

INDIAN RUBBER INSTITUTE  
PGDIRI EXAMINATION – 2019

Date : 6<sup>th</sup> July  
Duration : 3 Hours

Paper – II

Time : 14.00 – 17.00 hrs.  
Full Marks : 100

Rubber Processing Technology and Process Engineering

Answers should be illustrated with sketches wherever helpful  
Question number 1 is compulsory. Answer **four** from the remaining questions taking **two** from each group

GROUP – A

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

- (i) Two two rolls are usually made from  
(a) Allow steel (b) Carbon steel (c) Chilled Cast Iron (d) Grey Cast Iron
- (ii) To convert  $\text{kg/cm}^2$  to Pascal (Pa), it has to be multiply by  
(a) 98066.5 (b) 9806.65 (c) 980.666 (d)  $9.8 \times 10^2$
- (iii) Crowning of calendar rolls are done to  
(a) Increase the life of the calendar rolls  
(b) To make gradient of thickness of the calendered sheet  
(c) To maintain uniform gauge of the calendered sheet  
(d) To reduce thickness of the calendered sheet
- (iv) In a pin-barrel extruder, the pins mounted in the barrel provide an effective way to  
(a) Heat the stock inside the barrel (b) Improve homogenisation of the stock radially  
(c) Increase the head pressure (d) Improve homogenisation of the stock axially
- (v) The output rate of an extruder for SBR compound is not affected by  
(a) Viscosity (b) The head pressure  
(c) False Mooney (d) The screw design
- (vi) A high value of die swell indicates:  
(a) Low viscosity (b) High viscosity (c) Low elasticity (d) High elasticity
- (vii) Rubber Process Analyzer is used to evaluate:  
(a) Non-isothermal cure kinetics (b) Post cure characteristics  
(c) Scorch safety and processibility (d) All of the above
- (viii) The PRI test is conducted for ::  
(a) Reclaim Rubber (b) De-vulcanized rubber  
(c) Green strength of SBR (d) Technically specified NR

- (ix) In a Mooney Viscometer, the shear rate generated by the Mooney rotor is,  
 (a) Less than  $10 \text{ s}^{-1}$  (c) More than  $10 \text{ s}^{-1}$   
 (b) Equal to  $10 \text{ s}^{-1}$  (d) None of these.
- (x) LASE means;  
 (a) Modulus of rubber compound (b) Loss modulus  
 (c) A cure Index (d) Modulus of N6 tyre cord
- (xi) "Crow's feet" is a phenomenon connected with  
 (a) Calendering operation (b) Spreading operation  
 (c) Extrusion (d) Continuous curing
- (xii) Torque is defined as product of  
 (a) Force and distance (b) Force and area  
 (c) Pressure and distance (d) Pressure and area
- (xiii) Peripherally drilled roll design is superior to cored roll in 4-roll calendar, because –  
 (a) The surface of the roll temperature can be quickly cooled or enhanced.  
 (b) It has quick cooling system  
 (c) T C U not required  
 (d) It consumes more water
- (xiv) Optimum cure time = OCT in Rheometer is calculated by –  
 (a) Difference between minimum & maximum torque  
 (b) Difference between minimum & maximum cure time  
 (c) 90% of maximum time  
 (d) Time required for attaining 90% of maximum torque.
- (xv) Mill Bagging is due to  
 (a) Bending of mill rolls (b) Sticking of rubber to rolls  
 (c) Sagging of rubber & lack of adhesion to rolls (d) Addition of chemicals
- (xvi) Continuous vulcanization of an extrudate sponge profile is generally done by:  
 (a) LCM cure (b) Autoclave cure (c) Microwave cure (d) HAT
- (xvii) Heat setting process is required for processing  
 (a) Cotton ply tyre cords (b) Polyester tyre cords  
 (c) Rayon tyre fabrics (d) Steel tyre cords
- (xviii) A tight nip on a mixing mill exerts  
 (a) Lower shear force (b) Higher shear force  
 (c) Lower temperature build up (d) Does not improve dispersion
- (xix) Dispersion and distribution during mixing can be achieved by  
 (a) Low shear rate (b) high shear rate  
 (c) Combination of low and high shear rate (d) High fill factor

(xx) Banbury rotors are:

- (a) Cylindrical type (b) Tangential type (c) Inter-meshing type (d) None of the above

2. (a) Explain with a neat sketch the salient features of transfer molding technique. (1 x 20) = 20

(b) Where dual tread compound are used? What type of extruder one should for use for this purpose?

(c) What are the curing techniques used for

- (i) Cable (ii) Tyre (iii) Hose (iv) V-belt

(j) Bring out advantages and disadvantages of microwave curing

3. (a) How the quality of rubber mixing is influenced by the rotor speed, ram pressure and fill Factor? Explain with the help of suitable figures/diagrams. How can the power peak be reduced in a Banbury for filler dispersion in rubber matrix? 5 + 5 + 4 + 6 = 20

(b) Describe the suitable sequence of mixing process of the following –

(i) NR compound with 50 phr of HAF carbon black

(ii) EPDM with 60 phr ISAF and 6 phr paraffinic oil.

(c) A NR master batch is mixed, in an F-270 Farrel Internal mixed of 1.20 specific gravity with 220 kg. batch weight at 50 revolutions per minute with Inlet water temperature 22°C and out let water temperature of 30°C, calculate the Fill Factor of the batch.

(10 + 5 + 5) = 20

4. (a) A calender rubber sheet is found to be thicker in the middle than the sides. Suggest the reasons for this and how this can be corrected. What do you recommend if the same compound is modified with additional 10 phr of reinforcing filler?

(b) Discuss with sketches the cooling and heating arrangement in calendar rolls for maintaining constant temperature on the roll surface.

(c) What are the three major gauge control systems adopted in Calenders for achieving uniform gauges and explain?

(d) Write down 4 major calendaring defects and explain.

(6+5+5+4) = 20

### GROUP – B

5. (a) Describe a drive systems for a simple two roll mill.

(b) How heating and cooling of the mill rolls are effectively carried out?

(c) Define die swell. How do you measure it at very low and very high shear rates.

(d) What are the common defects one encounters during the extrusion process of a rubber compound and how to rectify them?

6+4+5+4 = 20

6. (a) Name different vulcanization techniques those are used in rubber industries.

(b) What processing techniques would you follow for manufacturing of i) Conveyor belt, ii) Air Spring, iii) An isolator iv) Dock fenders v) O-ring ?

(c) What is mold shrinkage and how do you measure it?

(d) Name different methods of rubber to metal bonding.

(5+5+5+5) = 20

7. (a) Calculate the line pressure to be used in rubber compression molding using Hydraulic Pre having Ram Diameter of 30 cm for a mold with dimension 30 cm for mold with dimension 35 cm (L) x 20 cm (B) and specific pressure of 46 Kg. per sq. cm of mold area.
- (b) Explain the remedial action to overcome the problem in the rubber processing stage: (i) Porosity in a blander slug extrusion, (ii) Spot under cure in rubber mat.
- (c) Why pressure is required during vulcanization of rubber? What are the ranges of shear rates required for different molding operations such as; compression molding, transfer molding, extrusion and injection molding?

(8+4x2+4)=20

8. Write short note on (any four):
- (a) Microwave vulcanization
  - (b) Cold-feed vs Hot-feed extruders
  - (c) Rubber Process Analyzer
  - (d) Ram type vs. screw type injection molding
  - (e) Dry bonding compound
  - (f) Roto cure

(4x5)=20