chapter of this Handbook	Chain-length dependence of T_g	98
Melting point T_m (°C)	~320	Normally PAN decomposes before melting	99,100
T_m (H_2O) (°C)	184.7	Melting temperature in the wet state under self generated pressure	14
	See also corresponding chapter of this Handbook		
Thermal conductivity κ (mW/cm/K)	0.022 (5 K) 0.440 (20 K) 1.600 (100 K)	Sample: discs from powder	101
Coefficient of expansion (K^{-1})			
Volume (1/V) × $(dV/dT)_P$	2.8×10^{-4}–3.8×10^{-4} (above T_g) 1.4×10^{-4}–1.6×10^{-4} (below T_g)		45,102,103
Linear (1/V) × $(dV/dT)_P$	1.6×10^{-4}–2.0×10^{-4} (above T_g) 1.0×10^{-4} (below T_g)		104,105

[a]The thermal decomposition temperature determined by thermogravimetric analysis ranges from 250°C for a PAN-sample prepared with an ionic catalyst, to 310°C for a commercial fiber. Pyrolysis of poly(acrylonitrile) carried out in the absence of oxygen at 500–800°C yields HCN and low molecular weight nitriles such as monomer, dimer and methacrylonitrile leaving a residue with a condensed ring structure.

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Physical Constants of Poly(vinyl chloride)*

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Birefringence See Stress Optical Coefficient.

Branching

Branching Content (Branches per 1000 Monomer Units (C_2)) as a Function of Polymerization Temperature

T_{polym} (°C)	-CH- (CH$_2$Cl)	-CCl- (CH$_2$CH$_2$Cl)	-CCl- (CH$_2$CHClCH$_2$CH$_2$Cl)	H/Cl -C-C-C- (C)	Refs.
45	3.9	< 0.1	0.5	< 0.1	1[a]
55	4.2	0.2	0.6	0.2	1[a]
65	4.6	0.2	0.8	0.3	1[a]
80	4.9	0.3	1.3	0.3	1[a]
100	5.0	1.4	2.1	0.8	2[b]

All data from ^{13}C-NMR.
[a]Extrapolated to 0 subsaturation, reduced with Bu_3Sn as per Ref. 3.
[b]Reduced with Bu_3Sn as per Ref. 4.

Brittle to Ductile Transition Pressure (kbar) Value of 0.2 kbar, measured under tensile deformation of 10% per minute at 25°C. (5)

Coefficient of Thermal Expansion (K^{-1})

$< T_g$ before annealing, 6.6–7.3 × 10^{-5} (6)
after annealing, 6.9 × 10^{-5}
$>T_g$ 17.0–17.5 × 10^{-5}
With plasticizer. (7)

Coefficient of Friction

PVC on Steel (8)

Plasticizer[a] (%)	Static	Dynamic
25.9	0.350	0.719
31	0.495	0.787
35.5	0.645	0.857
39.4	0.797	0.925

[a]Di-2-ethylhexyl phthalate (DOP), di-iso-decyl phthalate (DIDP), *n*-octyl-*n*-decyl phthalate (DNODP). A value of 0.45–60 for unplasticized PVC with steel has been reported (9). For further data see Ref. (10).

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Compressibility (MPa^{-1}) (×10^6) (11)

Uniaxially Stretched PVC

Elongation (%)	$\gamma_{\parallel}$	$\gamma_{\perp}$
85	4.88	8.0
125	4.25	8.45
160	3.57	8.75

See also Refs. 12,13, and 36.

Creep (14,15)

Crystallinity (%)

From Density Measurements (16)

T_{polym} (°C)	Crystallinity (%)
90	11.3[a]
55–60	11.3
50	13.2
20	15.0
−15	57.3
−75	84.2

[a]Assumes amorphous density equals 1.385 g/cm^3 and crystalline density equals 1.44 g/cm^3 (19). Since the crystalline density for highly crystalline (e.g., single crystal) PVC is considerably greater than 1.44 g/cm^3; as shown in the table on crystallographic data, the above % crystallinity values for the low temperature polymerized PVCs are greatly overestimated. As pointed out by Kostyuchenko and co-workers (20), if a crystalline density of 1.497 g/cm^3 or greater is used, the calculated percent crystallinity values agree better with X-ray diffraction measurements.

Crystallinity cont'd
From X-Ray Diffraction Measurements

T_{polym} (°C)	Crystallinity[a] (%) (17)	T_{polym}	Crystallinity[b] (%) (18,40)
90 frac. 1	10.4	50	13[c]
frac. 3	5.4	−20	17
53 frac. 1	10.4	−40	20.5,20
A	6.5	−60	23,25
B	8.2		
25	12.2	polym. in propionaldehyde	33[c]
−60	23.7		
	34.7[c]	polym. in *n*-butyraldehyde	

[a] Values obtained using the X-ray diffraction method of Hermans and Weidinger (21) and a double hump amorphous curve.
[b] X-ray diffraction method with Lorentz-polarization and atomic scattering factor corrections.
[c] Using a single hump amorphous X-ray curve and the method of Hermans and Weidinger (21). Lebedev and co-workers (22) (see also Ref. 17) report several commercial PVC crystallinites in the range 20–27%. In general, their method gives higher values than that of D'Amato and Strella (17).

From IR Measurements

Crystallinity from IR measurements deemed (by the authors) to be less accurate than NMR are in references 42, 44–46 and 56.

From Calorimetric Measurements (Unfractionated Polymers) (23)

M_n	T_{polym} (°C)	Crystallinity (%)
23,200	75	18.4
38,700	65	15.5
53,500	52	15.3
66,700	52	14.4
136,000	25	11.9
155,000	25	11.8

Crystallographic Data See under Unit Cell.

Density (g/cm^3)
Function of Polymerization Temperatures (16)

T_{polym} (°C)	M_n	Density (20°C)
90	23,750	1.391
55–60	75,000	1.391
50	91,250	1.392
20	172,250	1.393
−15	106,300	1.416
−75	105,300	1.431

Dependence on Thermal History (24)

History	Density (20°C)
Original state	1.3743
Quenched from 200°C in ice water	1.3656
Quenched from 130 to −70°C	1.3716
Quenched from 130 to −70°C and kept at RT for 6.5 h	1.3743
Annealed at 65°C for 136 h	1.3745
Annealed at 90°C for 136 h and slowly cooled	1.3834
Annealed at 90°C for 136 h and quenched to −20°C	1.3817

Effect of Temperature on Density (25,38)

T (°C)	Density
20	1.392
51	1.383
82	1.368
90.6	1.362
97	1.357

Dielectric Properties (26)
Dielectric Constant (ε′)

	T (°C)								
	25	40	60	80	90	100	110	120	140
60 Hz	3.50	3.51	3.70	4.25	6.30	10.30	11.89	12.05	11.76
1 kHz	3.39	3.40	3.61	4.09	5.05	7.77	10.21	11.30	11.27
10 kHz	3.29	3.34	3.45	3.89	4.45	5.77	8.50	9.96	10.94

Dielectric Loss Factor (ε″)

	T (°C)								
	25	40	60	80	90	100	110	120	140
60 Hz	0.110	0.116	0.125	0.172	0.410	1.20	0.675	0.481	1.65
1 kHz	0.081	0.081	0.080	0.120	0.500	1.415	1.645	0.630	0.319
10 kHz	0.058	0.058	0.050	0.110	0.920	1.37	1.35	1.22	0.490

T_{polym} = 50°C; [η] = 1.17; M_n = 66,700; M_w = 162,000. See also Ref. 27.

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Dynamic Viscosity (122,134)

Elongation at Break (%) (28)

T_{polym} (°C)	Test temp. (°C)	$[\eta]^a$	Strain rate (s^{-1}) 0.0026	0.020	0.20	2.0	20	200
70	25	68	171.5	18.5	13.5	16.5	17.0	13.3
65	25	75	194.5	20.0	14.2	21.0	19.5	16.0
56	25	91.3	196.7	21.0	18.0	21.0	19.5	16.0
50	25	116.9	210.7	23.0	16.5	17.0	18.5	17.0
70	60	68		71.6	20.0	20.0	16.5	24.0
65	60	75.0		160	23.8	22.5	22.5	27.5
56	60	91.3		207	26.0	25.0	22.0	30.0
50	60	116.9		243	27.0	26.5	22.5	35.0
70	80	68			168	82	60	41
70	100	68				240	168	157

[a]Intrinsic viscosity (ml/g) in cyclohexanone, 30°C.

Enthalpy Entropy as a function of pressure and temperature. (29)

Fatigue (135,136)

First Normal Stress Difference (118,119,145)

Flory–Huggins Parameter See Polymer–Solvent Interaction Parameter.

Flow Activation Energy ΔE_y (kJ/mol) (30,31,32,33,34)

Dependence on Temperature and Molecular Weight

T_{polym} (°C)	LVN[a]	ΔE_y (kJ/mol) $10\,s^{-1}$	$100\,s^{-1}$	$1000\,s^{-1}$
5	0.131	–	150.7	134.9
5	0.693	92.1	119.7	60.2
5	0.909	165.5	103.1	54.2
5	1.750	43.4	30.5	30.4
40	0.640	178.4	102.8	54.0
40	0.682	157.4	105.2	45.0
40	1.225	108.6	57.7	34.6
70	0.495	147.7	97.0	52.4
70	0.680	126.9	84.3	43.6

[a]Limiting viscosity number in cyclohexanone, 30°C.

Dependence on Shear Rate

Shear rate (s^{-1})	>220°C	190–220°C	<190°C
0.3	95.6	363.7	152.4
3	–	244.8	145.7
30	–	159.6	121.7

Glass Transition Temperature See also corresponding chapter in this Handbook.

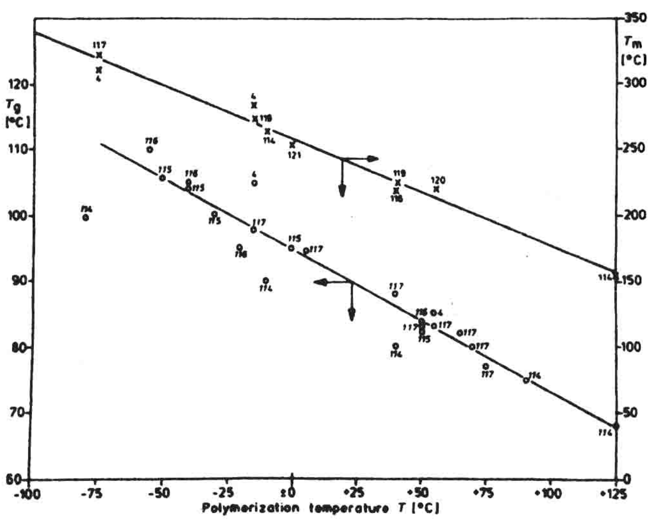
Effect of Pressure: dT_g/dP (°C/atm) 0.013 (35–38)

Effect on Molecular Weight and Polymerization Temperature (39)

T_{polym} (°C)	Intrinsic viscosity $[\eta]^a$ 50	75	100	125	150
70	78.5	82	83	83.5[b]	84.5[b]
50	80	84	85	86	86.5
40	81	85	87	88.5	89
30	84	87	89	89	90
20	85	88	90	90.5	91
5	86	91	93	94.5	95.5
−15	92	87	100	101.5	102[b]

[a]In cyclohexanone, 30°C (ml/g).
[b]Extrapolated from experimental data.

Effect of Polymerization Temperature on T_g and T_m (numbers give Refs.).



The lines through the data points represent the best least squares fit of the collective authors' data.

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***Glass Transition Temperature** cont'd*
Dependence on Polymerization Temperature (47)

T_{polym} (°C)	[η] (ml/g)[a]	T_g (°C) Initial	Final[b]
90		80	78
50	80	85	83
0	108	97	88
−20	103	100	90
−30	125	100	91
−40		101	90
−50		105	91
−60	90	107	95

[a][η] measured at 25°C in cyclohexanone.
[b]After thermal cycling to 230°C. See also Ref. 48.

Heat Capacity See corresponding table in this Handbook and Refs. 49–52.

Effect of Thermal Cycle on C_P (47)

T_{polym} (°C)	[η] (ml/g)[a]	ΔC_P ($\times 10^2$) (J/g/°C) Initial	Final[b]
90		28.9	29.3
50	80	27.2	27.6
0	108	24.3	25.1
−20	103	15.1	22.2
−30	125	10.9	20.9
−40		10.5	20.1
−50			18.0
−60	90	6.3	16.3

[a][η] measured at 25°C in cyclohexanone. [b]After heating to 140°C.

Heat of Combustion (kJ/kg) −19000. (53)

Heat of Fusion (kJ/mol)

11.3	(41)
12.65	(54)
2.76	(55)
3.28 (most probable value according to Ref. 56)	(16)
3.56	(57)
3.91	(58)

Heat of Dilution 30°C PVC-tetrahydrofuran (23)
PVC-cyclohexanone

Heat of Polymerization (kJ/mol) −96 to −109 (59–61)

Huggins Coefficient (62)

Intrinsic Viscosity – Molecular Weight Relationship See corresponding chapter in this Handbook and Refs. 63–89.

Mark–Houwink Parameters for PVC as a Function of Temperature (115)

Solvent	Temp. range (°C)	*a*	*K* (ml/g)
Cyclohexanone	20–60	0.803	$1.847 \times 10^{-2} - 4.85 \times 10^{-5}\, T$
Cyclopentanone	20–60	0.861	$9.086 \times 10^{-5} - 1.55 \times 10^{-5}\, T$
THF	20–50	0.851	$1.087 \times 10^{-2} - 1.67 \times 10^{-5}\, T$

k-values can be calculated for any temperature *T* (°C) within the temperature range given.

Melt Viscosity See Appendix 1 and Refs. 31–34,118, 119,144.

Permeability See chapter "Permeability Coefficients, Diffusion Constants, and Solubility Coefficients of Polymers" in this Handbook, and Refs. 24,92,93–99.

Diffusion Constants in PVC

Gas	$\log_{10}D$ (cm²/s)	E_D (kJ/mol)
(A) GASES, AT 25°C (92)		
He	−5.5	20.7
H_2	−6.3	34.5
Ne	−6.6	31.5
N_2	−8.4	62.0
Ar	−8.9	51.5
O_2	−7.9	54.4
CO_2	−8.6	64.5
CH_4	−8.9	70.3
H_2O	−7.6	41.8
Kr	−9.4	62.8
(B) ORGANIC VAPORS, AT 30°C, LOW ACTIVITY (90)		
n-C_4H_{10}	−13.6	
n-C_5H_{12}	−13.9	81.6
n-C_6H_{14}	−14.9	
C_6H_6	−13.7	
CH_3OH	−10.4	
C_2H_5OH	−12.4	
n-C_3H_7OH	−13.2	
n-C_4H_9OH	−13.9	
CH_3Cl	−11.3	59.9
CCl_4	−17.1	108.4
C_2H_3Cl	−11.7	71.2
$(CH_3)_2CO$	−12.8	
SF_6	−16.1	100.0

Poisson Ratio 0.38. (100)

Polymer–Solvent Interaction Parameter See corresponding chapter in this Handbook and Refs. 68,101–114.

Refractive Index PVC ($\rho = 1.384\ g/cm^3$) (14)

Wave length (nm)	Refractive index
486.1	1.54806
589.3	1.54151
656.3	1.53843

Reciprocal dispersive power V_d	59.3
Critical angle ($\lambda = 589.3$ nm)	56.23
Temperature coefficient of refractive index	0.0001142°/°C.

Specific Heat Capacity See chapter "Heat Capacity" in this Handbook, and Refs. 49,50.

Second Virial Coefficient See corresponding chapter in this Handbook and Refs. 43,77,84,116,117.

Shear Modulus (120–122,134)

Dynamic Test Results for Rigid PVC Formulation at Frequencies = 0.06–600 (rad/s) and at Temperatures 140–220°C[a]

	220°C		210°C		200°C		190°C	
ω (rad/s)	G′ (Pa)	G″ (Pa)	G′ (Pa)	G″ (Pa)	G′ (Pa)	G″ (Pa)	G′ (Pa)	G″ (Pa)
5.9749 E−2	3.669 E3	3.442 E3	1.256 E4	9.933 E3	3.205 E4	1.684 E4	6.882 E4	2.711 E4
9.4700 E−2	4.775 E3	4.472 E3	1.493 E4	1.096 E4	3.586 E4	1.827 E4	7.470 E4	2.782 E4
1.5008 E−1	6.028 E3	5.736 E3	1.813 E4	1.285 E4	4.153 E4	1.998 E4	7.971 E4	2.941 E4
2.3787 E−1	7.644 E3	7.047 E3	2.201 E4	1.468 E4	4.727 E4	2.245 E4	8.955 E4	3.137 E4
3.7700 E−1	1.012 E4	8.847 E3	2.732 E4	1.706 E4	5.594 E4	2.530 E4	1.011 E5	3.389 E4
5.9749 E−1	1.272 E4	1.096 E4	3.177 E4	1.999 E4	6.340 E4	2.771 E4	1.111 E4	3.598 E4
9.4700 E−1	1.606 E4	1.302 E4	3.859 E4	2.283 E4	7.154 E4	3.031 E4	1.238 E5	3.772 E4
1.5008 E0	1.976 E4	1.684 E4	4.488 E4	2.758 E4	7.935 E4	3.448 E4	1.304 E5	4.199 E4
2.3787 E0	2.506 E4	2.060 E4	5.404 E4	3.205 E4	9.033 E4	3.805 E4	1.440 E5	4.517 E4
3.7700 E0	3.109E4	2.477 E4	6.340 E4	3.645 E4	9.976 E4	4.147 E4	1.510 E5	4.817 E4
5.9749 E0	3.859 E4	3.031 E4	7.374 E4	4.309 E4	1.102 E5	4.859 E4	1.625 E5	5.432 E4
9.4700 E0	4.652 E4	3.645 E4	8.515 E4	4.838 E4	1.218 E5	5.204 E4	1.751 E5	5.526 E4
1.5008 E1	5.650 E4	4.001 E4	9.692 E4	5.166 E4	1.369 E5	5.391 E4	1.876 E5	5.885 E4
2.3787 E1	6.862 E4	4.549 E4	1.103 E5	5.638 E4	1.512 E5	5.885 E4	2.050 E5	6.013 E4
3.7700 E1	8.120 E4	5.219 E4	1.261 E5	6.142 E4	1.663 E5	6.413 E4	2.173 E5	6.552 E4
5.9749 E1	9.904 E4	5.885 E4	1.473 E5	6.810 E4	1.893 E5	7.108 E4	2.431 E5	7.293 E4
9.4700 E1	1.177 E5	6.552 E4	1.684 E5	7.139 E4	2.136 E5	7.618 E4	2.616 E5	7.957 E4
1.5008 E2	1.461 E5	7.293 E5	1.934 E5	7.947 E4	2.400 E5	8.587 E4	2.852 E5	8.369 E4
2.3787 E2	1.699 E5	8.475 E4	2.249 E5	9.039 E4	2.673 E5	9.435 E4	3.136 E5	9.848 E4
3.7700 E2	2.136 E5	9.848 E4	2.560 E5	1.028 E5	3.109 E5	1.073 E5	3.539 E5	1.120 E5
5.9749 E2	2.673 E5	1.189 E5	3.109 E5	1.236 E5	3.696 E5	1.444 E5	4.081 E5	1.594 E5

	178°C		170°C		160°C		140°C	
ω (rad/s)	G′ (Pa)	G″ (Pa)	G′ (Pa)	G″ (Pa)	G′ (Pa)	G″ (Pa)	G′ (Pa)	G″ (Pa)
5.9749 E−2	1.055 E5	3.137 E4	1.484 E5	3.724 E4	1.802 E5	3.971 E4	2.613 E5	4.236 E4
9.4700 E−2	1.150 E5	3.360 E4	1.625 E5	3.756 E4	1.850 E5	4.006 E4	2.658 E5	4.272 E4
1.5008 E−1	1.201 E5	3.507 E4	1.697 E5	3.821 E4	1.949 E5	4.058 E4	2.693 E5	4.291 E4
2.3787 E−1	1.352 E5	3.645 E4	1.834 E5	3.904 E4	2.124 E5	4.128 E4	2.751 E5	4.349 E4
3.7700 E−1	1.471 E5	3.821 E4	1.965 E5	4.075 E4	2.256 E5	4.291 E4	2.873 E5	4.537 E4
5.9749 E−1	1.570 E5	4.058 E4	2.078 E5	4.327 E4	2.386 E5	4.517 E4	3.000 E5	4.716 E4
9.4700 E−1	1.675 E5	4.199 E4	2.198 E5	4.365 E4	2.449 E5	4.615 E4	3.039 E5	4.903 E4
1.5008 E0	1.842 E5	4.615 E4	2.295 E5	4.817 E4	2.524 E5	5.051 E4	3.118 E5	5.283 E4
2.3787 E0	1.948 E5	4.817 E4	2.417 E5	5.029 E4	2.751 E5	5.386 E4	3.242 E5	5.621 E4
3.7700 E0	2.025 E5	5.226 E4	2.524 E5	5.456 E4	2.873 E5	5.744 E4	3.356 E5	5.940 E4
5.9749 E0	2.198 E5	5.769 E4	2.635 E5	6.021 E4	2.987 E5	6.205 E4	3.459 E5	6.357 E4
9.4700 E0	2.328 E5	5.844 E4	2.711 E5	6.506 E4	3.073 E5	6.703 E4	3.468 E5	6.829 E4
1.5008 E1	2.452 E5	6.217 E4	2.816 E5	6.523 E4	3.177 E5	6.865 E4	3.601 E5	6.939 E4
2.3787 E1	2.662 E5	6.552 E4	3.030 E5	6.987 E4	3.361 E5	7.169 E4	3.809 E5	7.293 E4
3.7700 E1	2.791 E5	7.139 E4	3.177 E5	7.452 E4	3.434 E5	7.712 E4	3.943 E5	7.959 E4
5.9749 E1	3.069 E5	7.613 E4	3.434 E5	7.947 E4	3.776 E5	8.293 E4	4.170 E5	8.587 E4
9.4700 E1	3.177 E5	8.296 E4	3.617 E5	8.585 E4	4.029 E5	9.049 E4	4.488 E5	9.354 E4
1.5008 E2	3.464 E5	8.848 E4	3.977 E5	9.039 E4	4.298 E5	9.517 E4	4.893 E5	9.899 E4
2.3787 E2	3.744 E5	1.015 E5	4.261 E5	1.028 E5	4.606 E5	1.079 E5	5.321 E5	1.111 E5
3.7700 E2	4.117 E5	1.144 E5	4.586 E5	1.199 E5	–	–	–	–
5.9749 E2	–	–	–	–	–	–	–	–

[a]Storage, G′, and Loss, G″, are in Pascal. Data from L. A. Utracki, SPE Techn. Papers **31**, 1024 (1985); J. Vinyl. Technol. **7** (4), 150 (1985). M_w of PVC tested is 90.700 (GPC in THF), LVN 30°C in 93 ml/g cyclohexanone.

Specific Refractive Index Increment See corresponding chapter in this Handbook.

Specific Volume

As a function of temperature and pressure. (29)

Spectral Data

a. Infrared absorption bands. (123)
b. Nuclear magnetic resonance (high resolution spectra). (124–126)
c. Carbon-13 magnetic resonance (chemical shift assignment) (127–129)

Stress Optical Coefficient (soc)

– 200 to + 50 – 6.5 (132,133)

The value of the SOC becomes positive at T_g, but there is some arbitrariness associated with it because above T_g the plots of birefringence change with stress and have an S shape.

Tacticity (Fraction of syndiotactic dyads)
Dependence on Polymerization Temperature[a]

T_{polym} (°C)	Tacticity[b]	Refs.
55	0.55	130
50	0.55[c]	129
25	0.57	130
0	0.60	130
– 30	0.64	130
– 50	0.66	130
– 76	0.68	130

[a]Data based on ^{13}C NMR measurements.
[b]High tacticity data may be low due to insolubility during measurement as discussed in Ref. 131.
[c]Bernoullian order.

Tensile Modulus (MPa) = (N/mm^2)

T (°C)	Value	Refs.
– 196°C	7584	137[a]
– 120°C	5171	137
– 75°C	3861	137
20°C	2964	137
30°C	3000	14[b]
40°C	2930	14
50°C	2427	14
60°C	1551	14
70°C	276	14

[a]Stress–Strain measurements at strain rate of 0.00250 s^{-1}.
[b]Measured in creep (100 s, 0.2% strain).

Thermal Conductivity (W/m/K) (138,140)

T (°C)	Thermal conductivity
– 170	0.129
– 150	0.134
– 125	0.139
– 100	0.144
– 75	0.148
– 50	0.152
– 25	0.155
0	0.158
20	0.160
30	0.161
40	0.162
50	0.163
60	0.164
70	0.164
80	0.165
90	0.165
100	0.165

Thermal conductivity of system PVC/di-2-ethylhexyl phthalte (see Ref. 139).

Molecular weight, sample polymerization temperature and syndiotactivity do not influence the thermal conductivity of polymers appreciably, except in the case where tacticity leads to crystallization.

Thermal Diffusivity (140)

T (K)	Density (g/cm^3)	Thermal diffusivity ($\times 10^{-4}$) (cm^2/s)
200	1.417	14.40
220	1.415	13.95
240	1.413	13.46
260	1.409	12.96
273	1.407	12.60
280	1.405	12.42
293	1.402	11.92
300	1.400	11.83
320	1.393	11.13
340	1.385	10.14
352	1.379	9.22
360	1.374	8.41
380	1.334	7.65
400	1.306	7.30
420	–	7.13
440	–	7.04
460	–	6.99
480	–	7.06

Unit Cell

PVC sample type	Crystal system	Space group	Unit cell parameters (Å) *a*	*b*	*c*	Monomers per unit cell	Calc. density (g/cm^3)	Refs.
Commercial, polymerized at 50–60°C	Orthorhombic	Pacm	10.6	5.40	5.10	2	1.44	19
Solution blended high molecular weight, low crystallinity commercial polymer and low molecular weight, high crystallinity polymer	Orthorhombic	Pacm	10.4	5.30	5.10	2	1.48	141
Single crystals, polymerized at −75°C	Orthorhombic		10.32[a]	5.32[a]	–	–	(1.49)[b]	142
Single crystals, low molecular weight, polymer made in *n*-butyraldehyde	Orthorhombic	Pacm	10.24	5.24	5.08	2	1.53	143

[a]Calculated from published *d*-spacings of major diffraction peaks.
[b]Calculated density assuming $c = 5.10$ (Å) and 2 monomers per unit cell.

Unperturbed Dimensions See corresponding chapter in this Handbook.

Viscosity–Molecular Weight Relationship See Intrinsic Viscosity.

Zero Shear Viscosity (34)

APPENDIX 1: APPARENT MELT VISCOSITY OF UNMODIFIED PVC[a] PREPARED AT VARIOUS POLYMERIZATION TEMPERATURES[b] (PAS) (× 10^4)

T_{polym} (°C)	L.V.N.[c] (ml/g)	Melt temp. (°C)	Shear rate (s^{-1}) 2.95	7.37	14.7	29.5	73.7	147	295	737	1470	2950
110	30.5	190	–	–	–	1.18	0.72	0.82	0.77	0.61	0.52	0.40
110	30.5	205	–	–	–	0.63	0.39	0.48	0.30	0.22	0.21	0.20
70[d]	40.1	140	1128.3	573.1	340.7	202	97.85	54.6	30.0	13.3	6.41	3.08
70	40.1	150	639.83	332.2	200.6	120.8	60.5	35.6	20.44	9.45	4.91	2.47
70	40.1	160	281.4	153.9	97.1	62.4	34.4	21.8	13.41	6.56	3.74	20.4
70	40.1	170	100.9	62.08	42.2	28.7	16.9	11.35	7.65	4.37	2.72	1.62
70	40.1	180	32.12	21.2	15.5	11.42	7.85	5.78	4.38	2.80	1.94	1.27
70	40.1	190	11.95	7.22	5.94	5.15	4.03	3.24	2.65	1.87	1.35	0.95
70	40.1	200	9.03	3.82	2.02	1.86	2.02	1.92	1.4	1.21	0.95	0.68
70	40.1	210	–	5.31	2.71	1.38	0.89	1.02	0.935	0.775	0.65	0.504
70[e]	49.5	140	2336.4	1209.8	721.6	423.5	191.6	102.1	51.11	20.2	9.29	4.24
70	49.5	150	1433.6	711.03	424.5	223.0	119.92	64.7	34.5	15.2	7.43	3.50
70	49.5	160	839.9	431.9	258.9	155.3	76.6	43.8	24.2	10.72	5.47	2.71
70	49.5	170	398.4	231.5	142.9	89.6	47.8	29.1	17.2	8.14	4.43	2.32
70	49.5	180	146.6	91.9	58.7	43.2	26.1	17.3	11.2	5.92	3.49	1.98
70	49.5	190	55.34	34.3	25.5	19.4	13.4	9.75	6.58	3.99	2.56	1.52
70	49.5	200	22.1	13.7	11.3	9.5	7.36	5.87	4.48	2.95	2.02	1.33
70	49.5	210	12.7	7.53	5.54	4.54	3.99	3.43	2.82	2.06	1.5	1.04
70	54.8	210	16.23	8.66	8.12	7.31	6.71	5.74	4.71	2.94	20.3	1.31
70	54.8	220	–	–	–	5.26	4.29	3.82	3.24	2.39	1.72	1.18
70	68	160	2464.2	1172.2	705.5	389.9	173.66	89.55	45.76	17.69	8.47	4.01
70	68	170	1196.9	599.14	359.27	218.53	113.21	64.04	34.39	14.44	7.16	3.49
70	68	180	562.8	320.5	205.9	125.6	64.7	37.7	21.8	10.3	5.52	2.92
70	68	190	244.2	144.9	100.8	69.8	40.1	25.5	15.5	7.75	4.40	2.44
70	68	200	94.2	62.1	46.6	35.0	23.7	16.6	11.0	5.94	3.55	2.07
70	68	210	48.1	29.5	23.5	19.6	14.6	11.1	8.02	4.68	2.92	1.73
70	68	220	19.4	15.5	13.2	11.7	9.34	7.51	5.71	3.62	2.51	1.57
65	75.4	180	976.7	522.7	318.4	195.6	103.5	58.7	31.26	13.3	6.87	3.46
65	75.4	190	545.1	254.7	158.9	101	53.6	31.9	19.0	9.25	5.01	2.63
65	75.4	200	271.1	128.5	85.3	59.8	36.3	23.1	14.2	7.2	4.15	2.32
65	75.4	210	95.6	56.7	43.7	33.1	22.1	15.7	10.5	5.53	3.36	2.02
65	75.4	220	52.6	33.2	25.9	21.4	14.9	10.96	7.75	4.49	2.73	1.64
65	86	180	930	448.5	273.3	198	84	45.1	23.22	9.77	4.92	2.46
65	86	190	686.2	381	243.6	148	82	48.1	25.5	11.1	5.7	2.93

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T_{polym} (°C)	L.V.N.[c] (ml/g)	Melt temp. (°C)	Shear rate (s^{-1})									
			2.95	7.37	14.7	29.5	73.7	147	295	737	1470	2950
65	86	200	229.5	138.7	100.6	67.75	38.75	34.02	13.67	6.77	3.77	2.01
65	86	210	163.9	94.96	71.05	53.3	33.1	21.4	13.5	7.23	4.37	2.47
65	86	220	–	–	–	26.25	17.13	11.8	7.88	4.22	2.56	1.56
65	91.3	180	1898.2	902.1	573.1	292.0	124.2	65.3	35.7	14.86	7.43	3.66
56	91.3	190	1139.9	584.7	373.8	250.4	113.5	60.1	31.5	13.5	6.87	3.53
56	91.3	200	857.7	350	207.1	130	74	43.3	23.4	10.2	5.45	2.85
56	91.3	210	286.9	155.0	112.0	79.2	45.7	28.5	18.7	9.08	4.81	2.54
56	91.3	220	154.9	90.8	55.9	49.5	31.3	18.5	13.1	7.21	4.27	2.37
56	91.3	230	92.7	60.5	48.7	37.7	24.6	17.0	11.1	6.0	3.98	2.48
56	91.3	240	82.3	11.9	54.7	44.6	31.0	24.1	20.1	10.0	6.367	3.611
50	116.9	180	1884	933.9	562.5	304	126.3	67.12	36.11	14.86	7.32	3.39
50	116.9	185	1452.2	730.1	464.3	284.1	126.8	66.1	34.25	14.22	7.0	3.4
50	116.9	190	1062	633.6	398	251.7	116.2	59.96	30.8	13.16	6.58	3.24
50	116.9	200	783.2	410.7	257.4	177.9	87.02	45.1	24.03	10.61	5.57	2.92
50	116.9	205	584.1	318.4	209.6	131.4	78.9	43.5	22.83	9.87	5.25	2.79
50	116.9	210	424.8	226.0	156.0	105.1	59.43	39.3	21.64	9.29	4.93	2.60
50	116.9	220	265.5	147.5	106.12	75.4	44.4	28.02	18.8	8.49	4.62	2.51
50	116.9	230	–	132.9	79.7	58.1	36.0	23.2	14.7	8.34	4.67	2.57
42	147.2	190	1878.6	897.0	537.1	276.7	113.5	58.4	31.8	13.3	6.36	3.04
42	147.2	200	1626.9	703.2	420.8	252.1	108.5	55.9	28.2	12.3	6.15	3.07
42	147.2	210	1352.7	567.6	319.7	206.3	93.3	48.9	25.3	10.7	5.52	2.77
42	147.2	220	968.4	415.3	231.5	142.5	73.5	39.9	21.2	9.19	4.93	2.85
42	147.2	230	–	299	164.5	106.2	60.2	35.2	19.0	8.44	4.55	2.48
42	147.2	240	–	243.6	199.3	157.7	89.7	53.2	33.5	–	–	–
40	122.5	190	2041.3	867.8	511.0	285.6	117.9	58.5	29.2	12.7	6.45	3.14
40	122.5	200	1162	–	323	–	80.8	41.5	21.0	9.09	–	–
40	122.5	205	445.4	244.5	170.5	111.5	64.4	36.6	19.4	8.35	4.37	2.25
40	122.5	210	–	–	–	98.4	53.5	28.7	14.76	6.28	3.28	1.72
40	122.5	215	338.8	185.6	133.4	94.0	53	35.7	20.2	8.73	4.56	2.39
28	208	190	2050.0	916.5	543.5	284.9	117.8	63.7	33.55	14.92	7.25	3.35
28	208	200	1658.7	740.6	452.3	239.6	102.8	52.2	27.4	11.94	6.07	2.87
28	208	210	1104.9	493.4	282.4	167.7	85.5	46.9	25.03	10.44	5.33	2.66
28	208	220	665.6	332.5	214.7	138.4	69.3	39.5	22.1	9.96	5.33	2.73
25	240.5	200	1513.3	647.4	387.4	223.0	94.98	49.08	26.55	11.67	5.84	2.81
25	240.5	210	1503	603	343	200	90.2	46.6	23.5	10.4	5.4	2.7
25	240.5	215	1340.7	562.5	311.5	180	80.44	41.76	21.4	9.49	5.2	2.6
25	240.5	220	1355.7	572.6	332.2	190.9	83.3	43.9	22.5	9.63	5.07	2.57
25	240.5	225	958.4	421.3	250.9	159.3	75.35	40.33	21.03	9.23	4.92	2.60
25	240.5	230	–	409.8	222.0	136.1	67.7	37.5	19.7	8.86	4.62	2.46
25	240.5	240	–	426.4	223.2	132.3	64.2	36.5	20.2	8.53	4.52	2.53

[a]Ref. original data, E. A. Collins, unpublished.
[b]Melt viscosity data obtained using a capillary having a 90° entrance angle, length 1.0 in and diameter 0.05 in. No correction applied to the data. All samples contained 2.5 parts dibutyltin dioctylthioglycolate stabilizer per 100 parts resin.
[c]Limiting viscosity number, determined in cyclohexanone 30°C.
[d]Modified with 5 parts trichloroethylene/100 parts vinyl chloride monomer.
[e]Modified with 3 parts trichloroethylene/100 parts vinyl chloride monomer.

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