

23/03/2021

Engineering ChemistryTutorial - 1 - Polymer.

1) If a polymer sample has population as:

10 molecules of molecular mass = 5000

20 molecules of molecular mass = 7500

20 molecules of molecular mass = 10000

25 molecules of molecular mass = 15000

20 molecules of molecular mass = 20000

5 molecules of molecular mass = 25000

Calculate its number-average and weight-average molecular mass of the polymer.

Solution

M	N
molecular weight = 5000	10
molecular weight = 7500	20
molecular weight = 10000	20
molecular weight = 15000	25
molecular weight = 20000	20
molecular weight = 25000	5

∴ The number average molecular weight:

$$\bar{M}_n = \frac{\sum N_i M_i}{\sum N_i}$$

$$= \frac{10 \times 5000 + 20 \times 7500 + 20 \times 10000 + 25 \times 15000 + 20 \times 20000 + 5 \times 25000}{10 + 20 + 20 + 25 + 20 + 5}$$

$$= \frac{1.3 \times 10^6}{100} = 1.3 \times 10^4 \text{ g/mol}$$

NOW,

The weight average molecular weight,

$$\bar{M}_w = \frac{\sum N_i M_i^2}{\sum N_i M_i}$$

$$= \frac{10 \times (5000)^2 + 20 \times (7500)^2 + 20 \times (10000)^2 + 25 \times (15000)^2 + 20 \times (20000)^2 + 5 \times (25000)^2}{1.3 \times 10^6}$$

$$= \frac{20125 \times 10^6}{1.3 \times 10^6} = 1.548 \times 10^4 \text{ g/mol}$$

Thus,

$$\bar{M}_n = 1.3 \times 10^4 \text{ g/mol}$$

$$\bar{M}_w = 1.548 \times 10^4 \text{ g/mol}$$

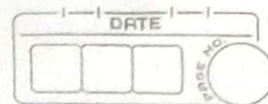
- 2) In a polymer, there are 100 molecules of molecular weight 100, 200 molecules of molecular weight 1000 and 300 molecules of molecular weight 10000. Find number average and weight average molecular mass, and PDI.

Solution. The number average molecular weight:

$$\bar{M}_n = \frac{\sum N_i M_i}{\sum N_i}$$

$$= \frac{100 \times 100 + 200 \times 1000 + 300 \times 10000}{100 + 200 + 300}$$

$$= \frac{3.21 \times 10^6}{600} = 5.35 \times 10^3 \text{ g/mol}$$



The weight average molecular weight,

$$\begin{aligned}\overline{M}_w &= \frac{\sum N_i M_i^2}{\sum N_i M_i} \\ &= \frac{100 \times (100)^2 + 200 \times (1000)^2 + 300 \times (10000)^2}{100 \times 100 + 200 \times 1000 + 300 \times 10000} \\ &= 9.4 \times 10^3 \text{ g/mol}\end{aligned}$$

\therefore The Polydispersity Index (PDI) is

$$PDI = \frac{\overline{M}_w}{\overline{M}_n} = \frac{9.4 \times 10^3}{5.35 \times 10^3} = 1.757$$

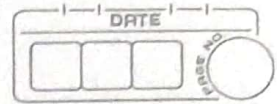
Thus,

$\begin{aligned}\overline{M}_n &= 5.35 \times 10^3 \text{ g/mol} \\ \overline{M}_w &= 9.4 \times 10^3 \text{ g/mol} \\ PDI &= 1.757\end{aligned}$

- 3) In a polymer, there are 50 molecules of molecular weight 100, 100 molecules of molecular weight 500 and 200 molecules of molecular weight 5000. Find number average and weight average molecular mass, and PDI.

Solution. The number average molecular weight:

$$\begin{aligned}\overline{M}_n &= \frac{\sum N_i M_i}{\sum N_i} \\ &= \frac{50 \times 100 + 100 \times 500 + 200 \times 5000}{50 + 100 + 200}\end{aligned}$$



$$\therefore \bar{M}_n = \frac{1.055 \times 10^6}{350} = 3014.286 \text{ g/mol}$$

\therefore The weight average molecular weight,

$$\bar{M}_w = \frac{\sum N_i M_i^2}{\sum N_i M_i}$$

$$= \frac{50 \times (100)^2 + 100 \times (500)^2 + 200 \times (5000)^2}{1.055 \times 10^6}$$

$$= 4763.507$$

$$\therefore \bar{M}_w = 4763.507 \text{ g/mol}$$

The Polydispersity index (PDI),

$$PDI = \frac{\bar{M}_w}{\bar{M}_n} = \frac{4763.507}{3014.286} = 1.58$$

Thus,

$$\bar{M}_n = 3014.286 \text{ g/mol}$$

$$\bar{M}_w = 4763.507 \text{ g/mol}$$

$$PDI = 1.58$$