Tutorial-1

April, 2023

(Introduction to Polymer Science)

1. Write down the mechanism of polymerization of styrene with the following initiators
   (a) AIBN (b) BF_3/H_2O (c) Bu-Li
2. Based on kinetics, explain the effect of initiator concentration on rate of polymerization and degree of polymerization
3. Why molecular weight of polymers are expressed as average molecular weights. Explain the common average molecular weights used.
4. What do you understand by molecular weight distribution curve? Draw a hypothetical molecular weight distribution curve and mark the molecular weight averages on the curve.
5. In a free radical polymerization reaction what would be the effect of (a) increasing $[M]_0$ four times at constant $[I]_0$ and (b) increasing $[I]_0$ four times at constant $[M]_0$ upon
   (i) Radical concentration at steady state (ii) the rate of polymerization (iii) degree of polymerization
6. Free radical polymerization of ethylene under high pressure will lead to the formation of LDPE. Explain the mechanism.
7. Styrene was polymerized at a mass concentration of 300 gL^{-1} in toluene using AIBN as initiator at a mass concentration of 1.64 x 10^{-2} g L^{-1} and a reaction temperature of 60 °C. Calculate the initial rate of polymerization and the molar mass of the styrene formed in the initial stages of the reaction if the termination happened entirely by combination. Given that the rate constants at 60 °C are

   initiator dissociation k_d= 4.5 x 10^{-6} s^{-1} propagation k*p*= 367 L mol^{-1} s^{-1},
   termination k_t = 9.5 x 10^{6} L mol^{-1} $s^{-}1$,Initiator efficiency *f* =0.7
   Molecular weight of AIBN= 164 $gmol^{-1}$, styrene= 104 $gmol^{-1}$
8. A sample of polystyrene is composed of a series of fractions of different sized molecules:

Fraction	Weight Fraction	Molecular weight
A	0.10	12,000
B	0.19	21,000
C	0.24	35,000
D	0.18	49,000
E	0.11	73,000
F	0.08	102,000
G	0.06	122,000
H	0.04	146,000

   Calculate the number average and weight average molecular weights of this polymer sample. Draw a molecular weight distribution curve.

9. A sample of polystyrene prepared by bulk polymerization at 60 °C using radioactive (^{14}C) AIBN as initiator was found to have Mn =1000 kg mol^{-1} and a radioactivity of 6 x 10^3 counts $s^{-1}g^{-1}$.Given that the AIBN has a radioactivity of 6x10^9 counts s^{-1} mol^{-1} , determine the mode of termination which operated in the preparation of polystyrene sample.