

**INDIAN RUBBER INSTITUTE  
PGDIRI EXAMINATION – 2011**

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Paper - II

Date : 29<sup>th</sup> June, 2011  
Duration : 3 Hours

Time : 14.00 – 17.00 hrs.  
Full Marks : 100

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**Rubber Processing Technology and Process Engineering**

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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**

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

- (i) If the saturated steam pressure in the system is 54 lbs/Sq. in, then the temperature shall be
  - (a) 145<sup>0</sup> C
  - (b) 150<sup>0</sup> C
  - (c) 155<sup>0</sup> C
  - (d) 160<sup>0</sup> C
- (ii) To convert Kgf/cm<sup>2</sup> to Pascals (Pa) multiply by
  - (a) 2.488 × 10<sup>2</sup>
  - (b) 3.376 × 10<sup>3</sup>
  - (c) 9.806 × 10<sup>4</sup>
  - (d) 1.013 × 10<sup>5</sup>
- (iii) Cambering of calendar rolls are done to
  - (a) Increase the life of the calendar rolls
  - (b) To bring smoothness on the surface 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 in the barrel
  - (c) Increase the head pressure
  - (d) None of the above
- (v) The output rate of an extruder is not affected by
  - (a) Mooney sorchtime and Mooney viscosity
  - (b) The head pressure
  - (c) The resilience and tensile strength of the compound
  - (d) The screw design
- (vi) The deflection of calender rolls during processing is mainly caused by
  - (a) Too much tension on the fabric being processed
  - (b) The excessive amount of feed material on the calendar
  - (c) The force required in the nip to flatten the feed material.
  - (d) The high speed of taking way the calendered materials.

- (vii) When a three roll calender is used for frictioning, the surface speed of the bottom roll is usually
- (a) Equal to the middle roll
  - (b) Slower than the middle roll
  - (c) Faster than the middle roll
  - (d) None of the above
- (viii) Hard rubber or ebonite is formed when rubber is vulcanized with sulphur in varying proportions (in phr) from
- |               |         |             |             |
|---------------|---------|-------------|-------------|
| (a) 0.5 – 2.5 | (b) 3-5 | (c) 10 – 20 | (d) 30 – 40 |
|---------------|---------|-------------|-------------|
- (ix) In a Mooney Visco meter, the shear rate generated by the Mooney rotor is,
- (a) Less than  $10\text{ s}^{-1}$
  - (b) More than  $10\text{ s}^{-1}$
  - (c) Equal to  $10\text{ s}^{-1}$
  - (d) None of these.
- (x) Mooney Viscometer is the most effective test for predicting the behaviour of rubber compounds during;
- |                          |                                 |
|--------------------------|---------------------------------|
| (a) Casting              | (b) Reaction injection moulding |
| (c) Compression moulding | (d) Injection moulding          |
- (xi) In a banbury mixing if large volume of Liquid softners and large volume of Carbon black fillers are to mixed in EPDM rubber it is suggested to have –
- |                                     |                                   |
|-------------------------------------|-----------------------------------|
| (a) Single stage / low speed mixing | (b) Two stage / high speed mixing |
| (c) Upside down mixing              | (d) Dough mixing.                 |
- (xii) In the recent past a two roll calendar combination with extruder feeding is used for Rubber profiles. This equipment is known as –
- (a) Vacuum – vented extruder
  - (b) Invented “L” calendar
  - (c) Roller – die – extruder
  - (d) Cross head extruder.
- (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) High temperature & shorter curing time is preferred for –
- (a) Thicker moulded articles
  - (b) Thin rubber moulded goods
  - (c) Commonly for all NR products
  - (d) None of the above.

(xvi) To improve the homogenization and to eliminate porosity in extrudates is it preferred to use –

- |  |   |
|--|---|
| (a) Dual extruder<br>(c) Pin barred extruder | (b) T-head extruder<br>(d) Triplex extruder |
|--|---|

(xvii) "3T" process is required for processing –

- |   |  |
|---|--|
| (a) Cotton ply tyre cords<br>(c) Rayon tyre fabrics | (b) Nylon tyre cords<br>(d) Steel tyre cords |
|---|--|

(xviii) PCI means –

- (a) Pre compressed Inhibitor
- (b) Post-cure-inflation
- (c) Proper Curing Index
- (d) Pre-cost index

(xix) The "Marching Modulus" is predominantly calculated in Rheograph of –

- (a) EPDM based compound
- (b) Butyl based tube compound
- (c) NR based Tread compound
- (d) SBR based PC Tread compound.

(xx) ML 1 + 8 at 125°C is related to –

- a) SBR
- b) IIR
- c) NBR
- d) NR

**(1 x 20) = 20**

2. (a) In rubber compounding, sequence of addition of additives to rubber play a significant role in achieving homogeneous dispersion. Discuss the normal sequence of addition of ingredients to rubber with reference to NR, NBR and EPDM rubber compounding. Compare this sequence with two – stage mixing adapted in these rubbers during compounding. Figure out the advantages and disadvantages of each sequences.  
(b) Calculate the batch weight of a two roll mixing mill of length and diameter of rolls as 60" and 20" respectively. The maximum nip gap may be taken as 10 mm and the higher specific gravity of the compounded stock assumed to be 1.2 Mill constant may be taken as 2.  
(c) Prove scientifically that all the functions of a mixing mill is carried out in an internal mixer (Banbury) more effectively and efficiently. Explain on the basis of machine and processing parameter and provide sketches wherever necessary.

**(4 x 2) + 4 + (4 x 2) = 20**

3. (a) Compare the mixing of "Master batch process" of a rubber compound –

- (b) Describe the suitable mixing process of the following –  
(i) NR compound with 50 phr of HAF carbon black  
(ii) EPDM compound with 200 phr of GPF carbon and 150 phr of Paraffinic Oil.  
(c) A NR master batch is mixed, in a F-270 Farrel Internal mixed of 1.10 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) List out with neat sketches the different configuration of Calenders on the basis of its shape.  
 (b) Describe the process flow chart of "Z" type 4-roll calendar from L/O to W/up.  
 (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.  $(5+5+5+5) = 20$
5. (a) Sketch the design of the extruder screws for hot feed, cold feed and pin barrel extruders and label the different design parameters at different zones. State the forces responsible for transverse and longitudinal flow in the barrel.  
 (b) Define die swell. State the reasons for this and the methods to check it.  
 (c) What are the common defects one encounters during the extrusion process of a rubber compound and how to rectify them?  $(6+2+4)+4+4 = 20$
6. (a) What are the different safety measures one has to adapt while working on a mixing mill, with respect to; (a) machine safety (b) compound safety and (c) human safety. Explain with sketches wherever necessary.  
 (b) Discuss the drive system adapted in an open mixing mill for driving the rolls at a speed of approx 18 rpm for the front roll and around 21 rpm for the back roll for mill of size 6"×13" connected to a 7.5 HP motor. Explain with sketches.  
 (c) 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.  $(8+6+6) = 20$
7. (a) Discuss and differentiate between different heating systems adopted in the rubber industry for moulding or processing in an extruder or in calenders? Compare the cost.  
 (b) What is the principle of microwave heating? With neat diagrams show how a rubber compound is vulcanized continuously when passed through a microwave oven? What precautions one has to adopt? What is the frequency of the microwave commercially used? How EPDM rubber compounds gets vulcanized by microwave heating?  
 (c) Why pressure is required during vulcanization of rubber? What are the ranges of pressure required for different molding operations such as; compression moulding, transfer moulding and injection moulding.  $(8+8+4)=20$
8. Write short note on (any four):  
 (a) LCM of vulcanization for rubber extrudates  
 (b) Criteria for Mould design  
 (c) Oscillating Disc Rheometer  
 (d) Steam vulcanization of rubber articles  
 (e) Spreading operation  
 (f) Roller-die head extruder  $(4x5)=20$