

INDIAN RUBBER INSTITUTE
PGD-IRI EXAMINATION – 2013

Paper – I

Date : 10th August, 2013
Duration : 3 Hours

Time : 10.00 – 13.00 hrs.
Full Marks : 100

Polymer Science

Answers should be illustrated with sketches wherever helpful
Total **FIVE** questions are to be answered. **Question No. 1** is compulsory. Answer **FOUR** from the remaining questions taking **TWO** from each group.

GROUP – A

1. Multiple choice questions: select the correct answer from the given alternatives:

- (i) Rosin is a
(a) Natural resin (b) Synthetic resin (c) Regenerated resin (d) Rubber
- (ii) Polyethylene terephthalate is a
(a) Polyamide (b) Polyimide (c) Polyether (d) Polyester
- (iii) For a Hookean region stress is directly proportional to
(a) Viscosity (b) Strain rate (c) Strain (d) Modulus
- (iv) Melt flow index of a polymer is inversely proportional to
(a) Density (b) Molecular weight (c) Crystallinity (d) Tacticity
- (v) S-I-S is a
(a) Resin (b) Thermoplastic elastomer
(c) Fibre (d) Brittle plastic
- (vi) Glass transition temperature of a polymer is determined by
(a) Infrared spectrophotometer (b) Differential scanning calorimeter
(c) Mass spectrometer (d) Scanning electron microscopy
- (vii) Atactic polymers are
(a) Crystalline (b) Semi-crystalline (c) Amorphous (d) None of these
- (viii) The total area under stress-strain curve is a measure of
(a) Modulus (b) Toughness (c) Hysteresis (d) Tensile strength
- (ix) A catalyst which is used for anionic polymerization is
(a) AIBN (b) BuLi (c) AlCl₃ (d) TiCl₄
- (x) Number average molecular weight of a polymer can be determined by

- (a) Osmometry (b) Viscometry (c) Light scattering (d) Sedimentation
- (xi) Gutta percha is
(a) Cis 1,4 polyisoprene (b) Trans 1,4 polyisoprene
(c) Trans 1,2 polyisoprene (d) Ebonite
- (xii) Mercaptans are generally used in polymerizations as
(a) Initiator (b) Chain transfer agent
(c) Short stop (d) Emulsifier
- (xiii) Glass transition temperature of silicone rubber is around
(a) - 120 Deg C (b) - 160 Deg C
(c) + 120 Deg C (d) + 160 Deg C
- (xiv) Example of semi-synthetic polymer is
(a) Cellulose nitrate (b) NR (c) EPDM (d) SBR
- (xv) Resistance to indentation is related to
(a) Conductivity (b) Hardness
(c) Ductility (d) Permeability
- (xvi) "Gel Point" in Condensation polymerization is used to express
(a) End of Reaction (b) Control of Reaction Rate
(c) Start of Cross-linking (d) Start of Degradation
- (xvii) A polymer which has very low coefficient of friction
(a) PVC (b) EVA
(c) NR (d) PTFE
- (xviii) The Power law equation is related to
(a) Rheology (b) Crystallinity (c) Morphology (d) Conductivity
- (xix) CMC is generally used in the following polymerization
(a) Bulk (b) Solution
(c) Suspension (d) Emulsion
- (xx) A polymer containing C - N bond is
(a) Silicone (b) SBR (c) Nitrile (d) NR

(1 x 20) = 20

2. Explain the following statements:

- (a) Polyacrylonitrile (PAN) is a plastic, but NBR is a rubber.
- (b) NR is a self reinforcing rubber.
- (c) Silicone rubber shows excellent low temperature flexibility.
- (d) Teflon coating is used in non-sticky frying pans.
- (e) PVC is plastic, but PVC with DOP is a rubber-like material.
- (f) NR is a rubber but Gutta percha is more like a plastic.
- (g) SBR is a rubber, but SBS is a thermoplastic elastomer.
- (h) Fluorocarbon elastomers are both heat and oil resistant.
- (i) Polychloroprene shows much better flame resistance property than Natural rubber.
- (j) EPDM is useful for making automotive window seal.

(2 x 10) = 20

3. (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

4. (a) A typical polyethylene polymer has chains of following repeating units:

First chain: 450

Second chain: 550

Third chain: 500

Fourth chain: 600

Fifth chain: 400

Calculate the average degree of polymerization and number average and weight average molecular weight.

- (b) Write down the starting raw materials and the method of preparation for the following polymers (**any five**):
- i) Butyl rubber
 - ii) Nylon 66
 - iii) PET
 - iv) PVC
 - v) Synthetic polyisoprene
 - vi) Nitrile rubber.

(2+4+4+ 2x5) = 20

GROUP - B

5. Discuss the differences between

- (a) Newtonian fluid and Non-Newtonian fluid
- (b) Maxwell model and Voigt model
- (c) Stress relaxation and Creep
- (d) Pseudoplastic and dilatant material
- (e) Elasticity and viscosity

(5 x 4) = 20

6. (a) What is Poisson's ratio and shape factor?
(b) Compare the stored energy and energy loss for rubber, plastic and fibre subjected to one extension cycle (extension – followed by relaxation) in load deflection curve.
(c) Explain the significance of WLF equation.

(2x2+12+4) = 20

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) Viscosity average molecular weight
(b) Carothers' equation
(c) Suspension polymerization
(d) Strain induced crystallization
(e) Solubility parameter
(f) Ring opening polymerization

(4 x 5) = 20