Appendix I

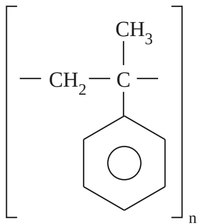
Polymer Nomenclature

The IUPAC has specific guidelines for the nomenclature of polymers. However, these names are quite frequently discarded for common names and even principal trade names. Even though there is currently no completely systematic polymer nomenclature, there are some widely accepted guidelines that are used to identify individual polymers.

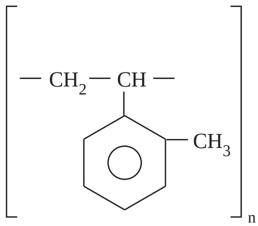
Simple vinyl polymers are named by attaching the prefix *poly* to the monomer name. For example, the polymer made from styrene becomes polystyrene. However, when the monomer name consists of more than one word or is preceded by a letter or a number, the monomer is enclosed in parenthesis with the prefix *poly.* Thus polymers derived from vinyl chloride or 4-chlorostyrene are designated poly(vinyl chloride) and poly(4-chlorostyrene), respectively. This helps to remove any possible ambiguity.

Diene polymerization may involve either or both of the double bonds. Geometric and structural isomers of butadiene, for example, are indicated by using appropriate prefixes — *cis* or *trans*; 1,2 or 1,4 — before *poly,* as in *cis*-1,2-poly(1,3-butadiene). Tacticity of the polymer may be indicated by using the prefix *i* (isotactic), *s* (syndiotactic), or *a* (atactic) before *poly,* such as *s*-polystyrene. Copolymers are identified by separating the monomers involved within parentheses by either *alt* (alternating), *b* (block), *g* (graft), or *co* (random), as in poly(styrene-*g*-butadiene).

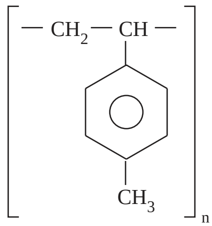
When side groups are attached to the main chain, some ambiguity could result from naming the polymers. For example, poly(methylstyrene) is an appropriate designation for any of the following structures.



(1)



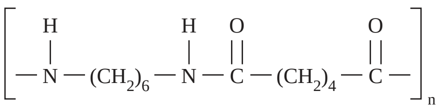
(2)



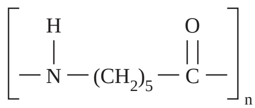
(3)

To avoid such ambiguity, these structures are designated poly(α-methylstyrene) (1), poly(*o*-methylstyrene) (2), and poly(*p*-methylstyrene) (3), respectively.

The nomenclature of step-reaction polymers is even more complicated than that of vinyl polymers and can be quite confusing. These polymers are usually named according to the source or initial monomer(s) and the type of reaction involved in the synthesis. For example, nylon 6,6 (4) is usually designated poly(hexamethylene adipamide), indicating an amidation reaction between hexamethylenediamine and adipic acid. Nylon 6 is called either poly(6-hexanoamide) or poly(ε-caprolactam). The former name indicates the structural and derivative method while the latter, which is more commonly used, is based on the source of the monomer.

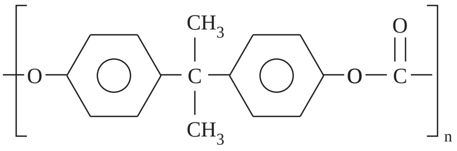


(4)



(5)

Some polymers are referred to almost exclusively by their common names instead of the more appropriate chemical names. An example is polycarbonate in place of poly(2,2-bis(4-hydroxyphenyl) propane) (6).



(6)

The following table lists the internationally accepted abbreviations for some common commercial polymers.

Name of Plastic	Abbrev.	Name of Plastic	Abbrev.
Cellulose acetate	CA	Polypropylene	PP
Chlorinated poly(vinyl chloride)	CPVC	Polystyrene	PS
Melamine–formaldehyde resins	MF	Polytetrafluoroethylene	PTFE
Poly(acrylonitrile-*co*-butadiene)	NBR	Polyurethane	PUR
Polyacrylonitrile	PAN	Poly(vinyl acetate)	PVAC
Bisphenol A polycarbonate	PC	Poly(vinyl alcohol)	PVAL
Polyethylene	PE	Poly(vinyl butyral)	PVB
Poly(ethylene terephthalate)	PETP	Poly(vinyl chloride)	PVC
Phenol–formaldehyde resins	PF	Poly(vinylidene fluoride)	PVDC
Poly(methyl methacrylate)	PMMA	Poly(vinyl pyrrolidone)	PVP
Polyoxymethylene	POM	Urea–formaldehyde resins	UF

Appendix II

Answers to selected problems

Chapter 1

1.5 (a) 1.13×10^5; (b) 1.92×10^5; (c) 1.18×10^5; (d) 2.54×10^5

Chapter 3

3.3 $\overline{M}_n = 3770$ g/mol; $\overline{M}_2 = 31{,}000$ g/mol; $\overline{M}_w/\overline{M}_n = 8.2$
3.4 $\overline{M}_n = 2.35 \times 10^5$ g/mol, $\overline{M}_w = 7.36 \times 10^5$
3.10 8.1

Chapter 4

4.2 $V_B = 32.4\%$
4.4 $\overline{X}_n = 50$
4.5 $T_m = 286.5°C$
4.6 $T_m = 194°C$
4.7 f = 0.028

Chapter 5

5.10 (a) 59.26 phr; (b) 296.30 phr

Chapter 6

6.1 (a) $\overline{M}_n = 5650$ g/gmol; (b) $\overline{X}_n = 30.45$; (c) $\overline{M}_n = 11{,}300$ g/gmol; (d) $\overline{M}_n = 7533$ g/gmol
6.2 (a) $\overline{M}_n = 6000$ g/gmol; $\overline{M}_w = 8667$ g/gmol; (b) melt viscosity will increase
6.3 (a) $\overline{M}_n = 2504$ g/gmol; (b) $\overline{M}_n = 4407$ g/gmol
6.4 (1) 2; 100; 00; (b) $\overline{X}_n = 199$; (c) $\overline{X}_n = 49$
6.5 (a) $\overline{M}_n = 9600$; (b) $\overline{M}_n = 19{,}104$; (c) 9.80×10^{-3}; (d) 2.94×10^{-6}
6.6 For n = 1 p = 0.1, $W_x = 0.98$
P = 0.9, $W_x = 0.01$
For n = 100 p = 0.1, $W_x = 8.1 \times 10^{-98}$
P = 0.9, $W_x = 2.95 \times 10^{-5}$
6.7 Nylon 6, $\overline{M}_n = 3260$
Nylon 12, $\overline{M}_n = 3240$
6.8 Fraction of monomers = 4.0×10^3

Chapter 7

7.2 (b) $R_i = 7.5 \times 10^{-11}$ mol/ml, $\overline{X}_n = 4.01 \times 10^3$; (c) 94.3%
7.3 (a) $R_p = 0.715[I]^{1/2}[M]$; (b) $R_p = 0.044$ mol/l.s.; (c) 15 ls
7.4 (a) $C_M = 0.6 \times 10^{-4}$; (b) $\overline{X}_n = 602$; (c) $\overline{X}_n = 833$; (d) V = 415; (e) G = 0.055; (f) f = 0.61
7.5 Cyclohexane $\overline{M}_n = 3.69 \times 10^5$
Carbon tetrachloride $\overline{M}_n = 2.87 \times 10^3$
7.6 Styrene [S]/[M] = 19.35
Methyl methacrylate [S]/[m] = 11.54
Vinyl Aceptate [S][M] = 0.07
7.10 (a) $\overline{M}_n = 1.04 \times 10^6$; (b) $\overline{M}_n = 2.08 \times 10^6$; (c) $\overline{M}_n = 1.49 \times 10^5$
7.11 (a) 250 mn; (b) E = 7.3 Kcal/mol

Chapter 9

9.2 $E_L = 2.88 \times 10^6$ psi

Chapter 10

10.2 $t = 11.1$ h
10.3 $t = 5.96 \times 10^{t}$ s
10.4 $[M]/[M_o] = 94.9\%$
10.5 $\Delta T = 617°C$
10.6 $(\overline{X}_n)_b/(\overline{X}_n)_s = 4.75$
10.8 Ratio of total surface area of micelles to droplets = 20×10^7
10.9 (a) $t = 0.40$ h; (b) $D = 4.44 \times 10^{-5}$ cm
10.10 $T_c = 30.1°C$
10.11 (a) $\tau = 2.53$ h; (b) flow rate = 19.73 m^3/h
10.12 (a) $p = 0.632$; (b) $L = 100$ m
10.16 Feed temperature = 50°F

Chapter 11

11.1 Power Requirement = 7–18 hp
11.3 (a) Polystyrene Q = 591/b/h; (b) Polyethylene Q = 259/b/h; (c) Nylon 6,6 Q = 329/b/h
11.4 (a) 176 hp; (b) 233 hp
11.5 (a) 1.3%; (b) 2.1%; (c) 3.6%

Chapter 12

12.1 Polymer Most Suitable Solvent
Natural Rubber Dichlorobenzene
Polyacrylonitrite Nitromethane
12.4 (a) 6.9; (b) 1.86; (c) 6.04; (d) 3.47×10^4 A°
12.6 $P_1 = 92$ mmHg
12.7 $M = 1.58 \times 10^6$
12.8 $(\overline{r^2_{of}})^{1/2} = 302$ A°
12.9 (a) 3.98×10^4 A°; (b) r = 76 A°; (c) $(\overline{r^2_{of}})^{1/2} = 750$ A°
12.11 $k = 0.561$; $\overline{M}_n = 2.22 \times 10^5$ g/mol
12.12 (a) Solution A: $\overline{M}_n = 1.89 \times 10^5$ g/mol
Solution B: $\overline{M}_n = 1.01 \times 10^5$ g/mol
(b) $\overline{M}_n = 1.14 \times 10^5$ g/mol
(c) $\overline{M}_w/\overline{M}_n = 2.16$

Chapter 13

13.1 79.78×10^4 J/m^3
13.4 7.07×10^5 N/m^2
13.5 2×10^2 N
13.6 67.55×10^6 N/m^2

Chapter 14

14.2 78.04×10^5 N/m^2
14.3 0.517
14.4 0.701
14.5 83°C
14.6 2.5×10^2 s
14.7 194°C
14.8 1.29×10^{-3}

Appendix III

Some Useful Conversion Factors

To Convert From	To	Multiply By
atmosphere (760mm Hg)	pascal (Pa)	1.013×10^5
Btu	joule (J)	1.055×10^3
calorie	joule (J)	4.187
centipoise	pascal-second (Pa·s)	1.00×10^{-3}
foot	meter (m)	3.048×10^{-1}
ft-lb_f	joule (J)	1.356
gallon (U.S. liquid)	cubic meter (m^3)	3.785×10^{-3}
horsepower	watt (W)	7.460×10^2
inch	meter (m)	2.540×10^{-2}
inch of mercury (60°F)	pascal (Pa)	3.377×10^3
inch of water (60°F)	pascal (Pa)	2.488×10^2
kilogram-force (K_{gf})	newton (N)	9.807
micron	meter (m)	1.000×10^{-6}
pound-force (lb_f)	newton (N)	4.448
$lb_f/in.^2$ (psi)	pascal (Pa)	6.895×10^3
watt-hour	joule (J)	3.600×10^3
yard	meter (m)	9.144×10^{-1}

Values of Some Useful Physical Constants

	cgs	SI
Avogadro's number, No.	6.02×10^{23} molecules/mol	6.02×10^{23} molecules/mol
Velocity of light, c	3.00×10^{10} cm/s	3.00×10^8 m/s
Boltzmann's constant, K	1.38×10^{-16} erg/K	1.38×10^{-23} J/K
Gas constant, R	8.31×10^7 erg/g mol·K (1.98 cal/mol·K)	8.31×10^3 J/kg mol·K