

INDIAN RUBBER INSTITUTE  
PGDIRI EXAMINATION - 2011

Paper - I

Date : 29<sup>th</sup> June, 2011  
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. From "Group-A" answer FOUR questions out of which Question No. 1 is compulsory and From "Group-B" answer ONE question only.

GROUP - A

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

- (i) Shellac 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) Aramids are high performance  
(a) Polyesters (b) Polyethers (c) Polyimides (d) Polyamides
- (v) NBR is a  
(a) Random copolymer (b) Alternate copolymer  
(c) Block copolymer (d) none of the above
- (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) If PE has a molecular weight ( $M_n$ ) of 2,80,000 what is its degree of polymerization?  
(a) 100 (b) 1000 (c) 10000 (d) None of the these
- (ix) A rubber having good biocompatibility is  
(a) NR (b) SBR (c) NBR (d) PDMS

- (x) Weight average molecular weight of a polymer can be determined by  
 (a) Osmometry (b) Viscometry (c) End group analysis (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) Polymers with high molecular weight and high rate of polymerization are obtained from  
 (a) Mass polymerization (b) Solution polymerization  
 (c) Suspension polymerization (d) Emulsion polymerization
- (xiv) Which polymer has an Iodine value of 370?  
 (a) EVA (b) NR (c) EPDM (d) Thiokol
- (xv) Durometer is an instrument used for measuring  
 (a) Electrical 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 Crosslinking (d) Start of Degradation
- (xvii) A copolymer which is non oil resistant:  
 (a) Nitrile rubber (b) SBR  
 (c) Poly chloroprene (d) Poly Isoprene
- (xviii) Increase of Vinyl content of Polybutadiene leads to decrease in Glass transition temperature  
 (a) True (b) False (c) Can not be correlated  
 (d) Can be correlated only when Cis content is above 93%
- (xix) Lewis Acids can be used as catalyst for which type of Chain Polymerisation  
 (a) Cationic (b) Anionic  
 (c) Free Radical (d) None of the above
- (xx) A polymer containing C - N bond is  
 (a) Silicone (b) SBR (c) Wool (d) None of the above

(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 Guttapercha 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) 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+ 4) = 20

5. (a) A typical poly ethylene polymer is 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 6

iii) Polyester

iv) PVC

v) Synthetic polyisoprene

vi) Nitrile rubber.

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

6. Write short notes on **any four** of the following

(a) Z-average molecular weight

(b) Carothers' equation

(c) Dilatometer

(d) Strain induced crystallization

(e) Solubility parameter

(f) Spherulite

(4 x 5) = 20

4

GROUP - B

7. 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

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

(2x2+12+4) = 20