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**INDIAN RUBBER INSTITUTE  
PGDIRI EXAMINATION – 2018**

Paper – II

Date : 14<sup>th</sup> July, 2018  
Duration : 3 Hours

Time : 14.00 – 17.00 hrs.  
Full Marks : 100

**Rubber Processing Technology and Process Engineering**

Answers should be illustrated with sketches wherever helpful  
Total **FIVE** questions are to be answered. **Question number 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:

- a) Most difficult part of rubber mixing is
  - i) Sulphur
  - ii) Anti-oxidants
  - iii) Fillers
  - iv) Accelerator.
- b) EPM rubber can be cured using:
  - (i) Sulphur vulcanization system,
  - (ii) Peroxide system,
  - (iii) Metal oxide based curing system
  - (iv) Diamine cure.
- c) Optimum cure temperature for NR based compound is usually
  - (i) 100 °C
  - (ii) 150 °C
  - (iii) 200 °C.
  - (iv) 120 °C
- d) In 'Frictioning' process, compared to the textile the rubber moves at:
  - (i) Faster
  - (ii) Slower
  - (iii) Equal speed
  - (iv) None of the above.
- e) Highest shear rate is associated with:
  - (i) Compression molding
  - (ii) vulcanization process
  - (iii) extrusion process
  - (iv) Injection molding.
- f) The total area under stress strain curve is called:
  - i) Impact strength
  - (ii) Toughness
  - (iii) Resilience
  - (iv) Hysteresis
- g) What is the unit of viscosity?
  - (i) Kgf
  - (ii) Pa.s
  - (iii) N.s
  - (iv) Pa
- h) Both the sides coating of a fabric can be simultaneously done by using:
  - (i) Z-type 4 roll calendar
  - (ii) Inverted 'L' type 3 roll calendar
  - (iii) L type 3 roll calendar
  - (iv) None of the above
- i) In a coloured compound the given colour is added at the end of the mixing cycle:
  - (i) To save colour
  - (ii) To avoid oxidation
  - (iii) As curing agent
  - (iv) For better uniformity of mixing of colour
- j) For a continuous process of a profile of a rubber compound it is suggested to have:
  - (i) RAM extruder
  - (ii) Screw extruder
  - (iii) Strainer
  - (iv) None of the above

- k) The purpose of T C U in an internal mixer is –
- To give hot water to the rotors
  - To give cold water to the chamber
  - To manipulate the temperature by operator to reduce the mixing time.
  - To maintain the mixing temperature for the Consistent & Quality output.
- l) For GPRs the mooney viscosity of compound is normally tested at:
- 75° C
  - 100° C
  - 175° C
  - 90° C
- m) To improve the homogenization and to eliminate porosity in extrudates is it preferred to use:
- Dual extruder
  - T-head extruder
  - Pin barred extruder
  - Triplex extruder
- n) “3T” process is required for processing:
- Cotton ply tyre cords
  - Nylon tyre cords
  - Rayon tyre fabrics
  - Steel tyre cords
- o) The “Marching Modulus” is predominantly calculated in Rheograph of:
- EPDM based compound
  - NR based Tread compound
  - Butyl based tube compound
  - SBR based PC Tread compound.
- p) In a compounded rubber if the “Sulphur” ingredient moves from bulk to the surface, then the phenomenon is called as –
- Frictioning effect
  - Blooming effect
  - Finishing effect
  - Sulphanization
- q) The complex configuration on moulded article are most likely made by:
- Compression molding
  - Injection molding
  - RIM
  - None of the above
- r)  $ML_{1+8}$  at 125° C is related to:
- SBR
  - IIR
  - NBR
  - NR
- s) Most appropriate treatment for polyester fabric for textile to rubber bonding:
- RFL alone
  - RFL followed by isocyanate
  - Isocyanate alone
  - Isocyanate followed by RFL
- t) Bull gear is associated with:
- Injection moldi
  - Extruder
  - Reaction injection mold
  - Two roll mill
- ( 1x20)=20

3. Name and sketch different arrangements of four-roll calendaring rolls assigning the feed and take off. Why do blisters form on the calendared sheets and how blisters as well as crow's feet defects can be rectified? What is the reason for 'calendar shrinkage' and how can it be controlled? What are the maximum and minimum thicknesses of rubber sheet those can be made by calendaring process (without lamination)? Name major gauge control systems adopted in Calenders for achieving uniform gauges

(8+4+4+2+2)=20

2. a) Write a neat sketch of :
- Mooney Viscometer and
  - Moving disc Rheometer (MDR)

- b) How do you apply the data of Viscometer & Rheometer during rubber processing?  
 c) Following experimental Time - Torque data is obtained from a Rheometer curve of a compound tested at 150 ° C

<u>Time in seconds</u>	<u>Torque in Kg m</u>
0	$70 \times 10^3$
45	$32.3 \times 10^3$
90	$57.6 \times 10^3$
105	$173 \times 10^3$
120	$461 \times 10^3$
135	$559 \times 10^3$
150	$588 \times 10^3$
180	$611 \times 10^3$
210	$625 \times 10^3$
300	$652 \times 10^3$
450	$669 \times 10^3$
750	$681 \times 10^3$
1200	$686 \times 10^3$

Draw the Rheograph and calculate the Maximum and minimum viscosity, cure index and O C T from the graph. (5+ 5 + 10)=20

4. With a simple sketch show different elements of an extruder screw with barrel. What is compression ratio? What are the advantages of 'pin and barrel' extruder over conventional extruders? How different are the hot-feed and cold-feed extruders? For which type of products duplex extrusion is practiced? When do you use T-head extruders? Differentiate between tangential and intermeshing rotor. How can die swell of a rubber compound be minimized with extrusion parameters? (5+2+2+2+2+2+3+2)=20

#### GROUP – B

5. What is 'self-bonding' rubber mixes? Name four major methods for rubber to metal bonding. How can a hose be cured? What are the advantages of transfer molding over compression molding? Name a product that can be vulcanized by drum-cure? How a thick-sectioned article is vulcanized? How do you prepare surface of a metal for rubber to metal? How do you treat aramid for rubber to textile bonding? (3+3+2+3+1+4+2+2)=20

6. (i) A laboratory internal mixer has maximum capacity of 3.0 liters (available volume). Determine the amount of NR (in kg) you would weigh up if one master batch is required to have following composition:

#### Master batch composition :

<u>Ingredients</u>	<u>phr</u>	<u>Density (g/cc)</u>
<del>EPDM NR</del>	100	0.95
MT black	90	2.0
Process oil	40	0.90
Minor ingredients	20	1.5 (average density)

The fill factor is specified to be 0.8 at a given rotor speed.

- (ii) A polymer of melt viscosity 10Pa-s has to be injected through a pipe with a velocity of 8500 ms<sup>-1</sup>. Calculate the diameter of the pipe if Reynold's number is 2200.

(iii) A rubber masterbatch is processed in a two roll mixing mill of length and diameter of rolls as 24" and 12", respectively. The maximum nip gap may be taken as 10mm and higher specific gravity of the compound stock can be assumed to be 1.5 and Mill constant may be taken as 1.8. The same batch is taken in an internal mixer with a fill factor of 0.9. What is the capacity of the mill?

(iv) During compounding of rubber on a two roll mill, what are the forces acting at the nip and the forces responsible for front to back roll transfer of the stock. Discuss from nip gap and roll temperature considerations. (5+4+5+6)=20

7. What is pressureless vulcanization? State its advantages and disadvantages. How do you calculate mold shrinkage of a rubber in a given mold? Bring out advantages and disadvantages of microwave curing. Compare transfer and compression molding. Explain with a sketch for continuous vulcanization of EPDM based extrudate profiles. (1+3+4+4+3+5)=20

8. Write short notes. Answer any FOUR of the following –

- a) Spreading operation
- b) Rapid Plastometer
- c) Injection molding
- d) Power integrated mixing vs. temperature based mixing in Internal mixer
- e) Steam vulcanization of rubber articles
- f) Upside down mixing

(5x4)=20