

[ Numerical on  $\overline{M}_n$ ,  $\overline{M}_w$ , PDI ]

In a polymer, there are 100 molecules of molecular weight 100, 200 molecules of molecular weight 1000, and 300 molecules of molecular weight 10,000.

Find  $\overline{M}_n$ ,  $\overline{M}_w$ , PDI

Solution :

$$\textcircled{i} \quad \overline{M}_n = \frac{\sum N_i M_i}{\sum N_i} = \frac{N_1 M_1 + N_2 M_2 + N_3 M_3}{N_1 + N_2 + N_3}$$

$$\overline{M}_n = \frac{(100 \times 100) + (200 \times 1000) + (300 \times 10000)}{100 + 200 + 300}$$

$$\left[ \overline{M}_n = \frac{3.21 \times 10^6}{600} = 5.35 \times 10^3 \right]$$

$$\textcircled{ii} \quad \overline{M}_w = \frac{\sum N_i M_i^2}{\sum N_i M_i} = \frac{100 \times (100)^2 + 200 \times (1000)^2 + 300 \times (10000)^2}{(100 \times 100) + (200 \times 1000) + (300 \times 10000)}$$

$$\left[ \overline{M}_w = 9.4 \times 10^3 \right]$$

$$\textcircled{iii} \quad \text{PDI} = \frac{\overline{M}_w}{\overline{M}_n} = \frac{9.4 \times 10^3}{5.35 \times 10^3}$$

$$\left[ \text{PDI} = 1.757 \right]$$

2) A polymer mixture prepared by mixing 3 polymers A, B & C having  $\overline{m}_n, \overline{m}_w$  & weights in mixture as given below:

Polymer	$\overline{m}_n$	$\overline{m}_w$	wt. in <sup>mixture</sup> <del>mixture</del> (gm)
A	$1.2 \times 10^5$	$4.5 \times 10^5$	200
B	$5.6 \times 10^5$	$8.9 \times 10^5$	200
C	$10 \times 10^5$	$10 \times 10^5$	100

Find  $\overline{m}_n$  &  $\overline{m}_w$  of mixture.

Solution:  $(\overline{m}_n)_A = \frac{\sum W_A}{\sum N_A}$

Hence,  $\sum N_A = \frac{\sum W_A}{(\overline{m}_n)_A}$

$$(\overline{m}_n)_{\text{mix.}} = \frac{(\sum W)_{\text{mix}}}{(\sum N_i)_{\text{mix}}} = \frac{W_A + W_B + W_C}{N_A + N_B + N_C}$$

$$= \frac{W_A + W_B + W_C}{\frac{W_A}{(\overline{m}_n)_A} + \frac{W_B}{(\overline{m}_n)_B} + \frac{W_C}{(\overline{m}_n)_C}}$$

$$= \frac{200 + 200 + 100}{\frac{200}{1.2 \times 10^5} + \frac{200}{5.6 \times 10^5} + \frac{100}{10 \times 10^5}}$$

$$\left[ (\overline{m}_n)_{\text{mix}} = 2.35 \times 10^5 \right]$$

$$\bar{m}_w = \frac{\sum N_i m_i^2}{\sum N_i m_i} = \frac{\sum W_i N_i}{\sum W_i}$$

$$(\bar{m}_w)_A = \frac{\sum W_A n_A}{\sum W_A}$$

$$\therefore \sum W_A n_A = (\bar{m}_w)_A \cdot \sum W_A$$

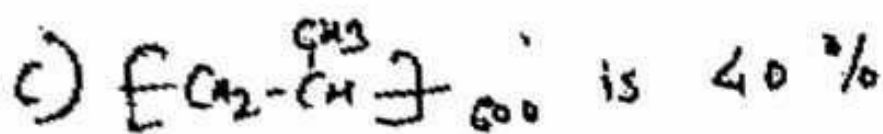
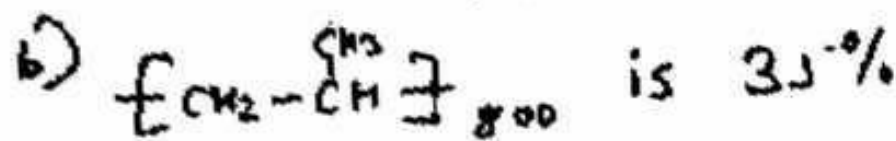
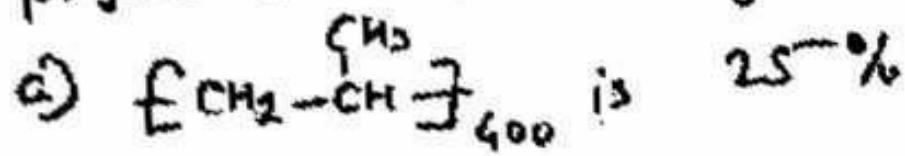
$$\therefore (\bar{m}_w)_{mix} = \frac{\sum (W_A n_A) + \sum (W_B n_B) + \sum (W_C n_C)}{\sum (W_A + W_B + W_C)}$$

$$\text{S.W.} \quad = \frac{(\bar{m}_w)_A \sum W_A + (\bar{m}_w)_B \sum W_B + (\bar{m}_w)_C \sum W_C}{200 + 200 + 100}$$

$$= \frac{(4.5 \times 10^5 \times 200) + (8.9 \times 10^5 \times 200) + (10 \times 10^5 \times 100)}{500}$$

$$\left[ (\bar{m}_w)_{mix} = 7.36 \times 10^5 \right]$$

3) Calculate  $\overline{m}_n$  &  $\overline{m}_w$  of polypropylene polymer with the following composition.



[Given, Atomic mass of C=12, H=1]

Solution: Molecular mass of (a) =  $[(12 \times 3) + (6 \times 1)] \times 400$   
 $m_1 = 16800$

Molecular mass of (b) =  $[(12 \times 3) + (6 \times 1)] \times 800$   
 $m_2 = 33600$

Molecular mass of (c) =  $[(12 \times 3) + (6 \times 1)] \times 600$   
 $m_3 = 25200$

$n_1 = 25, n_2 = 35, n_3 = 40$

Thus  $\overline{m}_n = \frac{n_1 m_1 + n_2 m_2 + n_3 m_3}{n_1 + n_2 + n_3}$

$\overline{m}_n = \frac{(25 \times 16800) + (35 \times 33600) + (40 \times 25200)}{100}$

$\overline{m}_n = 26040$

And,

$\overline{m}_w = \frac{n_1 m_1^2 + n_2 m_2^2 + n_3 m_3^2}{n_1 m_1 + n_2 m_2 + n_3 m_3}$

$\overline{m}_w = \frac{7.1966 \times 10^{10}}{2604000} = 27637$