INDIAN RUBBER INSTITUTE
PGD-IRI EXAMINATION – 2017

Paper - II

Date : 19.08.2017   Time : 14.00-17.00 hrs.

Duration : 3 Hours   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

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°C   (b) 150°C   (c) 155°C   (d) 160°C

(ii) To convert psi to Pascals (Pa), it has to be multiply by

    (a) 2.488×10^2 (b) 6.894×10^3 (c) 9.806×10^3 (d) 1.013×10^5

(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 scorchtime 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) Rubber Process Analyzer is used to evaluate:

    (a) Non-isothermal cure behavior   (b) Post cure characteristics

    (c) Scorch safety and processibility   (d) All of the above

[TURN OVER]

(viii) The complex configuration on molded articles are most likely made by following molding techniques:

(a) Compression   (b) Blow   (c) Injection   (d) Transfer

(ix) 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.

(x) Mooney Viscometer is the most effective test for predicting the behaviour 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) Continuous vulcanization of an extrudate sponge profile is generally done by:

(a) LCM cure   (b) Autoclave cure   (c) Microwave cure   (d) Rotocure

(xvii) Heat setting process is required for processing

(a) Cotton ply tyre cords   (b) Nylon tyre cords

(c) Rayon tyre fabrics   (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) RFL dipping process is required for processing:
    (a) Cotton tyre cords   (b) Aramid 6 tyre cords
    (c) Nylon 6 tyre cords   (d) Steel tyre cords

$$(1 \times 20) = 20$$

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 1.5 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.

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

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?

(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 degree C and out let water temperature of 30 degree 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.

$$(5+5+5+5) = 20$$

GROUP – B

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) 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 ?

(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) 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 shear rates 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) Microwave vulcanization

(b) Injection molding

(c) Rubber Process Analyzer

(d) Cross head extrusion

(e) Dry bonding compound

(f) Roller-die head extruder

$$(4 \times 5)=20$$