

FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI
 SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY
 DEPARTMENT OF POLYMER AND TEXTILE ENGINEERING
 2014/2015 HARMATTAN SEMESTER EXAMINATION
 PTE 503: POLYMER CHAIN PROPERTIES AND SOLUTION
 TIME: 2½ HRS DATE: 23rd APRIL, 2015.



INSTRUCTION: ANSWER ALL QUESTIONS

1. (a) (i) Briefly explain how freezing point depression can be used to determine the molecular weight of a polymer.
 (ii) What is the major drawback associated with this method?
 (b) How can a polymer sample be fractionated using several different solution techniques?
 (c) State the major difference between fractionation by precipitation and purification by precipitation.

2. (a). State the equations for the following (i) Mark-Houwink (ii) Huggins (iii) Van't Hoff. Explain the terms appearing in the equations.
 (b). Determine the Kraemer's constant from the viscosity data obtained for polystyrene sample in xylene solution at 29°C. Flow time for solvent = 216sec

Conc (g/dl)	0.2716	0.1940	0.1569	0.1235	0.1045
Flow time, t (sec)	459.8	378.2	337.9	312.8	296.4

3. (a) Estimate the solubility parameters of the following polymers:
 (i) Poly (methyl methacrylate) with density 1.18g/cm³. (ii) Polyisobutylene with density of 0.84g/cm³. (iii) High density polyethylene with density 0.97g/cm³.
 Given that the molar attraction constants, $G \times 10^{-3} (\text{Jm}^3)^{1/2} \text{mol}^{-1/2}$ are $-\text{CH}_2- = 269.05$;
 $-\text{CH}_2- = 303.42$; $>\text{C}< = 65.53$; $>\text{C}=\text{O} = 538.02$ and $-\text{O}- = 235.25$.

- (b) Polyisobutylene has a molecular weight of 885,000g/mol and density of 0.80 g/cm³. If $(\bar{r}_0^2/M) = 800 \times 10^{-21}$, where M is the molecular weight,
 (i) What is the root-mean end-to-end distance of the molecule?
 (ii) Estimate the Flory's characteristic ratio given that the C-C bond length is 1.53Å.

4. (a) Using illustrative diagrams, explain how polymer solubility occurs.
 (b) State the general rules for polymer solubility.
 (c) A polyethylene molecule has a degree of polymerization 1500. Calculate (i) the total length of the chain. (ii) The contour length of the planar zig-zag, if the bond length and valence angle are 1.54Å and 110° respectively.
 (d) State the mathematical relationship between enthalpy of mixing and cohesive energy density, as suggested by Hildebrand and Scott, and explain all the terms involved.

5. (a) Using a schematic phase diagram, explain the lower critical solution temperature (LCST) and upper critical solution temperature (UCST).
 (b) Write short note on (i) freely jointed chain model (ii) rigid polymer chain model (iii) the long-range interactions.

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2006/2007 HARMATTAN SEMESTER EXAMINATIONS
PTE 503: POLYMER CHAIN PROPERTIES AND SOLUTION

Date: 20/06/07

TIME: 3HOURS

Instructions: attempt any five questions

Q1 (a) State the basic assumptions of the freely-jointed chain model. (b) A polyethylene molecules has a degree of polymerization of 2000. Calculate (i) the total length of the chain, and (ii) the contour length of the planar zig zag if the bond length and valence angle are 1.54\AA and 110° , respectively.

Q2 (a) State the general rules for polymer solubility. (b) Explain the observation that the rate of polymer solubility increases with short branches but decreases with longer branches. (c) Calculate the solubility parameters of (i) Low density polyethylene (LDPE) and (ii) High density polyethylene (HDPE) using the following information where applicable.

Density of LDPE = $0.92 \times 10^3 \text{ Kg m}^{-3}$

Density of HDPE = $0.95 \times 10^3 \text{ kg m}^{-3}$

M_o (HDPE) = $28 \times 10^3 \text{ kg m}^{-3}$

M_o (LDPE) = $28 \times 10^3 \text{ kg m}^{-3}$

G [$10^{-3} (\text{Jm}^3)^{1/2}$] mol⁻¹ values are:

>CH - = 175.94

-CH₂ - = 269.05

-CH₃ = 306.42

-CH = (olefin) = 248.65

Q3 (a) State the assumptions that formed the basics of Flory and Huggins theoretical calculation of entropy of mixing of a polymer with a low molecular weight solvent. (b) Give two different expressions for the entropy of mixing of a polymer with a low molecular weight solvent obtained by Flory and Huggins. (c) Give a brief account of Flory-Krigbaum theory of dilute polymer solutions.

Q4 (a) Differentiate between regular and ideal solutions, (b) Show schematically the three different types of phase diagrams of polymer-solvent system. Indicate in each diagram, the regions of unlimited polymer solubility. (c) List the methods available for assessing the thermodynamic affinity of a solvent to a polymer. Briefly describe any one of them.

Q5 (a) With a suitable sketch, explain the dependence of intrinsic viscosity on the molecular mass of dilute polymer solution. (b) If a dilute polymer solution has the following data at 27°C

Conc (g/100ml)	Times
0	59.90
0.49	100.00
1.00	150.00
1.22	198.00
2.02	255.00

Determine,

i. the intrinsic viscosity of the polymer sample, (ii) the Huggins constant (iii) if the Mark-Houwink constant, K and a are 1.0×10^{-4} and 6.9×10^{-1} respectively.

Q6 (a) Describe any absolute method that can be used to determine the number average molecular weight of a polymer sample. (b) What are the limitations of membrane Osmometry. (c) With the aid of a suitable sketch, describe the operation principle of Gel permeation chromatography.