HK

INDIAN RUBBER INSTITUTE

PGD-IRI EXAMINATION – 2016

Paper - I

Date: 22.07.2016   Time: 10.00-13.00 hrs.

Duration: 3 Hours   Full Marks : 100

Polymer Science

Answers should be illustrated with sketches wherever helpful

Total **FIVE** questions are to be answered. From **Question No. 1** is compulsory.
Answer **FOUR** from the remaining questions taking **TWO** from each group.

GROUP – A

1. Choose the correct answer from the given alternatives :

(i) Name a rubber which is prepared by cationic polymerization

(a) SBR   (b) IIR   (c) NBR   (d) PVC

(ii) EPDM is commercially prepared by

(a) Radical polymerization   (b) Ziegler-Natta polymerization

(c) Cationic polymerization   (d) Anionic polymerization

(iii) Crystallinity of a polymer is quantitatively determined by

(a) XRD   (b) TGA   (c) Dilatometry (d) Ostwald's viscometer

(iv) If BR has molecular weight ($\overline{M}_n$) of 54,000 what is its degree of polymerization ?

(a) 999   (b) 1000   (c) 10,000   (d) Difficult to calculate

(v) Name a polymer which has sulphur (S) in the backbone

(a) SBR   (b) IIR   (c) MQ   (d) Thiokol - T

(vi) Name an initiator which is used in anionic polymerization

(a) $AlCl_3$ (b) AIBN   (c) BuLi   (d) Potassium persulfate

(vii) The Carother's equation involves

(a) $1 - 1/p$ (b) $1 + 1/p$ (c) $1 / (1 - p)$ (d) $1 / (p - 1)$

(viii) Living polymers are formed by

(a) Anionic polymerization   (b) Cationic polymerization

(c) Coordination polymerization   (d) None of the above

(ix) Chain carrires in case of cationic polymerization are

(a) Carbanions   (b) Carbonium ions

(c) Hydroxy ions   (d) None of the above

[Turn Over]

(x) DOP is the most suitable plasticizer for
    (a) NR   (b) IIR   (c) NBR   (d) SBR

(xi) Cellulose is
    (a) Synthetic polymer   (b) Re-generated polymer
    (c) Natural polymer   (d) Not at all a polymer

(xii) The total area under the stress – strain curve is called
    (a) Modulus   (b) Toughness
    (c) Resilience   (d) UTS

(xiii) Solubility of a polymer in a solvent occurs when
    (a) the solubility parameters of the two closely match
    (b) the molecular weights of the two closely match
    (c) they differ widely in their cohesive energy densities
    (d) the solvation process is exothermic

(xiv) The crosslink density of cured rubber sample is determined by
    (a) Infrared spectroscopy   (b) ultra-violet spectroscopy
    (c) Swelling method   (d) NMR spectroscopy

(xv) When the glass transition temperature (T_g) of a polymer is well below the ambient temperature, it is called a
    (a) Plastic   (b) Fibre   (c) Rubber   (d) Dendrimer

(xvi) EVA is a
    (a) Homopolymer   (b) Copolymer   (c) Terpolymer   (d) Non polymeric material

(xvii) Which of the following is a branched chain polymer ?
    (a) HDPE   (b) Isotactic polypropylene   (c) LDPE   (d) Starch

(xviii) The diene monomer which is used in EPDM rubber during polymerization
    (a) Dichlropentadiene   (b) ENB
    (c) Trans 1,4–Hexadiene   (d) All the above

(xix) The most pure form of polymer is obtained from
    (a) Bulk   (b) Solution
    (c) Suspension   (d) Emulsion polymerization process

(xx) The polymeric component in ball pen ink is generally
    (a) Cellulose acetate   (b) Cellulose nitrate
    (c) Cellulose butyrate   (d) Cellulose acetate - butyrate $(1 \times 20) = 20$

2. Explain briefly why ?

   i)   Tg of PMMA (polymethyl methacrylate) is 100°C, but Tg of polymethyl acrylate is +10° C.

   ii)   Polyacrylonitrile (PAN) is a plastic, but NBR is a rubber.

   iii)   Air permeability in IIR is very poor, but in silicone rubber it is very high.

   iv)   SBR is a rubber, but SBS is a thermoplastic elastomer.

   v)   PVC is plastic, but PVC with DOP is rubber-like material.

   vi)   An unfilled natural rubber vulcanizate has a much higher value of tensile strength than a similar vulcanizate prepared from synthetic rubber.

   vii)   Low temperature flexibility of silicone rubber is much better than acrylonitrile – butadiene rubber.

   viii) Polychloroprene shows much better flame resistance property than natural rubber.

   $$(2.5 \times 8) = 20$$

3. a) What is understood by molecular weight of polymers and why is it necessary to express it in terms of an average ?

   b) Give the general expressions of any two different types of average molecular weights known to you.

   c) A polymer sample contains mixture of molecules of the same chemical type: fraction A with 540 molecules having molecular weight 1000 each and fraction B with 360 molecules having molecular weight 9000 each. Calculate the number and weight average molecular weight of the polymer sample.

   d) How does molecular weight affect the processing properties and vulcanizate properties of polymers ?

   $$(4 + 4 + 8 + 4) = 20$$

4. a) Explain the terms : Elastic, Viscous and Viscoelastic.

   b) How do the elastic and viscous components of an elastomer and a plastomer differ ?

   c) What do you mean by the term Resilience? How is it related do Hysteresis ?

   d) How does the impact strength and toughness of a polymeric material differ ? Explain why they are so called?

   $$(4 \times 5) = 20$$

Group - B

5. a) Draw a stress – strain curve of a typical polymer and indicate the following :

   i) Yield point   ii) Hookian zone   iii) Necking   iv) Breaking point

   b) Differentiate between the following pair of terms giving suitable example in each case :

   i) Inhibitor and short stop   ii) Creep and stress relaxation

   iii) Alternating and block copolymer   iv) Isotactic and syndiotactic polypropylene

   $$(4 \times 2 + 4 \times 3) = 20$$

6. a) Explain the role of emulsifier in a typical emulsion polymerization system.

   b) Write down the advantages of using an emulsion polymerization system.

   c) Why short stop is added in the manufacture of SBR by emulsion method ?

   d) What are the advantages of using redox initiator over conventional free radical initiator ?

   e) What type of catalyst is used in making solution SBR ?

   $$(6+6+ 3+3+2) = 20$$

[Turn Over]

7. a) What is meant by tacticity in polymers ? Explain, with suitable example, the terms : isotactic, syndiotactic and atactic polymer.

   b) What is a co-ordination catalyst ? Name any two co-ordination catalysts commonly used.

   c) Why stereo-regular polymers are so important?

$$(9 + 6 + 5) = 20$$

8. Write short notes on **Any Four** of the following :–

   a) Cis and trans polymers

   b) Dilatometer

   c) Strain induced crystallization

   d) Newtonian and Non-Newtonian fluid

   e) Step growth polymerization

$$(4 \times 5) = 20$$