

**SOLUTIONS TO PROBLEMS IN POLYMER SCIENCE AND TECHNOLOGY,
3RD EDITION**

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CHAPTER 1

1-1 A polymer sample combines five different molecular-weight fractions, each of equal weight. The molecular weights of these fractions increase from 20,000 to 100,000 in increments of 20,000. Calculate \bar{M}_n , \bar{M}_w , and \bar{M}_z . Based upon these results, comment on whether this sample has a broad or narrow molecular-weight distribution compared to typical commercial polymer samples.

Solution

Fraction #	M _i (×10 ³)	W _i	N _i = W _i /M _i (×10 ⁶)
1	20	1	5.0
2	40	1	2.5
3	60	1	1.67
4	80	1	1.25
5	100	1	1.0
Σ	300	5	11.42

$$\bar{M}_n = \frac{\sum_{i=1}^5 W_i}{\sum_{i=1}^5 N_i} = \frac{5}{1.142 \times 10^{-4}} = 43,783$$

$$\bar{M}_w = \frac{\sum_{i=1}^5 W_i M_i}{\sum_{i=1}^5 W_i} = \frac{300,000}{5} = 60,000$$

$$\bar{M}_z = \frac{\sum_{i=1}^5 W_i M_i^2}{\sum_{i=1}^5 W_i M_i} = \frac{4 \times 10^8 + 16 \times 10^8 + 36 \times 10^8 + 64 \times 10^8 + 100 \times 10^8}{3 \times 10^7} = 73,333$$

$$\frac{\bar{M}_z}{\bar{M}_w} = \frac{60,000}{43,783} = 1.37 \text{ (narrow distribution)}$$

1-2 A 50-gm polymer sample was fractionated into six samples of different weights given in the table below. The viscosity-average molecular weight, \bar{M}_v , of each was determined and is included in the table. Estimate the number-average and weight-average molecular weights of the original sample. For these calculations, assume that the molecular-weight distribution of each fraction is extremely narrow and can

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