National Chung Hsing University / Polymer Synthesis / Spring 2013
Quiz 3

Name_____

1. In a free radical polymerization, 1 mol of acrylic acid monomer CH_2=C(H)(COOH) is placed in a reactor with 0.001 mol of hydrogen peroxide. In this problem, ignore volume shrinkage during polymerization, and assume no chain transfer (no loss of radicals to anything except another monomer once a chain reaction has begun).
a. How much monomer remains at 90 % conversion?
b. If the initiator efficiency is 0.4, what is the average chain length in the reactor, including the remaining monomer? ($\overline{x_n}$)
c. After the monomer is removed (by evaporation under vacuum), what is the average chain length of PAA?
d. What is the number-average molecular weight of the PAA in part c?
(4 points)

a) $1 \times (1 - 90\%) = 0.1$ mol monomer left

b) $f = 0.4$

$\Rightarrow 0.001 \times 0.4 \times 2 = 8 \times 10^{-4}$ mol polymer chain

$\overline{X}_{n\,polymer} = 0.9 / 8 \times 10^{-4} = 1125$

$\overline{X}_{n\,total} = (0.1 \times 1 + 8 \times 10^{-4} \times 1125) / (0.1 + 8 \times 10^{-4}) = 9.92$

c) $\overline{X}_{n\,polymer} = 1125$

d) $\overline{M}_n = M_r \times \overline{X}_{n\,polymer} = 72 \times 1125 = 81000$ g/mol

2. For emulsion polymerization, please derive
$\bar{x}_n = (k_p \times N \times [M]) / (6 \times 10^{23} \times r_c)$
where k_p is homogeneous propagation rate constant for polymerization within micelle;
N is number of free radicals/liter;
[M] is equilibrium monomer concentration within micelle;
r_c is rate of free-radical caputured.
(4 points)

$$r_p = k_p [M] [P\cdot]$$

$$= k_p [M] \frac{N}{2 \times 6 \times 10^{23}}$$

$$\bar{\chi}_n = \frac{r_p}{r_c/2} = \frac{k_p \frac{N}{2 \times 6 \times 10^{23}} [M]}{r_c/2} = \frac{k_p \cdot N \cdot [M]}{6 \times 10^{23} \cdot r_c}$$

3. What's the difference between inhibitors and retarders? Please discuss from the viewpoint of conversion verse time. (2 points)