INDIAN RUBBER INSTITUTE
PGDIRI EXAMINATION – 2023

Paper – II

Date : 9th March, 2024 **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 **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) In a master batch compound if the specific gravity is lower than the specification that means.....
(a) Less sulphur added (b) Less oil added (c) Less carbon black added (d) None

(ii) To improve the homogenization and to eliminate porosity in extrudates it is preferred to use.....
(a) Dual Extruder (b) T-head extruder (c) Pin barrel extruder (d) Triplex extruder

(iii) PCI means ..... (a) Pre compressed inhibitor (b) Post cure inflation
(c) Proper cue index (d) Pre cost index

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

(v) 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

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

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

(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) Scorching of rubber compounds is mainly caused by.....
(a) Excessive oil dosage (b) Slow curing accelerators
(c) Excessive processing temperature (d) improper black dispersion

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

(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) In a compression moulding, ... process needs to be done to remove entrapped air of a rubber product.
(a) Frictioning (b) Pickling (c) shaping (d) Bumping

(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) Butyl rubber is generally compounded & mixed at higher temperature than NR due to its relatively.....
(a) Low level of unsaturation (b) High unsaturation
(c) Low Mooney Viscosity (d) None of these

(1 x 20) = 20

Q2. (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

Q3. (a) What are different types of cure curves obtained from Rheometric study? Explain with sketch.
(b) Sketch and explain a Mooney curve.
(c) What is 60 ML_{1+4} @100°C?
(d) Give reason why Butyl Rubbers are Tested at 1+4 @ 120 °C

6 +6+6+ 2 = 20

Q4. (a) Explain Mater batch process with an example. Explain the advantages of making master batches. (b) Explain (i) Nip size (ii) Friction ratio (iii) Roll temperature affect the mixing of natural rubber compound. (c) Write a neat sketch of section view of typical hot feed extruder and label the main parts. (d) Write the objectives of "Dual Tread" in truck tread compound and basic difference in compound formulation in dual tread compound. (e) What is die swell? Explain briefly which affect die swell.

4 x 5 =20

GROUP – B

Q5. 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

Q6. (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) Calculate the batch weight of 2 Roll Mixing Mill of length and diameter as 24 & 12" respectively. The maximum nip gap is 10 mm and the higher specific gravity of compound is assumed to be 1.5 and mill constant may be taken as 1.8 . The same batch is taken an internal mixer with fill factor 0.9. what is the capacity of the mixer?

6+4+10 = 20

Q7. (a) Following carbon black filled NR compound is mixed in Banbury mixer of 270 Ltr capacity. Calculate (i) density in gm/cc, (ii) Fill Factor, (iii) %age of bulk Vol to the Chamber volume, (iv) % reduction of Bulk Vol. after mixing.

Ingredients	Kg	Bulk Volume (L)	Volume after mixing (L)
NR	100	103	103.00
N330	50	150	30.00
Ar. Oil	10	11	11.00
ZnO	5	12	1.00
St. Acid	3	4	1.5
6 PPD	2	3	1.0

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

(c) Sketch and explain various roll arrangements of calendar. Sketch and illustrate a typical 4-roll calendar process for coating both sides of a textile nylon fabric.

10+4+5=20

8. Write short note on **(any four)**:

(a) Spreading operation (b) Microwave vulcanization

(c) Reaction injection molding (d) Dry bonding compound

(e) Cold-feed vs Hot-feet extruders (f) Upside down mixing

4 x 5=20