INDIAN RUBBER INSTITUTE
PGDIRI EXAMINATION – 2022

Paper – II

Date : 25.03.2023
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.
Question number 1 is compulsory. Answer **any two** questions from **question no 2 to question no 4** and **any two** from **question no 5 to question no 8**.
GROUP – A

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

(i) 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 exceeds the bending moment of rolls.
   (d) The high speed of taking way the calendered materials.

(ii) The complex configuration on molded articles are most likely made by following molding techniques:
   (a) Compression   (b) Blow   (c) Injection   (d) Transfer

(iii) Mooney Viscometer is the most effective test for predicting the behavior rubber compounds during;
   (a) Casting   (b) Reaction injection molding
   (c) Compression molding   (d) Injection molding

(iv) In a Banbury mixing if large volume of liquid softeners 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.

(v) Continuous vulcanization of an extrudate sponge profile is generally done by:
   (a) LCM cure (b) Autoclave cure (c) Microwave cure   (d) Rotocure

(vi) In 'Frictioning' process, compared to the textile the rubber moves at:
   (a) Faster   (b) Slower   (c) Equal speed   (d) None of the above.

(vii) The total area under stress strain curve is called:
   (a) Impact strength   (b) Toughness   (c) Resilience   (d) Hysteresis

(viii) In a colored compound the given color is added at the end of the mixing cycle:
   (a) To save color   (b) As curing agent
   (c) To avoid oxidation   (d) For better uniformity of mixing of color

(ix) "3T" process is required for processing:
   (a) Cotton ply tyre cords (b) Nylon tyre cords
   (c) Rayon tyre fabrics   (d) Steel tyre cords

(x) The purpose of T C U in an internal mixer is –
    (a) To give hot water to the rotors
    (b) To give cold water to the chamber
    (c) To manipulate the temperature by operator to reduce the mixing time.
    (d) To maintain the mixing temperature for the Consistent & Quality output

(xi) 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.

(xii) ML(1 + 8) @ 125 ° C is related to:
    (a) SBR   (b) IIR   (c) NBR   (d) NR

(xiii) Most appropriate treatment for polyester fabric for textile to rubber bonding:
    (a) RFL alone   (b) RFL followed by isocyanate
    (c) Isocyanate alone   (d) Isocyanate followed by RFL

(xiv) To convert kg/cm^2 to Pascal (Pa), it has to be multiply by
    (a) 98066.5   (b) 9806.65   c) 980.666   (d) 9.8×10^2

(xv) 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

(xvi) 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

(xvii) The PRI test is conducted for :
    (a) Reclaim Rubber   (b) De-vulcanized rubber
    (c) Green strength of SBR   (d) Technically specified NR

(xviii) In a Mooney Viscometer, the shear rate generated by the Mooney rotor is,
    (a) Less than $10\ s^{-1}$ (c) More than $10\ s^{-1}$ (b) Equal to $10\ s^{-1}$ (d) None of these.

(xix) 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

(xx) Banbury rotors are:
    (a) Cylindrical type (b) Tangential type (c) Inter-meshing type (d) None of the above
                                                    (1 x 20) = 20

Q 2. 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 feel 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

Q 3.

(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) Write down 4 major calendaring defects and explain.

(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.

$$(4 \times 2) + 4 + (4 \times 2) = 20$$

Q 4.

(a) How the quality of rubber mixing is influenced by the rotor speed, ram pressure, temperature 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?

(b) Describe the suitable sequence of mixing process of the following –
  a. NBR compound with 50 phr of HAF carbon black and sulphur.
  b. 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.

$$(11 + 4 + 5) = 20$$

GROUP – B

Q 5.

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

(b) What curing technique will be employed for curing i) Conveyor belt, ii) Tyre, iii) An isolator iv) continuous cure of cables, v) Hose vi) Air spring vii) O-ring viii) Dock Fender?

(c) A polymer of melt viscosity 10Pa-s has to be injected through a pipe with a velocity of 8500 ms^{-1}. Calculate the diameter of the pipe if Reynold's number is 2200.

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

$$(6+4+6+4) = 20$$

Q 6.

(a) A rubber master-batch 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 1.2 and Mill constant may be taken as 1.5. The same batch is taken in an internal mixer with a fill factor of 0.8. What is the capacity of the mill?

(b) Write short note on (any three):
  i. Dry bonding compound.
  ii. Upside down mixing.
  iii. Power integrated mixing vs. temperature based mixing in Internal mixer.
  iv. Non-isothermal curing.

$$(8+(4x3))=20$$

Q 7.

    (a) A laboratory internal mixer has maximum capacity of 5.0 liters (available volume). Determine the amount of NR (in kg) you would weigh up if one master batch is required to have following composition:

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Master batch composition :

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

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

    (b) Compare Cold-feed vs Hot-feed extruders.

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

    (d) 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.

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(6+4+4+6)=20

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Q 8. Write short notes on **any four** of the following:

    (a) Microwave vulcanization

    (b) ODR vs MDR

    (c) Bias Truck Tyre curing Process

    (d) Injection moulding of rubber

    (e) Spreading Process

    (f) Dip Solution for N6 Tyre Cord

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(5 x 4) = 20

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